



# Annual Report 2021-2022



**Sree Chitra Tirunal Institute for Medical Sciences and Technology**

Thiruvananthapuram, Kerala, India 695011



**SREE CHITRA TIRUNAL INSTITUTE FOR  
MEDICAL SCIENCES AND TECHNOLOGY**

TRIVANDRUM - 695 011, KERALA



**ANNUAL REPORT**

2021-22



**Annual Report 2021-22**

Sree Chitra Tirunal Institute for Medical Sciences and Technology  
Trivandrum

**Editorial Team**

Dr Kesavadas C  
Dr Deepti A N  
Dr Manoj Komath  
Dr Srinivasan K  
Dr Sanjay G  
Dr Anugya Bhatt  
Mrs Sandhya C G  
Dr Jeemon P  
Dr Divya K P  
Dr Neethu Mohan  
Dr Shiny Velayudhan  
Smt Beena P Nair  
Mr Venkita Subramania Iyer N  
Mr Lijikumar G

**Technical support**

Research and Publications Cell  
SCTIMST

**Cover and Graphics**

Dr Manoj Komath

**Photography**

Medical Illustration  
SCTIMST

**Design and Printing**

Vision Grafix, Trivandrum  
Phone: 0471-2340914  
Mobile: 9072340914

# CONTENTS

---

History.....	05
Our Mission, Our Vision.....	07
Message from the President .....	09
2021-22: Looking Back .....	13
Highlights of the Year .....	16
Hospital Wing .....	33
Biomedical Technology Wing .....	101
Achutha Menon Centre for Health Science Studies ...	163
Division of Academic Affairs.....	169
Publications.....	180
Research Projects.....	213
Statutory Committees .....	232
Statement of Accounts .....	245





## ..... History .....

The origins of the Institute date back to 1973 when the Royal Family of Travancore gifted a multi-storey building, for the people of the region, and the Government of Kerala resolved to develop the gift as the Sree Chitra Tirunal Medical Centre for medical specialties. Sri P N Haksar, the then Deputy Chairman of the Planning Commission, inaugurated the Sree Chitra Tirunal Medical Centre in 1976, and patient services got under way. The Biomedical Technology Wing followed soon at the Satelmond Palace, an exquisite gift of the Royal family, located 11 km away from the Hospital Wing. The Vision of the first Director, Professor M S Valiathan, transformed the Centre into a unique institution that blends the practice of modern medicine with relevant research and technology within the same institutional framework.

The concept of amalgamating medical sciences and technology within a single institutional framework was regarded sufficiently important by the Government of India to declare the Centre an Institute of National Importance under the Department of Science and Technology by an Act of Parliament in 1980, and name it as Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum. Dr Manmohan Singh, the then Hon'ble Finance Minister, Government of India, laid the foundation stone for the third dimension of the Institute, the Achutha Menon Centre for Health Science Studies (AMCHSS), on June 15, 1992. AMCHSS was dedicated to the nation by Dr Murali Manohar Joshi, the then Hon'ble Minister of Science and Technology and Human Resource Development, Government of India, on January 30, 2000.



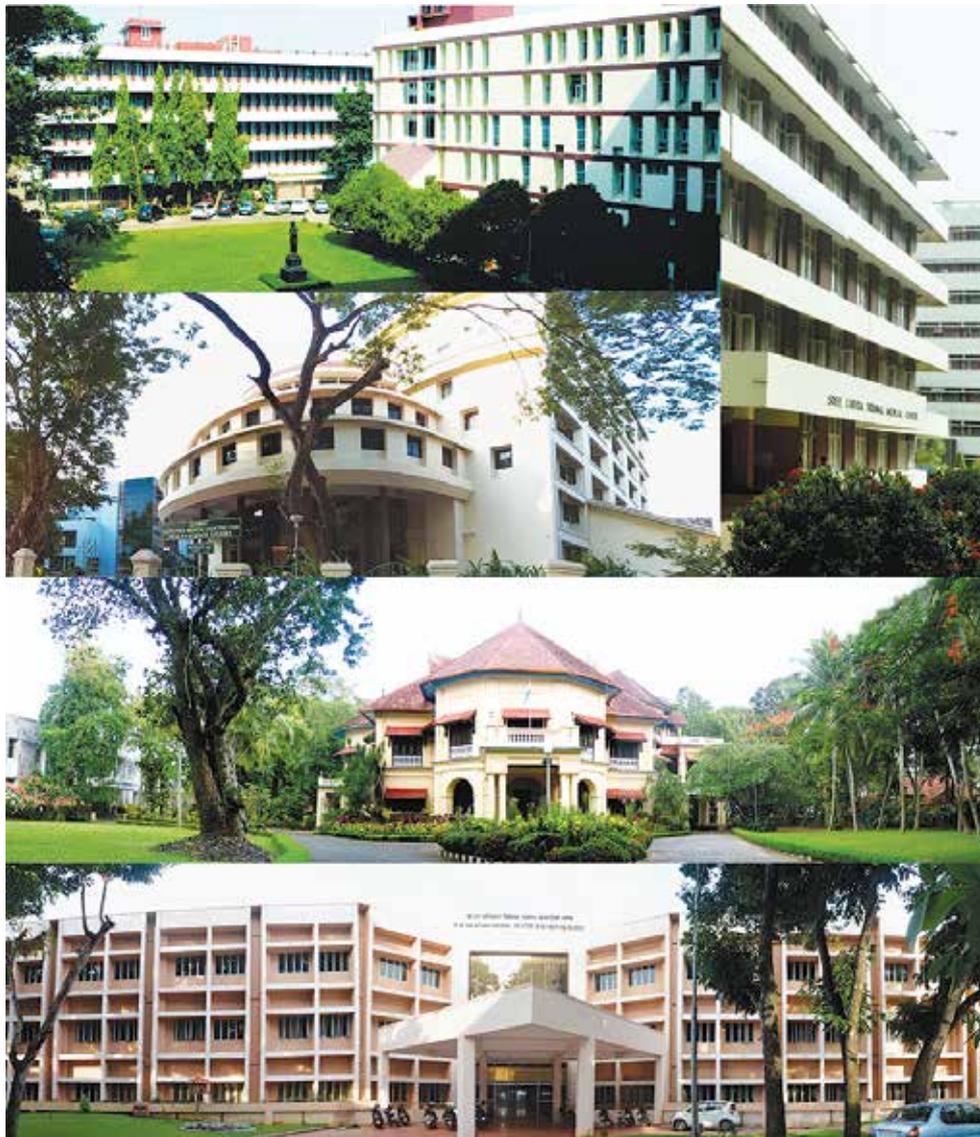


## ..... Our Mission .....

- Promote research and development in biomedical engineering and technology
- Deliver high quality patient care in selected specialties and sub-specialties
- Develop innovative postgraduate training programs in advanced medical specialties and biomedical engineering and technology
- Participate in public health reforms through research, training and interventions

## ..... Our Vision .....

- Become a global leader in affordable medical devices development, high quality patient care and health science studies







डॉ. वी.के. सारस्वत  
Dr. V.K. Saraswat

सदस्य  
Member

Tele : 23096566, 23096567

Fax : 23096603

E-mail : vk.saraswat@gov.in



सत्यमेव जयते

भारत सरकार  
नीति आयोग, संसद मार्ग  
नई दिल्ली - 110 001  
Government of India  
National Institution for Transforming India  
NITI Aayog, Parliament Street,  
New Delhi - 110 001

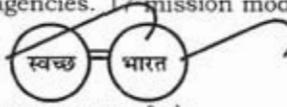
#### **MESSAGE**

Sree Chitra Tirunal Institute of Medical Science & Technology (SCTIMST), set up under an Act of Parliament as an Institute of National Importance, has been functioning with the unique mandate of applying Science and Technology in clinical medicine, to meet the societal needs in healthcare. In the past two years, the Institute has made commendable contributions in the nation's battle against the COVID-19 pandemic. In addition to the development of medical devices and technologies, several measures were initiated on multiple fronts. It is very gratifying to see that these ventures were successful in taking up the challenge posed by the pandemic.

During 2021-22, SCTIMST has continued its legacy to contribute for the social needs in both clinical and research areas. The Institute is trying its best to cater to the needs of the medical device industry. This year, the technology of the Multiplex RT PCR kit has been transferred to M/s Huwel Lifesciences, Hyderabad and M/s Meril Diagnostics Pvt Ltd, Vapi, Gujarat. The Kerala State Electronics Development Corporation (Keltron) has taken two products - infant warming wrapper and bassinet systems. The validation of "Rapidogram" Rapid diagnostic kit for UTI transferred earlier to M/s Agape diagnostics, Pattimattom, Kochi, has been completed this time by ICMR.

The Hospital Wing of the Institute, an advanced center for neurological and cardiovascular diseases, has been catering to the medical needs of thousands of patients. The first Heart Failure Bio-bank in the country got established here under the funding of ICMR. 3D printing for cerebral and aortic aneurysms and simulation in Angio Suite were done by the Department of Imaging Sciences and Interventional Radiology which can provide for detailed understanding of the complex anatomy and better patient management. New specialized geriatric care from the Pain Clinic was initiated, which exclusively caters to the aged patients with chronic musculoskeletal non-cancerous pain conditions.

I could see a remarkable performance in the academic realm with 318 research publications in the peer reviewed journals. 31 research projects were newly initiated during the year with various funding sources - 27 national and 4 international agencies. 17 mission mode R&D projects aimed



एक कदम स्वच्छता की ओर

at developing medical device technologies were underway during the year under the Technical Research Centre (TRC) for Biomedical Devices, funded by the Department of Science and Technology, Government of India. As a part of fulfilling the commitments to the society, the Institute has taken up two projects for the empowerment of SC and ST students provided by the Science for Equity Empowerment and Development (SEED) Division of DST with a budget of Rs.6.12 crores.

SCTIMST significantly contributes to the human resource development in India in the areas of medical, biomedical and public health areas. During the period, 18 PhD students graduated. In the medical post-PG courses (DM/MCh/PDCC/PDF/MD) 169 students were trained. The manpower trained in Public Health in the various Courses/ Projects/ Apprenticeship/ Observership in the AMCHSS was 587 during the year. The Institute extended facilities for affiliated programmes with CMC-Vellore, NIE-Chennai, IIPH-Delhi and IIITM-K, Trivandrum, which trained 142 students.

Apart from these structured courses, the Institute also contributed substantially to manpower generation through workshops/ conferences/ training programmes/ popular lectures/ awareness camps/ seminars and exhibitions, inside and outside the Institute. The Institute continued and started collaborations with other scientific institutions for development of biomedical technology. An international seminar "Nobel Laureate Science & Technology Seminar Series and India-Japan Science and Technology seminar" has been held online on 6<sup>th</sup>-7<sup>th</sup> December 2021. The main achievements of the Institute were show-cased in the 7<sup>th</sup> edition of the four-day India International Science Festival (IISF) held in Panaji, Goa, from 10-13 December, 2021. Dissemination of medical knowledge through the internet is very important and the Computer Division has made a remarkable step by starting a web site for Moyamoya disease (<https://moyamoya.sctimst.ac.in>). In the area of Intellectual Property Rights, the Institute has been granted eighteen Indian patents and one International patent. Sixteen Indian and nine International patent applications were processed this year.

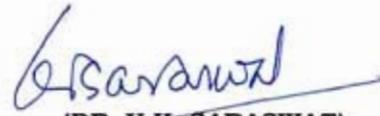
The contributions of SCTIMST-TIMed Technology Business Incubator are nothing less. This incubator nurtures the new entrepreneurs. This year, a startup company at TIMed, M/s Sascan Meditech, was adjudged winner of National Startup Award for their product OralScan. It also won Startup India Grand Challenge 2021 and Anjani Mashelkar Inclusive Innovation Award 2021.

Infrastructural additions are on-going, like the installation of 5-Axis CNC Milling Machine from GF Machining Solutions, Switzerland, in the tool room in the BMT Wing for machining intricate shapes for devices.

The construction of the "Combination Devices Block" in the BMT Wing Campus and the 182-bedded Super Specialty Hospital Block under PMSSY Scheme are in progress. These will ensure new work space for research and development of medical devices as well as for implementing advanced patient care, in the Institute.

Looking into these achievements, I have no hesitation in stating that SCTIMST is a compelling example of how a productive team of clinicians and scientists working together seamlessly, can create knowledge and infrastructure to make relevant breakthroughs.

I appreciate the dedication, consummate skill, sincerity and hard work of all staff/members of SCTIMST Family, and believe that we will continue to serve our Nation in the best possible way in areas ranging from development of indigenous technologies to implementation of modern medical treatment to the dissemination of social services. I convey my best wishes to all of you and exhort you all to contribute your best enabling India to achieve self-reliance in medical science and technology. Your efforts will go a long way in realizing the vision of Atmanirbharta of our Hon'ble Prime Minister Shri Narendra Modi.

  
(DR. V.K. SARASWAT)





## 2021-22: Looking back

Prof Ajit Kumar V K, Director, SCTIMST

The year that was past had an eventful progress. It was perhaps the worst of times, the winter of despair, with COVID raging and taking its toll. Humanity was desperately trying to find a scientific solution with all its research capability, mankind doing all that was possible to contain the pandemic and rescue all, with co-operative contribution from every one. It is on this background that we, at SCTIMST have contributed to patient care and taken forward the positive spirit of scientific research.

The problems faced by the Institute were always there in addition to the COVID pandemic. If one is tuned to believe that problems are an integral part of progress and need to be accosted head on, then solutions are easy to come; which is what we did. The economic issues were put in proper perspective, the pandemic was analysed scientifically, patient care areas were taken on priority, research and technology and academics were taken forward. Personnel from all fronts: faculty, students and employees were taken into confidence and the spontaneous outpouring of dedicated and sincere work helped the institute to carve out its destined path. It is my privilege to report our achievements and accomplishments during the year.

Keeping in line with the mission of the institute, we continued to deliver high quality patient care in the specialities and subspecialities of cardiac sciences and neuro sciences. Speciality Clinics in cardiology were introduced with the aim of improving advanced and focussed care which included Arrhythmia Clinics, Interventional Clinics, Fetal Cardiology Clinics and Neonatal Clinics. This is the route to develop subspeciality advances in all core areas which is a first in the country. New interventional procedures such as 3D printing of cerebral and aortic aneurysms, percutaneous TEVAR using endo sutures and imaging modalities like 4D flow MR imaging for congenital cardiac diseases were initiated by the Department of IS & IR. The Cognition and Behavioural Neurology Section was involved in the development of ICMR - Neurocognitive tool box to evaluate patients with mild cognitive impairment and dementia. Complex spine and intracranial aneurysm surgeries were performed by the neurosurgeons. The Neurosurgery department also launched a website dedicated to Moyamoya disease.

This year also, the Institute performed well in the area of biomedical device technology development and commercialization. The institute continued to contribute to various National Missions like Make in India, Skill India and Digital India. The technology of Chitra SARS CoV2 Multiplex COVID-19 detection RT-PCR kit was taken by M/s Huwel Life sciences, Hyderabad and M/s Meril Diagnostics Pvt. Ltd., Gujarat, and a Technology Transfer Agreement for the 'Infant Warming Wrapper and Bassinet' was signed with

Kerala State Electronics Development Corporation. The Technology Business Incubator (SCTIMST-TIMed) hosted start-up companies received national recognition. M/s Sascan Meditech Pvt. Ltd., won the National Startup Award for the development of 'Oral Scan' device. It also won Startup India Grand Challenge 2021 and Anjani Mashelkar Inclusive Innovation Award 2021. M/s I-EON Pvt. Ltd. won the Biotechnology Ignition Grant of BIRAC. 17 mission mode R&D projects aimed at developing medical device technologies under the Technical Research Centre (TRC) for Biomedical Devices progressed well. In the spirit of Digital India initiative, the Computer Division designed the Moyamoya disease website, developed in-house software for online academic activities and ensured that the digital requirements for offering Rashtriya Arogya Nidhi and Ayushman Bharath schemes were met.

It is a matter of pride that the first Heart Failure Biobank in the country established at SCTIMST under the ICMR-funded CARE-HF project started functioning, providing state-of-the art storage facilities for bio samples of patients with heart failure, opening avenues for research and development. Keeping with our broad objective to promote research and development in biomedical engineering and technology, the new "Combination Devices Block" with modern laboratories and facilities for development and testing of medical devices was ready to be commissioned by end of 2022. The commissioning of the 182-bedded Super Specialty Hospital Block under the Pradhan Mantri Swasthya Suraksha Yojana (PMSSY) was expected by March 2023.

Sree Chitra is a unique blend of patient care, biomedical technology development and public health components, with collaboration being the key to new initiatives across disciplines. These collaborative efforts led to execution of MoUs with government departments, institutions and industries. The AMCHSS, in collaboration with BITS Pilani executed a MoU with Head of Informatics of Oslo University, Norway and Korea Advanced Institute for Science and Technology. The Comprehensive Stroke Care Centre entered into a MoU with the University of Lancashire.

We continued to be a much sought-after destination for superspeciality courses, PhD and other academic programmes. The institute chose to be a part of the INI-CET exams for the DM and MCh selection process. This facilitated the entrance exam process and unified the selection process in the country. The DM and PDF Curriculum and SOP and PhD SOP were refined. The M Phil programme was terminated as per National UGC guidelines, and it was decided to have MS programmes in the area of Biomedical Technology. The feasibility of doing part-time PhD for the medical faculty was facilitated. A conceptual change of improving the research environment was introduced by bringing in the notion of a dual DM-PhD programme for the first time in the country. Having embraced the concept, the idea was undergoing structural organisation soon to become a reality.

The Institute, true to its Mission to "Develop innovative postgraduate training programs in advanced medical specialties and biomedical engineering and technology" contributed substantially to human resource development. We trained: 18 PhD students, 169 in DM/MCh/PDCC/PDF/MD in Cardiac and Neuro Sciences, 142 in affiliated programmes with CMC-Vellore, NIE-Chennai, IIPH-Delhi, IIITM-K, Trivandrum) and 587 in MPH/ DPH/ Diploma courses, projects, apprenticeship and observership. The Institute also contributed significantly to manpower generation through workshops, conferences, training programmes, popular lectures, awareness camps, seminars and exhibitions, inside and outside the institute.

The research and publication activities were testimony to the commitment of the faculty and students to excellence in research and development. 31 new research projects: 4 internationally-funded and 27 nationally-funded were initiated during the year. 318 research articles were published in peer-reviewed international and national journals. The Intellectual Property Rights activity was vibrant with 19 granted patents (including 1 international Patent) and 25 applications filed (including 9 international Patent applications).

The Faculty, staff and students brought laurels to the Institute. It is a matter of immense pride that Dr Jeemon P, Associate Professor, AMCHSS, was awarded the prestigious “Shanti Swarup Bhatnagar Prize” instituted by CSIR for the year 2021 in the field of Medical Sciences. The Division of Vascular and Thoracic Surgery was adjudged second best institute among all teaching institutions in the country at the Annual National Level Midterm Meet in 2021. 26 awards were won by students, Faculty and Staff in conferences.

The Institute was part of many important events. The Annual Convocation ceremony of the 37th batch of graduates was conducted through virtual mode on 22 May 2021 with 162 students receiving their degrees/diplomas/ certificates. Various programmes and activities were organized as part of “Azadi Ka Amrit Mahotsav” initiative and “Swachhta Pakhwada Fortnight”.

The economic issues facing the Institute were exaggerated by the pandemic. However, discussions with DST led us to believe that no matter what the problems are, the budgetary requirements will be honoured. And in true spirit we were not only able to carry on without compromising patient care, but also carry on with the research and project work that resulted in COVID-related technological innovations.

The Institute generated revenue of Rs 100.03 Crores during the current financial year which was 29.85% of the grant-in-aid received from the Department of Science and Technology during the year. We thank the Department of Science and Technology for the financial aid of Rs 335.01 Crores.

The Institute continued its pace of progress to carve out a distinct place for itself in the Indian firmament of Science, Technology and Medicine, a unique brand in the country. It places on record its deep sense of gratitude to the Department of Science and Technology for its unwavering support at all times.

Strengthened by our accomplishments these 12 months, we move forward towards a promising future with the hope of achieving bigger and better targets, overcoming complex challenges, but remain firmly entrenched in our vision to become a global leader in affordable medical devices development, high quality patient care and health science studies.

AJIT KUMAR V K

# Highlights of the Year 2021-2022

## INFRASTRUCTURE DEVELOPMENT

- ◆ The first Heart Failure Bio-bank in the country established at SCTIMST under the project Centre for Advanced Research and Excellence in Heart failure funded by ICMR was inaugurated virtually by Prof (Dr) Balram Bhargava, Director-General of Indian Council of Medical Research on 5 August 2021.
- ◆ The 5-Axis CNC Milling Machine (Mikron-Mill S 400U from GF Machining Solutions, Switzerland) was installed and commissioned at the Biomedical Technology Wing. It is utilized for machining intricate shapes/prototypes in ferrous, non-ferrous and polymeric materials.
- ◆ The construction of the “Combination Devices Block” in the Biomedical Technology Wing progressed well during the year and will be ready for commissioning by end of 2022. The new Block will house various modern labs and facilities for development and testing of medical devices.
- ◆ The construction of the 182-bedded Super Specialty Hospital Block under PMSSY Scheme progressed well during the year and commissioning of the Facility is expected by March 2023.

## CONTRIBUTIONS TOWARDS NATIONAL MISSIONS

### 1. “Make in India”

#### ◆ Product Development

##### A. Commercialization

The technology of Chitra SARS CoV2 Multiplex COVID-19 detection RT-PCR kit was successfully translated to commercial product by M/s Huwel Lifesciences, Hyderabad.

##### B. Clinical Validation

The ICMR validation of Rapidogram – Rapid diagnostic kit for UTI along with antibiotic sensitivity pattern was ongoing. The technology was transferred to M/s Agappe Diagnostics Ltd., Kochi

##### C. Technology Transfer

- Technology transfer agreement for multiplex RT-PCR kit was signed with: M/s Huwel Lifesciences, Hyderabad, on 14 May 2021 and M/s Meril Diagnostics Pvt. Ltd., Gujarat, on 21 May 2021.
- Technology transfer agreement for infant warming wrapper and bassinet was signed with Kerala State Electronics Development Corporation (Keltron) on 27 October 2021.



## D. Training as part of Technology Transfer

Training activities in relation to the technology transfer was imparted to the following companies during the year:

- M/s Huwel Lifesciences, Hyderabad for the multiplex RT-PCR kit
- M/s Prevest DenPro, Jammu, for bioactive ceramic composite and bioactive cement
- M/s Bioradmedisys Pvt. Ltd. for two products - Atrial septal defect closure device and flow diverter stent
- Meril Life Sciences Pvt. Ltd., Gujarat - Phase III training for left ventricular assist device
- Kerala State Electronics Development Corporation (Keltron) for infant warming wrapper and bassinet

### ◆ Technical Research Centre for Biomedical Devices

- 17 mission mode R&D projects aimed at developing medical device technologies were underway during the year under the Technical Research Centre (TRC) for Biomedical Devices, funded by the Department of Science and Technology, Government of India.
- Three technology transfer agreements were signed with various industries for scaling up and commercialisation of the devices developed. Two technologies reached commercialisation stage during the year.
- Fourteen patent applications including ten international patents were filed during the year from the TRC projects.

### ◆ Technology Business Incubator (SCTIMST-TIMed)

- M/s Sascan Meditech Pvt. Ltd., a start-up company incubating at TIMed was won the National Startup Award for Oral Scan. It also won Startup India Grand Challenge 2021 and Anjani Mashelkar Inclusive Innovation Award 2021.
- M/s I-EON Pvt. Ltd., a start-up at TIMed won the Biotechnology Ignition Grant (BIG) of BIRAC.
- SCTIMST TIMED was selected as the CSR partner of HDFC Parivarthan Smartup Grant for 2021-22.
- Technology & Intellectual Property Services @TIMed (TIPS@TIMed), a Technology Transfer Office funded by National Biopharma Mission, BIRAC, commenced its operation.

## 2. “Skill India”

### ◆ Industry-Institute Partnership Cell

Industry-Institute Partnership Cell (IIPC) of the institute organized workshops for the academia and medical device industry.



### ◆ Competency Development Cell

The Competency Development Cell (CDC) organized three training programmes for the staff and other members of the institute during the year.

### 3. “Digital India”

#### ◆ The Computer Division undertook the following software-related activities :

- Launched a website for Moyamoya Disease: <https://moyamoya.sctimst.ac.in>
- Created a Mobile Application for video consultation using Jitsi platform for patients
- Installed all hardware and software for starting Rashtriya Arogya Nidhi and Ayushman Bharath service for the patients.

### NETWORKING WITH OTHER INSTITUTIONS

#### ◆ The Institute collaborated with government departments, institutions and industries to facilitate networking.

The Institute executed MoUs with:

- University of Lancashire for extension of the study entitled “Improving Stroke Care in India” at the Comprehensive Stroke Care Centre.
- Head of Informatics of Oslo University, Norway for the project “Digital platforms for disease surveillance and control: Best practice case studies from Asia”. This is a collaborative project of AMCHSS of the institute with Department of Informatics, University of Oslo (Norway), BITS Pilani (India), JNU (India), Korea Advanced Institute for Science and Technology (KAIST-Korea), Society for Health Information Systems Programs (HISP-India) and SHE-Health Education (SHE-UiO, Norway).
- IIT-Madras for joint research on “Molecular genetics of myocardial infarction” in the Centre for Advanced Research and Excellence (CARE) in Heart Failure.
- InStem Bengaluru to collaborate on “Genetics of Cardiomyopathy” in the Centre for Advanced Research and Excellence (CARE) in Heart Failure.
- NIT Calicut for the project “Non-invasive measurement and monitoring of pulmonary congestion”.
- M/s VST IOT Solutions Pvt. Ltd., Kochi for the collaborative development of antimicrobial coating for applying on surface for enhanced protection from bacteria and viruses.
- M/s Phraction Scientifics Pvt. Ltd., for the joint development of platelet concentrator and aggregator. Phraction was awarded funding under the Biotechnology Ignition Grant Scheme of BIRAC for the development.
- Tata Steel Limited for collaboration on the development of “Biodegradable orthotic wrist support device from short coir fibre reinforced polylactic acid biocomposite”. A research agreement was signed in February 2022.



- BITS, Pilani, IISER- Berhampur, IIT- Madras, NIT, Surathkal, TKM College of Engineering, Kollam and NIT, Kozhikode, for collaborative research activities in Medical Image Processing, Artificial Intelligence and Virtual Reality were initiated by the Department of Imaging Sciences and Interventional Radiology.

## NEW INITIATIVES

- ◆ Science for Equity Empowerment and Development (SEED) Division, Department of Science and Technology, granted two projects to SCTIMST for the empowerment of SC and ST students with a budgeted outlay of Rs 6.12 Crore. These projects are aimed to bring an impact on the education, skill development, employability and health of students belonging to Scheduled Caste and Scheduled Tribe communities in the country through a series of interventions.
- ◆ The Cardiology Specialty Review Clinics were inaugurated by the Director, Prof Ajit Kumar V K on 2 August 2021. The Specialty Clinics included Grown up Congenital Heart Diseases Clinic, Neonatal Clinic, Fetal Clinic, among others. These dedicated high-end specialty Clinics would foster focussed patient care and clinical research.
- ◆ New specialized geriatric care from the Pain Clinic was initiated, which exclusively caters for the aged patients with chronic musculoskeletal non-cancerous pain conditions.

## RESEARCH PROJECTS/PUBLICATIONS/PATENTS

- ◆ **Number of Research Projects newly initiated during the year: 31**
  - Nationally-funded: 27
  - Internationally-funded: 4
- ◆ **Number of Research Publications: 318**
- ◆ **Patents**
  - Granted: 19 (Foreign = 1, Indian = 18)
  - Applications Filed: 25 (Foreign = 9, Indian = 16)

## HUMAN RESOURCE DEVELOPMENT/TRAINING

- ◆ **PhDs graduated: 18**
- ◆ **Research/Technical Manpower trained in DM/MCh/PDCC/PDF/MD in Cardiac and Neuro Sciences: 169**
- ◆ **Other Research/Technical Manpower trained in MPH/ DPH/ Diploma Courses/ Projects/ Apprenticeship/Observership: 587**
- ◆ **Manpower trained against affiliated programmes (CMC-Vellore, NIE-Chennai, IIPH-Delhi, IITM-K, Trivandrum): 142**
- ◆ **Apart from these structured courses, the Institute also contributed substantially to manpower generation through Workshops/Conferences/Training Programmes/Popular Lectures/Awareness Camps/Seminars and Exhibitions, inside and outside the Institute.**



## EVENTS/CONFERENCES/WORKSHOPS

### ◆ Annual Convocation

The Annual Convocation ceremony of the 37th batch of graduates was conducted through virtual mode on 22 May 2021. 162 students received their degrees/diplomas/ certificates during the year 2020-2021.

### ◆ National Science Day 2022

The National Science Day 2022 was celebrated at the Biomedical Technology (BMT) Wing. The theme of this year's National Science Day was 'Integrated Approaches in S&T for Sustainable Future' with emphasis on the application of science for a sustainable future. Around 105 students from Saraswathy Vidyalayam, Kattakada, Government Arts College, Trivandrum, and VTM NSS College, Trivandrum participated in the programme.

### ◆ "Nobel Laureate Science & Technology Seminar Series" was jointly organized by the institute and Indian JSPS Alumni Association on 6-7 December 2021 at AMCHSS Auditorium.

### ◆ The institute participated in the 7th edition of the four-day **India International Science Festival (IISF)** held in Panaji, Goa, from 10-13 December 2021. The festival theme was "Celebrating Creativity in Science, Technology and Innovation for Prosperous India".

### ◆ A two-day Workshop on "**Handling Scientific Images for Publication: Techniques and Ethics (SITE-22)**" was conducted by the Biomedical Technology Wing and Division of Academic Affairs on 30-31 March 2022. Twenty participants attended the Workshop.

### ◆ Azadi Ka Amrit Mahotsav

Azadi Ka Amrit Mahotsav is an initiative of the Government of India to celebrate and commemorate 75 years of independence. As per the Department of Science and Technology's "Proposed plan for DST's AIs India@75", various activities and programmes were organized at SCTIMST to accomplish the vision of the Government of India. A Committee headed by Prof Ashalatha Radhakrishnan was constituted for the implementation and co-ordination of these activities.

Some of the programmes organized during the year 2021-22 are given below:

- The Inaugural Function of Exhibition, Documentary & Souvenir Release - "Saga of 4 decades of Chitra" and "Metal Art Wall Decor" Inauguration was on 24 May 2021.
- Painting and Photography Contest and Exhibition, Logo competition and Poster competition and exhibition contest focused on "Unsung Heroes" were from 24-26 May 2021.
- The Curtain Raiser was on 29 May 2021 at AMCHSS Auditorium (hybrid mode) with an inaugural address was by Lt. Col. Dr Bharath Mohanlal. The programmes included a short movie "Azadi ke Liye", announcement of winners of various competitions and "Slice of Music" by the Chitra Music Group.
- Lecture series on the theme "75th year of Independence: Ideas, Achievements, Actions and Resolves" from 10 July 2021 to 7 August 2021.



- Virtual Tour of the Institute and its three Wings, Walkathon during July and August 2021 with march from both campuses and Mega Musical Night on 15 August 2021.
- Celebration of World Music Day (21 June 2021) and World Environment Day (5 July 2021) in the spirit of Azadi Ka Amrit Mahotsav.

#### ◆ **International Yoga Day**

The Institute celebrated the International Yoga Day on 21 June 2021. Online yoga training and Yoga Quiz were conducted. A live programme on yoga was conducted in collaboration with Kanyakumari Vivekananda Kendra and Arogyabharathi. Staff, students and pensioners participated in these programmes.

#### ◆ **Swachhta Pakhwada Fortnight**

Activities were organized during the fortnight from 1-15 May 2021 at Hospital and Biomedical Technology Wings. The “Green Initiative” was started with planting of medicinal plants and vegetable saplings at both campuses. Webinars on E-waste management and Household waste management were organized. Poster competitions on “Quest for a Cleaner Kerala” and “Swachhata at home: innovative ideas for domestic waste management” were organized for institute employees and school children.

#### ◆ **International Women’s Day**

The International Women’s Day was celebrated on 8 March 2022. Hon’ble Director, Prof Ajit Kumar V K delivered the inaugural address and officially launched the Gender Advancement for Transforming Institutions (GATI) at SCTIMST. The Guest of Honour, Dr Pratibha Jolly, addressed the gathering online and presented the guidelines and assessment criteria for implementation GATI at SCTIMST. Dr Hari Krishna Varma, Head, BMT Wing released the GATI Charter online. Prof Mala Ramanathan, Prof Achuthsankar S Nair and Dr Navjot Khosa IAS delivered the Women’s Day message. A panel discussion on the topic “He For She” was conducted, with panel members consisting of Prof Kesavadas C, Prof Easwer H V, Prof Krishnamoorthy K M and Prof Sankara Sarma P.

#### ◆ **Progressive use of Hindi**

The Institute complied with the provisions relating to the Official Language Act, Rules and instructions, and directives of the Government of India. During the year, various competitions like calligraphy, noting and drafting, short story writing, and essay writing was held for the employees, in Hindi. Hindi Fortnight/Hindi Day was observed. The Institute participated in the Town Official Language Implementation Committee (TOLIC) meetings. Hindi Cell organized training/workshop on typing and drafting in Hindi for the institute staff.

#### ◆ **Pension Adalat**

Pension Adalat, 2022 was held on 19 March 2022 in virtual mode. Out of 11 grievances received in the Adalat, two cases were resolved and rest nine cases were found beyond the extent of pension policy guidelines and therefore referred to Administration Division for necessary action.



- ◆ The **Vigilance Awareness Week 2021** and **Rashtriya Ekta Diwas 2021** were observed with pledge taking ceremony.
- ◆ **Events were organized in connection with:**  
World Parkinson's Day - 11 April 2021, World Hand Hygiene Day - 5 May 2021, World Blood Donors Day - 14 June 2021, World Alzheimer's Day - 21 September 2021, National Voluntary Blood Donation Day - 1 October 2021, World Cerebral Palsy Day - 6 October 2021, World Stroke Day - 29 October 2021, Social Work Day - 15 March 2022, International Purple Day - 26 March 2022
- ◆ **Scientific presentation in Conferences by Faculty and students: 118**
- ◆ **Number of Conferences/Workshops organized by the Institute: 16**

## AWARDS

- ◆ **Dr Jeemon P**, Associate Professor, Achutha Menon Centre for Health Science Studies was awarded the prestigious "Shanti Swarup Bhatnagar Prize" instituted by CSIR for the year 2021 in the field of Medical Sciences.
- ◆ The **Vascular Surgery Department** was adjudged second best institute in India among all teaching institutions in the country at the Annual National Level Midterm Meet in 2021.
- ◆ **Prof Kesavadas C**, Department of Imaging Sciences and Interventional Radiology and **Prof Harikrishnan S**, Department of Cardiology, were conferred the Fellowship of the National Academy of Medical Sciences at the convocation held on 7 August 2021.
- ◆ **Awards won by students, Faculty and Staff in conferences: 26 numbers**

## CORPORATE SOCIAL RESPONSIBILITY FUNDS RECEIVED

- ◆ M/s Tata Elxsi Ltd. contributed CSR donation of Rs 50 Lakh towards financial assistance to economically poor patients treated at SCTIMST during the year.

## REVENUE GENERATED BY THE INSTITUTE

- ◆ Revenue generated by the Institute by way of Hospital Services during the current financial year was Rs 100.03 Crore, which is 29.85% of the grant-in-aid received from the Department of Science and Technology during the year.
- ◆ The Institute has a balance of Rs 15 Crore under the Emergency Reserve Fund, which was created out of patient care income of previous years.

## FINANCIAL SUPPORT FROM THE DEPARTMENT OF SCIENCE AND TECHNOLOGY

- ◆ Total grant received from the Department of Science and Technology for 2021-22 was Rs 335.01 Crore (as against Rs 310 Crore received for 2020-21)
  - Revenue Grant: Rs 310.01Crore
  - Capital Grant: Rs 25.00 Crore



- 
- ◆ Total Extramural Research (EMR) funding received by the Institute from Government Agencies, Non-Governmental Agencies and International Agencies during 2021-22: Rs 21.86 Crore
  - ◆ DST and SERB Contribution towards EMR funding:
    - Funding for Ad hoc Research Projects: Rs 3.31Crore
    - Total number of ongoing research projects funded by DST and SERB was 30, out of which 10 were initiated during 2021-22.

*The Institute places on record its deep sense of gratitude to the Department of Science and Technology for its unswerving support at all times.*





*Inauguration of the Heart Failure Bio-bank virtually by Prof (Dr) Balram Bhargava, Director-General of Indian Council of Medical Research on 5 August 2021*





Technology Transfer of Chitra Multiplex RT-PCR kit for COVID-19 detection to Huwel Lifesciences Pvt. Ltd., Hyderabad



Launch of RT PCR kit on 11 August 2021





**Inauguration of the Website for Moyamoya disease**

on 14 May 2021

by  
Prof(Dr.)  
K.Jayakumar



*Launch of website for Moyamoya Disease (<https://moyamoya.sctimst.ac.in>)*



*Inauguration of the Cardiology Specialty Clinics on 2 August 2021*





*Annual Convocation Ceremony on 22 May 2021 (in virtual mode)*



*National Science Day celebration at BMT Wing*





*Nobel Laureate Science & Technology Seminar Series on 6-7 December 2021*



*Azadi ka Amrit Mahotsav Curtain Raiser on 29 May 2021*





*Independence Day celebration and Walkathon as part of Azadi Ki Amrit Mahotsav*



*Swachhta Pakhwada Fortnight from 1-15 May 2021*



*International Women's Day celebration on 8 March 2022*





*Pension Adalat on 19 March 2022*

 <p>SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY TRIVANDRUM - 695 012, KERALA, INDIA (An Institution of National Importance, Dept. of Science and Technology, Govt. of India)</p> <h2 style="text-align: center;">SCTIMST</h2> <h3 style="text-align: center;">Vigilance Awareness Week 2021</h3>	<h3>INTRODUCTORY CLASS ON VIGILANCE PROCEDURE</h3> <hr style="border: 1px solid yellow;"/> <p style="color: black; font-weight: bold; text-align: center;">H.VENKATESH IPS</p> <p style="text-align: center;">B.Sc (Ag), M. Sc (Ag), MBA, PG. Dip( Criminal Justice) <b>INSPECTOR GENERAL OF POLICE</b> VIGILANCE &amp; ANTI-CORRUPTION BUREAU, KERALA THIRUVANANTHAPURAM</p>
---	---



*Observance of Vigilance Awareness Week 2021*





*National Voluntary Blood Donation Day on 1 October 2021*



*Social Work Day celebration on 15 March 2022*





*Republic Day celebration 2022*





# HOSPITAL WING

# HOSPITAL ADMINISTRATION

Hospital Administration of the Institute includes the Office of the Medical Superintendent and other Departments/Divisions that support patient care services. The objectives of Hospital Administration are:

- To improve patient care
- To ensure better patient satisfaction
- To check medical errors, costs, and minimise wastage and pilferage
- To develop inclusivity in service provision targeting marginalised sections of the society

## Activities

### Hospital Statistics

The COVID-19 pandemic had reduced the inflow of patients in the last couple of years. During the year 2021-22, the effect of the COVID-19 pandemic had waned considerably and the number of patients visiting the hospital had improved compared to the earlier years. However, precautions related to COVID-19 continued to be followed to prevent the continuous spread of COVID-19 in the community. The annual

statistics of the hospital services for the year 2021-2022 are indicated in the charts given (Figures 1-9):-

During the year 2021-22, the Departments of Cardiology, Neurology, Cardiac Surgery, Neurosurgery, and Imaging Sciences & Interventional Radiology served 15,838 new patients, a figure that was 32% higher compared to the year 2020-21. Even the admission numbers were reported higher during 2021-22 with an increase of 42.1% compared to the previous year. The number of those patients who had arrived at the hospital for a follow-up visit had gradually increased from the beginning of the year

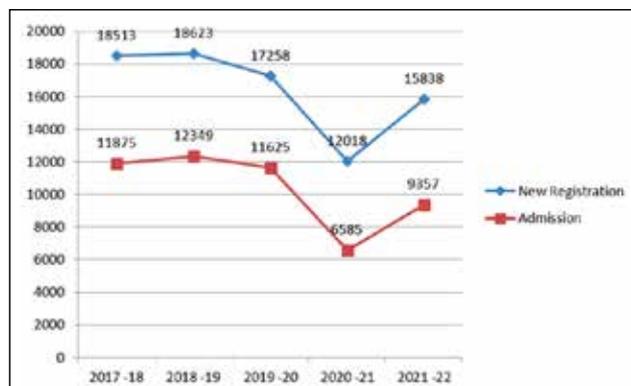


Figure 1. Trends in new registrations and admissions

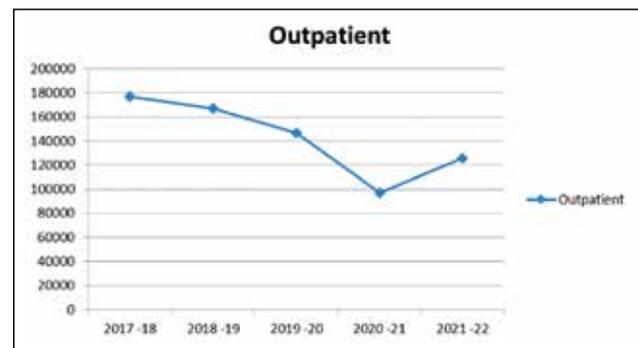


Figure 2. Trends in outpatient visits for follow-up (review)

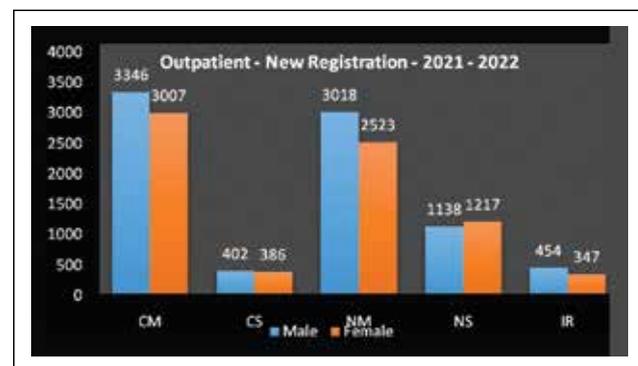


Figure 3. Gender-wise disaggregated data. Department-wise new registrations in the year 2021-22 (CM- Cardiology, CS-Cardiac surgery, NM-Neuromedicine, NS-Neurosurgery, IR-Interventional Radiology)



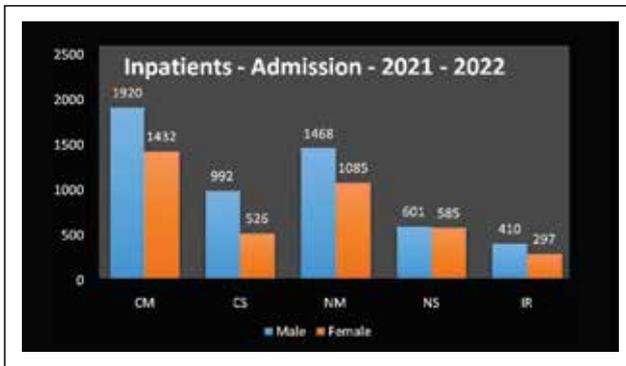


Figure 4. Gender-wise disaggregated data. Department-wise patients admitted in the year 2021-22 (CM- Cardiology, CS-Cardiac surgery, NM-Neuromedicine, NS-Neurosurgery, IR-Interventional Radiology)

to the end of 2021-22. However, the increase in the number of patients was still 30% lesser for new patients arrived for outpatient consultations and 43% lesser for inpatient admission compared to the pre-COVID-19 period.

The bed occupancy rate (BOR) indicates the utilisation of bed capacity in the hospital and the efficiency in its use. The BOR for 2021-22 was 70.01%. Similar to the number of outpatients and admissions, COVID-19 pandemic had significantly affected the bed occupancy rate (Figure 5).

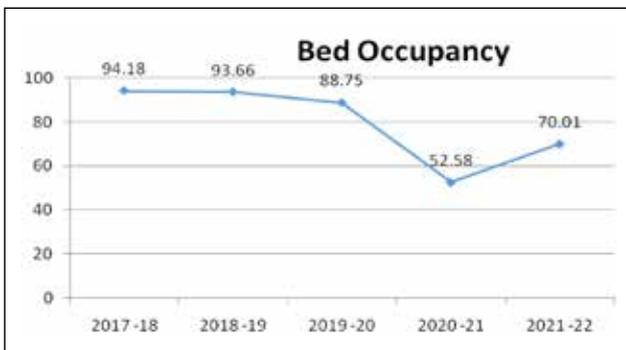


Figure 5. Bed Occupancy Rate

### Free and subsidized treatment for patients

The Institute provided free treatment to 1.25% of the inpatients and subsidized treatment to 40.52% of its inpatients, while following the socio-economic status criteria (Figures 6 and 7).

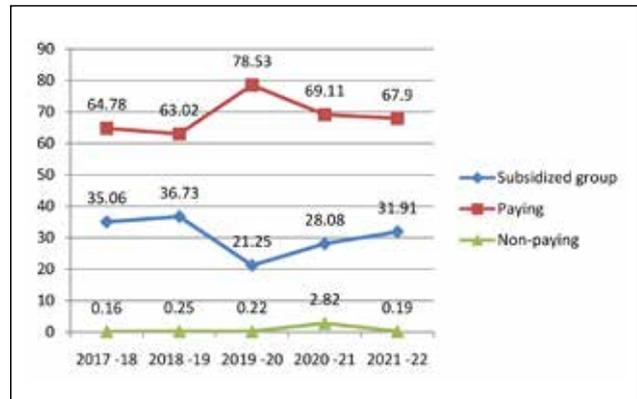


Figure 6. Trends in the proportion of patients in the paying, non-paying, and subsidized treatment categories- Outpatients

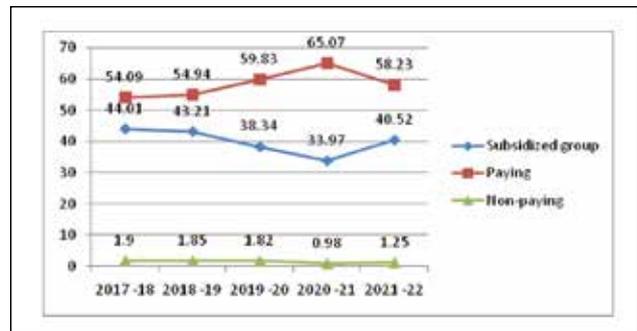


Figure 7. Trends in the proportion of patients in the paying, non-paying, and subsidized treatment categories- Inpatients

### Bed Turnover Rate

The observed mean bed turnover for the year 2021-22 was 37 patients/bed/year, which was better than in the prior year. However, it was 20% lesser than the pre-COVID-19 period (Figure 8).

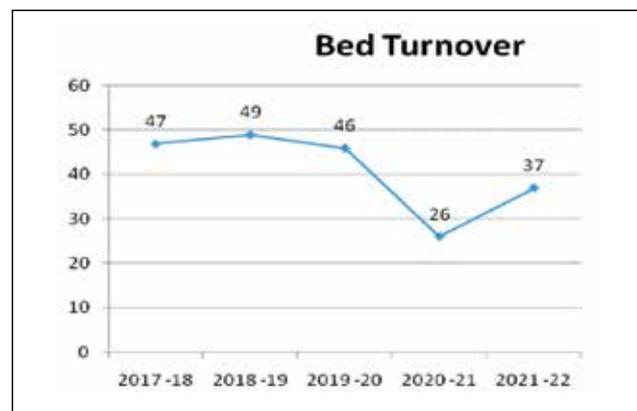


Figure 8. Trends in the Bed Turnover Rate





### Average length of stay at the hospital

The observed average length of stay at the hospital for the year 2021-22 was 6 days which was same as the previous years (Figure 9).

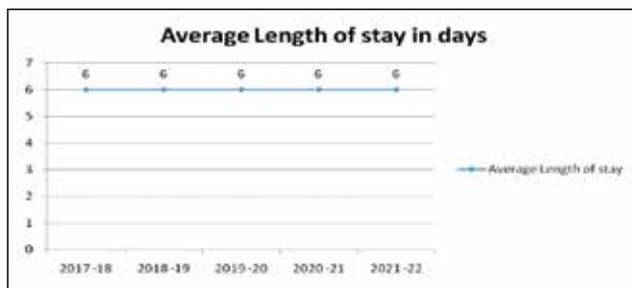


Figure 9. Average length of hospital stay

### Other Activities

1. A long awaited demand for the roll-out of Ayushman Bharat Scheme was realized this year when an MOU was signed by Dr Ajit Kumar V K, Director SCTIMST and Dr Bijoy, Joint Director, State Health Agency, Kerala, on 31 March 2021.
2. A new dedicated Outpatient Care Services (Cardiac Sciences) was inaugurated by Dr Ajit Kumar V K, Director SCTIMST on 22 March 2022.
3. The Crèche Service at the Hospital Wing which was temporarily suspended following the guidelines from the Government of Kerala COVID protocols was reopened on 31 March 2022 for the children of staff members and students of the institute.
4. Webinar on "Prevention and management of COVID-19 in a non-COVID health care setting" was jointly organized by the Hospital Infection Control Unit and the Department of Microbiology, SCTIMST, on 12-13 March 2021.

### Events Organized

1. Online International Yoga day celebrations were held on 21 June 2021.
2. 75th Independence Day celebrations were held in the Hospital Wing on 15 August 2021.
3. 76th Republic Day celebrations were held on 26 January 2022 in the Hospital Wing.
4. Social Work Day was celebrated on 15 March 2022. The theme of the day: "Co-Building a New Eco-Social World: Leaving No One Behind" The highlight of the programme was the display of a photo story depicting the role of social workers deployed in different departments and areas of the hospital.

**The details of the Departments/Divisions under the Medical Superintendent engaged in patient care are provided below.**

### Physical Medicine and Rehabilitation

The Physical Medicine and Rehabilitation (PMR) team plays the vital role in placing patients on the path to recovery after a medical event or a surgical intervention and in restoring them to their optimum level of functioning. The Rehabilitation Team consists of a physiatrist as the leader, supported by seven physiotherapists. Inpatients and outpatients requiring an expert opinion on their rehabilitation are referred to the physiatrist. The physiotherapists provide routine chest and limb physiotherapy to patients in the various wards and ICUs of the Hospital Wing. Out-patients and stable in-patients are brought to the department for interventions and specialised physical therapy programmes. Patients from Speciality Clinics are also referred. One physiotherapist is deputed to the Stroke Clinic. The physiatrist provides interventional services for managing pain, spasticity and range of movement restriction among others.



The Services provided by PMR during the year are summarized in the Table below:

Service	Number
Rehabilitation Clinic	15
<b>Inpatient Procedures</b>	
Exercise for single or multiple regions	4723
Respiratory therapy	9294
Physical modalities	113
Physiatrist consultation	10
Trigger point injections	3
Static cycling	49
Balance and gait training	4
Tilt tabling	91
Virtual reality training	3
<b>Total</b>	<b>14290</b>
<b>Outpatient Procedures</b>	
Exercise for single or multiple regions	1074
Respiratory therapy	2
Physical modalities	1569
Physiatrist consultation	141
Static cycling	151
Balance and gait training	47
<b>Total</b>	<b>2984</b>

### Medical Social Work Division

Medical social workers are placed at different clinical departments to provide direct service to patients, caregivers, and family members. This helps in minimizing the negative feeling of illness and hospitalisation. Being a member of the multidisciplinary team, social workers offer unique services to the patients and their families. The socio-economic assessment, psycho social assessment, counseling services, and educative sessions for the patients are conducted by the social workers. In addition, they co-ordinate various clinics, financial support schemes, beneficiary schemes such as Ayushman Bharat (Pradhan Mantri Jan Arogya Yojana - PMJAY) and Rashtriya Arogya Nidhi and any treatment plans in collaboration with the clinical departments.

### Pharmacy

The Pharmacy deals with the procurement, storage, dispensing and distribution of medicines to all inpatients of the institute. The Pharmacists provide the specifications of drugs, prepare indents for purchase of drugs, maintain records and store following a monitoring system for expiry dates of all medicines. In addition, drugs and medications are dispensed to the permanent staff and their dependents through the pharmacy, based on the prescription of the staff physician. Underprivileged patients are also dispensed medicines for a maximum amount of Rs 500 per patient per month up to a total of Rs 25000 per month and monthly reports on them are prepared.

During 2021-2022, based on the indents prepared by the pharmacy department, a total 995 receipt vouchers for Rs 96741482 were prepared. Total number of issue vouchers prepared by the Pharmacy was 4831. Total of 60 receipt vouchers for Rs 1164683 was prepared for the staff pharmacy. Total number of beneficiaries under the patient welfare schemes was 529 and drugs worth Rs 176311 was dispensed to them. As a new initiative, drug doses were calculated for paediatric patients and dispensed after adding adequate adjuvant (as per their prescriptions) to ensure that drug doses were administered most accurately to children post-cardiac surgery. During the year, 985 paediatric prescriptions were processed. Patient counselling related to administration of medicines was also provided based on need.

Pharmacy also offered a one-year training programme for young pharmacists.

### Dietary

The Dietary maintains high standards of hygiene as well as quality and serves nutritious diet to all the inpatients. Food menu following the individual and therapeutic requirements of the patients were prepared by the dieticians. Three major and three small meals were provided daily. Daily ward rounds were performed by the dieticians to ensure the needs of the patients were met. Nutritional assistance in terms of diet counselling was also provided to the inpatients and their care-givers while getting discharged from the hospital. Diet counselling was also provided to





outpatients based on need. During 2021-2022, 76800 patients were served diet (including Ryle s tube feeds and semisolid diet).

During the COVID-19 pandemic, as a special intervention, diet was provided for bystanders as well. A total of 10500 people benefited by that. Currently, provision of diet for bystanders is limited to patients who are admitted for Video EEG and Deep

Brain Stimulation (DBS). In addition, from 13 May 2021 to 29 June 2021, food was also served to COVID-19 positive staff members of SCTIMST (410 diet trays) who were accommodated at the COVID-19 Isolation Facility in Biomedical Technology Wing.

### Laundry

The Laundry section of the hospital plays a key role in ensuring infection control. The total number of linen pieces processed in the laundry during the year was around 400000 and the total number of items ironed in the laundry was about 180000. The laundry received used linen from the wards, operation theatres, outpatient departments, intensive care units, and procedure rooms in the hospital. The soiled and infected linen were processed separately. During the COVID-19 pandemic, special training sessions were conducted for the laundry staff.

### Central Sterile Supplies Department

Central Sterile Supplies Department (CSSD) is the critical service unit that processes, issues and controls the sterile supplies to all hospital areas including operation theatres and Intensive Care Units. The CSSD receives unsterile linen, instruments, and equipment from operation theatres, catheterisation laboratories, and Intensive Care Units of the hospital and processes them. It plays a crucial role in infection prevention and control.

CSSD conducted online sessions on for Vocational Higher Secondary Education (VHSE) students in

Government Vocational Higher Secondary School Pathanamthitta and Peruva Kottayam and for GVHSS Veeranakavu on 7 April 2021.

CSSD also conducted orientation classes for nursing students on disinfection, processing and reprocessing steps, types of sterilisation, shelf-life of packing materials, sterility assessment, sterility monitoring, and record keeping on 19 July 2021.

The total units processed by CSSD in the year 2021-22 are as follows:

Area	Daily	Yearly
Wards and CSSD items	464	144620
Pediatric Cardiac Surgery Operation Theatre	58	21900
Catheterisation Laboratory	101	36865
Digital Subtraction Angiography Laboratory	58	21170
Cardiac Surgery Operation Theatre	139	50835
Neurosurgery Operation Theatre	76	27740
Surgical Block steam sterilisation	10 loads (700 Litres each)	3650
Medical Block steam sterilisation	5 loads (700 Litres each)	1825
Plasma sterilisation	5 loads (140 Litres each)	1825
Ethylene oxide sterilisation	4 loads/ week (170 Litres each)	1460



## Staff

### Hospital Administration

Dr Rupa Sreedhar, Medical Superintendent  
Dr Krishnakumar K  
Associate Medical Superintendent  
Dr Rahul D Nambiar  
Administrative Medical Officer (until 17-09-2021)  
Dr Manju Nair R  
Administrative Medical Officer (since 18-09-2021)  
Ms Archana Rajan D A  
Assistant Administrative Officer (OMS) - A

### Nursing Services

Ms Nirmala M O  
Nursing Superintendent  
Ms Hepzibah Sella Rani J Deputy Nursing  
Superintendent  
Ms Gracy M V, Assistant Nursing Superintendent  
Ms Smitha A S, Assistant Nursing Superintendent  
Ms Anasooya R, Assistant Nursing Superintendent

### Physical Medicine and Rehabilitation

Dr Nitha J, Assistant Professor (until 05-10-2021)  
Dr Jijo Varghese  
Assistant Professor (since 25-11-2021)

### Central Sterile Services Department

Ms Prasannakumari K  
Senior Nursing Officer (Ward)

### Infection Control Unit and Biomedical Waste Management

Ms Shiny Biju, Infection Control Nurse

### Construction Wing

Col (Rtd) Vijayan Pillai K, Construction Engineer

### Security & Safety

Mr Anil Kumar B S, Security & Safety Officer - B

### Dietary

Ms Leena Thomas, Senior Dietician - B  
Ms Jyothi Lekshmy S, Deputy Dietician - A

### Laundry

Mr Umesh Sankar S, Laundry Supervisor - B

### Medical Social Work

Ms Rosamma Manuel, Scientific Officer & In-charge  
OPD services & Patient Management Services  
Dr Jiji T S, Medico Social Worker - A

### Medical Records

Mr Sivaprasad R, Senior Medical Records Officer - A

### Pharmacy

Ms Deepa K Nair, Senior Pharmacist

### Transport

Mr Saji M S, Transport Supervisor



# MEDICAL RECORDS DEPARTMENT

Medical Records Department (MRD) is responsible for collecting, analyzing the data and providing the right information, to the right person at the right time. MRD plays a very important role in Revenue Cycle Management as most of the requirements of governmental and non-governmental schemes, insurance claims etc are dependent on Medical Records. MRD handles a large volume of complex medical record requests for patient treatment, continuous educational programmes, research as well as patient requests for release of information that portals could not handle.

## Activities

- Documentation and updation of socio-economic and socio-demographic data related to patients.
- Processing patient registrations, admissions and maintenance of staggered appointment system.
- Digitization of Medical Records and implementation of Electronic Medical Records.
- Quantitative and qualitative analysis of results.
- ICD-coding and indexing and premedical preservation of records.
- Supporting academic and research activities.
- Generation and management of hospital statistics to administrators and Heads of departments periodically.
- Handling patient care-related correspondence and assisting in tele-consultations.
- Processing and issuance of various certificates, insurance claims and social security papers to patients.
- Online reporting of overseas patients to Foreigner's Regional Registration Officer, and deaths to the Corporation of Thiruvananthapuram.
- Printing, storage and supply of all Medical Records Forms.
- Conducting academic programme in Medical Records Science.

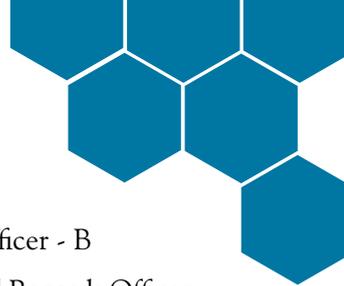
The statistics for the year is summarized in the Table below:

Activity	Number
New Registrations	15838
Admissions	9357
Reviews	125886
Bed Occupancy Rate	70.01%
Bed Turnover Rate	37 discharges/bed
Average length of stay	6 days
Records released for study/research	34835
Certificates processed/ issued	7452
Insurance Claims processed	1059
Records scanned and uploaded	604976
Telemedicine consultations	12793

## Geographic distribution of patients

	Out Patient		In Patient	
Kerala	13135	83.02%	7954	85.39%
Tamil Nadu	2069	13.08%	1046	11.23%
Karnataka	36	0.23%	10	0.11%
Andhra Pradesh	30	0.19%	15	0.16%
Maharashtra	40	0.25%	18	0.19%
Other States	492	3.11%	260	2.79%
Outside India	20	0.13%	12	0.13%
<b>Total</b>	<b>15822</b>	<b>100.00%</b>	<b>9315</b>	<b>100.00%</b>





### **New Initiatives**

1. Launched telemedicine services for patients at the time of COVID-19 pandemic and facilitated safe and structured video-based clinical consultations.
2. Initiated the adoption of electronic medical record with necessary support from Computer Division.

### **Staff**

Mr Sivaprasad R, Senior Medical Records Officer and Central Assistant Public Information Officer (Patient Information)

Ms Susan Jacob, Medical Records Officer - C

Mr Christudas J, Medical Records Officer - B

Ms Manna George, Assistant Medical Records Officer

Ms Manju K. K, Senior Medical Records Assistant

Ms Asha Krishna R O, Medical Records Assistant - B

Ms Suma B, Medical Records Assistant - B

Ms Remya L T, Medical Records Assistant - B

Mr Ragesh D V, Medical Records Assistant - A

Ms Sandhya C K, Medical Records Assistant - A

Ms Suma K K, Medical Records Assistant - A

Ms Sreena T, Medical Records Assistant - A

Mr Sumesh P S, Medical Records Assistant - A



# DIVISION OF NURSING SERVICES

The Nursing Division has a major role in providing highest quality patient care with utmost dedication. The aims of the Division are to: deliver excellent patient care through planning and supervision, provide well-structured staff development programme, serve as health educators and counsellors to patient and families and encourage and facilitate higher education and research activities among nurses. The Division is also engaged in activities for the control and prevention of COVID-19.

## Activities

1. Orientation to the newly joined nurses and cleaning attendants.
2. Training on COVID-19 precautions, hand hygiene, personal protective equipment, cleaning and disinfection.
3. Infection control Link Nurses Meeting - 8 sessions were conducted.
4. Clinical teaching by Nursing Officers in all units were conducted regularly.
5. Precaution dose COVID-19 vaccination was started from 18 February 2022.

## Events Organized

1. Hand Hygiene Day was celebrated on 5 May 2021 (Figure 10). As part of the celebration various programmes were organized: demonstration of hand hygiene and appropriate wearing of masks was conducted for patients and bystanders in the waiting area and hand hygiene awareness posters were displayed in out-patient and in-patient units and knowledge, attitude and practice of staff with regards to hand hygiene was assessed using a questionnaire. A video prepared on appropriate hand hygiene steps was published in the intranet for wider dissemination of the knowledge to the staffs and students of the institute.

2. International Nurses Day was celebrated on 12 May 2021 and Nurses Day Pledge was taken. The theme for 2021 was “Nurses: A voice to lead - A vision for future health care”. Distributed sanitizer and surgical mask to the patients and relatives in patient waiting area.
3. Conducted a National level Conference on “Intracranial aneurysms - Essentials of Nursing Care” in association with the Department of Neurosurgery on 24 July 2021 (Figure 11). 175 participants attended the Conference.
4. On World Heart Day - 29 September 2021, arranged poster presentation for patients and relatives in OPD waiting area and classes were taken by Cardiology consultants (Figure 12). Conducted a Webinar on Cardiac Resynchronization Therapy (CRT).
5. Conducted a webinar on “Stroke Unit Care: Training for nurses” in association with Comprehensive Stroke Care Program on World Stroke Day on 31 October 2021.
6. Webinar on “Mechanical ventilation – From Physiology to Clinical Practice” in association with the Department of Anaesthesiology on 8-9 April 2021.
7. Webinar on “Therapeutic Care Solutions Show - A dedicated technology update program” in continuum of patient care (50 Participants).
8. Training programme on Donning & Doffing of PPE to nursing students and COVID Lab staff by Shiny Biju, Infection Control Nurse (21 participants).

## Awards and Honours

Ms Shani S D, Senior Nursing Officer completed PhD programme from AMCHSS, under the guidance of Professor P Sankara Sarma.



**Staff**

Ms Nirmala M O, Nursing Superintendent  
Ms Hepzibah Sellarani J, Deputy Nursing Superintendent

Ms Gracy M V, Assistant Nursing Superintendent  
Ms Anasooya R, Assistant Nursing Superintendent  
Ms Smitha A S, Assistant Nursing Superintendent



Figure 10. World Hand Hygiene Day

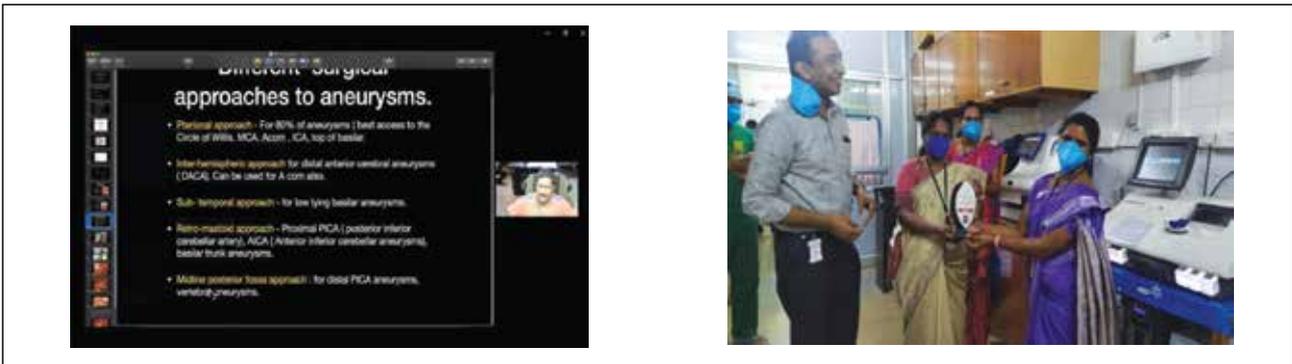


Figure 11. Conference on “Intracranial aneurysms - Essentials of Nursing Care”

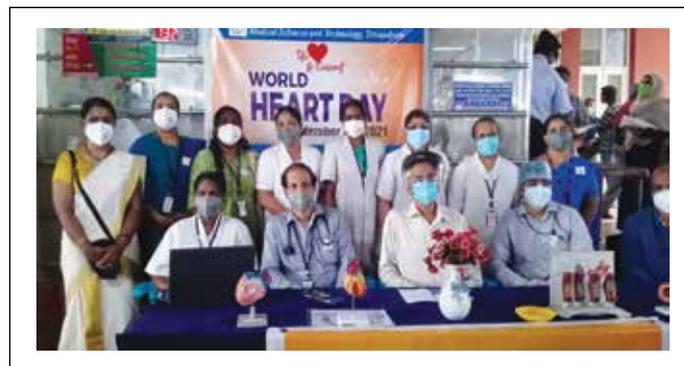


Figure 12. World Heart Day Celebration



# DEPARTMENT OF ANAESTHESIOLOGY

The Department of Anaesthesiology has two Divisions: Division of Cardiothoracic and Vascular Anaesthesiology and Division of Neuroanaesthesiology and Neurocritical care. Both Divisions run 3-year DM Programme and a 2-year Diploma in Operation Theatre and Anaesthesia Technology (DOTAT) in their respective specialities.

## DIVISION OF CARDIOTHORACIC AND VASCULAR ANAESTHESIOLOGY

### Activities

#### Clinical Activities

The Division provided services to patients attending: adult cardiac surgery, paediatric cardiac surgery, vascular and thoracic surgery, cardiology and cardiac radiology departments. The areas of work comprised six cardiac surgical operation theatres, three catheterization laboratories, two DSA labs, two MRI suites and one CT scan room. Cardiac anaesthesiologists rendered critical care services in adult cardiac surgical ICU, paediatric cardiac surgical ICU and Coronary Care Unit. It is a commitment on the part of the Anaesthesiology department to play an active role during cardiopulmonary resuscitations 24 X 7 in the hospital. Code Blue Programme and Code Orange Programme were successfully implemented by the department for resuscitating the patients brought to the hospital. Round-the-clock back up for emergency assistance was ensured by the department for all surgical and major interventional procedures performed at the hospital. Expertise in ventilatory therapy and invasive cannulations was utilised by the anaesthesiologists for the service of patients in the ICUs. Anaesthesiologists also shouldered the responsibility of in-house and inter-hospital transportation of critically ill patients.

The Division updates itself periodically to improve in the areas of monitoring technology and interventional

procedures. Advanced monitoring consisted of 3D and 2D perioperative echocardiography, lung ultrasound, NIRS, fibre-optic bronchoscopy and anaesthesia-depth monitoring. Anaesthesiologists routinely perform procedures such as neuro-axial anaesthesia, ultrasound-guided regional anaesthesia, lung isolation using double-lumen endobronchial tubes and bronchial blockers and percutaneous tracheostomies. Microprocessor-based ventilators with advanced modes of ventilation and display of curves and loops were available in the critical care armamentarium of the Division. Chronic Pain and Geriatric Care Unit was run by the Division to alleviate suffering from chronic pain and geriatric diseases. During COVID-19 pandemic, anaesthesiologists strictly followed perioperative COVID-protocols.

The Cardiothoracic and Vascular Anaesthesiology Division dispensed perioperative care for the following surgeries and diagnostic and interventional procedures during the year:

Area	Number of surgeries/ procedures
Adult Cardiac surgery OT	1155
Paediatric cardiac surgery OT	640
Cardiac Catheterization Laboratory	399
Cardiac Electrophysiology Laboratory	147
CT scan room	64
MRI	12
ICU procedures	1120
<b>Total</b>	<b>3537</b>





### **Academic Activities**

All faculty members conduct bedside teaching and training in the perioperative period. Resident doctors were given psychomotor training in performing minimum number of hands-on procedures under the supervision of faculty members. The Division conducted a structured academic programme on all working Saturdays. Academic sessions included seminars, symposia, case presentation, journal club, pro-con sessions, presentation of meta-analysis and problem-based discussions. Online academic activities were organised during the COVID-19 pandemic.

### **Research Activities**

The faculty members and resident doctors were actively involved in research activities. Some of the projects received intramural funding. Research was performed in the areas of clinical work and biomedical technology. Important projects are summarized below:

#### **Ongoing Projects:**

1. The Project “Universal device for lung isolation” using bronchial blockers was processed and submitted for design patent (PI: Dr Suneel P R).
2. Team member in the development of platelet concentrator and segregator. The project is now being jointly developed by SCTIMST and Phraction Scientifics Pvt. Ltd. (PI: Dr Suneel P R).
3. “Comprehensive and novel model for health care on geriatric pain conditions in India”. Implementing a unique 5-year comprehensive programme model approach on chronic musculoskeletal and neuropathic pain conditions for elderly aiming at point integrated health solutions (regenerative therapy services, rehabilitation & research) in pain care. This project involves all three Wings of the institute for the execution of this project in a staged and phased manner. (PI: Dr Subin Sukesan).
4. SEED /TIDE Project for diabetic foot offloading device- Bio-inspired total foot pressure off-loading device for diabetic foot ulcer management in geriatric population (PI: Dr Subin Sukesan).
5. SEED/TIDE Project: Development of stance control knee ankle foot orthosis (SKAFO) for knee instability management (PI: Dr Subin Sukesan).
6. New Orthosis device development with TYNOR Orthotics Pvt. Ltd. “Athmanirbhar Bharat” initiative (Clinical PI: Dr Subin Sukesan):
7. Phraction Scientifics Pvt. Ltd. - Technology readiness level 4 medical device,- regenerative therapeutic aspects (Clinical PI: Dr Subin Sukesan, DST BIRAC- BIG Funding).
8. Multicentre study on Chitra heart valve prosthesis involving SCTIMST, AIIMS, New Delhi and PGIMER, Chandigarh (PI: Drs Saravana Babu and Shrinivas G).
9. Femoral artery cannulation in paediatric population; conventional versus ultrasound-guided; a single centre, prospective, randomized controlled trial.
10. An ultrasound-based comparison of postoperative respiratory outcome after paediatric congenital heart surgery in COVID-19 recovered patients and COVID-19 unaffected patients - An observational pilot study.
11. Effect of sevoflurane versus propofol on strain quantification in patients with severe aortic stenosis undergoing aortic valve replacement.
12. Evaluation of mitral annular displacement using speckle tracking: Effects of sevoflurane versus propofol on left ventricular longitudinal function.
13. Role of new PaO<sub>2</sub>/FiO<sub>2</sub> X PEEP) {P/FP ratio} and static lung compliance in fast tracking cardiac surgery.
14. Comparison between intravenous and inhalational anaesthetic induction agents on echocardiographic parameters of mitral stenosis patients undergoing mitral valve replacement surgery.
15. Femoral artery cannulation in paediatric population with and without ultrasound - A single centre prospective randomized controlled trial.



16. TEE probe insertion under video laryngoscope guidance - A multicentre randomized controlled trial.
17. Comparison of TIVA Vs inhalational maintenance of anaesthesia on CPB for early postoperative delirium in adult cardiac surgery. A prospective randomized single blinded study.
18. Correlation between renal NIRS and renal resistance index in predicting postoperative AKI- A prospective observational study

### Completed Projects

1. Comparison of transoesophageal echocardiography - guided modified 2-dimensional and M-mode tricuspid annular plane systolic excursions with transthoracic echocardiography-guided M-mode tricuspid annular plane systolic excursion in adult and paediatric cardiac surgeries for assessment of right ventricular function-completed
2. Assessment of diastolic function in paediatric Tetralogy of Fallot patients - an intraoperative transoesophageal echocardiographic study.
3. Use of video laryngoscope to reduce complications of transoesophageal echocardiography probe insertion: a multi-centre randomised controlled study.

### New Initiatives

1. A patent was filed for “Biological fluids component separator and mechanism thereof”. MoU was signed by Dr Ajit Kumar V K, Director, SCTIMST and Mr Asok Sreedhar, Director, Phraction Scientifics Pvt. Ltd. for development of biological fluid component separator and segregator on 31 March 2022.
2. The new specialised Geriatric Pain Care and Regenerative Intervention Services (GPCRIS) OPD was inaugurated on 15 April 2021 under the multidisciplinary Pain Clinic (Figure 13). A MOU was signed between SCTIMST and KUSUMA Trust UK.
3. Clinical and Research collaboration with IIT



Figure 13. Inauguration of the GPCRIS OPD

Kanpur for research involvement for osteoarthritis pain involving regenerative autologous therapies, Startup Tech talks and clinical mentoring sessions. Nodal co-ordination for newer medical device technology development and industrial translation.

### Awards and Honours

1. Dr Markose L Paret, Senior Resident, was 1st runner-up for presentation titled “Ultrasound-guided bilateral pecto-intercostal facial block: Role as a pre-emptive analgesics adjunct in fast tracking for mitigating postoperative sternotomy pain” at IACTACON, Madurai, in March 2022.
2. Dr Saravana Babu, Assistant Professor is undergoing international Clinical Fellowship in Cardiovascular Anaesthesia and Critical Care at Toronto General Hospital, Canada. He is receiving advanced training in perioperative care for aortic root repair or replacement, ventricular assist devices, Heart and lung transplants, TEVAR and ECMO.

### DIVISION OF NEUROANAESTHESIOLOGY AND NEUROCRITICAL CARE

Neuroanesthesia Division is involved in the perioperative management of patients with various neurological diseases for neurosurgical, neurovascular and neurological interventional procedures, critical care of the above group of patients as well as involvement in diagnostic modalities like CT scans, MRI, Digital Subtraction Angiography requiring anesthesia support. In addition, the Division is also actively involved in resuscitation of hospital patients, transport of critically ill, acute pain management, infection control and safe blood transfusion practices.

The faculty are involved in teaching residents and students as well as various research activities in patient care and biomedical device development

## Activities

### Clinical Activities

The clinical activities are summarized in the Table below:

Area	Number
Neuro-surgery operating room	1250
Radiology Cath Lab	190
MRI	386
Acute Stroke	40
Neuro ICU	1400
Wards/OPD : Resuscitations, IV and LP, Consultations, muscle biopsies, CT and MRI	-

### Research Activities

#### Ongoing

1. Development of low-cost portable defibrillator (PI: Dr S Manikandan, Funding Agency: DST).
2. Development of autonomic function monitor for pain monitoring (PI: Dr S Manikandan, Funding Agency: TRC, SCTIMST).
3. Non-opioid versus opioid perioperative analgesia in neurosurgery: A prospective multi-centric randomized controlled trial (PI: Dr S Manikandan, Funding Agency: ICMR).
4. Development of device for non-invasive continuous measurement of jugular venous saturation (Clinical PI: Dr S Manikandan, Funding Agency: DST).
5. Cognitive decline in elderly- a randomized controlled trial in patients with chronic subdural hematoma (PI: Dr Smita V, Funding Agency: CSRI Programme, DST)
6. Development of a spinal cord stimulator for pain management (PI: Dr Ajayprasad Hrishi, Funding Agency: TRC, SCTIMST).

7. Design and development of a microdialysis set-up for cerebral applications (Co-PI: Dr Ajayprasad Hrishi, Funding Agency: TDF, SCTIMST).
8. Comparison of depth of anaesthesia indices (SNAP vs. Bispectral index) during desflurane general anaesthesia and awakening in patients undergoing interventional neuroradiology procedures (PI: Dr Ajayprasad Hrishi, Funding Agency: Bellscurallc).
9. 15 intramural projects were underway.

#### Completed

1. Chitra Acrylosorb fluid solidification system (Co-PI: Dr Ajayprasad Hrishi, Funding Agency: TRC, SCTIMST).
2. Comparison of the efficacy of virtual airway assessment and physical airway examination as part of the pre-anaesthetic evaluation of patients presenting for neurosurgery with relevance to COVID-19 pandemic - A prospective observational study (PI: Dr Ajayprasad Hrishi, Funding Agency: SNACS).

### Events Organized

Dr S Manikandan organized the CME and awareness activities on Head Injury Awareness Program for intensivists and allied health care personnel across the country in a Virtual program under Society of Neurocritical Care on World Head Injury Awareness Day on 20 March 2022.

### Awards and Honours

1. Dr Sapna Suresh, Senior Resident, won the best paper presentation at the annual conference of the Indian Society of Anaesthesiologists, Kerala Chapter held in December 2021.
2. Dr Jeeva George, Senior Resident, won the best paper presentation at the annual conference of the Indian society of Neuroanaesthesia and Critical Care held in Kolkata in January 2022.
3. Drs Salini Varma and Aiswarya Sree won 2nd Prize in the Quiz competition at the annual



Neurocritical Conference (NCSI) held in August 2021 at NIMHANS, Bengaluru.

4. Dr Ajay Prasad Hrishi, Associate Professor, completed Fellowship in Neuroanaesthesia and Neurocritical care from Oxford University Hospitals, Oxford, United Kingdom.



Figure 14. Planning for deep brain stimulation surgery under Monitored Anesthesia Care



Figure 15. Combined transnasal and intracranial surgery with two teams operating simultaneously in a skull base tumor excision

## Staff

### Faculty

Dr Shrinivas V Gadhinglajkar  
Professor and Head of the Department  
Dr Rupa Sreedhar, Professor (Senior Grade)  
Dr Thomas Koshy, Professor (Senior Grade)  
Dr Prasanta Kumar Dash, Professor  
Dr Manikandan S, Professor  
Dr P R Suneel, Professor  
Dr K P Unnikrishnan, Professor  
Dr Smita V, Additional Professor  
Dr Subin Sukesan, Additional Professor  
Dr Ajay Prasad Hrishi P, Associate Professor  
Dr Unnikrishnan P, Associate Professor  
Dr Ranganatha Praveen, Associate Professor  
Dr Saravana Babu M S, Assistant Professor

### Technical

Binu Thomas, Senior Scientific Assistant  
Shibu V S, Senior Technical Assistant  
BaijuBavura S, Senior Technical Assistant  
Tiny Babu, Senior Technical Assistant  
Pradeep S L, Senior Technical Assistant  
Sumesh T M, Senior Technical Assistant  
Damodara Sarma E, Technical Assistant - B  
Archana S, Technical Assistant - A  
Manju R S, Technical Assistant - A

# DEPARTMENT OF BIOCHEMISTRY

The Department of Biochemistry has three Sections: (a) Research laboratories (b) Central Clinical Laboratory (CCL) and (c) Molecular Genetics Unit (MGU).

The research laboratories have been pursuing the molecular basis of disease processes affecting the vascular system leading to neurological and cardiovascular disorders. The main areas under investigation include: a) impact of autophagy modulators on cardiac mitochondrial metabolism b) changes in mitochondrial metabolism in glioma cells under hyperglycemia c) exosomal microRNA and proteins in neurodegenerative disease d) Glucocerebrosidase assay development for the assessment of lysosomal dysfunction in neuronal disorders e) S100 proteins and cardiac fibrosis.

The Central Clinical Laboratory undertakes the laboratory diagnostics for the institute in areas of biochemistry, haematology, clinical pathology and amino acid analysis.

Molecular Genetics Unit (MGU) undertakes molecular testing including mutation/SNP using Sanger sequencing.

## Activities

### Clinical Activities

#### 1. Central Clinical Laboratory

Fully automated equipment used at CCL include: Dade-Behring/Siemens RXL, Aspen A1c HPLC Analyzer LD 500, Mindray 5-part Hematology Analyzer-BC 5180 and BC 5000, Gem Premier 3000-ABG analyzer, CobasU 411 (Roche) Urine Analyzer and Amax Destiny Coagulation Analyzer. The Central Clinical Laboratory performed a total of 867194 investigations during the year which are summarized in the Table below:

Investigations	Number
General Chemistry	403932
Hematology and Coagulation	296733
Clinical Pathology (CSF, Stool, Urine)	141817
Arterial Blood Gas	22570
Plasma Amino Acids	2124
Neurochemistry	18
<b>Total</b>	<b>867194</b>

#### 2. Molecular Genetics Unit

Sanger sequencing for single mutation/SNP was performed at MGU. A total of 159 Sanger sequencing tests were performed during the year.

#### Research Activities

The research laboratories supervised by faculty members were together training 5 PhD students. The training included mandatory seminars and work presentation on Tuesday, mid-course comprehensive examinations and PhD thesis preparation.

#### 1. Impact of autophagy modulators on cardiac mitochondrial metabolism

Autophagy, a degradative cellular process has proven to play a critical role in cellular and tissue health, especially in postmitotic tissues like myocardium, where terminally differentiated cardiomyocytes are the functional players. Thus, any impairment could have an enormous impact on muscle function. Pharmacological modulators of autophagy are being increasingly used in clinical conditions, as well as for research purposes. One such agent is chloroquine, the anti-malarial drug, being recently used as an effective anticancer agent, either alone or in combination with other drugs. However, the effect of these agents on the mitochondrial bioenergetics, particularly in



cardiac muscle cells remains elusive. It is well-known that cardiomyocytes rely heavily on mitochondrial OXPHOS for their function and survival and its impairment can lead to muscle damage. Our results shows that pharmacologic modulators of autophagy influence mitochondrial dynamics (Figure 16), mitochondrial function (Figure 17) and mitochondrial ROS production (Figure 18), which could ultimately impact the cardiac function.

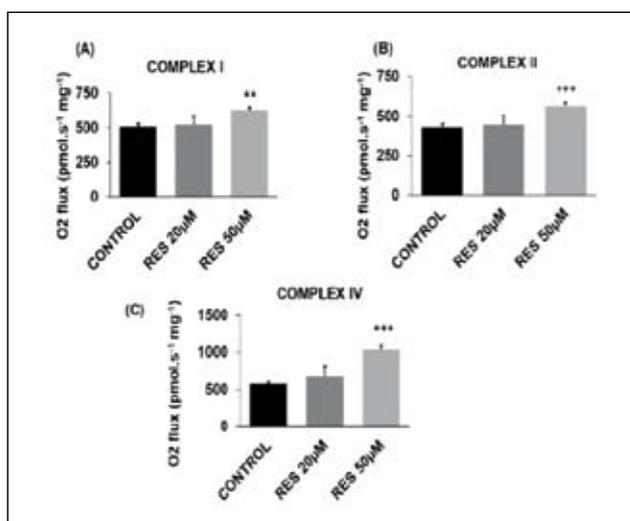


Figure 16. Substrate-linked respiration of cardiomyoblasts post Resveratrol

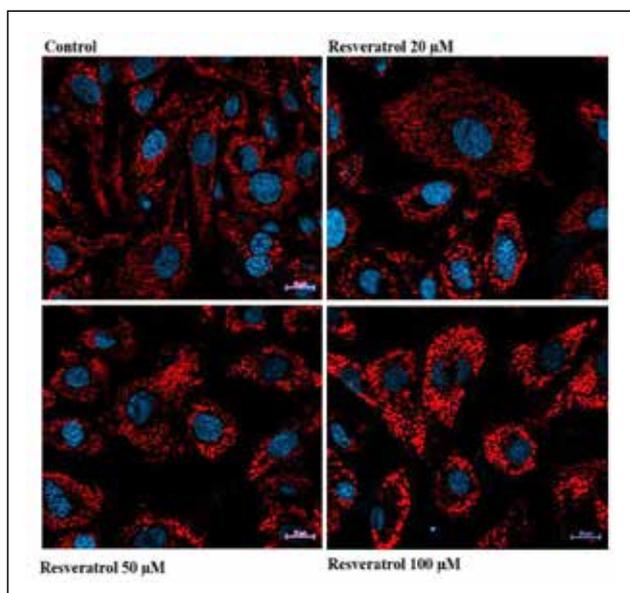


Figure 17. TMRE staining for mitochondrial membrane potential - Resveratrol's dose dependent

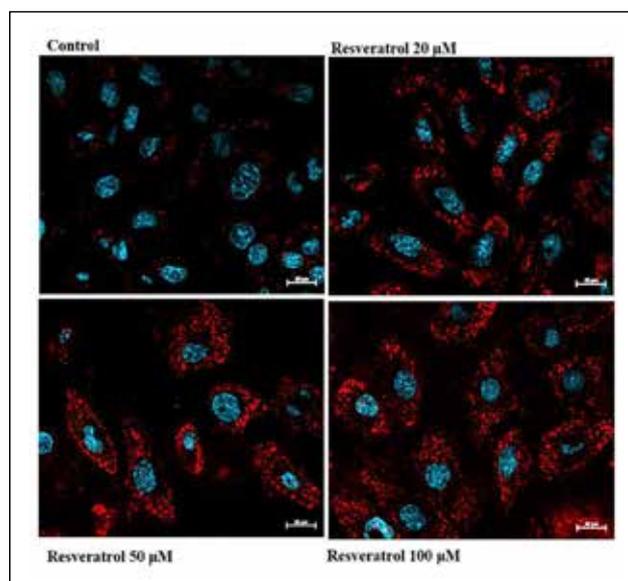


Figure 18. MitoSox Red for mitochondrial ROS - mitochondrial superoxide levels were analysed 24h post Resveratrol treatment

## 2. Changes in mitochondrial metabolism in glioma cells under hyperglycemia

The hyperglycemic stress in glioma caused the reduction in mitochondrial oxidative phosphorylation i.e., increased Warburg effect, and thus could contribute towards the aggressiveness and metastasis. We determined the molecular events that cause decline in mitochondrial dependency and, checked if the modulation of the key cellular quality control process of cells can help revert the changes induced by the hyperglycemic stress (Figure 19).

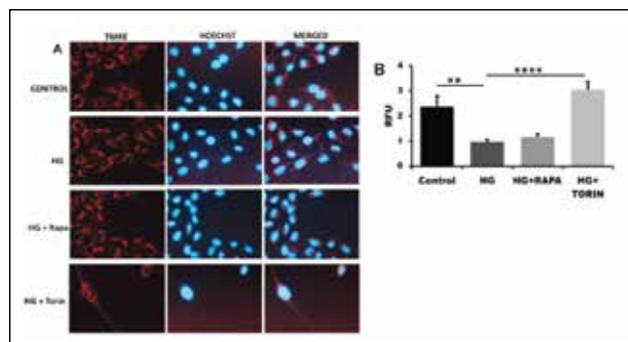


Figure 19. TMRE imaging to assess the mitochondrial membrane potential under High Glucose (HG) condition with autophagy activators, Rapamycin (RAPA) and Torin. (A) Quantification of the TMRE fluorescent image (B).

### 3. Exosomal miRNA and protein profiling in Parkinson's disease

The main objective of this study was to identify dysregulated miRNA and proteins in neuronal-derived exosomes isolated from plasma of patients with Parkinson's disease using next-generation sequencing and mass spectrometry. Towards this, total plasma exosomes were isolated using ultracentrifugation and/or commercially available kits. Figure 20A, 20B show the Coomassie (SDS-PAGE) and Ponceau S stained images of proteins in the total exosomal preparation. The morphological characteristics of isolated exosomes were analyzed using transmission electron microscopy (Figure 20C) and the homogeneity of exosomes was analyzed by dynamic light scattering (Figure 20D).

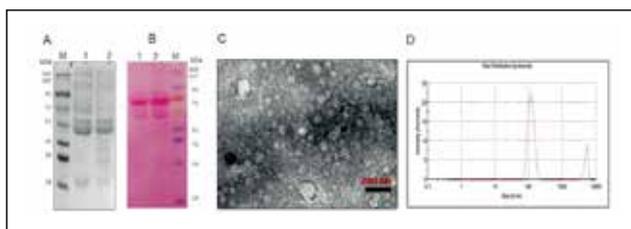


Figure 20. Neuronal-derived exosomes from patients with Parkinson's disease

### 4. Glucocerebrosidase assay development for monitoring lysosomal dysfunction

The susceptibility of a person with defective lysosomal function, even in the absence of any gene mutation, to neurodegenerative disease development or disease progression cannot be predicted by the existing biochemical assays or genetic testing. Therefore, development of a specific and sensitive biochemical assay is critical for monitoring the lysosomal function in age-related diseases. The modified assay will be validated using samples from Parkinson's disease patients where an inverse correlation between GCCase activity and  $\alpha$ -synuclein accumulation has been reported. This study is expected to provide accurate values of GCCase activity that could be used as an indicator of lysosomal functional status in our population.

A total of 213 plasma samples were collected from patients at diagnosis of Parkinson's disease (PD; n = 145), progressive supra nuclear palsy (PSP; n = 59), multiple system atrophy (MSA; n=2), amyotrophic lateral sclerosis (ALS; n = 7) and healthy donors (n = 27). The clinical and demographic details of samples collected are shown in Figure 21.

	Controls	PD patients
n (gender)	N=27 (15F, 12M)	N=145 (46F, 99M)
Age (range)	38.2±9.3	56.8±10.4
Age at onset (years)	-	50.3±11.5
Disease duration (years)	-	7.3±5.5
MoCA	-	25.2±4.3
H&Y scale	-	2.04 ± 0.78
UPDRS scale III	-	20.7 ± 11.8

MoCA - Montreal Cognitive Assessment; H&Y- Hoehn and Yahr; UPDRS - Unified Parkinson's Disease Rating Scale; N - total number of samples, F - Female, M - Male

Figure 21. Demographic and clinical details of samples from Parkinson's disease and controls

The results illustrated in Figure 22 indicate the mean  $\pm$  SD of absolute glucocerebrosidase activity in PD patients to be  $3.39 \pm 1.76$  nmols/ $10^7$  WBC/hr and those of controls as  $3.83 \pm 1.39$  nmols/ $10^7$  WBC/hr.

	GCCase Activity (nmols/ $10^7$ WBC/hr)		
	GCCase activity (-CBE)	GCCase activity (+CBE)	Absolute GCCase activity
PD Patients	3.95±1.76	0.57±0.61	3.39±1.76
Controls	4.50±1.29	0.67±0.76	3.83±1.39

Figure 22. Mean  $\pm$  SD glucocerebrosidase activity in PD patients and healthy controls. GCCase activity is expressed in nanomoles of glucose hydrolysed from 4-MUG (4-methylumbelliferyl-*-D*-glucopyranoside), per  $10^7$  leukocytes, per hour.

### 5. S100 proteins and cardiac fibrosis

Heart failure has emerged as a global disease with age, diabetes and obesity identified as important risk factors. Even after identification of several molecular targets, only very few have been developed as therapy for heart failure. This study investigates whether the levels of S100 proteins in heart failure patients can be associated with the disease. The molecular mechanism of action of S100 proteins is also being studied using an *in vitro* model.





## Other Activities

### 1. COVID- 19 testing at SCTIMST

The Faculty of the Department:

- Participated in discussions with private medical colleges in Kerala for setting up BSL-2 level RT-PCR Laboratories and participated in ICMR-MCI-NABL-Mentee Institute Meeting.
- Participated in the online discussion on “Onboarding of government and private medical colleges to ICMR, RT-PCR for Covid-19 testing network”, organized by the Department of Health Research, Ministry of Health and Family Welfare.
- Attended the COVID vaccine-related discussion with District Collector at Government Medical College, Trivandrum.
- As Members of Technical Committee, evaluated the VTM and RNA kits from various companies, as part of the procurement procedure of KMSCL, at the State Public Health Laboratory.
- Selection Committee Members for the recruitment of Research Officer, Data Entry Operator and Laboratory Assistant for COVID Lab
- Attended Online meeting for COVID-19 genome sequencing in Kerala, organized by Joint Secretary to Government, Department of Health and Family Welfare, Government of Kerala.

### 2. Vaccination at SCTIMST

The Department of Biochemistry co-ordinated the COVID-19 Vaccination Programme for staff, students, pensioners and dependents of the institute. The vaccines were administered at Molecular Genetics Unit with a support team comprising doctors, nursing officers, social workers, administrative staff and security staff of the institute. A total of 4425 doses (covering the first, second and third dose of almost all the staff and students of the institute) of Covishield was administered during the programme.

## Staff

### Faculty

Dr Srinivas G  
Scientist G and Head of the Department  
Dr Madhusoodanan U K, Assistant Professor  
Dr Cibin T R, Assistant Professor

### Technical

Jayasree K K, Scientific Officer (Lab)  
Dr Geetha M, Junior Scientific Officer (Lab)  
Vijayalekshmi L, Junior Technical Officer (Lab)  
Sumitha K C, Technical Assistant (Lab) - B  
Santhosh Kumar R, Technical Assistant (Lab) - B  
Sheeja M, Technical Assistant (Lab) - B  
Sreedevi V S, Technical Assistant (Lab) - B  
Dr Deepa D, Technical Assistant (Lab) - B  
Sreekala Balan P, Technical Assistant (Lab) - B  
Manju G Nair, Technical Assistant (Lab) - B  
Saritha Gopakumar, Technical Assistant (Lab) - A  
Sunitha S, Technical Assistant (Lab) - A  
Siju K S, Technical Assistant (Lab) - A  
Divya T Nair, Technical Assistant (Lab) - A  
Anooja V, Technical Assistant (Lab) - A  
Mangalamma H R, Technical Assistant (Lab) - A  
Valsala B, Senior Unit Assistant  
Shaji V, Unit Helper - A  
Shamnad J, Cleaning Attendant - A



# DEPARTMENT OF CARDIOLOGY

The Department of Cardiology comprises the Divisions of:

1. Adult Cardiology and Interventions
2. Cardiac Electrophysiology
3. Paediatric Cardiology

## DIVISION OF ADULT CARDIOLOGY AND INTERVENTIONS

The Division offers its expertise in risk stratification, prevention and comprehensive management of cardiac ailments affecting the adult population such as coronary heart diseases, valvular and structural heart diseases, heart failure and grown-up congenital heart diseases. The Division is actively involved in research – both basic science and clinical in these domains and imparts formal training to doctors for their Post-doctoral degrees and Fellowships.

### Activities

#### Clinical Activities

The Division offers evaluation and state-of-the-art management of all types of coronary and structural heart interventions and continues to be a referral centre for the region. The patients presenting to the outpatient department are evaluated clinically along with basic non-invasive investigations on the same day with the formulation of a management strategy.

#### 1. Non-invasive testing

- Echocardiography including advanced echocardiographic methods like trans-esophageal echocardiography, tissue Doppler imaging, strain, speckled tracking, 3D echocardiography (trans-thoracic and trans-esophageal). Currently, there are five echocardiography machines available in the Department of Cardiology.
- Stress testing- tread mill exercise electrocardiogram

and Dobutamine stress echocardiography.

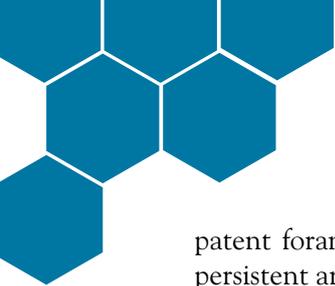
#### 2. Invasive diagnostic facilities

- Diagnostic cardiac catheterization and angiography: The department has two cardiac catheterization laboratories installed presently, where various diagnostic and interventional cardiac catheterizations are undertaken. Digital Subtraction Angiography is also available for imaging of vascular structures.
- Intravascular Ultrasound Imaging - for anatomical evaluation of coronary stenosis and optimization of coronary stenting.
- Optical Coherence Tomography (OCT) - used routinely to assess coronary plaque characteristics and decision making in management.
- Coronary physiology for functional assessment of coronary lesions – Hyperaemic (FFR) and Non-hyperaemic indices (RFR, iFR) are routinely undertaken
- Intra-cardiac echocardiography - used to aid in device closure of atrial septal defects.

#### 3. Interventional cardio-vascular procedures offered include:

- Percutaneous coronary interventions - both emergent and elective, including advanced interventions with rotational atherectomy support. The procedures are guided by physiological evaluation and imaging by OCT and IVUS.
- Percutaneous balloon valvotomies (mitral, aortic and pulmonary). This service is also offered for pregnant patients with valvular heart diseases, in collaboration with the SAT Hospital, Government Medical College, Trivandrum.
- Percutaneous closure of atrial septal defects,





patent foramen ovale, ventricular septal defects, persistent arterial ducts in adult, ruptured sinus of Valsalva aneurysm, para-prosthetic valvular leak, coronary-cameral fistula, arterio-venous fistula, pulmonary arterio-venous fistula, among others.

- Percutaneous implantation of IVC filter
- Intra-aortic balloon pump counter pulsation, which is used to support hemodynamically unstable patients.
- In addition to the routine OP Clinics, the Division runs the Heart Failure Clinic weekly and Interventional Cardiology Clinic twice a week.

### **Academic Activities**

The Division offers the following programmes where in the candidates are given exposure to various aspects of practice of Interventional Cardiology:

#### *1. Post-Doctoral Fellowship in Adult Cardiology and Interventions - 2 positions*

One year programme after completion of DM Cardiology. The programme involves hands-on training in all diagnostic aspects of adult cardiac care as well as interventional cardiac catheterizations. The fellowship provides ample opportunities for professional and academic enhancement including research projects and publication/ presentation of scientific papers.

#### *2. Residency in Cardiology*

DM Cardiology residents are trained in various aspects of cardiac care including clinical cardiology, various non-invasive diagnostic methods and protocols, work up and management of patients with various ailments, work up of patients for invasive procedures, interpretation and analysis of various hemodynamic data, performance of invasive cardiac procedures including hands-on training wherever applicable.

#### *3. Technicians Programme - PG Diploma in Cardiac Laboratory Technology*

The students enrolling for the technician courses in Cardiology are imparted training on

the performance and maintenance of various modalities.

4. Nursing students – Post-basic nursing programme in cardiology.
5. The Division conducts dedicated sessions on interventional cardiology and device to DM cardiology residents and fellows every Wednesday.
6. The Division also actively participates in the weekly MRI meet along with the ISIR department.

### **Research Activities**

#### *Newly initiated Projects:*

1. Development of a semi-automatic angiography system for facilitating coronary angiography and angioplasty in collaboration with Biomedical Technology Wing (Investigator: Dr Bijulal S, Funding Agency: TDF).
2. Novel technique of developing trans catheter heart valve from human homograft for percutaneous pulmonary valve replacement in collaboration with Biomedical Technology Wing and Department of CVTS (Investigator: Dr Bijulal S).
3. Non-invasive measurement and monitoring of pulmonary congestion in emergency rooms - joint Project with NIT Calicut (Clinical PI: Dr Harikrishnan S, Funding Agency: Device Development Programme, DST).
4. MERETHON RCT: A prospective open label multicentre, randomised, non-inferiority clinical trial to compare safety and performance of Meres100 sirolimus eluting bioresorbable vascular scaffolding system versus contemporary DES platforms in patients with de novo coronary artery lesions (PI - Dr Abhilash S P).
5. The animal studies on TiN-coated Chitra coronary stent started at BMT Wing.

#### *Ongoing Projects*

1. Centre for Advanced Research and Excellence (CARE) in Heart Failure (HF)



The ICMR Centre for Advanced Research and Excellence (CARE) in Heart Failure (HF) with a funding of INR 5 Crore is one of the flagship research initiatives of the Department. Seven research projects were under the umbrella of this programme.

- The National HF database with nearly 25000 patients from different parts of the country.
- National HF Biobank Facility

The first in the country provides state-of-the-art storage facilities for bio samples of patients with heart failure and was inaugurated in August 2021.

- The genetic study in patients and family members of hypertrophic cardiomyopathy continued with identification of novel mutations which are going to be validated by Sanger sequencing.
- Other nationwide multicentric research activities including assessment of economic impact of heart failure, development of a new tool for assessment of quality of life (QOL) in Indian patients, and a 2x2 factorial trial on HF management is ongoing as part of CARE-HF.
- Development of a point-of-care device for estimating biomarkers (NT Pro-BNP) in patients with heart failure in collaboration with Biomedical Technology Wing of our institute and Rajiv Gandhi Centre for Biotechnology.

2. National Heart Failure Registry (NHFR) - 9 nodal centres, 54 sub centres across 24 states across India (PI: Dr Harikrishnan S, Funding Agency: ICMR)
3. Trivandrum Heart Failure Cohort (PI: Dr Harikrishnan S, Funding Agency: ICMR)
4. Prognostic value of circulating microRNAs in heart failure (PI: Dr Sanjay G, Funding Agency: ICMR)

### **Networking with other institutions**

The following MoU were executed with:

1. InStem Bengaluru (DBT institute) to collaborate on “Genetics of Cardiomyopathy” in the Centre for Advanced Research and Excellence (CARE) in Heart Failure.
2. NIT Calicut for the project “Non-invasive measurement and monitoring of pulmonary congestion”. This project is in collaboration with Department. of Clinical Engineering, SCTIMST and Department of Electronics and Communication Engineering, NIT Calicut.
3. IIT-Madras for joint research on “Molecular genetics of myocardial infarction” in the Centre for Advanced Research and Excellence (CARE) in Heart Failure.

### **Patent**

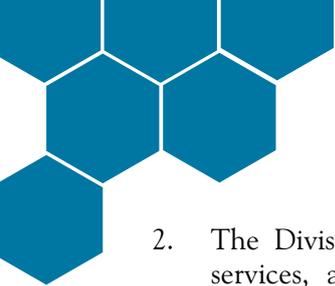
An Indian Patent was filed (Number – 202141037246) for a device with AI interface for predicting dosage of vitamin K antagonists for managing oral anticoagulant drugs. (Dr Harikrishnan S et al).

### **New Initiatives**

1. The National Heart Failure Biobank (Figure 23) under the CARE-HF initiative, provides state-of-the-art storage facilities and was inaugurated virtually by Dr Balram Bhargava, DG ICMR and Secretary DHR on 5 August 2021.



Figure 23. National Heart Failure Biobank

- 
2. The Division started Intravascular Lithotripsy services, a novel technique for treatment of calcific coronary lesions in February 2022.

### Events Organized

1. Heart Failure Clinics - monthly online PG training programme in cardiology, involving all major teaching institutes in the country. This was conceptualised and this initiative is under Heart Failure Association of India with Dr Harikrishnan S as one of the Course Directors and Dr Arun Gopalakrishnan as one of the Course Co-ordinators. Completed monthly programmes for 2021 and the next cycle for 2022 was ongoing.
2. The Annual National conference of Heart Failure Association of India – HFAI 2022 Hybrid was held on 11-13 February. Dr Harikrishnan S was the Organising Secretary and Dr Arun Gopalakrishnan was the Joint Organising Secretary. Seven international faculty from Heart Failure Association of ESC and Heart Failure Society of America participated in the meeting. About 5000 delegates attended the meeting online.
3. “Heart Failure Conflux”, an online event was organised by the ICMR Centre of Excellence in Heart Failure, SCTIMST, in collaboration with Heart Failure Association of India and the Indian Section of the International Academy of Cardiovascular Sciences on 4-5 February 2022. In the event, basic researchers and clinician-researchers discussed how to have better interaction and ways to remove roadblocks for collaborative research. Dr Harikrishnan S, Professor, Department of Cardiology was the Organising Secretary.

### Awards and Honours

1. Dr Harikrishnan.S was conferred the Fellowship of the National Academy of Medical Sciences – FAMS at the convocation held on 7 August 2021.
2. CSI National Innovation Award – Finalist: The mobile application “A machine learning model and mobile application tool to aid in prediction

of dosage of vitamin K antagonists in patients from India.” developed jointly by SCTIMST and NIT Calicut was selected as the finalist for the CSI National Innovation Award.

### DIVISION OF CARDIAC ELECTROPHYSIOLOGY

The Division of Cardiac Electrophysiology (EP) is one of the premier services of its kind in the country devoted to the care of patients with abnormalities in heart rhythm. The EP Division of the institute has been recognized at international level in the evaluation and treatment of cardiac arrhythmias for its clinical, academic and research activities. The Division takes care of patients at risk for sudden cardiac death and patients with heart failure who may potentially benefit from device-based therapy as well. The Division offers a full range of diagnostic and therapeutic services from simple to extremely complicated and life-threatening arrhythmias.

#### Activities

##### *Clinical Activities*

The Electrophysiology Programme in the department undertakes over 800 cases of pacemaker implants and electrophysiological studies supplemented by radiofrequency ablation each year. Catheter-guided electrophysiology testing and radiofrequency ablation is provided to patients with various cardiac rhythm disorders like atrioventricular re-entry (AVRT), atrioventricular nodal re-entry (AVNRT), atrial tachycardia, atrial flutters, atrial fibrillation and ventricular tachycardias (Figure 24).

Our Electrophysiology Division is equipped with a dedicated Cardiac Electrophysiology Laboratory with state-of-the-art 240-channel intracardiac ECG monitoring system (BARD-EP LAB SYSTEM PRO) and the 3D Electro anatomic mapping system (EnSite system and CARTO-RMT Version 3). SCTIMST is one of the leading centres in the country for advanced 3D electro anatomical mapping facilities for arrhythmia management with an annual turnover of over 150 cases.



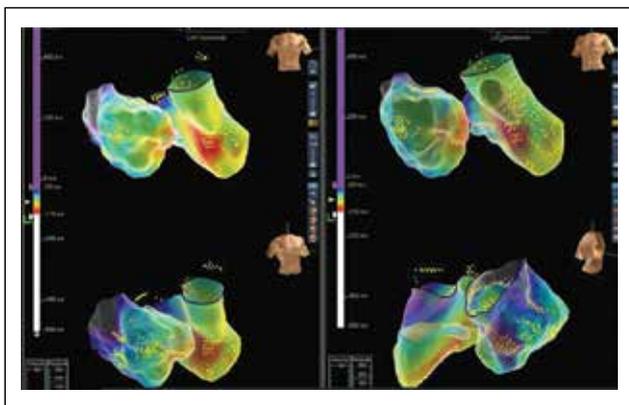


Figure 24. An example of successful case of “3D guided LOT CRT” case done in 2022 in a case of CCTGA. This is an innovative technique for treatment of this condition.

The Division is also one of the Centres with largest experience in managing paediatric arrhythmias in the country.

With the availability of the Cryoablation Facility, our Centre is the only public sector hospital in the country to have this as an adjuvant to the ablation of complex arrhythmias like atrial fibrillation.

The Division also undertakes device implantation therapies, like single and dual chamber implants, regularly. Significant experience in conduction system pacing is one specialty of our Division. The Division regularly performs intracardiac cardioverter-defibrillator implantations for recurrent ventricular tachycardias not amenable to radiofrequency ablation and biventricular pacing therapies (cardiac resynchronization therapy) for congestive heart failure.

Apart from these, the Electrophysiology Division maintains a non-invasive Cardiac Laboratory which has a 24-hour Holter System with advanced features. The Division also performs the Head-up-tilt-table test (HUTT), an essential test in the diagnostic evaluation of syncope. The additional diagnostic evaluations in the Electrophysiology Lab include assessment of sinus nodal and AV nodal functions, assessment of inducibility of ventricular tachycardia, drug challenge (flecainide, adrenaline), tests for channelopathies, autonomic function tests and implantation of loop recorders.

Electrophysiology Division offers comprehensive care to patients with arrhythmia ranging from foetus to elderly. Service of the Division is available as outpatient (new and review), in-patient, ICU and invasive EP facility round-the-clock.

- Comprehensive Device and Arrhythmia Clinic run every Thursday is dedicated to optimization and follow up of patients with complex cardiac devices like CRT, AICD conduction system pacing and combo device.
- EP Clinic and VT Clinic are the new arrhythmia clinic for review of patients with complex arrhythmia. They are run on Thursdays in Speciality Clinics.
- The Pacemaker Follow-Up Clinic is run every Tuesday for meticulous programming of these devices to ensure optimal clinical utility and battery management.

#### Academic Activities

The Division of cardiac electrophysiology offers training to candidates in following programmes where in the candidates are given exposure to various aspects of practice of adult and paediatric electrophysiology:

##### 1. Post-Doctoral Fellowship in Cardiac Electrophysiology

One year programme after completion of DM Cardiology. The programme involves hands-on training in all diagnostic aspects of adult and paediatric cardiac arrhythmias well as interventional electrophysiology and pacing. The Fellowship provides ample opportunities for professional and academic enhancement including research projects and publication/presentation of scientific papers. SCTIMST is the first Centre to initiate a dedicated Cardiac Electrophysiology Fellowship Programme. So far, 18 candidates have completed this postdoctoral course and are now practising the subspeciality in various parts of the world.

##### 2. Residency In Cardiology

DM cardiology residents are trained in the various aspects of cardiac arrhythmias including clinical cardiology, various non-invasive



diagnostic methods and protocols, work-up and management of patients with various ailments, work-up of patients for invasive procedures, interpretation and analysis of various tracings performance of invasive cardiac procedures including hands-on training where ever applicable.

3. PhD scholar in genetics of cardiac arrhythmia
4. *Technicians Programme - PG Diploma in Cardiac Laboratory Technology*

The students enrolling for the technician courses in Cardiology are imparted training on the performance and maintenance of various modalities.

5. Nursing students – Post-basic nursing programme in cardiology.
6. The Division conducted dedicated sessions on EP and device to DM cardiology residents and fellows every Friday.
7. Periodic ECG forums, journal clubs and problem-oriented discussions were conducted regularly.
8. The Division also actively participates in the weekly MRI meet along with the ISIR department.

### Research Activities

1. Cardiac Channelopathies- Genotype and phenotype correlation, recognition, family screening and optimal management (PI: Dr Narayana Namboodiri, Funding Agency: ICMR).
2. Cardiac Conduction System Pacing Registry (multicentric, extramural funding)
3. Effect of yoga on cardiovascular risk factors, heart rate variability and Framingham score - a community-based study (Funding Agency: DST – Satyam).
4. Image integration: Fusion of 3D electroanatomic mapping systems with cardiac MR/CT acquired images.
5. Post-atriotomy atrial tachycardias - delineation of the electrophysiological characteristics of complex re-entrant circuits

6. Cryoablation Registry (extramural funding)
7. Stereotactic beam radiotherapy for treatment of VT (Funding Agency: IHRS)
8. AF Registry (follow-up evaluation of Kerala AF registry)
9. Rheumatic atrial fibrillation - epidemiology, rhythm vs. rate management and electrophysiological characteristics

### New Initiatives

1. Comprehensive Device and Arrhythmia Clinic, EP Clinic and VT Clinic were started.
2. Cardiac Conduction System Pacing was started.
3. Cryoablation technology was introduced which uses freezing temperatures as low as -40 to -60°C to treat serious cardiac diseases safely (Figure 25).

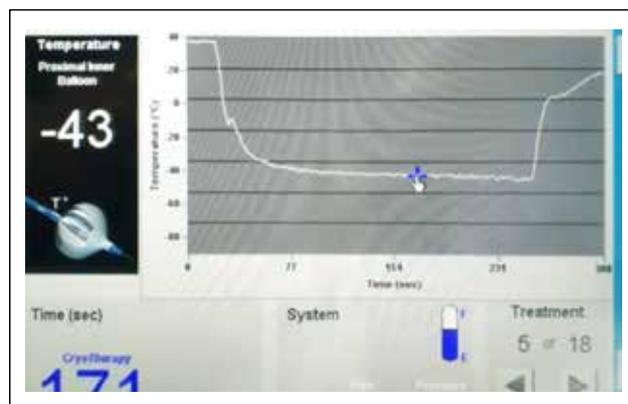


Figure 25. Image of cryoablation technology

### Events Organized

Electrophysiology Division conducted the monthly IHRS DM-DNB arrhythmia programme which is an online monthly national cardiology teaching event on 1 August 2021. Many interesting cases on focus area “Arrhythmias in grown up congenital heart disease” were presented.

## Awards and Honours

1. Dr Narayanan Namboodiri was invited to be a lead author in the writing committee of European Heart Rhythm Association Consensus on management of patients with clustered ventricular arrhythmias/electrical storm in May 2021.
2. Dr Narayanan Namboodiri was selected in 2021-22 as:
  - Member of National level coordination Committee for FNB Electrophysiology 2021
  - Member - APHRS EP writing committee
  - Member - APHRS translational research committee
  - Member - EHRA/HRS/APHRS guidelines on management of electrical storm writing group
  - Member - HRS/APHRS/EHRA guidelines on management of rhythm disorders in neuromuscular disorders - writing group
  - Editorial Board Member - PACE journal
  - President, KHRS

## DIVISION OF PAEDIATRIC CARDIOLOGY

The Paediatric Cardiology Division is an apex referral facility for children with various cardiac ailments in the country. The Division offers foetal echocardiography and follow-up of high-risk fetuses with structural heart diseases and cardiac dysrhythmias. The Division does an average of 500 paediatric cardiac catheterizations and interventions annually, which is one of the largest in the Government Sector in India. The Division works in close harmony with Congenital Heart Surgery Division of Cardiac Surgery for hybrid interventions, comprehensive postoperative care and long-term rehabilitation of children with complex congenital heart diseases.

## Activities

### Clinical Activities

1. The Division attends to children with heart diseases on all days of the week. We also run weekly:
  - Grown-up congenital heart disease Clinic
  - Newborn-infant Clinic
  - Paediatric cardiology Clinic
  - Pediatric Heart failure Clinic
2. Complex interventions like right ventricular outflow tract stenting, patent arterial duct stenting, stenting of coarctation of aorta, closure of portosystemic shunts are also done.
3. The Division performs complex transthoracic, transoesophageal and foetal echocardiographic imaging for structural heart disease. Approximately 200 echocardiograms are performed in the Division weekly.
4. The Division conducts daily ward and CCU rounds with bedside training to the residents.
5. The Division conducts weekly paediatric forums for training residents.
6. The Division also conducts twice weekly joint surgical conferences with the paediatric cardiac surgeon and the cardiac radiologist as part of providing heart team approach to managing congenital heart disease.

### Academic Activities

1. Postdoctoral Fellowship Programme in Paediatric Cardiology – a one-year programme after DM Cardiology..
2. Numerous didactic lectures were delivered inside and outside the institution. We also participated in academic activities of the department, institution, sponsored by national associations and other educational institutions.
3. Mentorship and guidance were provided to students for thesis work.





### **Research Activities**

1. Trivandrum Congenital Heart Disease Registry for Newborns (PI: Dr Deepa S Kumar, Funding Agency: ICMR).
2. Effect and outcome determinants of right ventricular function in post operative Tetralogy of Fallot: A retrospective descriptive cohort study (PI: Dr Deepa S Kumar, Funding Agency: ICMR).
3. Association and impact of 22q11.2 deletion in conotruncal defects: a prospective observational study (PI: Dr Deepa S Kumar).
4. Kerala Registry of Infective Endocarditis (KIND Registry) (PI: Dr Arun Gopalakrishnan, Funding Agency: Cardiological Society of India – Kerala Chapter).
5. Pulmonary Embolism Registry of Kerala – PERK (PI: Dr Arun Gopalakrishnan, Funding Agency: Cardiological Society of India – Kerala Chapter).
6. Digoxin in patients with rheumatic heart disease - A randomized placebo-controlled multicentric trial (PI: Dr Arun Gopalakrishnan, Funding Agency: ICMR).

### **Events Organized**

1. The Division of Paediatric Cardiology organized a Clinico-Pathological Conference on 3 July 2021 with the Departments of Pathology and Imaging Sciences and Interventional Radiology, SCTIMST. Invited external faculty included: Dr Raghavan Subramanyan from Frontier Lifeline Chennai, Dr Jaganmohan Tharakan, former Director SCTIMST, Dr Ajay Bahl from PGIMER Chandigarh, Dr R Krishna Kumar and Dr Sheela Nampoothiri from AIMS Kochi, Dr Sankar V H from SATH, Thiruvananthapuram and Dr Pradeep Vaideeswar from KEM Mumbai.
2. The Division of Paediatric Cardiology organised Children's Day celebration for children who have undergone interventional or surgical treatment for congenital heart disease at our Institute.

### **Staff**

#### **Faculty**

- Dr Krishnamoorthy K M  
Professor and Head of the Department
- Dr AjitKumar V K, Professor (Senior grade)
- Dr Harikrishnan S, Professor
- Dr Bijulal S, Professor
- Dr Narayanan Namboodiri, Professor
- Dr Sanjay G, Professor
- Dr. Abhilash S P, Additional Professor
- Dr Deepa S Kumar, Associate Professor
- Dr Krishna Kumar M, Associate Professor
- Dr Arun Gopalakrishnan, Associate Professor

#### **Technical**

- Mr Suji K, Scientific Officer, Cath Lab
- Mr Subrahmanya H R, Junior Technical Officer (until 31 August 2021)
- Ms Resmy P V, Senior Technical Assistant
- Ms Sheeja S, Senior Technical Assistant
- Ms Sethu Parvathy V K, Senior Technical Assistant
- Ms Rasmi Mohan, Technical Assistant - B
- Mr Midhun S V, Technical Assistant - B
- Ms Princy V, Technical Assistant - A



# DEPARTMENT OF CARDIOVASCULAR AND THORACIC SURGERY

The Department is the largest cardiac surgery unit in the state, with over 2000 cardiac operations being performed annually, patients ranging from neonates to octogenarians. The department has three functional divisions: Paediatric Cardiac Surgery, Adult Cardiac Surgery and Vascular and Thoracic Surgery, with 6 operating rooms and 2 ICUs and being manned by ten consultant surgeons, one post-doctoral fellow and 14 MCh CVTS and MCh Vascular Surgery senior residents. Services offered are complex congenital heart surgeries in neonates and children, coronary surgeries, valve repairs and replacements including minimal access aortic and vascular surgeries.

## Activities

### Clinical Activities

The surgical procedures performed during the year are summarized below:

1. Congenital heart surgery procedures performed:
  - Open heart procedures: 531
  - Closed heart and miscellaneous: 87
2. Adult cardiac surgeries performed:
  - Both On-pump and Off-pump: 1000
3. Vascular and Thoracic Surgery:
  - Major arterial cases: 175
  - Thoracic cases: 30
  - Minor cases and AV access procedures: 145

More than 15000 outpatients were catered to.

### Research Programmes

Division of Paediatric Cardiac Surgery – Ongoing Projects:

1. Effect and outcome determinants of right ventricular function in postoperative Tetralogy of Fallot a retrospective descriptive study (Funding

Agency: ICMR)

2. Development of transcatheter heart valve using homograft (Funding Agency: TDF, SCTIMST)
3. Development of decellularized porcine pericardium (Funding Agency: TDF, SCTIMST)
4. 4D modeling and assessment of flows in Fontan procedure (Funding Agency: TRC, SCTIMST)
5. Alginate dialdehyde gelatin as a post-surgical adhesion prevention material in cardiac surgery - Swine model (Funding Agency: SERB)

Division of Adult Cardiac Surgery - Ongoing Projects:

1. *TC2- Titanium Chitra Heart Valve*

The second generation TTK-Chitra Heart Valve Prosthesis, a joint venture with TTK Health Care entered the single centre pilot human implant trial phase. After meeting all the necessary regulatory requirements and successful extensive in vitro and animal studies, the human trial was initiated. It was ongoing successfully and is expected to be completed next year.

2. *Ventricular Assist Device*

The device is aimed as an affordable solution to end-stage heart failure. Currently, the available imported devices are unaffordable by our patients. Centrifugal pump with a magnetically levitating impeller, providing good haemodynamics at rest and activity with minimal damage to blood cells, was therefore designed and underwent extensive in vitro testing. Subsequently, pilot animal trials were completed successfully. Data obtained were being analysed for further improvements in design. Technology transfer was underway.

3. *Bioprosthetic Pericardial Heart Valve*

Durable and thrombosis resistant prosthetic heart valve with good haemodynamic parameters are the ideal replacement alternatives in heart valve disease. Bioprosthetic pericardial tissue valves are





currently the ideal solution in these situations. Animal trials were ongoing successfully with both the proposed models. Preliminary data demonstrated promising result in terms of design and materials.

#### 4. *Mitral Annuloplasty Ring*

Mitral annuloplasty procedures in selected patients provide near natural heart valve function without the need for anticoagulation. The annuloplasty ring was designed in two forms and underwent testing for material properties and tissue compatibility. Animal implant studies were successfully initiated in 2021 and initial results were promising.

### Events Organized

1. Technocollege CME 2021, a National conference under IACTS was organized at AMCHSS Auditorium on 24-25 July 2021. Dr Sabarinath Menon, Additional Professor was the Organizing Secretary.
2. The Surgical Conclave of HFAI 2022 was organized in virtual mode on 4-5 February 2022. Dr Vivek Pillai, Professor was the Co-Organizing Secretary.

### Awards and Honours

1. SCTIMST Vascular Surgery Department was adjudged second best institute in India among all teaching institutions in the country at the Annual National Level Midterm Meet in 2021.
2. Dr Ashutosh Kumar Pandey and Dr Sriram, senior residents, secured overall first and second places, respectively at various events in The Annual Midterm Meet 2021.
3. Dr Neelam and Dr Akash Rajeev secured 1st and 3rd Prizes, respectively for Poster presentation at the Annual Vascular Society of India conference from 22-24 October 2021.

### Staff

#### Faculty

Dr Baiju S.Dharan, Professor and Head of the Department

Dr Vivek V.Pillai, Professor

Dr Varghese T Panicker, Professor

Dr Sabarinath Menon, Additional Professor

Dr Bineesh K R, Associate Professor

Dr Sudip Dutta Barua, Associate Professor

Dr Soumya Ramanan, Associate Professor

Dr Shivanesan P, Assistant Professor

#### Technical

Ms Beegum Thaslim, Senior Scientific Assistant (Perfusion)

Ms Maya L, Senior Perfusionist

Mr Sujith V M, Perfusionist - B

Mr Don Sebastian, Perfusionist - B

Mr Shanu P S, Perfusionist - B

Mr Rijesh S R, Perfusionist - A

Mr Sujesh S, Perfusionist - A

#### Transplant Co-ordinator

Ms Beena B Pillai, Transplant Co-ordinator - A



# DIVISION OF CLINICAL ENGINEERING

The Division of Clinical Engineering (DCE) at SCTIMST is vital to the efficiency, productivity and safety of the hospital. Clinical engineering, in addition, is designed to not only manage contracts but also engaged in effectively maintaining the medical equipment and technology devices at the hospital facility. The Division assists in the daily operations of the hospital and is responsible for implementing and managing technology-based projects from the beginning to the end.

## Activities

The Division promoted the use of standard-based approaches by imparting safer, efficient and high-quality management of medical equipment. DCE is involved in the selection of suitable equipment to support the services of the Hospital and conducted training on medical equipment for all the users for the purpose of assuring safety and effective treatment of patients. DCE conducted need assessment to ensure regular technical support of medical equipment, for calibration, inspection, maintenance, and repairs.

Clinical Engineers are experts in medical technology towards providing in-house technical support during different stages of equipment life-cycle - pre-purchase evaluations, equipment recommendation, purchase assistance, inspection, equipment service, contract management, user training, preventive maintenance, performance testing, calibrations, breakdown work, equipment installations, replacement recommendations, biomedical networking, user error tracking and maintenance of equipment history.

Activities of the Electrical and Mechanical Sections during the year included routine operation and maintenance of HT panel, transformer, DG sets and hospital electrical system; overhauling shutdown maintenance for ACB in a substation, completed the commissioning of the solar power plant in institute

rooftop, electrical work in the up-gradation of DR system, routine operation and maintenance of AC plants, AHUs, medical gas systems, CSSD and laundry equipment.

During 2021-22, DCE handled more than 15,000 work requests registered on the computerized complaint-management system. This included testing and certification of the newly- installed equipment, maintenance and repair of the existing equipment and infrastructure facilities and modification of electrical and air-conditioning systems. The Division also monitored and documented the activities of external company service engineers who executed their services within the warranty and service period.

The work requests managed are summarized in the Table below:

Subdivision	Complaints attended
A/C	888
Communication	885
Electrical	2095
Biomedical/Electronics	9255
Fitting/ Medical Gas Line	2276
<b>Total</b>	<b>15399</b>





## Equipment installed during the year

Description	Department	Quantity
Ultrasonic Surgical Aspirator	Neuro OT	1
Handpieces For Ultrasonic Surgical Aspirator	Neuro OT	7
Medical Vacuum Pump 10hp	1.Medical Block Basement 2.Surgical Block Basement	2
Patient Warming System	Paediatric OT	1
CFX 96 Real Time PCR System	Microbiology	2
Nucleic Acid Extractor	Microbiology	1
Livanova S5 CPB Machine	Perfusion	2
C-Mac Monitor For CMOS Endoscopes	Anaesthesiology	1
Hygeia EVA-X Multiparameter Monitor	Congenital Heart Surgery Ward	3
DLX Ultralite Pro HD Camera	Paediatric OT	1
DFM100 Defibrillator Biphasic / Monitor	Paediatric OT	1
Labostar Water Purification System	Biochemistry	1
Syringe Pump- Graseby C9	Neurology Ward	2
ERBE , VIO 300S	Neuro OT	2
Jeevitronics Sanmitra 1000 HCT Defibrillator	Anaesthesiology	1
Prosim Spot Light Spo2 Functional Tester	Division Of Clinical Engineering	1
Functional Electrical Stimulator	Physical Medicine & Rehabilitation	1
Refrigerated Centrifuge	Cardiology	1
Mindray UMEC15 Multipara Monitor	Cardiacsurgery Ward	2
Contec CMS6000 Pulse Oximeter	Cardiology ICU, Cardiology Ward, General Medical Ward	4
Tyrone Workstation CamareroDIT400TR-55RL	Imaging Sciences & Intervention Radiology	1

### Research Activities

The Division was involved in the following projects:

1. Development and evaluation of airborne infection control system for healthcare facilities (PI – Mr Shaj Upendran, Funding Agency: TDF, SCTIMST)
2. Non-invasive measurement and monitoring of pulmonary congestion (PI - Mr Shaj Upendran, Funding Agency: DST)
3. Development of a device for non-invasive continuous measurement of jugular venous saturation (PI – Mr Manoj G S, Funding Agency: DST)
4. Development of a device for continuous non-invasive percutaneous capillary glucose measurement in children (PI – Mr Vishal V P, Funding Agency: TDF, SCTIMST)
5. Development of portable low-cost defibrillator for cardiac arrest management. (Co-PI: Mr Shaj Upendran, Funding Agency: DST)





### Other Activities

1. 6 students completed internship in the Division.
2. DCE Faculty members actively participated in the M Tech Clinical Engineering programme.
3. Around 20 numbers of apprentices with BTech, Diploma and ITI qualifications were trained in the Biomedical, Electrical and Mechanical Divisions of DCE.
4. The Division provided technical support to many government institutions in Trivandrum, including Regional Cancer Centre, Rajiv Gandhi Centre for Biotechnology, Government Homeo Medical College, Medical College, Trivandrum and Institute of Advanced Virology, Government of Kerala.

### New Initiatives

1. DCE actively participated in the construction of the new Hospital Block infrastructure facilities. DCE involvement included, planning and evaluation of services (electrical power, air

conditioning, water supply, drainage, medical gases, vacuum chute system, etc.) in consultation with CPWD and monitoring the progress along with the Construction Wing.

2. DCE completed the modernisation of the MGPS system at the hospital. New air compressors, vacuum pumps and oxygen manifold control panels were installed and commissioned. Also, began the installation work of the MGPS for the new Hospital Block.
3. A new Digital X-ray facility was commissioned.
4. Layout of medical gas lines and Modular OTs were prepared, and the work was awarded.

### Events Organized

“HEATS” (Hospital Equipment Awareness Training Series) for imparting advanced technical training on various medical equipment continued its endeavour since 2013. During the year, DCE organized Workshops, the details of which are provided in the Table below:

Sl. No	Title and Theme of the Event	Date and Venue	Organizers/ Co-organizers
1	HEATS-64-Patient Monitoring	16-04-2021-DCE	DCE in association with Philips
2	HEATS-65-Heart Start Intrepid Defibrillator	17-05-2021-Code Blue	DCE in association with Anamdev Engineers
3	HEATS-66-Ultrasonic Surgical Aspirator	23-06-2021 Neuro OT	DCE in association with Toshbco Medical Pvt.Ltd
4	HEATS-67-Nucleic Acid Extractor	10-08-2021 Microbiology	DCE
5	HEATS-68- Real Time PCR System	15-08-2021 Microbiology	DCE
6	HEATS-69-Heart Lung Machine	26-08-2021 Perfusion	DCE in association with Medi Bright Surgicals
7	HEATS-70- Hygeia Eva-X Multiparameter Monitor	06-09-2021 Congenital Heart Surgery Ward	DCE in association with AARBEE Medical System
8	HEATS-71-C-MAC Monitor for CMOS endoscopes	06-09-2021 Anaesthesiology	DCE in association with Karl Storz
9	HEATS-72- Defibrillator Biphasic / Monitor	08-10-2021 Paediatric OT	DCE in association with Anamdev Engineers



10	HEATS-73- Syringe Pump-Graseby C9	27-10-2021 Neurology Ward	DCE in association with Anamdev Engineers
11	HEATS-74-ERBE , VIO 300S	21-12-2021 Neuro OT	DCE in association with ERBE
12	HEATS-75-Ventillators	12-01-2022 DCE	DCE in association with Hamilton
13	HEATS-76- Jeevitronics Sanmitra 1000 HCT Defibrillator	20-01-2022 Anaesthesiology	DCE in association with Jeevitronics
14	HEATS-77-Prosima Spot Light Spo2 Functional Tester	07-02-2022 DCE	DCE
15	HEATS-78-Mindray UMEC15 Multipara Monitor	02-03-2022 Cardiac Surgery Ward	DCE in association with Sree Gokulam Healthcare Pvt. Ltd.
16	HEATS 78- Contec Cms6000 Pulse Oximeter	03-03-2022 Cardiology ICU, Cardiology Ward, General Medical Ward	DCE in association with AARBEE Medical System
17	Elevator Safety Awareness	31-08-2021 DCE	DCE in association with M/s Kone Elevators India Ltd.



Figure 26. Class on Elevator Safety Awareness

#### Staff

Mr Shaj Upendran, Engineer F and Acting Head of the Division

Mr Manoj G S, Engineer C

Mr Anoop Jose, Engineer C

Mr Vishal V P, Engineer B

Mr Praveen James, Engineer B

Mr Ganesh P, Assistant Engineer (Electrical)

# DIVISION OF CELLULAR AND MOLECULAR CARDIOLOGY

The Division focuses on basic and translational research in cardiovascular biology. The current focus is on molecular regulators of myocardial tissue response to injury that could be therapeutically targeted to prevent or minimise cardiac dysfunction. During the year, the Division provided guidance to 2 PhD students, three ICMR project staff and the Principal Investigator under the DST Women Scientists Scheme. The Division carried out collaborative research with other departments of the Institute. Ongoing work on cardiac progenitor cells and cardiac fibroblasts resulted in one conference presentation and one best poster presentation award.

## Activities

### Research Programmes

#### 1. *Role of connexins in the phenotypic transformation of cardiac fibroblasts and extracellular matrix synthesis in cardiac diseases*

Conditions such as heart failure and atrial fibrillation, which are associated with altered activity of cardiac fibroblasts, are marked by significant variations in the distribution of the gap junction protein, Connexin 43 (Cx43). As part of an ICMR-funded project, we explored how Cx43 is regulated in cardiac fibroblasts by peptide hormone angiotensin II, transforming growth factor beta or collagen that were upregulated during cardiac fibrosis. Cardiac fibroblasts from Sprague Dawley rats were isolated, characterized and exposed to these signals. Molecular mechanisms involved in the regulation of Cx43 in cardiac fibroblasts, in presence of these signals are being elucidated. Scanning electron micrograph of cardiac fibroblasts cultured in presence and absence of collagen is shown in Figure 27. In the long-term, our study would potentially pave the way for the development of novel therapies for Cx43-

mediated conduction abnormalities associated with fibrosis and consequent pump dysfunction.

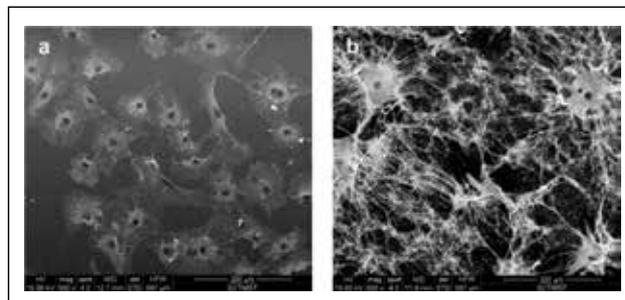


Figure 27. Scanning electron micrograph of cardiac fibroblasts cultured on polystyrene tissue culture dish (a) and collagen coated dish (b)

#### 2. *Regulation of progenitor cell function in the heart*

Cardiac progenitor cells (CPCs) in the adult mammalian heart are known to exhibit cardio-protective properties that enhance angiogenesis, reduce apoptosis of cardiomyocytes and decrease fibrosis during the repair process post-myocardial injury. In this ICMR-funded project, we investigate whether angiotensin II and other pathological signals upregulated in the damaged myocardium affects the survival and functional activity of CPCs.

C-kit, CD105, CD90, and GATA4-positive cells were derived from cardiac atrial explants (Figure 28). They were characterized using immunostaining, western blotting and flow cytometry techniques for specific markers. These cells were exposed to angiotensin II and our results indicate that c-kit positive cells underwent changes in their survival and phenotype. Currently, we are probing how their paracrine secretions are being affected in presence of these pathological signals.



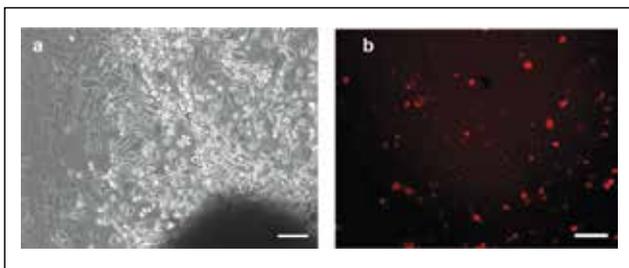


Figure 28. Phase bright cells outgrowing from atrial explants (a) and immunostaining of PE-tagged c-kit positive cells after sorting (b, red)

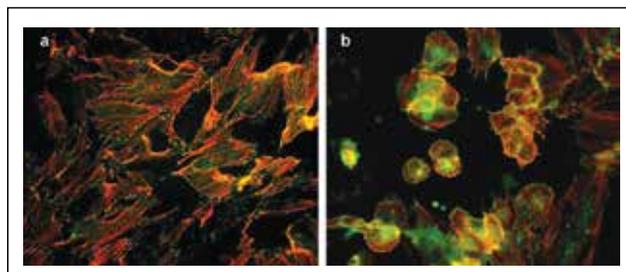


Figure 29. Cytoskeletal reorganization in (a) untreated and (b) drug treated H9C2 cardiomyoblasts (vimentin is stained green and actin in red)

### 3. *Transcriptional and translational regulation of periostin and its interaction with DDR2 in cardiac fibrosis*

As part of DST-funded WOS-A project, we investigate how collagen cross-linking in the heart is regulated by the matricellular protein, periostin expressed by activated cardiac fibroblasts during cardiac fibrosis. Since cross-linking of collagen alters the mechanical properties of the cardiac wall, it is critical to characterize how the expression of an enzyme lysyl oxidase (LOX) involved in collagen cross-linking is regulated in these cells. Cardiac fibroblasts exposed to angiotensin II and TGF-beta showed increased expression of LOX. Molecular mechanisms involved in this process are being elucidated in this project.

### 4. *Cardiotoxicity of anticancer drugs*

The Division initiated a new study on understanding the cellular and molecular mechanisms of cardiotoxicity induced by anti cancer drugs. This study focuses on cardiotoxic effects of anti-cancer drugs that remain inadequately addressed. This work specifically addresses the impact of nanomolar concentrations of anti-cancer agents on cytoskeleton, focal adhesion, gap junction, survival, cardiac sarcomeric proteins and characteristic proteins in cardiac fibroblasts. Figure 29 shows changes in skeletal reorganization in cardiac cells in response to anticancer drug.

### New Initiatives

The Division initiated a new study on understanding the cellular and molecular mechanisms of cardiotoxicity induced by anti cancer drugs.

### Awards and Honours

1. Ms Sruthi Radhakrishnan (PhD student, DCMC) received the 1st prize for e-poster entitled: "Periostin-mediated regulation of lysyl oxidase in cardiac fibroblasts: Implications in cardiac wall stiffening" at the National Science Day celebrations at Biomedical Technology Wing.
2. Ms Hima V M received the 1st prize for poster presentation held during World Antimicrobial Awareness Week (WAAW) – 2021, 18-24 November 2021, organized by the Department of Microbiology and Hospital Infection Control Unit, SCTIMST.

### Staff

#### Faculty

Dr Neethu Mohan, Scientist D

#### Technical

Ms Hima V M, Technical Assistant (Lab) - A

# COMPUTER DIVISION

The Computer Division, an integrator for the total Information Technology infrastructure of the Institute, provides services to all three Wings of the Institute. It also serves as a scientific, technological and data resource for academic, administration, patient care, research and finance management. The Division provides hardware and in-house developed software. Data Centre maintained by the Computer Division is built on the latest information technology with state-of-the-art infrastructure for housing various servers, storage and networking equipment.

## Activities

1. Maintenance of online application software, updating and development of new modules as per the user requests.
2. Maintenance of website (Intranet, Internet) and email, site updates and new development.
3. Network monitoring, management, maintenance and new cabling work.
4. Tender publishing and online recruitment of staff and students.
5. Updating and maintenance of all Portals (Blood Donor, Vendor, Pension, CSC, Patient), D Space, e-learning among others.
6. OMR evaluation, Recruitment (SSSC, JSSC) and Academic admissions
7. Report generation for Auditors, IT Committee, Administration and DST.
8. Hardware and software maintenance of servers, storage, PCs, routers, switches, scanners and printers with a remarkable uptime of 99.98% (Total 1722 devices).
9. Monitoring of Data Centre, management of 18 Physical Servers and 60 Virtual Servers, Storage (350 TB x 2) and Network.
10. Data backup, maintenance of data and network security.
11. Monitoring e-payment status.
12. Monitoring of medical equipment integrated to EMR, Surveillance etc.
13. Work related to online Video Conference Meeting for various departments and selections.
14. Training of apprentices, staff and students.
15. General help to staff, students on IT-related issues.
16. Preparation of monthly reports, work orders, indents and tender processing.
17. Conduct of various examinations related to departmental recruitment.
18. Upgradation of various software platforms such as Cloud Storage, Redcap data collection software, Email Server, VC Software, Openproject, Gateway Security and Backup Software.

## New Initiatives

1. Integrated PayGov India as a second payment gateway for all online payments as an alternate to SBI gateway.
2. Made a web platform for submission of income tax saving proposal for staff and pensioners.
3. Launched a web site for Moyamoya Disease: <https://moyamoya.sctimst.ac.in>.
4. Developed online forms for SBF Education Loan entry and approval.
5. Incorporated attendance status intimation system in web platform for staff and students.
6. Created a mobile application for video consultation using Jitsi platform for patients.
7. Provided options to upload investigation reports such as ECG, Holter, TMT, EEG and Video EEG into Electronic Medical Records.





8. Article Upload Module was added to the Academic Student Portal.
9. Installed R Studio Server, Bigbluebutton VC software, Open Data Kit Server and Shiny Server for academic and research activities.
10. Enabled listing all types of library collections and for listing the library collection status wise for libraries of both Wings.
11. Developed and implemented new online software for File Archival, Library, No Dues and MIS Dashboard.
12. Installed all hardware and software for starting Rashtriya Arogya Nidhi and Ayushman Bharath services for the patients.
13. Upgraded Cash Counters with bill printing through laser and introduced barcode in bills.
14. Software for Personal Information Register was implemented

#### **Staff**

Mr Suresh Kumar B, Engineer F and Acting Head of the Division

Dr Geetha G, Scientist G

Mr Rejith L R, Programmer - B

Mr Saji K S, Programmer - B

Mr Manoj M, Technical Assistant (Computer) - B

Mr Anish R, Technical Assistant (Computer) - B

Mr Sakilnag P S, Technical Assistant (Computer) - B



# DEPARTMENT OF IMAGING SCIENCES AND INTERVENTIONAL RADIOLOGY

The Department of Imaging Sciences and Interventional Radiology (IS and IR) caters to the radiological needs of the institute. It runs separate DM Programmes in Neuroimaging and Interventional Neuroradiology, Cardiovascular Imaging and Vascular Interventional Radiology and a 2-year Diploma in Advanced Medical Imaging Technology (DAMIT) programme. The department runs a teaching programme from 8-9 AM every morning on weekdays and also participates in multi-disciplinary clinical meetings with the Neurology, Neurosurgery, Cardiology and Cardiac Surgery Departments. The Department runs separate OPDs for Interventional Neuroradiology and Vascular Radiology and has a dedicated ICU and Ward for the patients undergoing interventional procedures.

## Activities

### Clinical Activities

The number of diagnostic procedures performed during the year is summarized in the Table below:

Modality	Number
MRI	5943
USG	2631
CT	4788
X-Ray	31039

The details of the interventional procedures (Figure 30) performed during the year are summarized in the Table below:

Intervention	Number
Neuro interventions	158
Peripheral interventions	406
Diagnostic angiograms	496

Outpatient new cases	801
Review cases	3148
Admissions	710

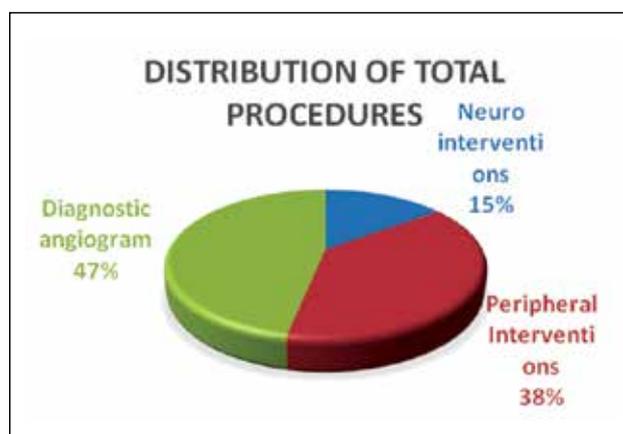


Figure 30. Distribution of Interventional procedures

The mortality rate, morbidity rate and hospital acquired infection rate were all <1% with an average length of hospital stay of 5 days and a bed occupancy rate of 98%.

### Research Activities

1. The major Collaborative research activities in Medical Image processing, AI, Virtual reality include:

- Collaboration with TKM College of Engineering, Kollam for research project on “Development of algorithms to improve SNR and resolution of ASL images for accurate CBF quantification using minimum number of label-control pairs”. Collaboration with National Institute of Technology, Kozhikode on “Development of an indigenous tool for the enhancement of medical images using deep neural networks”. Development of an Artificial Intelligence-based System for



comprehensive cerebral arterial stroke imaging and prognostication (Funding Agency: DBT).

- Collaborative project with IIIT, Hyderabad and Government Medical College, Thiruvananthapuram on “Virtual reality-based solution for effective neuroanatomy teaching”. Deployment of projection system done at our institute (Funding Agency: SERB, DST).
  - Collaborative project with National Institute of Technology, Surathkal, on “Automatic detection and quantification of focal cortical dysplasia regions from magnetic resonance brain images using machine learning techniques” (Funding Agency: DST-CSRI)
2. Collaborative project with Birla Institute of Technology & Science, Pilani, Hyderabad on “MRI-based non-invasive quantitative biomarker for early diagnosis and prognosis of brain tumour (Funding Agency: DBT). Project funded by Department of Biotechnology, Govt. of India.
  3. Project on "Alterations in resting state functional connectivity and relationship with cognitive changes in intracranial dural arterio-venous fistulas" was ongoing (Figure 31). 2 international original articles and 2 conference abstracts were published from this (Funding Agency: DST-CSRI).

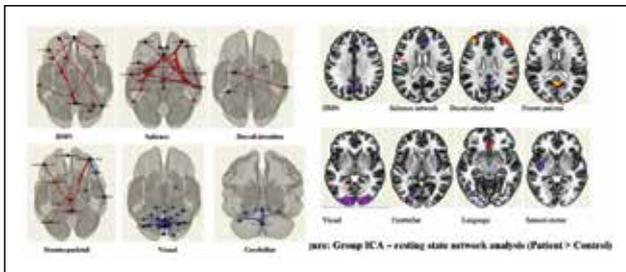


Figure 31. Alterations in resting state functional connectivity changes in intracranial dural arterio-venous fistulas

4. Multi-institutional collaborative projects were initiated with IISER- Berhampur and IIT- Madras.

## Patent

A foreign patent (USA, EU) application was filed for radiopaque polymeric liquid embolising agent (Figure 32) with Dr Jayadevan E R, Additional Professor as one of the inventors.

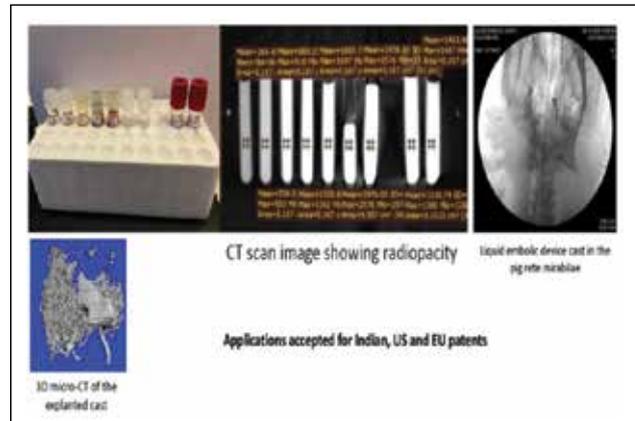


Figure 32. Radiopaque polymeric liquid embolising agent

## New Initiatives

### 1. New procedures in interventional radiology

- 3D printing for cerebral and aortic aneurysm (Figure 33) and simulation in Angiosuite were started. This helps in better understanding of the complex anatomy and helps simplify patient management.



Figure 33. 3D printed aneurysm

- Radial artery approach for intraabdominal interventions were started.
- Catheter-directed thrombolysis with thrombectomy and stenting in complicated deep vein thrombosis was started (Figure 34).

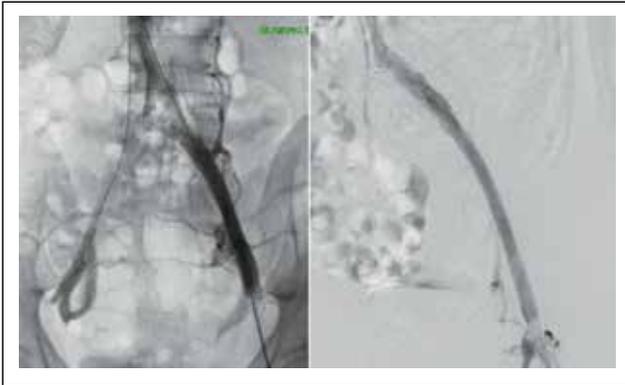


Figure 34. Catheter-directed thrombolysis and stenting in complicated deep vein thrombosis

- Radiofrequency ablation was started for varicose veins.
- Percutaneous TEVAR using endo sutures (Figure 35) were done obviating the need for surgical cut down in complex aortic aneurysms.



Figure 35. Percutaneous TEVAR using endo sutures

- Complex portal vein interventions (Figure 36) including portal vein thrombectomy with DIPS and embolization of gastric varices in refractory gastrointestinal bleed was performed.

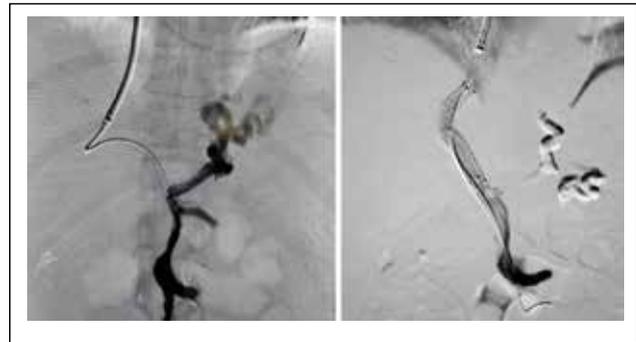


Figure 36. Complex portal vein intervention

## 2. Newer techniques in imaging

- 4D flow MR imaging in congenital cardiac diseases (Figure 37).

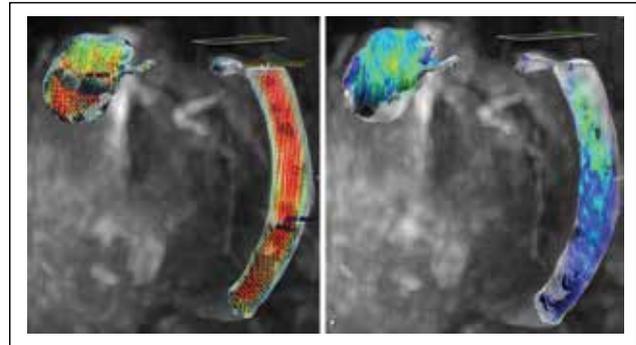


Figure 37. 4D MR image in congenital heart disease

- Use of radiomics and AI -based tools in evaluation of brain tumors and hepatocellular carcinomas was initiated.
- MRI contrast lymphangiography technique with lymphatic interventions was started to diagnose complex lymphatic malformations (Figure 38).

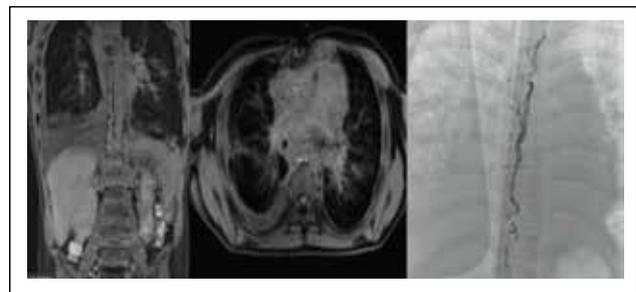


Figure 38. MRI contrast lymphangiography

- Cardiac MR strain imaging was done to analyse the myocardial strain in hypertrophic cardiomyopathy patients assisting their early detection (Figure 39).

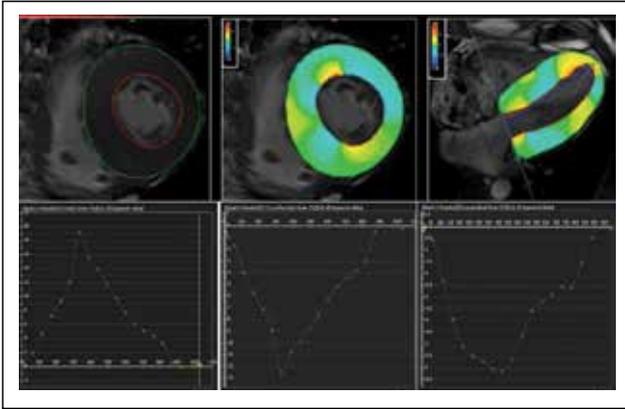


Figure 39. Cardiac MR strain imaging

- Arterial spin labelling (ASL) techniques were used in peripheral artery disease to obviate the need of MR contrast agents in patients with renal failure (Figure 40).

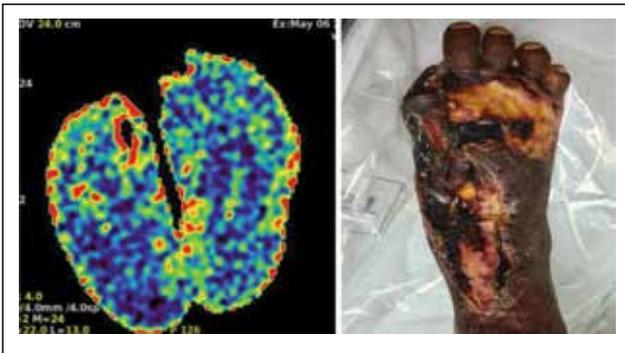


Figure 40. ASL in peripheral artery disease

- Role of multi delay arterial spin labelling (ASL) using arterial cerebral blood volume (aCBV) as a novel imaging biomarker for magnetic resonance imaging grading of glial neoplasms as compared T1 DCE and T2 DSC perfusion technique was started (Figure 41).

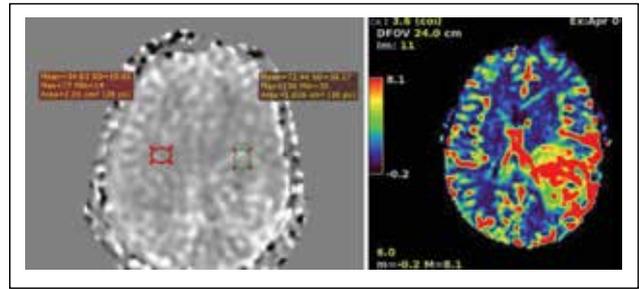


Figure 41. Multi delay ASL using aCBV in glioma

3. The department started regular monthly mortality and morbidity meetings to improve the standard of patient care

### Events Organized

The Department co-hosted the World Congress on Emergency Radiology (Figure 42) along with AIIMS, New Delhi on 23-25 April 2021. Dr Anoop and Dr Jineesh were in the organising committee and delivered multiple lectures at the Congress.

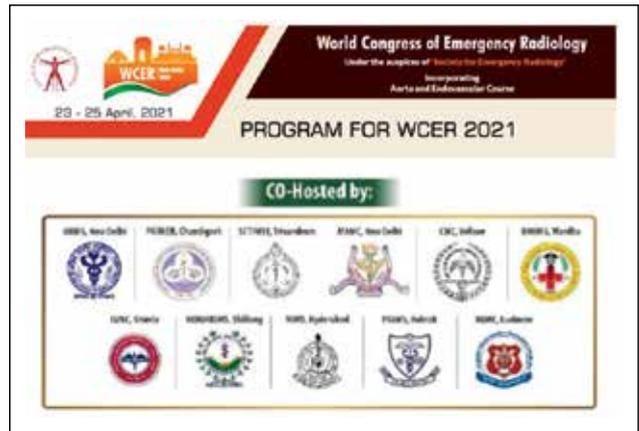


Figure 42. World Congress on Emergency Radiology

### Awards and Honours

1. Prof Bejoy Thomas was selected in the top 2% most cited scientists' list by Stanford University published in August 2021.
2. Prof Bejoy Thomas was awarded the President s Appreciation award of IRIA 2021 and Chairman s Appreciation Award, ICRI 2021.
3. Prof Bejoy Thomas was nominated by Chairman as the Subspecialty Head of Indian College of



Radiology and Imaging for 2020-2023.

4. Prof Kesavadas was selected as Fellow of National Academy of Medical Sciences.
5. Prof Kesavadas was elected Editor-in-Chief of Indian Journal of Radiology & Imaging
6. Prof Kesavadas was elected to the Board of Directors of Asian Society of Magnetic Resonance in Medicine.
7. Prof Kesavadas received the Certificate of Merit for serving Member, Co-ordinator of National Scientific Committee of IRIA, 2021.
8. Dr Jayadevan E R, Additional Professor, was awarded the President's Appreciation Award of IRIA 2021.
9. Dr Jineesh, Assistant Professor, was part of the Indian College of Radiology Imaging - subspecialty Task Force Group of Interventional Radiology for formulating Indian guidelines for biliary imaging.
10. Dr Vikas Chauhan, senior resident, won 1st prize at international Neuro Quiz Programme.
11. Dr Ansan Joseph and Dr Vimal Chacko Mondy, senior residents won 1st place in Quiz at the 11th annual conference of Indian Association of Cardiac Imaging conducted as a virtual conference on 23-24 October 2021.
12. Dr Vimal Chacko Mondy 2nd prize in e-poster and 3rd prize in Oral presentation at the 11th annual conference of Indian Association of Cardiac Imaging conducted as a virtual conference on 23-24 October 2021.
13. Dr Vimal Chacko Mondy received the Best Scientific Award for the presentation "Hemoptysis in congenital heart disease" at the Indian Society of Pediatric Radiology conference.
14. Dr Vimal Chacko Mondy received the Certificate of Merit at RSNA 2021.

## Staff

### Faculty

Dr Bejoy Thomas, Professor and Head of the Department

Dr C Kesavadas, Professor

Dr E R Jayadevan, Additional Professor

Dr Santhosh Kannath, Additional Professor

Dr A Anoop, Assistant Professor

Dr Jineesh V, Assistant Professor

### Technologists

Githakumari V, Junior Scientific officer

Alex Jose D, Senior Technical Assistant

SheebaKumari R, Senior Technical Assistant

Johnson C, Senior Technical Assistant

Krishna Kumar N, Senior Technical Assistant

Vikas N, Senior Technical Assistant

Mahesh P S, Senior Technical Assistant

Joyi K, Senior Technical Assistant

Sandhya V S, Senior Technical Assistant



# DEPARTMENT OF MICROBIOLOGY

The Department carries out the following functions:

- Provide accurate and quick reports on all specimens sent to the Laboratory and COVID Lab.
- Support ICMR and State Government in COVID-19 testing
- Give a consultant clinical microbiology service, antibiogram sharing and antibiotic stewardship.
- Liaison with Hospital Infection Control Unit
- Outbreak investigation and containment using microbiological methods
- Conduct training in infection control for all classes of staff
- Observership Programme and project support for MSc students
- Enhance and support research activities of all Wings of the institute

## Activities

### Clinical Activities

#### 1. Bacteriology: 9416 samples

- Infective endocarditis – 14 cases. Out of the 14 cases, 4 each were due to alpha-hemolytic Streptococci and *Enterococcus faecalis*, one each of *Aggregati bacteraphrophilus*, *Granulicatella elegans*, *Brucella melitensis* and *Candida parapsilosis*, *Staphylococcus warneri* and *Klebsiella pneumoniae*. Treatment was initiated based on our advice and monitored for any complications.
- Rare isolates included *Burkholderia pseudomallei* from a brain abscess, Salmonella Group D from a clot, Salmonella Group B from a case

of diarrhoea and 2 isolates of Vancomycin-resistant *Enterococcus faecium*.

2. Mycobacteriology: 153 samples (5 positive)
3. Mycology: 105 samples
  - Isolates included *Candida* of different species, two isolates of *Aspergillus* and one *Kodameaohmeri*.
4. Serology: CRP: 3929, Rheumatoid Factor: 1109, ASO: 315, TPHA: 207, RPR :15, Widal: 8, Malaria card test: 18, Procalcitonin: 2104, Thyroid function tests:13751
5. Viral Serology: Total – 24515 tests
  - HIV antibody: 8172 tests (4 positive)
  - HBsAg: 8174 tests (54 positive)
  - HCV: 8169 tests (14 positive)
6. The Laboratory participated in two rounds of EQAS bacteriology and serology from CMC, Vellore and one round of Mycology from PGI Chandigarh and got excellent results in both.
7. Homograft Valve Bank

During the year, 26 valves were harvested and 12 of them were implanted. Rest were stored in the Valve Bank under aseptic conditions at -180° C in liquid nitrogen cylinders.

#### 8. Molecular Diagnostics

- i. CE- IVD approved standard PCR tests for:
  - Encephalitis Panel - 17 tests
  - Tropical Fever Panel - 24 tests (6 positive - 5 Dengue and 1 Chikungunya)
- ii. Multiplex PCR Film Array:
  - Respiratory Panel – 16 tests (detected 2 SARS CoV2, 2 Corona Virus229E



and Influenza virus AH3, 1 Respiratory Syncytial Virus, 1 Human Rhino Virus)

- Meningitis Panel – 12 tests (detected *Listeria monocytogenes*)

iii. Single PCR for Hepatitis B, C and HIV started this year - 11 samples

#### 9. Sequencing studies

Started as a new initiative during the year. The sequencing was done at the Molecular Genetics Unit under the Biochemistry Department with support from their team.

- Targeted Sanger sequencing done for the first time on an isolate from blood culture of a case of infective endocarditis was identified as *Aggregati bacteraphophilus*, a HACEK group organism, which usually causes culture-negative endocarditis, being difficult to grow.
- Whole genome sequencing of clusters of COVID cases that occurred in Neurosurgery, Cardiac surgery and Neurology was done as per an IEC approved study and being processed. Another cluster that occurred in the Congenital Heart Surgery unit was sequenced at the RGCB, a distinct minor variant found.

#### COVID Lab

A full complement of NHM Staff, including research officers, technicians and lab assistants were there to run the COVID Lab until 31 October 2021. From November 2021 to February 2022, the District Medical Officer appointed one research officer, 4 technicians and 4 lab assistants. From 1 March 2022 onwards, 4 technicians (temporary) were appointed by the Director to process the samples from the Hospital Wing. One Technical Assistant from the Department was also posted there to look after and organise the samples.

Samples tested during the year:

- Anti-SARS CoV2 IgG - 102
- Anti-SARS CoV2 IgM - 85

- SARS CoV2 antigen tests - 1411 (71 positives)
- SARS CoV2 RT-PCR - 71107 samples (15744 positives). Included samples from the State Government Hospitals and SCTIMST samples
- Rapid RT-PCR (ABBOTT ID Now) - 58 samples (4 positives)

#### Infection Control and Antibiotic Stewardship

- Conducted one HICC and two ICT meetings
- Planned surgical prophylaxis for Neurosurgery was implemented from 1 April 2021 onwards. An improvement was seen in the antibiogram of the department as compared to other departments with more antibiotic sensitive Gram- negatives being detected.
- Monthly infection audit for Neurosurgery Department.
- COVID ICT activities continued and new guidelines were issued whenever necessary.
- One cluster of Delta virus involving one patient and 12 health care workers was controlled in the CHICU
- Regular Link Nurse Programmes were conducted on a weekly basis.
- Training was given to new Senior Nursing Officers who joined.
- Advice on antibiotics for infected patients and suggestions for reducing rates of infection were given

#### Research Activities

##### Ongoing Projects

1. A prospective cohort study on infective endocarditis - microbiological profile and outcomes (PI: Dr Kavita Raja).
2. Whole Genome Sequencing to understand the evolution of COVID-19 clusters in Healthcare workers and inpatients in a non-COVID tertiary care hospital and the impact of vaccination and selection pressure on the genome of SARS CoV2 (PI: Dr Kavita Raja) in collaboration





with AMCHSS and Molecular Genetics Unit, Department of Biochemistry.

3. “A prospective study on cerebrospinal fluid (CSF) diversion catheter-related infections in a tertiary referral neurosurgical care center” in collaboration with Department of Neurosurgery and Hospital Infection Control Unit (PI: Dr Dinoop K P, Funding Agency: ICMR).
4. “Role of novel Biomarkers and clinical Scoring systems in predicting progression to Sepsis in infected post-Cardiac Surgery patients (BioSSCaS study)” (PI: Dr Dinoop K P, Funding Agency: Hospital Seed Grant, SCTIMST).
5. Development of rapid diagnostic kits for sepsis (procalcitonin-based) and Chlamydia trachomatis in collaboration with BMT Wing (Co-PIs: Drs Dinoop K P and Dr Jyoti E K, Funding Agency: TRC, SCTIMST).
6. Development and evaluation of air borne infection control systems for healthcare facilities in collaboration with Department of Clinical Engineering (Co-PI: Dr Jyoti E K, Funding Agency: TDF, SCTIMST).
7. Point-of-care of detection of Human Papilloma Virus using loop-mediated amplification of DNA in collaboration with BMT Wing (Co-PI: Dr Jyoti E K).

#### Completed Projects

Development of a real time RT-PCR kit for detection of SARS-CoV-2 (PI: Dr Jyoti E K, Funding Agency: TDF, SCTIMST).

#### Patents

1. Test kit for determination of procalcitonin (Filed)
2. Test kit for detecting *Chlamydia trachomatis* (Filed)

#### New Initiatives

1. Two RT-PCR Systems and one automated extractor received from the Department of Health Research and started functioning from July 2021 (Figure 43).

2. Started COVID-19 Rapid PCR, ABBOTT ID Now (Figure 44).
3. Sanger sequencing at Molecular Genetics Unit for identification of bacteria (Figure 45).

#### Events Organized

1. World Antibiotics Awareness Week 18-24 November 2021 (Figure 46)
2. World Hand Hygiene Day
3. Dr Kavita Raja (Chairperson of ICC) and Dr Jyoti EK organised a one-day awareness programme (online) on commemoration of Prevention of Sexual Harassment Act 2013 (PoSH Act 2013) on 9 December 2021. Advocate Bismi Gopalakrishnan delivered a talk (Figure 47).
4. As member of GATI, Dr Kavita Raja helped in organising the Women's Day programme.
5. Dr Jyoti E K was involved in organising various programmes of “Azadi ka Amrit Mahotsav”.

#### Awards and Honours

1. Dr Kavita Raja was:
  - selected as Member of SERB Task force for BSL-3
  - continued as Vice- President of Academy of Clinical Microbiologists
  - Selected as Member of Board of Studies, Kerala University of Health Sciences
  - DAC member for PhD students in IIT , Chennai and KUHS
2. Dr Dinoop K P received the Young Researcher Award – Clinical Microbiology at the Venus International Healthcare Awards 2021 on 6 November 2021.
3. Dr Dinoop K P was Member of Board of Studies, BSc Microbiology, JIPMER.



## Staff

### Faculty

Dr Kavita Raja, Professor and Head of the Department

Dr Dinoop K P, Assistant Professor

Dr Jyothi E K, Scientist C

### Technical

Ms Sujatha, Scientific Officer (until June 2021)

Ms Soja Rani G S, Scientific Assistant (Lab)

Ms Smitha M, Scientific Assistant (Lab)

Ms Reeja Rani D C, Senior Technical Assistant (Lab)

Ms Sudha Chandran R, Technical Assistant (Lab) - B

Mr Ranjith S, Technical Assistant (Lab) - B

Ms Cinta Rose, Technical Assistant (Lab) - A



Figure 43. Automated nucleic acid extractor and two RT-PCR systems (Supplied by DHR)

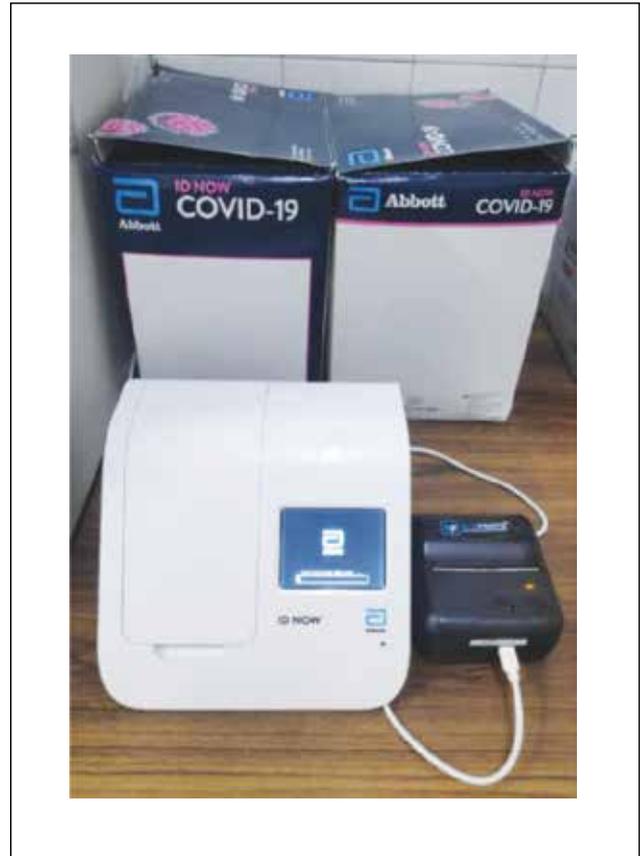


Figure 44. ABBOTT ID NOW – Rapid PCR for SARS CoV2 (CSR donation)

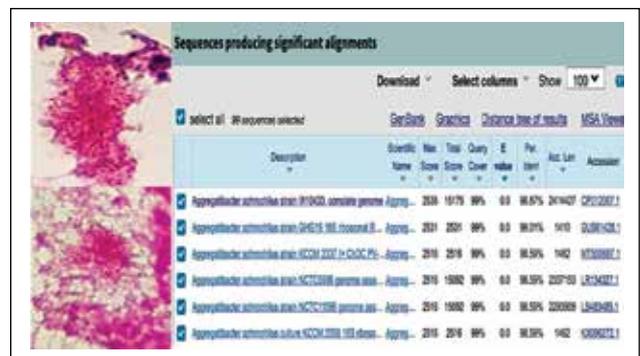


Figure 45. Gram stain showing clusters of Gram-negative bacilli *Aggregatibacter aphrophilus* and the Sanger sequencing identification



Figure 46. World Antibiotic Awareness Week



Figure 47. PoSH Act 2013 online awareness programme

# DEPARTMENT OF NEUROLOGY

The Department of Neurology comprises multiple subsections which provide specialised and comprehensive care to patients with various neurological disorders. The Department conducts general neurology outpatient clinics daily from Monday to Friday as well as weekly Speciality Clinics for review of patients under different subsections.

During 2021-22, a total of 39676 outpatients were seen in general neurology which included 34135 reviews and 5541 new registrations and inpatient number was 2567. The bed strength was 60, bed occupancy rate was 71.36 % and 24 mortalities were recorded.

Many conferences were organized by the individual subdivisions of the Department. The 4th P K Mohan Oration was conducted by the Department on 14 August 2021. Prof Ronald C Petersen, Professor of Neurology and Director, Mayo Alzheimer s Disease Research Centre, Rochester, Minnesota, delivered the oration.

The faculty and students of the department participated in many national and international conferences and received several prestigious awards during the year. The Department continued to pursue major research projects and produced notable publications. The Department conducted many patient outreach programmes including the Athiyanoor Clinic outreach programme. The activities of the various subsections of Neurology in the last year are enumerated in the individual sections.

## COGNITION AND BEHAVIOURAL NEUROLOGY

The Cognition and Behavioural Neurology Section (CBNS) provides clinical services to children and adults with cognitive problems in disorders like mild cognitive impairment, dementia, epilepsy, Alzheimer s

dementia, stroke, learning disability, developmental delay, and post-operative cognitive problems. CBNS conducts a Memory and Neurobehavioral Disorders Clinic every week. It also provides advice and technical support to the Alzheimer s & Related Disorders Society of India (ARDSI), a voluntary organisation that helps dementia patients and caregivers. The Section also carries out clinical and basic science research in the fields of dementia, cognition and behaviour and traumatic brain injury

### Activities

#### Clinical Activities

During the year, CBNS introduced speciality patient care services for non-pharmacological treatment of autism, specific learning disability and included cognitive retraining for post-operative paediatric group. The Section also extended its post-operative rehabilitation services to the Division of Paediatric Cardiovascular Thoracic Surgery.

The activities undertaken during the year are summarized in the Table below:

Procedure	Number
Speech and language evaluation	1456
Speech therapy	407
Audiological evaluation	2
Videofluoroscopy swallow study	213
Neuropsychological testing	701
IQ/DQ assessments	57
Counselling sessions	25
Memory and Neurobehavioral Clinic attendance	505
Cognitive retraining	53





### Research Activities

The following extramural projects are ongoing in the Section:

1. The AADAR Dementia Science Programme titled “Dementia Science Programme: Incidence/ Prevalence/ Risk/ Intervention analysis of dementia and basic research thereof - A multicentre study in collaboration with, All India Institute of Medical Sciences, New Delhi, National Institute of Mental Health And Neurosciences, Bengaluru, Bangur Institute of Neurosciences, Kolkata, National Brain Research Centre, Manesar and University of Calcutta, Kolkata (PI from SCTIMST: Dr Ramshekhar N Menon, Funding Agency: DBT)
2. Quantitative EEG and multimodal neuroimaging biomarkers of memory dysfunction in epilepsy (PI: Dr Ramshekhar N Menon, Funding Agency: DST)

### Other Activities

Association/Membership in Task Force

The Indian Council of Medical Research - Neurocognitive tool box (ICMR-NCTB) was launched virtually by Director General of ICMR, Dr Balram Bhargava on 6 October 2021. This multilingual test battery provides a standardized set of cognitive tests that are culturally appropriate and available in different languages for our country. It is made available for clinical and research purposes to diagnose mild cognitive impairment and dementia. The Cognition and Behavioural Neurology Section was involved in development, multilingual harmonization and validation of the Indian English and Malayalam versions of the ICMR-NCTB.

### New Initiatives

1. CBNS extended its research resources to Traumatic Brain Injury and expanded the existing cognitive retraining resources.
2. During the pandemic, the Section also worked towards studying the impact of COVID-19 on delivery of care for dementia patients.

### Events Organized

In connection with the World Alzheimer’s Day 2021 on 21 September, CBNS displayed Dementia Awareness posters at the institute and distributed AADAR Dementia booklet as part of Dementia Awareness Campaign.

### COMPREHENSIVE CARE CENTRE FOR MOVEMENT DISORDERS

The Comprehensive Care Centre For Movement Disorders (CCCMD) caters to patients with Movement Disorders. Movement Disorders include Parkinson s disease, other Parkinsonian disorders, various tremor disorders and some conditions like chorea and dystonia. The CCCMD provides comprehensive medical and surgical care to patients affected with Movement Disorders and trains neurologists in their diagnosis and management. The Centre is also involved in many externally-funded clinical research projects and an R&D Project collaborating with the Biomedical Technology Wing of the Institute. Three students are currently doing their PhD projects in Movement Disorders, with the support of CCCMD. Two post-doctoral fellows completed their training. Thirteen scientific articles were published in medical journals and four chapters were authored by faculty in various ISBN-indexed scientific books.

### Activities

#### Clinical Activities

The clinical activities of CCCMD include outpatient clinic services (a weekly Movement Disorders Specialty Clinic), Deep Brain Stimulation Programming Clinic, Botulinum Toxin Injection Clinic and Movement Disorders Surgical Programme. During the year, 570 new patients with various movement disorders registered for the services of the Centre and there were 2130 review clinic visits by patients. In addition, 672 patients sought outpatient clinic review through the Telemedicine Facility. 74 patients visited for Deep Brain stimulation (DBS) programming and other surgical assessments. There were 335 patient visits for Botulinum Toxin injections. 29 surgical procedures were performed, including deep brain stimulation surgeries and IPG replacements. CCCMD completed



its 250th Deep Brain Stimulation surgery in April 2021 (Figure 48).

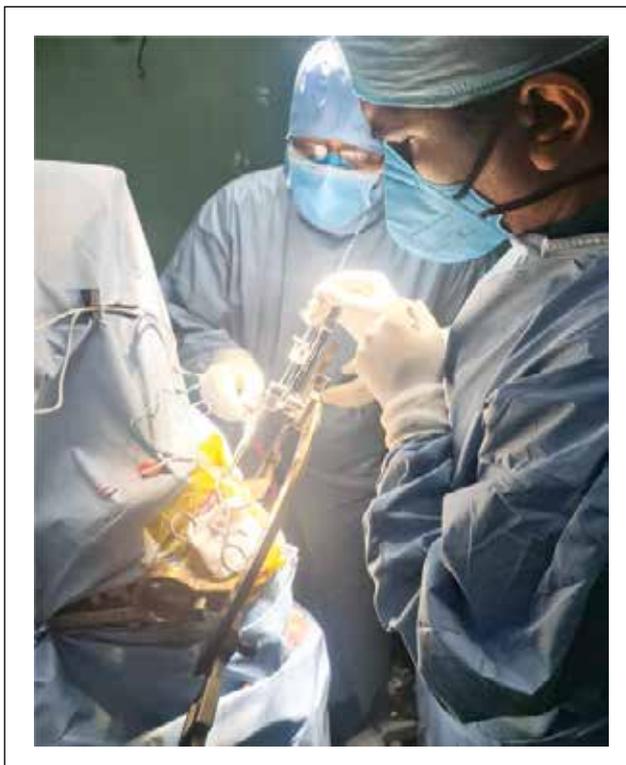


Figure 48. 250th Deep Brain Stimulation surgery performed at SCTIMST

### Research Activities

There are several ongoing externally-funded research projects. An international multi-centre research project, funded by the Michael J Fox foundation, USA is ongoing. This project, titled “Genetic Architecture of Parkinson's disease in India,” is a Genome-wide Association study (GWAS) aimed at exploring the genetic factors predisposing to Parkinson's disease in the Indian population and is the first of its kind from India. There are around 20 Centres participating from across India to ensure a pan-Indian representation for the study population. A second externally-funded collaborative research project, funded by ICMR aims to identify the differences in the gut microbial flora between patients with Parkinson's disease and healthy subjects and the relationship of the microbial flora pattern with metabolomic profile of body fluids, in patients with Parkinson's disease. Cochin University of Science and Technology (CUSAT) is

the collaborator for this project, for microbial and metabolomic studies and bio-informatics. The project is titled “Exploring the human gut microbiome and metabolome in health and in Parkinson's disease - a window to the Gut-microbiota- brain axis alterations in Parkinson's disease”. In addition to these ongoing projects, two new externally-funded projects were initiated during the period. The first one (Spiral Dx-Tremor Diagnosis and Quantification using Artificial Intelligence) is a multi-centre collaborative project funded by the Department of Biotechnology (DBT), Government of India. This project aims to develop an artificial intelligence algorithm to identify various tremor subtypes easily, by analysing the characteristics of spirals drawn by the patients on paper / a digital surface interface device (a tablet computer). The second project, funded by the Movement Disorders Society of India (Clinical Registry of Movement Disorders) is aimed at forming a systematic database of patients with Movement Disorders, to facilitate clinical research.

CCCMD participates as the clinical collaborator of an R&D project for the indigenous development of Deep Brain Stimulator System. This project, funded by the DST, is carried out by the Biomedical Technology Wing of the Institute. Bhabha Atomic Research Centre (BARC) is also a collaborator for this project, providing technical support for the sophisticated electronic circuitry involved. The prototypes are ready and animal implantation experiments are expected soon.

CCCMD is also involved in externally funded research projects, collaborating with Biochemistry Department, and aimed at addressing the pathogenic mechanisms and biomarkers of Parkinson's disease. A project titled “Identification and Characterization of Ubiquitin and SUMO-modified exosome proteins from Parkinson's disease patients' blood” is funded by the ICMR and is ongoing. This project explores the potential of exosomal cargoes in blood as biomarker for Parkinson's disease. A second project aimed at measuring glucocerebrosidase activity for monitoring lysosomal functions in Parkinson's disease, has been technically approved by ICMR for funding.





There are three students doing their PhD currently, attached to CCCMD, in Movement disorders-related areas. One of them is directly guided by the faculty of CCCMD and explores the connectivity between basal ganglia and cerebellum in healthy subjects and the alterations in Parkinson's disease, using advanced functional MRI-based techniques (Figure 49). A second PhD student works on an R&D project aimed at development of a Deep Brain Stimulation lead able to sense abnormal signals from Parkinson's disease brain so that adaptive Deep Brain Stimulation can be given. The third PhD student works on exosomal cargoes as biomarkers for Parkinson's disease.

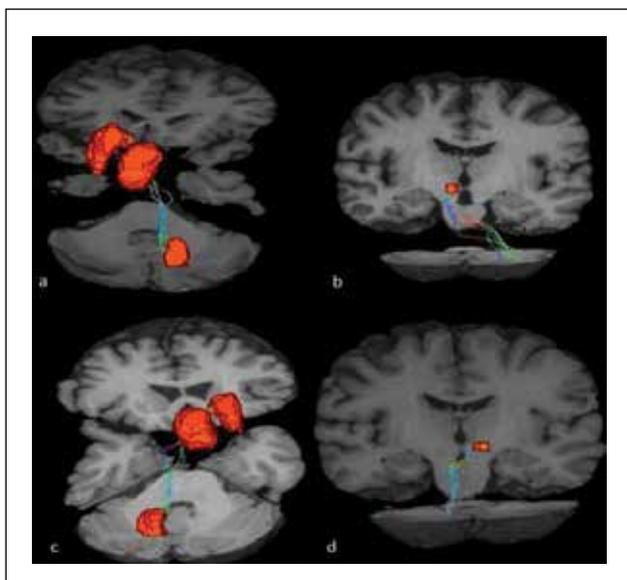


Figure 49. Demonstration of cerebellum – basal ganglia interconnecting network in a subject done using functional MRI and tractography techniques a) Figure showing the tracts between the right dentate and left putamen traversing the left thalamus b) Figure showing the tracts between the Left STN and contralateral cerebellar cortex, (Right) c) Figure showing the tracts between the left dentate and right putamen traversing the right thalamus d) Figure showing the tracts between the right STN and contralateral cerebellar cortex (left)

There are institute-funded and several non-funded research projects which are ongoing, in addition to the funded projects discussed above. These include “Unravelling the clinical and genetic spectrum of neurodegeneration with brain iron accumulation” (SCTIMST-funded) and several non-funded projects

addressing various aspects of movement disorders like surgical complications of deep brain stimulation, hurdles and obstacles to DBS surgery in the Indian perspective, clinical profile and temporal evolution of isolated dystonia, pain as a non-motor symptom in Parkinson's disease and impact of DBS on survival in Parkinson's disease

### Events Organized

The CCCMD organized an online awareness programme for patients with Parkinson's disease on 11 April 2021, in connection with world Parkinson's Day. This was subsequently streamed in YouTube and was widely appreciated by patients and care givers. The online programme was inaugurated by the then Director of SCTIMST, Prof K Jayakumar (Figure 50).

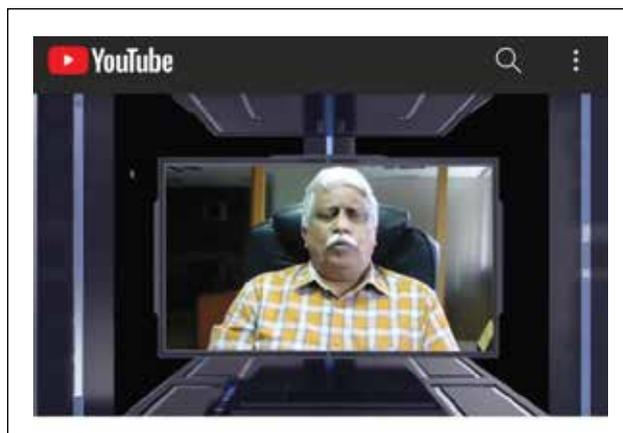


Figure 50. Inaugural comments by the Director, SCTIMST, during the online public awareness programme in connection with the world Parkinson's Day 2021

### Awards and Honours

1. Dr Divya K P, Assistant Professor, won 1st prize in the “Tournament of Minds” -International Neurology Quiz at World Congress of Neurology 2021.
2. Dr Divya K P, Assistant Professor, won the MDS-LEAP - Leadership Course 2022 and the MDS-AOS Virtual SYNERGIES and Leadership Course 2021 by the International Parkinson's Disease and Movement Disorders Society.



## COMPREHENSIVE CENTRE FOR SLEEP DISORDERS

Comprehensive Centre for Sleep Disorders (CCSD) runs clinical services through a weekly outpatient clinic catering to new and review patients with sleep disorders. In addition, the Division has a two-bedded Polysomnography Lab with facilities for overnight diagnostic study and multiple sleep latency tests.

### Activities

#### Clinical Activities

Clinical activities include regular outpatient services through Sleep Clinic which is conducted once a week on Thursday afternoon for new and review patients with varying sleep problems such as obstructive sleep apnoea, narcolepsy and insomnia. During the year, we catered to 359 patients and performed 120 diagnostic polysomnographies.

#### Research Activities

1. A clinical trial titled “A randomized multicentric, double-blind, placebo-controlled trial of SDA-217 as an add-on therapy in patients of chronic insomnia” was initiated in 2021 and recruited patients from the Sleep Clinic (PI: Prof Ashalatha R, Funding Agency: ICMR).
2. A study on predictors and outcome of sleep dysfunction in post-stroke survivors was initiated during the year (PI: Dr Sapna Erat Sreedharan).

## COMPREHENSIVE STROKE CARE CENTRE

### Activities

#### Clinical Activities

The Centre is involved in management of patients with acute stroke which involves thrombolysis and endovascular thrombectomy. In addition, carotid endarterectomy, carotid stenting and moyamoya revascularization are regularly performed. Currently, there are 3 PhD students and one postdoctoral fellow in the Stroke Programme. During the year, 560 acute stroke patients were admitted in the stroke unit and 3050 patients were seen in the stroke clinic; about 37 carotid revascularizations, 35 mechanical

thrombectomies, 35 intravenous thrombolysis and 19 moyamoya revascularizations were performed.

#### Research Activities

1. A Randomized controlled trial (RESTORE) Ayurvedic treatment versus conventional physiotherapy in the rehabilitation of ischemic stroke patients in India. SCTIMST is the National Co-ordinating Centre for this project (PI: Dr Sylaja P N, Funding Agency: ICMR).
2. The study titled “Development of Hospital Based Stroke Registries (HBSR) in different regions of India” (PI: Dr Sylaja P N, Funding Agency: ICMR).
3. The study titled “IMPROVing Stroke CarE in India – Advancing the INSTRuct Operations and Network (IMPROVIS-ATION) (PI: Dr Sylaja P N, Funding Agency :National Institute of Health Research ,UK).
4. The study titled “Early v/s late initiation of direct oral anticoagulants in post- ischaemic stroke patients with atrial fibrillation (ELAN): an International, multicentre, randomised-controlled, two-arm, assessor blinded trial (National PI: Dr Sylaja P N, Funding Agency :Inselspital University Hospital, Bern).
5. The study titled “A comprehensive framework for treatment of impairment of upper extremity due to stroke by combining computational modeling and virtual reality”. It is a collaborative project with IIT Madras, TCS and IITM, Hyderabad and NIMHANS (Funding Agency - IIT Madras).
6. Improvement of secondary prevention in stroke survivors by a primary health care approach in Kollam district. A collaborative project with AMCHSS (Funding Agency - NCD Division, Department of Health and Family Welfare, Government of Kerala).
7. Medication adherence and management of risk factors for secondary prevention of stroke using smart phone-based application: A feasibility study (PI: Dr Sylaja P N, Funding agency: World Stroke Organisation).





## Memorandum of Understanding

The Institute executed the following MoUs:

1. “Prospective Registry for Assessment of Acute Ischemic Stroke Patients Treated with Neurothrombectomy Devices in India (PRAAN study)” with India Medtronic Pvt. Ltd.
2. Extension of the study titled “Improving stroke care in India” with the University of Lancashire.

## Other Activities

As part of the World Stroke Day on 29 October 2021, the Centre made videos on stroke awareness in English and Malayalam and stroke survivors talking about their experience on stroke. These videos were uploaded in the SCTIMST YouTube and Facebook pages.

## Events Organized

As part of World Stroke Day, the Centre organised a webinar for the training of the nurses on stroke care on 31 October 2021. It was inaugurated by Smt Veena George, Hon'ble Minister of Health and Family Welfare, Government of Kerala. 180 nurses from both government and private hospitals across the state attended the webinar.

## Awards and Honours

1. Dr P N Sylaja received the IHW JANANI Award 2021 on Stroke Care Leadership by the Integrated Health and Well-Being Council, New Delhi.
2. Dr P N Sylaja was elected the National CME convener of the Indian Academy of Neurology for 3 years from 2021.
3. Dr P N Sylaja was the international scientific committee co-chair of the Asia Pacific Stroke Conference 2022.
4. Dr Balaswamy, senior resident received the young investigator award for the study titled “Clinical profile, aetiology and outcome of stroke in the young” at the World Stroke Congress 2021.

## NEURO-INTENSIVE CARE DIVISION

During 2021-2022, since half of the Neuromedicine Intensive Care Unit (NMICU) was modified and was functioning as “COVID Screening ICU”, the available bed strength for general neurological critical care was only five. All emergent admissions including neurological emergencies and hyperacute stroke admissions were managed in the COVID Screening area under NMICU and stroke patients were shifted to Stroke ICU (after the hyperacute treatment) after confirming COVID negative status (generally after about 24 Hrs).

## Activities

### Clinical Activities

The total number of neuro-critical care patients treated was 67 (Figure 51) and 4 patients expired with a mortality rate of 5.9%.

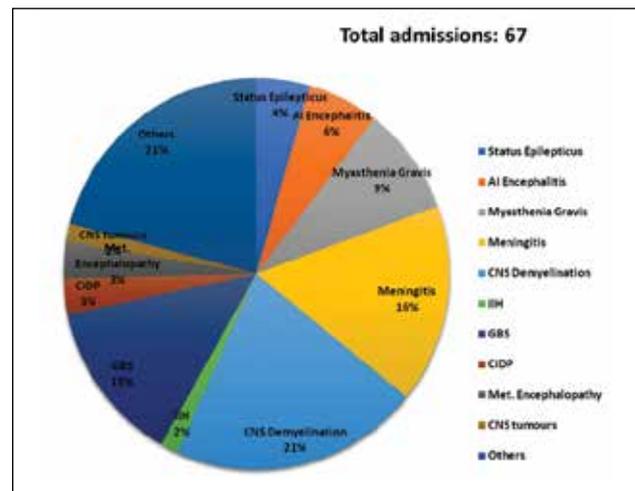


Figure 51. Distribution of diagnosis in Neuromedicine ICU during the year

Hyperacute care for stroke patients treated (initial 24 hours) under NMICU/COVID Screening division was 348. The distribution was 292 ischemic strokes (of which 31 underwent intravenous thrombolysis and 23 had mechanical thrombectomy), 50 intracranial bleeds and 6 cerebral venous thromboses.

The special procedures conducted were: plasma exchange in 21, intravenous immunoglobulin therapy in 7 and rituximab infusions in 24.





### Research Activities

One IEC approved study was initiated and two studies were ongoing in the Division. Institutional protocols for management of various neurological disorders were developed. Protocol for management of status epilepticus in pregnancy was developed and published.

## NEUROMUSCULAR AND MULTIPLE SCLEROSIS DIVISIONS

The Divisions cater to two broad groups of disorders: (a) Neuromuscular disorders which include anterior horn cell diseases, neuropathies, inflammatory myopathies, genetic muscle diseases including muscular dystrophies and neuromuscular junction disorders (b) Acquired central nervous system demyelinating disorders like multiple sclerosis (MS) and neuromyelitis optica spectrum disorders. The patient care services include a weekly Neuromuscular Clinic and monthly Multiple Sclerosis Clinic. The team also routinely caters to the care of patients with neuromuscular disorders and central nervous system demyelinating diseases admitted in the neurology wards and intensive care unit.

### Activities

#### Clinical Activities

During the year, the Neuromuscular Clinic recorded 1689 patient visits and the Multiple Sclerosis Clinic recorded 27 patient visits.

The summary of studies conducted in the Electrophysiology Lab in 2021-22 is summarized in the Table below:

Study	Number
Nerve conduction studies	1097
Electromyography	530
Repetitive nerve stimulation	112
Single fibre electromyography	16
Visual evoked potential	310
Brainstem auditory evoked potential	95
Somatosensory evoked potential	123

The faculty and fellow participated in several national and international virtual conferences and presented papers.

### Research Activities

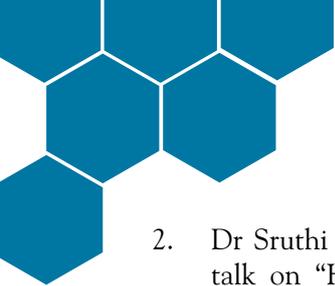
1. The three-year multicentric project "Indian multiple sclerosis and allied demyelinating disorders registry and research network" funded by Indian Council of Medical Research was initiated in August 2021.
2. SCTIMST was also part of the Guillain Barre syndrome (GBS) consortium which collected data from multiple centres across India on change in clinical patterns of GBS during COVID-19.
3. Other newly initiated intramural projects included studies on motor unit number index (MUNIX) in amyotrophic lateral sclerosis, therapy and recovery patterns of acute attacks of inflammatory demyelinating diseases of central nervous system and clinical profile and predictors of relapse in acquired paediatric central demyelinating syndromes. The study prevalence and patterns of cognitive impairment in amyotrophic lateral sclerosis and correlation with disease outcomes was initiated as a student thesis.

### Other Activities

#### Science Outreach

1. Dr Sruthi S Nair, Associate Professor, participated in three programmes on television:
  - "Samoohyadpadam" programme in Dooradarshan on Myasthenia gravis on 16 April 2021.
  - "Samoohyapadam" aired in Dooradarshan on 29 May 2021 on Covid 19 alert, vaccination and awareness on multiple sclerosis'.
  - A panel discussion on "A dialogue on Spinal Muscular Atrophy" in NEWS 18 television which was aired on 20 November 2021.





2. Dr Sruthi S. Nair delivered a public awareness talk on "How COVID-19 affects the nervous system" on All India Radio in November 2021.
3. Two activities were undertaken as part of Azadi ka Amrut Mahotsav. Dr Sruthi S Nair presented a lecture titled "Science – Bench to Bedside" on 31 July 2021 as part of the lecture series for Azadi ka Amrut Mahotsav. Dr Sruthi S. Nair delivered a public awareness talk on "Spinal muscular atrophy and treatment" for Arogyabharathy Keralam on 18 September 2021.

### New Initiatives

1. The single centre Genetic Neuromuscular Disease Registry was initiated during the year with the purpose of streamlining the diagnostic and therapeutic care of these complex diseases. SCTIMST was one of the few centres in India to initiate genetic therapies for spinal muscular atrophy.
2. The Division enrolled in the Training Program Partnership of American Association of Neuromuscular and Electrodiagnostic Medicine for advancing the exposure of the fellow in neuromuscular disorders and electromyography.
3. The technique of motor unit number index (MUNIX) measurements was standardized and was introduced in research.

### Awards and Honours

SCTIMST was selected as a Nodal Centre and Dr Sruthi S Nair, Associate Professor, was selected the Nodal Officer for the implementation of a support programme for multiple sclerosis patients undertaken by the Kerala Social Security Mission, Government of Kerala.

## PEDIATRIC NEUROLOGY AND NEURODEVELOPMENTAL DISORDERS DIVISION

The Division focuses on the evaluation and management of children with neurological disorders. For the rehabilitation of children with neurological

disorders, the Division has a specialized centre, the "Comprehensive Care Centre for Neurodevelopmental Disorders (CCCND)" for multidisciplinary management. The centre predominantly focuses on conditions like autism spectrum disorder, attention deficit hyperactivity disorder, intellectual disability, cerebral palsy, muscular dystrophy and has completed five years of functioning. A team of trained therapists including a psychologist, physiotherapist, speech language pathologist and occupational therapist assess and customize therapy plan for the children. A specialty clinic for autism and other neurodevelopmental disorders are conducted every first and third Saturday of the month. Paediatric Neurology Meet is conducted twice a month to discuss the management of complex cases. Academic sessions are conducted regularly at CCCND which includes seminars, case discussions and journal club. Various research projects by project staff, residents and faculty including functional neuroimaging techniques and neurogenetics in various childhood neurological disorders are ongoing.

### Activities

#### Clinical Activities

During the year, 492 new cases were registered in the outpatient, 90 cases were inpatient, 220 cases were seen at the autism clinic and 338 new cases registered at the CCCND.

Protocols for management of Wilson's disease, attention deficit hyperactivity disorder, intellectual Disability, developmental co-ordination disorders, oro motor strengthening exercise programme and augmentative alternative communication were formulated. The staff at CCCND were trained in administering the Bayley Scales of infant and toddler development - 4th edition and Bayley-4 screening test and were using these standardised tools for the assessment of developmental quotient of children.

Patient Management Conference was conducted twice a month for discussing and formulating the treatment plan in children with complex neurological disorders. Review and Appraisal Meetings were held once a week to discuss the previous week s activities and to plan the activities of the subsequent week. Regular





academic presentations including seminars, journals and case discussions were conducted at CCCND

The faculty delivered lectures and talks at national and international conferences/webinars on various topics in pediatric neurology and pediatric epilepsy.

### **Research Activities**

The Division had two ongoing extramurally-funded projects and one extramurally- funded project was completed. Nine IEC-approved projects were also ongoing.

### **New Initiatives**

1. Bayley Scales of infant and toddler development - 4th edition for developmental assessment and Weschler adult intelligence scale for assessing the intelligence quotient in adults was introduced.
2. Tele-rehabilitation services were started during COVID-19 pandemic for providing rehabilitation services to children with neurological and neurodevelopmental disorders.

### **Events Organized**

Parent awareness programmes using online platform were organized on:

- the occasion of World Cerebral Palsy Day on 6 October 2021
- Alternative Augmentative Communication Awareness month on 22 November 2021
- implementing Activities of Daily Living (ADL) for children with special needs was 29 January 2022

### **Awards and Honours**

Ms Dhiya Susan Jose, occupational therapist, won third prize in best paper award session for the paper titled “Autism spectrum disorders: Barriers in implementing parent based home programs” at Child Neurocon 2021, 11th AOCN Annual Conference held virtually from 9-11 April 2021.

## **R MADHAVAN NAYAR CENTER FOR COMPREHENSIVE EPILEPSY CARE**

R Madhavan Nayar Centre for Comprehensive Epilepsy Care (RMNCEC) provides comprehensive care for all types of adult and paediatric epilepsies to patients from all parts of India and the neighboring countries. It is the main Centre for epilepsy surgery in India and South-east Asia and offers world-class yet affordable comprehensive epilepsy care, comparable to any other Centre in the world. The mission of the Centre is as follows: (1) to provide comprehensive medical, surgical, psychosocial and occupational care for patients with epilepsy with a special emphasis on the surgical treatment of medically refractory epilepsies, (2) to undertake advanced clinical and basic science research in various areas of epilepsy, (3) to enhance epilepsy awareness among the primary care physicians and general public

### **Activities**

#### **Clinical Activities**

The Weekly activities of the Centre are as follows:

- Two Speciality clinics on Wednesdays (Paediatric, general and KREP) and Fridays (General and post-op) epilepsy clinics
- Admissions to epilepsy ward for video EEG, epilepsy care and pre-surgical evaluation - daily
- 2-3 epilepsy surgeries
- 1 Patient Management Conference

#### **Research Activities**

Genetics of complex paediatric epilepsy syndromes: electro-clinico-imaging based genotype-phenotype correlations in an Indian cohort (PI: Dr Ramshekhar N Menon, Funding Agency: ICMR).

### **Events Organized**

International Purple Day 2022 was observed on 26 March 2022. Purple Day is conducted every year to create awareness among general population and





persons with epilepsy. There were poster presentations and an online programme for persons with epilepsy by the faculty.

### Awards and Honours

1. Dr Ajith Cherian, Associate Professor, was awarded the Best Young Neurologist by The Economic Times subsidiary of The Times of India on the occasion of Doctor's Day Virtual Conclave 2021.
2. Dr Ajith Cherian, Associate Professor, was the winner of the MDS-AOS Virtual SYNERGIES and Leadership Course 2021.
3. Dr Ajith Cherian, Associate Professor was the member of the gold medal winning quiz team representing India at the XXV World Congress of Neurology which took place online from 3-7 October 2021.
4. Dr Ajith Cherian, Associate Professor was awarded the travel Bursary Award for international conference from Indian Academy of Neurology for winning the World Tournament of Minds Quiz 2021.
5. Dr Soumya V C, PDF, won the 1st prize in platform presentation at the KAN Monsoon Summit 2021.
6. Dr Pavan Kumar Rudrabhatla, PDF, won the 2nd prize in poster presentation at the KAN Monsoon Summit 2021.
7. Dr Harini Pavuluri, Senior Resident was awarded the ILAE Bursary Award at the 34th International Epilepsy Congress from 28 August to 1 September 2021 at Paris.
8. Dr Harini Pavuluri, Senior Resident selected for the ILAE Mentor Mentee Programme was mentored by Prof Sylvain Rheims, Chair of Functional Neurology and Epileptology, Lyon Institute for Neurosciences, France at the 34th International Epilepsy Congress from 28 August to 1 September 2021 at Paris.
9. Dr Manna Jose, post-doctoral fellow was selected for the ICMR-RA Fellowship. 2021.

### Staff

#### Faculty

- Dr Sylaja P N, Professor and Head of the Department  
 Dr Ashalatha R, Professor  
 Dr Syam K, Professor  
 Dr Sajith S, Professor  
 Dr Ramsekhar N Menon, Additional Professor  
 Dr Sapna Erat Sreedharan, Additional Professor  
 Dr Ajith Cherian, Associate Professor  
 Dr Sruthi S Nair, Associate Professor  
 Dr Soumya Sundaram, Associate Professor  
 Dr Divya K P, Assistant Professor

#### Technical

- Ms Nandini V S, Junior Scientific Officer  
 Ms Preetha Govind G, Senior Technical Assistant  
 Ms Salini K R, Technical Assistant - B  
 Mr Pradeep M J, Technical Assistant - B  
 Ms Shana N Nair, Technical Assistant - B  
 Mr Anees C A, Technical Assistant - B  
 Ms Deepa Paul Miranda, Technical Assistant - A

#### Therapists

- Mr Gangadhara Sarma S, Psychologist - B  
 Ms Lincy Phillip, Occupational Therapist - B  
 Dr Manju Mohan P, Speech Therapist - B  
 Ms Vipina V P, Speech Therapist - A  
 Ms Sushama S R, Psychologist - A  
 Ms Sreelakshmi, Medical Social Worker



# DEPARTMENT OF NEUROSURGERY

The Department of Neurosurgery is an apex referral Centre for neurosurgical cases in the state of Kerala, which performs the largest number of surgeries in the state. In spite of the pandemic, the Department continued to serve patients in need of advanced neurosurgical treatment. In the pursuit of excellence, the department provides world-class neurosurgical care, advances neurosurgical knowledge through research and innovation and ensures the best academic environment for neurosurgical education. The department trained 4 residents who were awarded the MCh Degree in Neurosurgery and 2 Postdoctoral Fellows completed their Fellowship in Cerebrovascular Surgery and Skull Base Surgery.

## Activities

### Clinical Activities

Despite a few setbacks due to the COVID-19 pandemic, outpatient clinics, intensive care for inpatients and operative procedures in all fields of neurosurgery, including skull base, vascular, epilepsy, neuro-oncology, functional neurosurgery and minimal access neurosurgery, continued in a co-ordinated manner. The department catered to 2340 newly registered patients and 17242 patients were reviewed in the out-patient clinic. A total of 1368 surgeries were performed during the year, encompassing various subspecialties of neurosurgery and spanning a spectrum of complexity. Academic inter-departmental meetings were conducted on-line. On working Saturdays, department scheduled meticulous planning of the surgical strategy for patients who were awaiting surgery, along with inter-departmental neuroradiology discussions, neuropathology sessions and departmental surgical audit sessions.

## Milestones achieved

1. Developed a website dedicated to Moyamoya disease ([moyamoya.sctimst.ac.in](http://moyamoya.sctimst.ac.in)). The website was inaugurated by the Director, SCTIMST on 14 May 2021.
2. A surgical safety checklist was introduced in the neurosurgical operating room in collaboration with Neuroanaesthesia and Nursing Divisions.
3. Dr Ganesh Divakar performed lumbar corpectomy and cage placement through transperitoneal approach in a patient with vertebral tumor for the first time in the institute.

## Research Activities

Ongoing research projects:

1. Cavity conformable self-retaining stent retractor: Design and Proof-of-Concept (PI: Dr George C Vilanilam, Funding Agency: TDF, SCTIMST)
2. Prospective observational study of patients undergoing microneurosurgical procedures through a interhemispheric transcallosal approach (PI: Dr Mathew Abraham, Funding Agency: CAREF)
3. Prospective observational study of outcomes of different transcranial approaches for craniopharyngiomas (PI: Dr Mathew Abraham, Funding Agency: CAREF)
4. Predictors of visual outcome and recurrence following surgical resection of medial sphenoid wing meningioma (PI: Dr Mathew Abraham, Funding Agency: CAREF)
5. Real time assessment of shift of ICA during extended endoscopic skullbase surgery using intraoperative doppler and the role of tumour





consistency in causing ICA displacement. (PI: Dr Prakash Nair, Funding Agency: DST - SERB)

6. Computational Fluid Dynamics based tools to the aid of clinical decision making in the management of intracranial aneurysms (PI: Dr B Jayanand Sudhir, Funding Agency: SUPRA Scheme, DST-SERB)
7. Development of High-Performance Computing tools for Computational Fluid Dynamics-based patient specific management of Cerebral Aneurysms (PI: Dr B Jayanand Sudhir, Funding Agency: National Supercomputing Mission)

#### **Outreach programmes**

The Hindi version of Moyamoya disease portal was introduced at <http://moyamoya.sctimst.ac.in>

#### **New Initiatives**

1. Dr Ganesh Divakar performed combined posterior and transthoracic multistaged resection with total spondylectomy for giant thoracic vertebral chondrosarcoma with intrathoracic extension.
2. Dr Jayanand B Sudhir performed multiple bypasses for a complex internal carotid artery aneurysm.
3. Dr Ganesh Divakar performed 360 degree fusion at D1 level, manubriotomy approach for corpectomy with assistance from Vascular Surgery.
4. Dr Prakash Nair performed and published a technical report on endonasal resection of a brainstem glioma.

#### **Awards and Honours**

1. Dr Ganesh Divakar was the 1st runner up for the presentation titled “Compressive vertebral hemangiomas with neurological deficits” at Periyar Neurocon 2021 on 27-28 November 2021 at Kochi.
2. Dr Prakash Nair won 1st prize for video presentation at the 4th Dr D K Chhabra and Dr V K Jain oration (virtual meeting) on 29-30 January 2022.

#### **Staff**

##### **Faculty**

- Dr Easwer H V, Professor and Head of the Department  
Dr Mathew Abraham, Professor  
Dr Krishna Kumar K, Professor  
Dr George C Vilanilam, Professor  
Dr Jayanand Sudhir B, Associate Professor  
Dr Prakash Nair, Associate Professor  
Dr Tobin George, Assistant Professor  
Dr Ganesh Divakar, Assistant Professor (Tenure)



# DEPARTMENT OF PATHOLOGY

The Department has a central role at the Institute, providing laboratory and autopsy services, participating in academic activities and carrying out research on the diagnosis and causation of neurological and cardiovascular diseases.

## Activities

### Clinical Activities

The Department provided surgical, cytology, immunopathology and autopsy services pertaining to neuropathology, cardiovascular and thoracic pathology to the clinical Departments. The clinical services provided by the Department during the year are summarized in the Table.

### Research Programmes

Both extramural-funded and intramural non-funded research projects continued during the year.

The ongoing extramural projects during the year were

#### 1. *In vitro* modelling of temporal aging in hiPSC-derived neural cells and organoids to elucidate the molecular pathology of $\alpha$ -synucleinopathy

Early detection of Parkinson's disease and other alpha-synucleinopathies is difficult due to relatively late onset with an uneventful pre-symptomatic phase, until the symptoms appear at an advanced age. There is a need for an alternative model for disease progression that can be probed longitudinally to discern the molecular events during the pathogenic course. Genomic manipulation and lineage-specific differentiation of human-induced pluripotent stem cells (hiPSC) into neural cells and organoids enables recapitulation of molecular and cellular aspects of disease pathogenesis in a near-physiological condition. Since aging is one of the major risk

Category	Number
<b>Surgical samples</b>	<b>1331</b>
• Neurosurgical biopsies	1013
• Cardiovascular & thoracic biopsies	318
<b>Muscle biopsies</b>	<b>26</b>
<b>Frozen sections</b>	<b>696</b>
<b>Cytology</b>	<b>96</b>
<b>Immunohistochemistry</b>	<b>4724</b>
<b>Autopsy</b>	<b>1</b>
<b>Haematology (peripheral smears)</b>	<b>584</b>
<b>Molecular tests (FISH for 1p/19q)</b>	<b>6</b>
<b>Immunopathology</b>	<b>6450</b>
• <b>ELISA</b>	<b>4224</b>
Anti-dsDNA	679
Anti-phospholipid antibody	1396
Anti-neutrophil cytoplasmic antibody	1378
Anti-thyroglobulin & thyroperoxidase	619
Anti-Acetylcholine receptor antibody	77
Anti-MUSK antibody	61
Anti-titin antibody	14
• <b>Indirect immunofluorescence tests</b>	<b>1204</b>
ANA	749
AQP4-MOG	205
VGKC	65
NMDA	61
Autoimmune encephalitis panel	124
• <b>Immunoblots</b>	<b>925</b>
ANA profile	667
Neuronal antigens profile	198
Ganglioside profile	43
Myositis profile	17
• <b>CSF oligoclonal band assay</b>	<b>97</b>



factors for alpha-synucleinopathies, inducing temporal aging in this model is worth testing.

This project aims to induce temporal aging through advanced glycation end products (AGE) build-up in alpha-synuclein mutation model which could faithfully recapitulate the pathological events of alpha-synucleinopathy progression. In order to model alpha-synucleinopathies, we are generating SNCA mutation resulting in protein misfolding, followed by incorporation of the aging factor by temporally inducing carbonyl stress endogenously resulting in AGE build-up and knocking down glyoxalase 1 (GLO1), a critical enzyme for AGE clearance. We have successfully generated guide RNA constructs targeting SNCA and GLO1 for CRISPR-based interference and confirmed the expression in HEK 293 T cell lines (Figures 52 and 53). Next, these guide RNA constructs will be transfected in human iPS cells and neuronal differentiation potential will be evaluated.

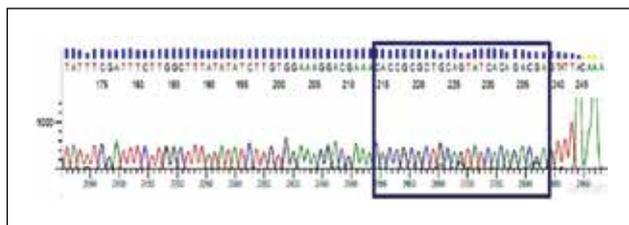


Figure 52. Representative image showing the sequence of guide RNA after Sanger sequencing

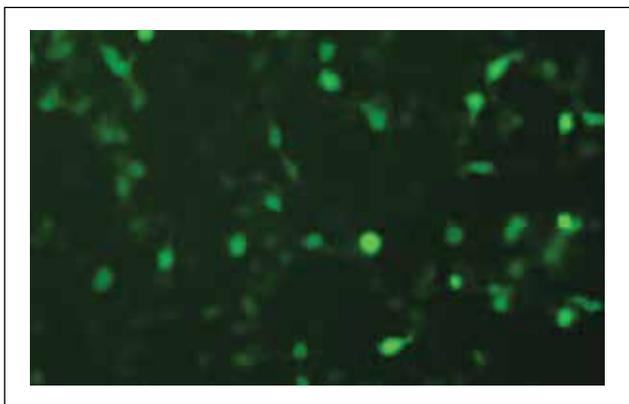


Figure 53. Representative image showing the EGFP expression in HEK 293T cells after transfection of guide RNA construct

## 2. DNA methylation profiling of gangliogliomas and dysembryoplastic neuroepithelial tumors

The aim of this study funded by DST-SERB is to perform in-depth molecular and histopathological analysis of glioneuronal tumors in the ganglioglioma/DNET spectrum - classic ganglioglioma, classic DNET and atypical tumors referred to as “glioneuronal tumors, Not otherwise specified”. Fifty-two cases have been included in this study. Immunohistochemistry was performed on all the cases and Sanger sequencing for BRAF and FGFR1 genes was standardized and sequencing is ongoing.

Completed Project:

The DST-SERB-funded project “Molecular, clinico-radiologic and pathological characterization of oligodendrogliomas with CIC and FUBP1 mutations” was completed.

### Teaching and training

1. Interdepartmental teaching sessions (Neuropathology, Radiology-Pathology, Epilepsy-Pathology)
2. Neuropathology classes for DM Neurology, MCh Neurosurgery senior residents
3. Pathology classes for MD Transfusion Medicine and Diploma in Medical Records students
4. Training for 2 Project Staff

### Other activities

Dr Rajalakshmi P was the Chairperson of the Organizing Committee for Swachhta Pakhwada May 2021 at the Hospital Wing.





### **New Initiatives**

1. Two new tests for patient care were introduced during the year:
  - Immunology test: Anti-IgLON5 indirect immunofluorescence test
  - H3 K27me3 immunohistochemistry
2. The standardization of the following tests were ongoing during the year:
  - FISH (EGFR, CDKN2A, BRAF)
  - Western blot for calpain
  - Assay for mitochondrial complex I
  - MGMT methylation test
  - Immunohistochemistry: EZHIP, BCOR antibodies

### **Faculty**

1. Dr Deepti A N, Additional Professor & Acting Head
2. Dr Rajalakshmi P, Associate Professor
3. Dr Divya Mundackal Sivaraman, Scientist C

### **Technical Staff**

1. Ms Sushama Kumari P, Scientific Officer (Lab, until 31 July 2021)
2. Mr James T, Scientific Officer (Pathology)
3. Ms Neena Issac, Technical Assistant (Lab) - B
4. Ms Resmi S R, Technical Assistant (Lab) - B



# PAIN CLINIC

The comprehensive multidisciplinary Pain Clinic is providing key services for the past 10 years since its inception, as a sole initiative within the public sector health care domain for the whole of India initially in 2012, as an unique model. All the major critical patient management decisions are being arrived on a broad based consensus under a single roof. This approach is facilitated collectively by the multidisciplinary Pain Clinician Team from various speciality departments of the institute and help in consensus facilitation of the following highly skilled intervention procedures (Figure 54):



Figure 54. Procedures performed at Pain Clinic

1. Regenerative Prolotherapy: Platelet-rich plasma (PRP) therapy using the patient's own blood component for regeneration in degenerative musculoskeletal conditions.
2. Radiofrequency ablation of ganglia and nerves - intracranial and spinal regions.
3. Interventions for spinal degenerative disc radiculopathies and chronic pain in non-cancer conditions.

4. Ultrasound- guided therapies and nerve blocks for chronic regional pain conditions.
5. Trigger point injections and therapeutic musculoskeletal infiltrations, facial plane infiltration and plexus infiltration interventions.
6. Epidural and anaesthetic injections.
7. Ozone therapy.

## Activities

### Clinical Activities

During the year despite COVID-19 pandemic, patients were catered to in the Pain Clinic, Geriatric Pain Care & Regenerative Intervention Services (GPCRIS), the details of which are provided in the Table below:

Outside Hospital Referrals (PainClinic)	27
Outside Hospital Referrals (GPCRIS)	43
In House Referrals (Pain Clinic)	292
In House Referrals (GPCRIS)	240
Total procedures and OPD services (PainClinic)	375
Total procedures and OPD services (GPCRIS)	840

Pain Clinic OPD offered services only on Friday from 2 PM onwards and GPCRIS OPD offered regenerative intervention services on all working days from 8 AM-5 PM.

Major interventions were performed in the Digital Subtraction Angiography or Radiology Cath Lab and minor interventions in the OPD procedure room/ observation room adjacent to the Cath Lab.

The Multidisciplinary Pain Team comprised Consultants from Anaesthesiology, Physical Medicine and Rehabilitation, Interventional Radiology and Neurosurgery along with a dedicated Pain Nurse, Physiotherapy trainee and Transfusion Medicine junior residents.



## Research Activities

1. Pre-clinical research collaboration with Prof Amitabha Bandyopadhyay, Department of Biological Sciences and Bioengineering, IIT Kanpur, for osteoarthritis pain with regenerative autologous therapies.
2. Drs Rupa Sridhar and Subin Sukesan were clinical investigators in the new research initiatives undertaken by Mr Subhash N and Mr Muraleedharan C V, Engineers, Division of Artificial Internal Organs, BMT Wing, in collaboration with TynorOrthotics Pvt. Ltd. (Tynor) for development of diabetic foot ulcer offloading device and rigid valgus OA knee brace.
3. The Faculty of the Clinic were part of the research initiative by Division of Thrombosis Research, BMT Wing, for „Biological fluids component separator and mechanism thereof. Patent was filed for “Biological fluids Component separator & Mechanism thereof”. MoU was signed by Dr Ajit Kumar V K, Director, SCTIMST and Mr Asok Sreedhar, Director, Phraction Scientifics Pvt Ltd. for development of biological fluid component separator and segregator on 31 March 2022.
4. Basic science studies and development of new point-of-care kits for Platelet Rich Plasma (PRP) separation continued in collaboration with Drs Renjith Nair and Anugya Bhat, Division of Thrombosis Research, BMT Wing, continued.

## New Initiative

### **Geriatric Pain Care & Regenerative Intervention Services & OPD (GPCRIS)**

The new specialised Geriatric Care from the Pain Clinic was inaugurated by our Former Director Dr Jayakumar K. and Medical Superintendent Dr Rupa Sreedhar on 15 April 2021 with funding support from Kusuma Trust, UK (Figure 55). This Clinic exclusively caters to aged patients with chronic-musculoskeletal non-cancerous pain conditions.



Figure 55. Inauguration of GPCRIS

## Awards and Honours

Dr Subin Sukesan was an invited faculty for Tech Talks, Clinical Advisory and Nodal Faculty for industries involved with medical devices at IIT Kanpur.

## Faculty

Dr Rupa Sreedhar, Professor (Senior Grade), Department of Anaesthesiology and In-charge, Pain Clinic

Dr Subin Sukesan, Additional Professor, Department of Anaesthesiology, Co-In-charge, Pain Clinic

Dr Shrinivas V G, Professor, Department of Anaesthesiology

Dr Easwer H V, Professor and Head of Department, Neurosurgery

Dr Santosh K, Additional Professor, Department of Imaging Sciences and Interventional Radiology

Dr Jijo Varghese, Assistant Professor, Physical Medicine and Rehabilitation

Patient care services: Prof P K Dash, Prof Suneel P R, Dr.Saravanababu M S (Department of Anaesthesiology), Prof Jayadevan E R (Department of IS&IR).

Autologous platelet Rich Plasma Therapies: Prof Debashish Gupta, Professor and Head of Department of Transfusion Medicine.

Public health and community level initiative models and technology suggestions: Dr Biju Soman, Professor, AMCHSS



# DEPARTMENT OF TRANSFUSION MEDICINE

The Department of Transfusion Medicine provides round-the-clock services for blood and blood components to the Institute, conducts state-of-the-art research in collaboration with the clinical team and Biomedical Technology Wing, and train future physicians and technicians in transfusion medicine.

## Activities

### Clinical Activities

1. During the year 2021-22, 6185 blood units were collected. 65 outdoor blood donation camps were conducted and 1852 units of blood were collected. 4333 units were from in-house collection.
2. On 21796 samples blood grouping was performed and 9119 units of blood were cross-matched (8646 units for in-house patients and 473 units for other hospitals).
3. 6185 units of blood collected were processed into various blood components: 6108 units of various types of packed red cells, 4747 units of fresh frozen plasma, 1361 units of cryo-poor plasma and 1361 units of platelets. Six single donor platelets were prepared by apheresis method.
4. 234 units of platelet-rich plasma were prepared for Pain Clinic under Regenerative Medicine Programme for 167 patients.
5. 42 therapeutic plasma exchange performed on 8 patients at Neurology ICU for neurological conditions was supported by residents and faculty from the Department.
6. Autologous transfusion was carried out in 35 patients.
7. Conducted training programme for 1st and 2nd year DM Neuroanesthesia students on Appropriate Blood Transfusion Practices.

## Research Activities

The following projects were ongoing in the department:

1. Incidence of delayed transfusion reactions in a tertiary care hospital (PI: Dr Shivanand K)
2. A study to analyze perioperative blood utilization practices in neurosurgery department of a tertiary care hospital (PI: Dr Shivanand K)
3. A study on the effect of storage of red cells in anticoagulant preservative solution on osmotic fragility (PI: Ms Lekshmi M G)
4. A study on the association of lewis and platelet antigen (1& 2) in patients with acute coronary syndrome (PI: Dr Raj Bharath R)
5. Incidence of delayed transfusion reaction (PI: Dr Shivanand K)
6. Transfusion support in neurosurgery (PI: Dr Shivanand K)

## Community Outreach Activities

A short film on awareness about blood donation titled "Role Model" was made and released on the occasion of National Voluntary Blood Donation Day celebration at SCTIMST on 1 October 2021.

## New Initiatives

1. Restarted autologous transfusion programme with all surgical units during the COVID-19 pandemic to improve blood safety as well as blood inventory.
2. Initiated Platelet-Rich Plasma therapy.

## Events Organized

1. World Blood Donors Day was celebrated on 14 June 2021. Competitions on poem writing, essay writing, slogan writing (in English, Hindi and





Malayalam) was organised for the staff and their family. Prizes were given for the best three in all the categories.

2. National Voluntary Blood Donation Day was celebrated on 1 October 2021. On this occasion, regular voluntary blood donors and voluntary blood donation camp organizers were felicitated. The programme was conducted observing full COVID protocol.
3. Three 1-day National training programmes for Blood Bank doctors of all licensed blood banks functioning in Tamilnadu, Puducherry, Kerala and Lakshadweep were organised by Hemovigilance Programme of India, Ministry of Health and Family Welfare along with State Drug Controller of Tamilnadu and Kerala. Dr Debasish Gupta was invited as a Resource Person to conduct the training programme.

#### Awards and Honours

1. Dr Debasish Gupta, Professor and Head, was an Executive Member of Expert Group on Blood and Blood Products of Indian Pharmacopoeia Commission, Ministry of Health and Family Welfare, Government of India.
2. Dr Debasish Gupta, Professor and Head, was an Executive Member of Hemovigilance Programme of India of National Institute of Biologicals, Ministry of Health and Family Welfare, Government of India.
3. Dr Debasish Gupta, Professor and Head, was re-nominated as a Chairperson for the Committee for developing National Reference Standards of Blood Grouping Antisera by National Institute of Biologicals, Ministry of Health and Family Welfare, Government of India.
4. Dr Debasish Gupta, Professor and Head, was appointed as a Resource Person for Training Program on Hemovigilance and Quality Assurance of South-East Asia Region (SEAR) countries organized by WHO, SEARO.
5. Dr Debasish Gupta, Professor and Head, was appointed Chairperson of Board of Studies – Life Sciences, SCTIMST for a period of 3 years.
6. Dr Angel Mary Sam, Junior Resident, won 3rd prize for oral presentation entitled “Experience of autologous blood transfusion during the COVID-19 pandemic in a tertiary care centre in south India” at the 1st Annual CME of Transfusion Medicine Academic Society (TMAS) held on 5 March 2022.
7. Dr Angel Mary Sam, Junior Resident, received an award for video presentation entitled “Hemoglobin estimation in a blood donor using Hemocue Hb-301 System” in virtual CME on Blood Safety & Quality (ISBSQ 2022) organized by the Department of Transfusion Medicine, AIIMS, New Delhi on 26 March 2022.
8. Ms Sindhu P N, Technical Assistant, won 1st prize in Hindi calligraphy during Hindi Fortnight, celebrations at the institute in September 2021.
9. Ms Jyothi M, Technical Assistant, won 2nd prize in Hindi calligraphy during Hindi Fortnight, celebrations at the institute in September 2021.
10. Dr Amita R, Assistant Professor, won 3rd prize in Hindi calligraphy and essay writing, and 2nd prize in Noting and Drafting and Short story writing during Hindi Fortnight, celebrations at the institute in September 2021.
11. Ms Preethy Prakash, Technical Assistant, won 1st prize in Malayalam poem writing competition during the National Voluntary blood donation day celebrations
12. Dr Raj Bharath R, Associate Professor, won 2nd prize in English short story competition during the World Antimicrobials Awareness Week (WAAW) - 2021 at SCTIMST.





## **Staff**

### **Faculty**

Dr Debasish Gupta, Professor and Head of the Department

Dr S Sathyabhama, Scientist G (till 30-11-2021)

Dr R Raj Bharath, Associate Professor

Dr R Amita, Assistant Professor

### **Technical**

Ms Sheela Devi K S, Scientific Officer

Ms Sindhu P N, Scientific Officer

Ms Baby Saritha G, Junior Scientific Officer

Mr Sivakumar S, Junior Technical Officer

Ms Jyothi M, Senior Technical Assistant

Mr Sunil K P, Technical Assistant - B

Ms Sindhu M S, Technical Assistant - B

Ms Renjini P, Technical Assistant - B

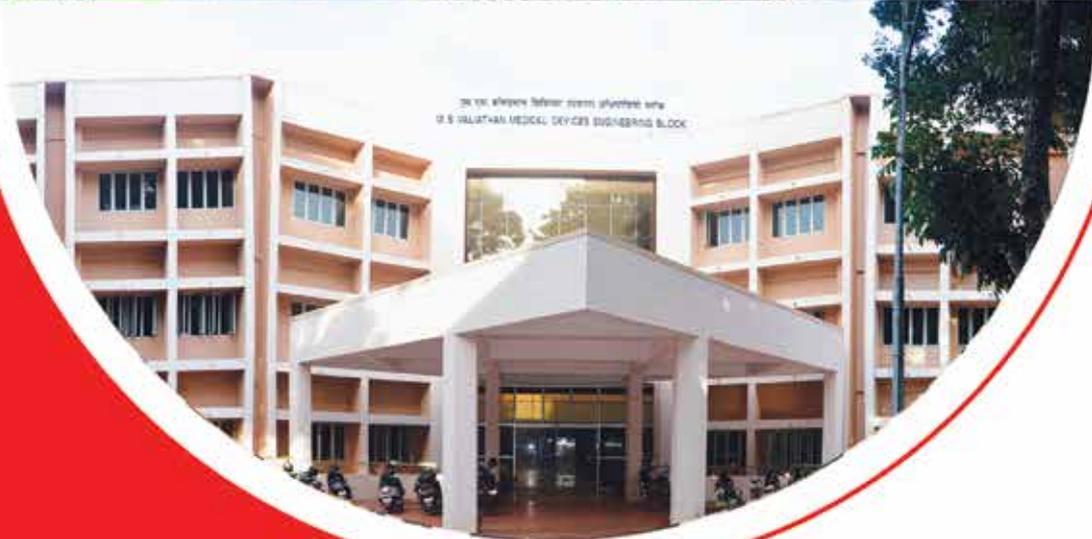
Ms Manju K Nair, Technical Assistant - B

Ms Preethy Prakash, Technical Assistant - B

Mr George Paul Thaliyath, Medical Social Worker

Ms Omana P N, Nursing Officer - D





# **BIOMEDICAL TECHNOLOGY WING**

# DEPARTMENT OF APPLIED BIOLOGY

The Department of Applied Biology plays a critical role in medical device development by providing medical device evaluation as per International Standards like ISO 10993 for biocompatibility, ASTM standards, OECD guidelines and United States Pharmacopia (USP). Many of the tests performed by the Department are on the quality platform as per ISO 17025 and are accredited by COFRAC of France. These tests are also available for external customers, both Indian and international medical device manufacturers. In addition, the Divisions under the Department have a strong research base, which resulted in a number of technologies. The Department is working on cutting edge research areas like 3D-bioprinting, regenerative technologies, stem cell therapy, research in memory and learning, sleep research, material-cell-microbial interactions, biomaterial-tissue interactions and laboratory animal models.

The Department of Applied Biology comprises the Divisions of:

1. Experimental Pathology
2. Laboratory Animal Science
3. Microbial Technology
4. Molecular Medicine
5. Sleep Research
6. Tissue Culture
7. Tissue Engineering and Regenerative Technologies
8. Thrombosis Research
9. Toxicology
10. In Vivo Models and Testing

## DIVISION OF EXPERIMENTAL PATHOLOGY

Histopathology laboratory is unique in the country as a COFRAC-accredited laboratory having facilities to undertake routine as well as a wide range of specialized techniques for evaluation of biocompatibility of various biomaterials as per international standards and pre-clinical evaluation of medical devices as per approved protocols. The Laboratory has maintained quality system for the past 19 years. The COFRAC surveillance assessment was completed during December 2021 and the Laboratory successfully retained COFRAC accreditation for intramuscular, subcutaneous, bone implantation and mucosal irritation tests.

The Division has three activities:

1. Development of biomedical device and evaluation of biomaterials
2. Consultancy services to internal and external researchers on all aspects of animal experimentation focusing on experimental pathology
3. Disease/health monitoring in laboratory animals

## Developmental Activities

During the previous years, the Division was working on an innovative non-detergent/enzymatic method for preparing biomaterial grade porcine cholecyst (gall bladder) extracellular matrix scaffold (CECM). It promotes faster healing of skin-wounds with minimal scarring, and a prototype was prepared. The know-how was transferred to M/s Alicorn Medical Pvt. Ltd. which later became an incubatee of TIMed. The product was named as Cholederm™ and obtained approval of the Central Drugs Standard Control Organisation (CDSCO). Validation of the manufacturing procedures and pre-clinical safety



evaluation were ongoing. Research was ongoing: (i) to evaluate the potential of CECM scaffold for cardiac application and for diabetic wound healing, (ii) to prepare various formulations of cholecyst scaffold-like powder, gel etc and evaluate the potential for various applications and (iii) to prepare hybrid products for hernia repair.

## Research Programmes

### 1. Programme support on translational research on biomaterials for orthopaedic and dental applications - histopathology evaluation in rabbit

During the period, animal implantation studies of the dental implants developed in the project were executed. The new design conceived by the investigators' team was fabricated for the test and compared with a commercial brand. These were implanted in the femoral condylar area of New Zealand white rabbits for a time period of 12 weeks (Figure 1). The implantation was carried out on 10 animals with the test implant on the left limb and control implant on the right limb. After the stipulated time period, the implant along with the surrounding tissue was removed for further histological and micro-radiographic examination. The test implants showed good apposition to bone and were stable after the implantation period. In histopathology sections, the new bone in the defect area was in close contact with the implant surface. The test implant depicted more bone contact. Thus, the newly developed implant was found to be safe in vivo, with reference to the material used as well as the design.



Figure 1. Rabbit femur medial condyle with metal orthodontic screw implant

### 2. Stem cell-derived exosome therapy for clinical management of lung damage in critically-ill corona viral pneumonia patients

Mouse animal model was used in this CRG short-term (special call on COVID-19) project. Mice lungs were collected. Using bleomycin infusion intratracheally, acute respiratory distress syndrome-like condition was developed. Animals were treated with exosomes and mesenchymal stem cells. Post-experimental period, animals were sacrificed humanely and lung tissue response was evaluated by macro and microscopic examination. Gross and histopathology evaluation of various treatment groups were completed and a report was issued.

## New Initiatives

Preparation and characterisation of an injectable gel formulation of porcine cholecystic extracellular matrix.

## Testing and Evaluation

1. Necropsy and histological evaluation of four Rabbits from the Division of Laboratory Animal Sciences
2. Histological evaluation for 2 work orders from external customers and 6 work orders from internal customers. Three studies were done - one from internal and two from external customers.
3. 216 tissue specimens were received for evaluation as per ISO 10993-6, which included muscle, subcutaneous tissue and bone with implant for biocompatibility. Preclinical evaluation specimens such as bone graft, dural substitute, wound healing products, neuroembolisation using liquid embolic agent, left ventricular assist device, bioprosthetic heart valve, scaffolds seeded with cells using 3D bioprinting technique and acute respiratory distress syndrome lung specimens were also received (Figure 2).



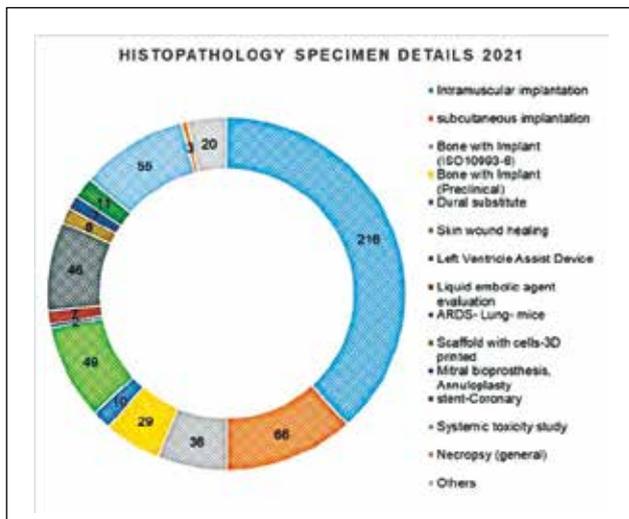


Figure 2. Details of histopathology specimens evaluated during the year



Figure 3. Gross image of cross section of rete mirabile with polymer cast in the lumen

4. 29 test reports were issued during the year which included 3 accredited, 16 non-accredited test reports and 10 necropsy reports.
5. Histopathology Laboratory is a notified medical device testing laboratory approved by CDSCO for evaluation of biocompatibility for medical devices under the Medical Devices Rules, 2017, Government of India.
6. Gross and histopathological evaluation progressed for the following medical device development activities in projects under Technology Research Centre (TRC) and Technology Development Fund (TDF):

- *Evaluation of liquid embolic agent*

Pig animal model was used for the study. Following standard procedure embolization of the rete-mirabile cerebri vessels was carried out. Post 3 months experimental period, animals were sacrificed humanely and rete-mirabile with polymer cast was harvested and subjected to histopathological evaluation. Gross (Figure 3) and histopathology evaluation was completed.

- *Evaluation of lint-free absorbent*

Gross and histopathology evaluation was completed in rabbit ear with venous ulcer wound healing model.

- *Development of paracorporeal left ventricular assist device*

Sheep animal model was used for this study. Post-72 hours of experiment, animals were sacrificed and complete necropsy examination was carried out.

- *Decellularised bovine pericardium bioprosthesis in mitral valve replacement*

Sheep animal model was used. Post-6 months experimental period, animals were sacrificed humanely and healing tissue response was evaluated which included thromboembolic complication, calcification and structural integrity of the leaflets.

- *Evaluation of ADA-gelatin anti adhesive material*

Rabbit thoracic adhesion model and rat abdominal adhesion model were used. Post 1- and 3-months experimental period, animals were sacrificed humanely. Surgical adhesions were studied and healing tissue response was evaluated (Figure 4).



Figure 4. Rabbit heart and adnexa histology. No adhesion between visceral thorax and epicardium, ADA gelatin material noted with encapsulation (H&E stain)

- **Evaluation of C band polymer annuloplasty ring**

Sheep animal model was used. Post-6 months experimental period, animals were sacrificed humanely and annulus healing tissue response was evaluated (Figure 5) which included thromboembolic complication, calcification, structural integrity of leaflets.

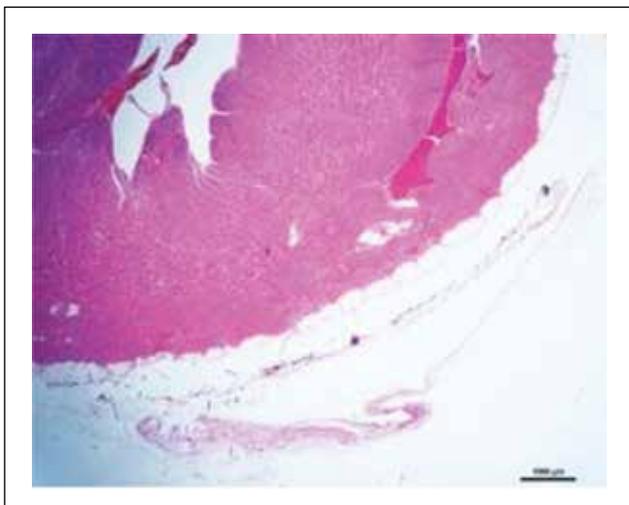


Figure 5. Sheep left atrium view with annuloplasty C-band in supra mitral position, healed completely and covered with pannus tissue

- **Evaluation of electrospun polymer**

Rabbit skull with parietal calvarial defect and dural substitution model was used. Post 3- and 6-month experimental period, animals were sacrificed humanely and healing tissue response was evaluated which included neural tissue response, inflammation, apposition at edges. Gross (Figure 6) and histopathology evaluation was completed.

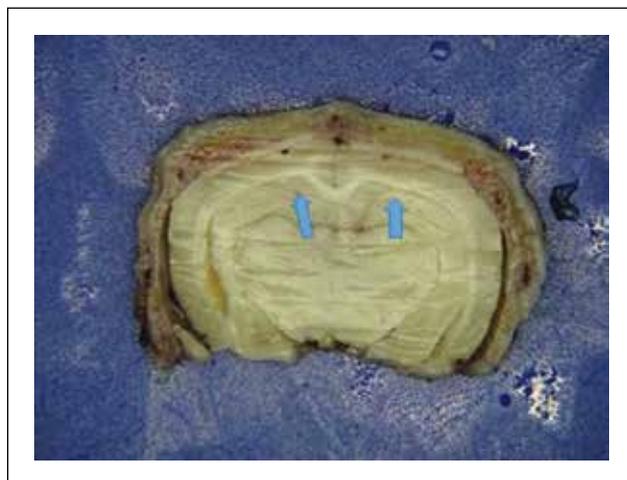


Figure 6. Gross coronal section of rabbit skull, cerebral cortex with bilateral dural substitute implant (arrows)

### Training/Outreach Programmes

Under SC/ST Empowerment Programme, one UG student was trained in routine and special staining techniques using tissue sections.

### Awards and Honours

Dr T V Anilkumar was nominated Executive Committee Member and Mr Pratheesh K V, PhD scholar, as Member of President's Council of Student Advisors, Society for Biomaterials and Artificial Organs (SBAOI), India.

### DIVISION OF LABORATORY ANIMAL SCIENCE

The Division facilitates research and testing using small laboratory animals by imparting care, welfare and management of small laboratory rodents and rabbits as per ISO standard 10993 Part-II of which



quality system is based on ISO/IEC 17025; 2005. The primary mandate of the Division is to breed, stock and supply good quality small laboratory animals for testing and research. The Division is under surveillance of COFRAC for the quality system in producing, maintaining and supplying animals for accredited testing. The Division is registered with the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) and has to its credit many work procedures maintained as per international guidelines applicable to the field.

### Developmental Activities

- The Division offered technical support developing animal models for various projects:
  - Meniscus tissue repair Rabbit model - Animal experiments were completed.
  - Animal study part for lung injury COVID-19 fibrosis treatment model development was completed.
  - Feasibility and efficacy of Emuloid, a novel iodine-based contrast agent for CT imaging.
  - Animal study part for 3D bioprinting of skin tissue constructs study was completed.
  - Animal study part for HLL's Blood bag study was completed.
- The Division primarily provided service and technical support to investigators and supplied animals. The animals supplied for testing and research during the year are indicated in the Table below:

Animal	Number
Rabbits	126
Rats	531
Mice	505
Guinea Pigs	112

- The Division conducted three IAEC meetings (26/07/2021, 21/10/2021 and 21/02/2022) and sanctioned 32B Forms to perform animal studies in the institute. 5 large animal B forms were sanctioned during the year.

### Research Programmes

- Development of mucoadhesive polymer-coated ferrous sulphate for treating anaemia - Study was completed and report issued to HLL.
- Stem cell-derived exosome therapy for clinical management of lung damage in critically-ill corona viral pneumonia patients - animal model development was completed.
- An animal study towards proof-of-concept evaluation of a biomaterial to treat meniscus tear in rabbit surgical model was completed.
- Study on feasibility and efficacy of "Emuloid" a novel iodine-based contrast agent for CT imaging was completed.
- Implantation of shell nacre-integrated bioactive composite material for bone defect - animal study was completed.
- Evaluate in diabetic (STZ) rat model, a laparotomic implant to regenerate islet s function using a cell-based implant - Animal study was completed.

### Testing and Evaluation

Breeding, quality control and supply of small laboratory animals and statutory and regulatory compliance maintenance remains the prime focus of the Division. The upgradation of the Animal Facility to integrate barriers was ongoing and the Facility was partially operational during the year. Annual inspection of the Animal Facility by CPCSEA nominees was conducted on 24 December 2021. The Division participated in the COFRAC Audit on 8-9 December 2021.

### Training/Outreach Programmes

Dr Harikrishnan V S participated as a Trainer in Nominees Training Programme, conducted by CPCSEA, New Delhi on 2 December 2021.

### Awards and Honours

- Dr Harikrishnan V S received the Best Poster Award for the presentation "Dental burr assisted laminectomy in spinal cord injury rat model: Acute and chronic effects on welfare and



outcome” at the 50th Anniversary Scand – LAS meeting at Tallinn, Estonia on 2-4 November 2021.

2. Dr V S.Harikrishnan was selected Member of CPCSEA, New Delhi. He was also was nominated Member of the Working Group constituted by CPCSEA for grading animal facilities in India.

## DIVISION OF MICROBIAL TECHNOLOGY

Division of Microbial Technology has the dual role of supporting medical device development and understanding medical device-associated infections. In supporting medical device development, the Division functions on a quality platform, offers a number of tests based on international standards and is ISO 17025 accredited. It also offers training of manpower to industries on quality systems in Microbiology. The research in the Division focuses on microbial biofilm and its molecular biology, development of tissue-engineered constructs to study material-cell-microbial interactions, immune modulations by bacterial biofilms and research and development of diagnostic devices for microbial infections. In its role of supporting medical device development and medical device industry, the Division offers a number of tests to the public and to researchers within the institute. It is also involved with health monitoring of experimental animals to ensure high quality animals for experimental purposes, biocompatibility assessments and pre-clinical studies.

## Developmental Activities

1. The ICMR validation of Rapidogram – Rapid diagnostic kit for UTI along with antibiotic sensitivity pattern was ongoing. The technology was transferred to M/s Agappe Diagnostics, Pattimattom, Kochi.
2. Validation of technologies developed in SCTIMST – (i) UVC steriliser, (ii) Flocked throat and nasal swab, and (iii) Polyurethane nasal and throat swabs.
3. ICMR guidelines-based technologies – Desktop evaluation regarding disinfectants and disinfecting devices were evaluated and reports issued (14 reports).

## Research Programmes

1. Dr A Maya Nandkumar as PI received DBT SAHAJ Infrastructure Fund of 9.95 Crore for the “National Translational Research Facility for biomaterials, medical devices and in vitro diagnostics” for the next 5 years.
2. **Carbon nanoparticles as inducers of pulmonary fibrosis- study on cell-material interactions**

In order to understand the impact of carbon black nanoparticles (CBNP), one of the largest components of atmospheric pollution, responses of type 2 alveolar epithelial cells, fibroblasts and monocytes were assessed after CBNP exposure. We observed that short term exposure (24-48hrs) of CBNP induced a dose-dependent pro-inflammatory and cytotoxic response in cells. Prolonged exposure to low doses of CBNP induced a pro-fibrotic response in alveolar cells. Epithelial-mesenchymal transition (EMT) occurred in alveolar epithelial cells on prolonged exposure to CBNP as evidenced by morphological, biochemical and molecular changes (Figure 7). The EMT mechanism was found to be TGF 1-mediated SMAD3-WNT pathway. Prolonged exposure to low doses also induced fibroblast activation and monocyte polarisation to M2 phenotype. These mechanisms are considered to activate fibrotic responses in alveolar cells.

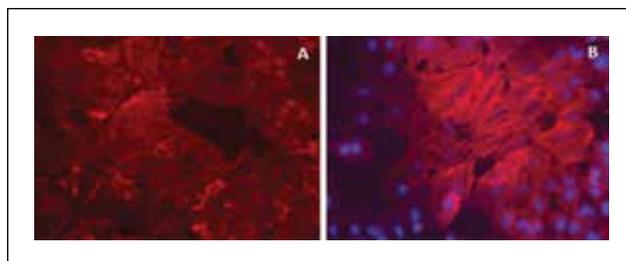


Figure 7. Cytoskeletal remodelling in CBNP exposed alveolar epithelial cells (120hr). Figure shows actin remodelling by CBNP using rhodamine-phalloidin stain. A - Control, B -10µg/ml CBNP exposed A549 cells showing a clear actin reorganisation from cortical thin bundles to thick parallel bundles.



### 3. Study on *Clostridioides difficile* biofilm interaction with gut epithelium and role of immune modulation

*Clostridioides difficile* is a Gram-positive, spore producing anaerobic bacterium. In US and Europe, it is a common pathogen causing antibiotic associated diarrhea (ADD) and colitis and a neglected, but emerging pathogen in India. This study aims to understand the molecular mechanism of interactions of *C difficile* with gut epithelium to find therapeutic solutions as its persistence in the gut causes recurrent infections.

#### Testing and Evaluation

For supporting medical device development and medical device industry the Division offers a number of tests to internal and external customers. The Division maintains Controlled Environment Class 10000 Facility for performance of sterility test, full-fledged Microbiology and Tissue Culture laboratories to meet the requirements of testing laboratories as per ISO 17025.

The tests offered by the Division are:

1. Accredited tests for (i) sterility; (ii) Bioburden Analysis ISO 11737-1; (iii) Genotoxicity test -ISO 10993 -3, OECD 471
2. Tests performed for maintenance of quality system such as microbiological monitoring of controlled environment - based on USP <1116> and microbiological analysis of water- based on ISO 4831
3. Test performed to support of research and development such as antimicrobial activity testing of materials, evaluation of biomaterial-bacterial interactions by bacterial adhesion studies.
4. Other tests such as spore viability test based on <USP 55>, culture and sensitivity and growth promotion tests for microbiological media - based on USP <71>, ISO 7218 and ISO 11133, and validation of filters 0.45 and 0.2u filters used in bioburden analysis (accredited).

5. During the year, a total of 76 test requests were received and 166 samples were tested.
6. An industry-sponsored study project “Evaluation of robotic disinfecting device - SERROBO” was executed. The device was tested, analysed and report issued.

#### DIVISION OF MOLECULAR MEDICINE

The Division is focusing on (i) the development of the molecular diagnostic kits for the early detection of infectious diseases and (ii) innovative research on neurological diseases involving memory loss using *C. elegans* as the model system. For the development of diagnostic kits, we have been focusing on pulmonary tuberculosis because of the high prevalence in our country and human papillomavirus because of the lack of low-cost technologies with high sensitivity for the early detection of cervical cancer, a preventable disease. The basic research on the neurobiology of learning and consciousness focuses on the role of various neurotransmitters like tyramine, dopamine, insulin and glutamic acid in the *C elegans* model system.

#### Developmental Activities

1. **Development of detection kits for infectious diseases**
  - **SARS CoV2**

Early detection of COVID-19 (SARS CoV2) was a challenge during the pandemic in 2020-2022 and still so because of the variants. We developed an RNA isolation kit and validated it at National Institute of Virology (NIV), Alappuzha. The kit showed 100% sensitivity and specificity. The kit was transferred to M/s Agappe Diagnostics and Tata Sons in April 2020 after ICMR approval. M/s Agappe Diagnostics brought this product to the market as “Agappe Chitra Magna - RNA isolation kit” (Figure 8). The kit is used in various diagnostic laboratories in the country for the COVID-19 RNA isolation and is considered one of the successful products from India. This technology was highlighted in a meeting



at World Economic Forum as one of the five best initiatives in the country during the early stages of the pandemic.

The second challenge was to accurately detect the COVID-19 when there were a series of variants of the virus in circulation in the population. Few kits were failing because of the mutations within the primer/probe regions of the target genes in the virus. We developed a multiplex RT-PCR kit with ORF1b nsp14 and RdRp as the target genes and RNAse P as the internal control. ORF1b nsp14 gene is an error-correcting protein nuclease and mutations in this gene result in structural protein errors leading to low survival of the virus. Hence, all the dominant variants of SARS CoV2 are devoid of ORF1b nsp14 gene mutations. Therefore, targeting this gene for the detection of the virus is a more appropriate choice when a series of variants are in circulation within the population. The kit was validated at NIV, Pune, in March 2021, and the report showed 100% specificity and 97.3% sensitivity. After ICMR approval, the technology was transferred to M/s Huwel Life Sciences, Hyderabad, and M/s Meryl Diagnostics, Gujarat. M/s Huwel Life Sciences marketed this kit as Chitra SARS CoV2 multiplex COVID-19 detection kit.



Figure 8. Chitra Magna kit for RNA isolation

### • Pulmonary tuberculosis

Mycobacterium tuberculosis is a major causative agent of pulmonary tuberculosis (TB). For accurate detection of the bacterium real-time PCR method has been used. As an alternate and most affordable method, we are developing a real-time Loop-mediated isothermal amplification (LAMP)-based technique for the detection of TB, especially for the resource limited settings. LAMP has high specificity since it employs six primers to recognize the target sequence. This amplification technique can be carried out at a constant temperature (60°C) eliminating the need for a thermal cycler and less affected by inhibitors commonly present in biological samples. We have standardized the technique targeting the mpt64 gene. The clinical validation part of the study was completed and is waiting for technology transfer to the industry.

### • Human papilloma virus - HPV16/18 detection

Detection of Human papillomavirus HPV 16/18 DNA and E6/E7 mRNA is an early marker for cervical cancer. We have developed a real-time multiplex LAMP-based amplification of HPV E6/E7 mRNA and HPV 16/18 DNA as a highly sensitive test for the detection of early stages of cervical cancer. The detection time is less than 30 minutes. The programme is at the stage of clinical validation.

## 2. Development of recombinant growth factors for wound healing application

It has been known that the growth factors like vascular endothelial growth factor, involved in angiogenesis, and transforming growth factor-alpha can initiate faster healing of skin wounds. The aim of the study is to express and purify recombinant mature growth factor peptides for the treatment of deep and chronic wounds. The prokaryotic system was used to develop these growth factors, which makes it a cost-efficient



method of development. An alginate scaffold matrix was used to deliver both these growth factors into the wound site. All the preclinical studies were completed and initiation of a limited clinical trial was underway.

## New Initiatives

*Developing optically active cationic carbon dots and dual emission carbon dots for colorimetric and fluorescence detection applications*

Nucleic acid amplification techniques are highly sensitive and specific in detecting the disease-causing organism. Compared to the traditional PCR technique, real-time fluorescent quantitative PCR technology (qRT-PCR) and real-time loop-mediated isothermal amplification (RT-LAMP) give the measurements in the fluorescence intensity in real-time. Unfortunately, irrespective of the various dyes used, high background fluorescence is always observed in this method thereby limiting their accuracy. TaqMan chemistry-based fluorogenic-labeled probes have been developed for real-time detection of specific amplification products. However, the design and labelling of fluorogenic probes and quencher pairs within a primer is laborious and expensive. Development of novel target specific biocompatible functionalized nanomaterials such as metallic nanoclusters, non-metallic carbon/silicon/phosphorene quantum dots (QDs) and two-dimensional materials viz., graphene, Mxenes QDs could serve as a potential alternative to TaqMan or dye-based nucleic acid assays. Herein, we have developed a one-step hydrothermal method to generate optically active cationic carbon dots (RCQDs) and dual emission carbon dots (dCQDs) for colorimetric and fluorescence detection applications. We used RCQDs to generate aggregated assembly of AuNPs and explored its use in the colorimetric detection of DNA. The detection principle is based on the ability of RCQDs to induce aggregation or de-aggregation of AuNPs in the absence and presence of DNA, respectively. The aggregation and de-aggregation process of AuNPs is accompanied by a visible colorimetric change from pale blue to red wine. The proposed assay could

selectively detect DNA even in the presence of 100-fold common interferants and showed a linear response over the concentration range of DNA from 0-14 nM with a detection limit (LOD) of as low as 1.25 nM. This unique fluorescence response of dCQDs was tested to detect negative and positive TB samples using RT-LAMP assay and found to have good sensitivity.

## Technology Transfer Activities

1. Chitra Magna RNA isolation kit – Technology transferred to Agappe Diagnostics, Kochi and Tata Sons. Agappe Diagnostics commercialized the product in the market.
2. Chitra Multiplex SARS CoV2 RT-PCR kit – Technology transferred to Huwel Life Sciences, Hyderabad and Meryl Diagnostics, Gujarat. Huwel Life Sciences marketed the product.

## Research Programmes

1. **Regulation of neuronal function during learning and memory:**

### a) Role of tyramine

Tyramine (TA), one of the precursors for monoamines like dopamine and serotonin, plays a critical role in the risk-reward pathway and could act as a neurotransmitter. However, the molecular mechanisms underlying the tyramine pathway is poorly understood and their role in memory formation is unclear. *C. elegans* is an apt model to verify the role of monoamines in olfactory adaptive learning and memory. We found a significant increase in short-term associative memory in worms exposed to exogenous tyramine. On the other hand, no significant effect was found in long-term associative memory under similar treatment. The mutants seem to have impaired memory and decision-making capabilities in *C. elegans*. These results suggest that fast-acting tyramine receptor LGC-55 in the head neurons of the organism plays an essential role, which in turn could be assisted by the second tyramine receptor SER-2 in



the mid-body facilitating the initiation of the escape cascade. This event can also render the organism with a stronger memory of the threats in near future thereby adapting it to its immediate surroundings. This top-down approach of multisensory decision-making is regulated by tyramine and has an essential role in behavioural changes based on learning and memory in worms.

#### b) *Role of insulin and dopamine*

The significance of proper insulin signalling during the critical period of early developmental stages is poorly understood. In *C. elegans* a proper insulin signalling is vital for the maintenance of normal memory. We found that exogenous insulin administration could compensate for the downregulated insulin pathway of dauers and improves cognitive functions.

We also study the link between insulin and dopamine. Insulin-dopamine crosstalk is relevant in the metabolic effects of various antipsychotic drugs. Dopamine is one of the critical neurotransmitters known to modulate neuronal function. Another influential hypothesis posits that dopamine biases reinforcement learning. Based on the current study, it was found that insulin could also act as a reward signal during associative learning. Further, dopamine signalling was found to work downstream of insulin signalling. Our study is trying to elucidate the effect of insulin, dopamine, and their relationship, thereof, in the context of learning and memory.

### **DIVISION OF SLEEP RESEARCH**

Studies in the Division of Sleep Research are aimed to understand the functions and neural mechanisms of sleep, and to provide evidences for herbal products and non-pharmacological measures like Yoga nidra to improve sleep quality for improving human health and wellbeing. This laboratory is equipped with latest instruments to study the role of sleep in developmental programming for ontogenetic

organization of sleep-wakefulness, autonomic balance for an optimal cognitive development using insomnia model in rodents. Research output from the Division are published in international Journals and presented at various international conferences and forums. The Division provides extensive training for techniques in this area in animal models and undertakes sleep awareness programme.

#### **Research Programmes**

Effects of sleep loss in pregnant rats were evaluated in offspring immediately after birth until adolescence taking various parameters including the heart rate variability during different states of sleep-wakefulness along with cognitive development. Sleep and heart rate were assessed using electrophysiological parameters by recording electrical activity of brain (EEG) and neck muscle activity (EMG) and ECG in free moving animals. These signals were analysed offline for depicting changes in state dependent heart rate variability. Sleep deprivation during pregnancy not only activated the sympathetic outflow, but also suppressed development of parasympathetic component of the autonomic system in pups. This study depicted brain and heart connect during early development as both are vulnerable to stress. The postnatal development of brain network is a complex process and requires time dependent fine tuning for achieving an age matched appropriate behavior in children. A pilot study conducted in a postmenopausal subject with insomnia showed that practice of yoga nidra in morning and 25 -30 minutes of walking in evening significantly improved her sleep quality and overall wellbeing. Sleep and activity rhythms were monitored continuously using actigraphy (Somnomedics Plus) for 28 weeks (4 weeks of pre-intervention control and 24 weeks of Yoga Nidra intervention) and a sleep diary. Yoga Nidra and walking dual protocol is proposed as an efficient therapeutic tool to contain insomnia and to improve overall wellbeing in postmenopausal age.

#### **Outreach Programmes**

1. Dr Kamalesh K Gulia delivered a talk on the "Functions of Sleep" at the virtual Special



National Sleep Medicine Course for MBBS students organized by the Indian Society for Sleep Research from 23-25 April 2021.

2. Dr Kamalesh K Gulia delivered a talk on “Sleep quality linked to sound mind and happiness” during the World Sleep Day celebration with the theme “Quality Sleep, Sound Mind, Happy Life” organized at BMT Wing on 16 March 2022 (Figure 9).
3. Dr Kamalesh K Gulia delivered a talk (online) on “Let’s understand the link between sleep and happiness” at a programme organized by the VTM NSS College, Dhanuvachapuram, Kerala on 18 March 2022
4. Dr Kamalesh K Gulia delivered a talk (online) on “Sleep for good health and happiness: Nature’s Samurai” at the Chairman’s Lecture Series Programme organised by GEMS Arts and Science College, Malappuram, Kerala on 21 March 2022.



Figure 9. World Sleep Day Celebration at BMT Wing

### Awards and Honour

Dr Kamalesh K Gulia received Dr B K Anand Oration Award for the year 2020-2021 by the National Academy of Medical Sciences at NAMSCON 2021 Conference held at Institute of Medical Sciences, BHU, Varanasi on 27 November 2021 (Figure 10).

Dr Gulia delivered the Dr B K Anand Oration 2021 on the topic “Sleep for an active brain: An underestimated phenomenon”. This award was given by National Academy of Medical Sciences (India) in recognition of her outstanding contribution in the field of Neurophysiology.



Figure 10. Dr Kamalesh K Gulia with Dr B K Anand Oration Award

### DIVISION OF TISSUE CULTURE

The Division of Tissue Culture is involved in research and development activities and provides technical support for product development. The Division also participates in academic programmes of the institute to generate trained human resource specifically in cell culture and tissue engineering through academic projects and research projects. The Division offers *in vitro* cytotoxicity testing as per the ISO/IEC 17025 quality platform to internal and external customers. The tests are accredited by COFRAC, France. The Division also extend a range of *in vitro* tests to customers as per the specific requirement such as cell-material interactions, image analysis and cell-based assays. The research activities include cell-material interaction, stem cells, scaffolds for tissue engineering, three dimensional (3D) bioprinting and *in vitro* tissue models. Two major focus of the Division is biofabrication of liver construct and corneal epithelial cell sheet engineering. Various other ongoing research



programmes are development of 3D bioprinted hepatotoxicity test system, efficacy evaluation of cell sheet technology for translation, studying role of Hsp 70 in myoblast differentiation and bioengineered construct for myocardial repair. The Division also maintains the 3D Bioprinting and Biofabrication Facility of the institute that is equipped with multi-technology 3D bioprinter with tissue and organ printing capabilities. The main technology-oriented research programmes on 3D bioprinting are carried out in the Facility. The Division initiated the 3D bioprinting of liver construct as the part of institute's core research programme. Other research attached to the facility is development of 3D bioprinted *in vitro* skin toxicity systems. The Division also has academic collaboration with Wake Forest Institute for Regenerative Medicine, USA.

## Developmental Activities

### 1. Bioink for 3D bioprinting

The Division of Tissue Culture initiated the 3D Bioprinting and Biofabrication programme under the Technical Research Center (TRC) programme. Aiming at developing transplantable liver construct, the research was initiated to develop 3D bioprinted *in vitro* hepatotoxicity test system. The primary and key component in 3D bioprinting of liver construct is the bioink which is composed of a hydrogel, functionally active cells and growth supplements. The hydrogel was developed by functionalising gelatin (GelMA) and formulated to shield UV irradiation while photo crosslinking. This novel multi-component extrudable bioink underwent basic evaluation and is now awaiting industry partners.

### 2. 3D Bioprinted *in vitro* hepatotoxicity test system

The methods for 3D bioprinting of liver constructs for *in vitro* hepatotoxicity testing was developed and is offered as a test system. The 3D construct is bioprinted in multiwell plates using hepatocytes and exposed to various drugs and molecules for hepatotoxicity analysis. The workflow diagram is shown in Figure 11.

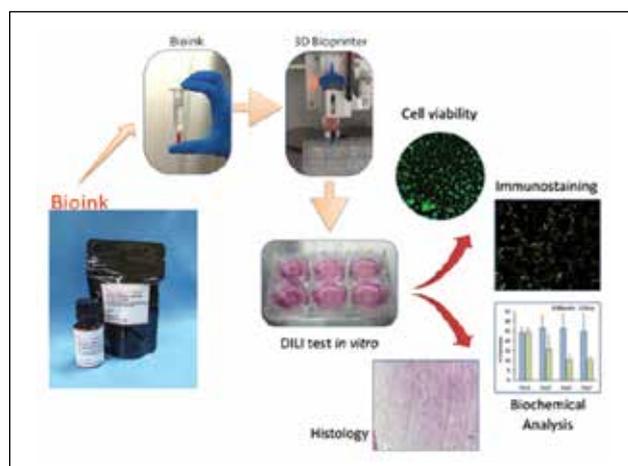


Figure 11. *In vitro* 3D bioprinted hepatotoxicity test system

### 3. The proof-of-concept on 3D bioprinted hepatotoxicity test system

This was established with rat hepatotoxicity system. This technology is aiming at an alternative test system for animal testing and as a prediction system for clinical evaluation of drugs. A pre-validation research programme was started to extend the proof-of-concept to a validated *in vitro* test system. Currently, the test system is offered to external and internal customers as non-validated non-accredited test for research.

### 4. Regeneration of ocular surface by cell sheet engineering

Ocular surface damages of the eye are treated by transplantation using donated cornea. To meet the shortage of donor tissue bioengineered corneal tissues are considered as a potential technology. Cell sheet engineering is a cell-based approach to develop tissues using a temperature responsive culture substrate. Under the TRC programme, a thermoresponsive polymeric substrate, Poly(N-isopropylacrylamide-co-glycidyl methacrylate) (NGMA) was developed in the Division and was undergoing systematic characterisation. Corneal cell sheets prepared from rabbit and human cornea were evaluated *in vitro* for tissue specific characteristics. Limbal stem cell deficient rabbit models were being developed for the pre-clinical evaluation of cell sheets.



5. **Point-of-care rapid multiplex lateral flow assay kit for cardiac markers**

Although well-established clinical tests could provide early diagnosis of heart failure, myocardial infarction and pulmonary embolism, access to these tests is limited in developing countries. To address the urgent need for developing a cost-effective, rapid and robust diagnostic tool a study was initiated under Science Engineering and Research Board, Research Scientist Scheme. A point-of-care multiplex lateral flow assay kits for the detection of three cardiac markers (Cardiac Trop T, BNP, D-Dimer) in single test strip was being developed.

6. **Bioink for 3D bioprinting**

A bioink formulation, Chitra UVS-GelMA was developed for 3D bioprinting of functional tissues. The product was at Technology Readiness Level 3 and was notified for inviting Expression of Interest.

7. **An in vitro cell culture device for multi-cell co-culture**

A Co-culture model, composed of more than one cell type, is key to understanding several physiological and pathological phenomena. A novel cell culture multiwell insert was developed that could accommodate custom-made scaffold and allowed free-flow of fluids/gases that support dual cell seeding for co-culture. The device was designed for stacking of multiple inserts for transport of cultured cells (Figure 12). The device can be scaled to appropriate dimensions to suit various commercially available multiwell plates. This device can be used for co-culture studies to understand fundamental cell biology and develop in vitro cytotoxicity testing model.

8. **A multi-well format bioreactor setup for bone tissue engineering**

Synthetic bone grafts are used as alternative to autologous bone harvested from the patient. Bioceramic scaffolds with axially aligned pores

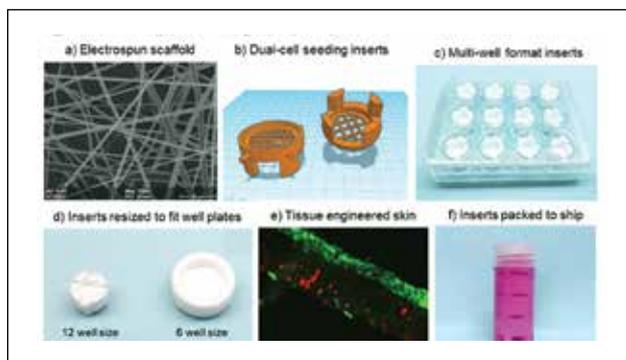


Figure 12. A multi-well format versatile setup for co-cultured tissue engineering

have been proposed to overcome the limitation of conventional random porous scaffolds. However, seeding cells inside long capillary pores of the scaffold is challenging. As part of a TRC Programme on developing bioceramic cages with axially aligned pores for tricortical bone graft application, our team designed and developed a novel dynamic culture system comprising a multi-well plate with specialized inserts that could hold cell-laden cages and could be placed on a rocker platform inside a CO<sub>2</sub> incubator.

9. **3D bioprinting of skin tissue constructs**

Biofabrication of skin tissue equivalents using 3D bioprinting technology has gained much attention in recent times due to the simplicity, the versatility of the technology and its ability in bioengineering biomimetic tissue histology. Under a TRC Programme on 3D bioprinting of skin tissue constructs, our team was involved in the printability assessment of various alginate- and gelatin-based multi-component bioink formulations. They were systematically evaluated for their flowable nature, dispensing velocity, filament collapse width limits, printable angles, effective line spacing, printability factor and filament properties such as width, smoothness and fusion at crossover points, and printability when making multi-layered constructs.

## Research Programmes

### 1. *Stem cell-derived exosome therapy for lung repair and regeneration*

The 2019 novel corona virus, subsequently renamed as the severe acute respiratory syndrome corona virus 2, is causing several pathological conditions including acute respiratory distress syndrome (ARDS), and eventually leading to respiratory failure and death. In this study, funded by the Science Engineering and Research Board, the mesenchymal stem cell (MSC)-derived extracellular vesicles (EVs) is being proposed as a potential therapeutic regime for lung regeneration. Here, the team successfully isolated human Wharton's jelly-derived MSC-EVs, characterized them systematically and conducted animal studies to evaluate its performance in lung regeneration in C57BL/6J mice models with ARDS.

### 2. *Bioengineered cardiac mesenchymal construct for myocardial repair*

The overall hypothesis of this project is that growing cardiac mesenchymal cells (CMCs) in 3D collagen scaffold will increase their homing capacity in the myocardium and microRNA-mediated reprogramming will increase their lineage commitment towards cardiomyocyte. N-cadherin in CMCs may increase the therapeutic potential of these cells by augmenting cell adhesion, survival and differentiation. In addition, we found that the cardiac-specific miRNAs such as miR-1, 133, 208, and 499 were significantly low in the CMCs. To determine the role of cardiac-specific miRNAs (miRNA-1, 133, 208, and 499) in CMC differentiation, we transiently transfected CMCs with these miRNAs and analyzed for the expression of cardiomyocyte-specific genes such as *mef2c*, *Gata4*, *Tnni3*, *Nkx2.5*, *Actc1*, *Tnnt2* and *Cx40*. Quantitative PCR analysis using miRNA assays showed that the cardiac miRNAs were either less or not expressed in CMCs, whereas transient transfection significantly elevated them. The extracellular vesicles (EVs) from the CMCs

harbouring cardiac miRNAs and encapsulated in the collagen hydrogel were isolated and characterized. We found the presence of cardiac miRNAs in EVs, which suggest that EVs also can be used as a therapeutic agent.

### 3. *Defining the regulatory role of HSP70 in myoblast differentiation*

The study on role of HSP70 in myogenesis was initiated in the SERB, Ramalingaswamy Fellowship Programme. H9C2 cells were differentiated to form myotubular structures in presence of low serum conditions. Specific inhibition of HSP70 clearly demonstrated the loss of differentiation potential of H9C2 cells. A detailed investigation of the molecular pathways showed downregulation of phospho JNK, mTOR and Raptor. Furthermore, reduced levels of phosphorylated S6 kinase, loss of Bcl2 and presence of unaltered levels of JNK might help cells to become apoptotic. Results indicated that HSP70 was essential for differentiation of H9C2 cells and its inhibition resulted in loss of differentiation and apoptosis of the undifferentiated cells.

### 4. *Biofabrication of functional liver tissue construct by organoid bioprinting*

Liver tissue function is greatly attributed to the spatial organization of cells in the bioengineered constructs. The interaction between parenchymal hepatocytes and non-parenchymal cells is essential for structural organization to achieve histological architecture in bioprinted liver construct. Restoring such tissue microenvironment is achieved by novel 3D bioprinting approach using self-organized liver microtissues called organoids. The organoids were developed by two approaches – inkjet bioprinting and using a temperature-sensitive culture substrate. A high throughput method for fabrication of organoids was developed (Figure 13). A novel hanging drop cell culture (HdCC) device for mass production of parenchymal microtissues was developed. The microtissues were viable and exhibited an active



response to insulin stimulation. Cells within the microtissue reorganised to form hepatic plate-like structures and expressed apical (MRP2) and epithelial (ZO-1) markers. A complete liver tissue organoid was developed using indigenously developed temperature-sensitive substrate. The 3D bioprinted organoid construct exhibited hepatic tissue-like cellular organization along with enhanced expression of liver-specific genes and functions.

#### 5. *Pre-clinical evaluation of photo-protective bioink*

To protect cells from UV irradiation for longer duration, a radical scavenging bioink formulation was developed. A combination of selected molecules effectively nullified the reactive oxygen species formed during the UV exposure. The bioprinting of soft organs like liver needs high cell density in the bioink which is challenging task. A method of bioprinting liver constructs at high cell density was done to optimize the cell number and the histo-architecture to mimic native liver tissue.

#### 6. *Development and optimization of tissue-specific bioink for 3D bioprinting of liver construct*

Research on new formulation of bioink with hybrid hydrogel and liver extracellular proteins was initiated to develop transplantable liver constructs. An organ perfusion set up was arranged for decellularizing porcine liver. The bulk polymer in the bioink was a modified form

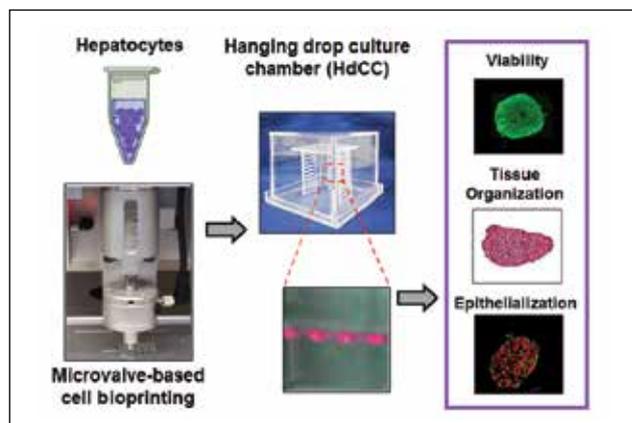


Figure 13. Highthroughput production of liver parenchymal microtissues

of gelatin. The physicochemical characterization and basic cytotoxicity of the hybrid hydrogel was completed that showed its suitability as bioink.

#### 7. *Optically clear silk fibroin films for corneal tissue engineering*

The main challenge in developing artificial corneal equivalent is in realizing the necessary optical properties. Bombyx mori cocoon-derived silk fibroin-based membranes has been proposed as a biocompatible and a bioresorbable scaffold. Membranes from reconstituted silk fibroin were prepared at different conditions and the process parameters on the physico-chemical properties of the resultant film were investigated. To address the criticism on source-dependent variations of silk-based biomaterials, the team also studied the optical properties of silk fibroin scaffold prepared from cocoons collected from various geographical locations. The results showed potential for using silk films for corneal tissue engineering.

#### Testing and Evaluation

The Division of Tissue Culture actively participated in the cytotoxicity evaluation of the biomaterials and biomedical devices developed in the institute under various research programmes. The Cytotoxicity Testing Facility of the Division was maintained according to requirements of ISO 10993 standard and quality policies of institute. Accredited and non-accredited tests were offered to internal and external customers as initial screening of materials. In vitro tests catering to the specific needs of the customers such as osteogenic study, IC50 and wound healing study, image analysis of cell morphology evaluation were offered to customers under study plan mode. The Division participated in internal and external audit organised by the Quality Cell. The Division also participated in inter-laboratory comparison of Test on Extract Method with Johner Institut, Germany to ensure the proficiency of testing. A total of 83 samples were tested under accredited and non-accredited categories. The Division also extended in vitro test services to meet the customer's requirement with very specific and customized tests such as: 1) Cytotoxicity and wound healing, 2) Osteogenic induction study, 3) Cytotoxicity evaluation of ionized air and 4) Reactive oxygen species assay. The testing services carried out during year are summarized in the Table below:

Type of tests	Number of samples
<i>Accredited tests</i>	
Direct contact test	18
Test on extract	36
Cell adhesion study	12
<i>Non-Accredited Tests</i>	
MTT assay	8
Cytotoxicity and wound healing assay	3
Osteogenic induction study	5
Cytotoxicity evaluation of ionized air	1
<b>Total</b>	<b>83</b>

### Training/Outreach Programmes

1. Dr Naresh Kasoju and Dr Anil Kumar PR organized an International Workshop on Electrospinning and Electrospaying in Biomedical Applications in association with University of Madras, Chennai, Bharathiar University, Coimbatore, NASI Kerala Chapter, SBAOI Chennai Chapter, STERMI Trivandrum, ISAS Chennai Chapter, Palms Connect LLC, USA and Abinnovus Consultancy Pvt. Ltd. (Virtual mode, 23-24 April 2021). A total of 184 participants, national and international were registered for this (Figure 14). The Workshop

included very interactive discussions with experts from academia and industry and was also a platform for sharing latest updates on electrospinning/spraying technology from basics to clinical applications.

2. Drs Anil Kumar P R, Naresh Kasoju and Manoj Komath, along with Division of Academic Affairs organised a Workshop on “Handling Scientific Images for Publication: Techniques and Ethics” on 30-31 March 2022.

### Awards and Honours

1. Dr Naresh Kasoju, Scientist C was selected as Early Career Editorial Board Member of the Bioactive Materials journal (impact factor 14.593).
2. Drs Naresh Kasoju and Anil Kumar P R, along with Dr Linh Nguyen from UCL, London, guest edited a special issue on “Nano-tissue engineering: Nanomaterials and nanoengineered systems in fabricating artificial tissues” as part of Journal of Nanomaterials (IF 2.986) in August 2021.
3. Dr Naresh Kasoju obtained additional qualification of PG Diploma in Medical Device Management from Institute of Good Manufacturing Practices, Noida in e-learning mode.

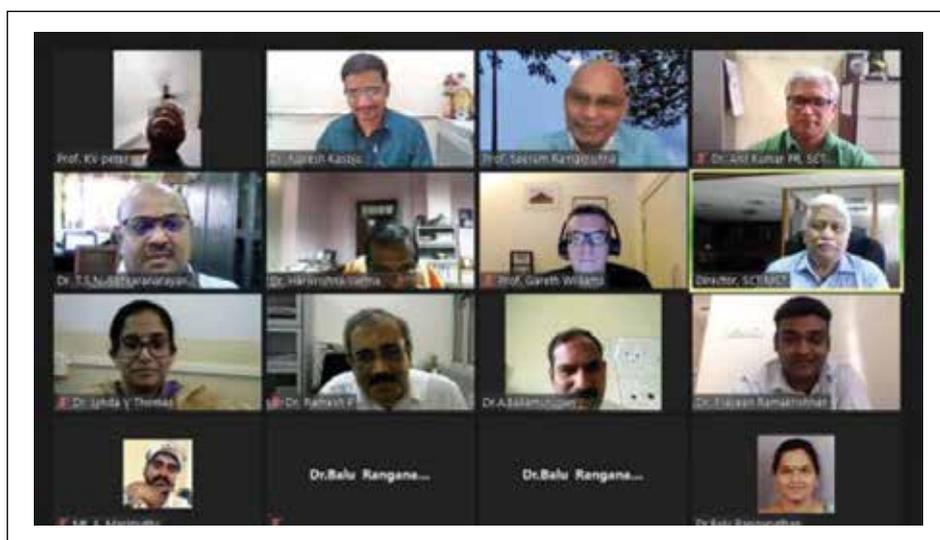


Figure 14. International Workshop on Electrospinning and Electrospaying in Biomedical Applications



## DIVISION OF TISSUE ENGINEERING AND REGENERATIVE TECHNOLOGIES

The main aim of this Division is the designing of suitable biological substitutes / tissue-engineered constructs through the principles of tissue engineering and wound dressing development. The research of the Division has been focussed to develop (a) novel, biodegradable and bio mimetic "designer" scaffolds (b) understand the regeneration process using adult cells and directed stem cell differentiation and (c) delineate the molecular pathways that regulate the growth factors and other molecules or drugs to promote regeneration. Other areas of our interest deal with the use of bioprinting technology to generate cell-incorporated tissue constructs for varying applications and also development of advanced wound dressings. Scaffolds and biomaterials made by conventional techniques, electro spinning, 3D bioprinting and other regulator combinations generated by our Division, find additional medical applications as products for drug delivery, wound healing and haemostats. Our Mission is to promote research and development in biomedical engineering and technology especially in the realm of tissue regeneration and repair.

### Developmental Activities

#### 1. Indo –Danish Programme - MUSTER

Nanoparticles and other scaffolds which can be used to deliver specific drugs, biochemicals, miRNA or exosomes specific for bone or cartilage lineages from stem cells were being pursued as part of an Indo-Danish Programme funded by DBT, India. The information on the novel biocompatible and functionalised scaffolds developed at SCTIMST were shared with collaborating national and international partners through regular joint video conferencing meetings and collaborative research on further assisting the regeneration of tissues was ongoing.

#### 2. Fabrication of a cell-free dermal equivalent with enclosed pits

As part of the WOSA project, the objective of this present work was to generate a tissue-engineered

3D bioprinted skin construct with embedded pits for the incorporation of hair follicle stem cells.

3. Research study projects in the areas of wound dressing development and development of highly specific and biomimetic scaffolds for osteochondral, chondral, cardiovascular and pancreatic tissue-engineering are long term projects being pursued in the division.
4. As part of the TRC activities of the institute, preclinical evaluation of lint-free absorbent dressing was carried out in Rabbit full-thickness wound model. The study was done for a period of two weeks. The dressing was changed every two days. The wound healing analysis and histological analysis were ongoing to assess wound healing with our developed dressing.

### Research Programmes

#### 1. A tissue-engineered skin substitute with localized hair follicle stem cells for hair follicles and sebaceous gland regeneration in a stress induced wound healing model

The present study investigated the potential of 3D printing for placing hair follicle stem cells in a full thickness tissue-engineered skin construct. Physiologically, hair follicle stem cells (HFSC) are aggregated in the follicular bulge region. Hanging drop array technique was employed to develop HFSC spheroids in culture with a seeding density of  $1 \times 10^4$  cells/ml. The crosslinked and

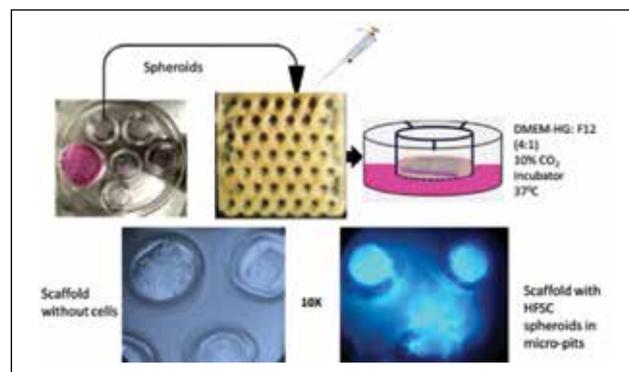


Figure 15. Seeding and culturing of HFSC spheroids in localized pits

surface sterilized scaffolds were initially seeded with fibroblasts and after 5 days HFSC spheroids were introduced in to the micro-pits (Figure 15). Wound-induced hair neogenesis model was reported and here a study was attempted to elucidate the effect of four stress induced signals- oxidative, hypoxic, UV and shear stress that were expected in a wound area that could trigger the migration of hair follicle stem cells. The study was based on the migration of hair follicle stem cells growing in a transwell cell insert upon exposure to stress signals secreted by keratinocytes and fibroblasts. The study revealed migration of stem cells in oxidative and shear stress. This observation was an indication that stress induced signals have the potential to trigger HFSCs and more work is required along this line to elucidate the mechanism.

## 2. *Bio-engineering of a tracheal construct - identification of appropriate biomaterial scaffolds and conditions*

The project deals with the development of a tissue-engineered tracheal construct having 3D cell distribution and comparable mechanical properties as that of the native trachea. In Fused Deposition Modeling-based 3D printing, it was not possible to seed cells along with the molten polymer being extruded; hence, a biphasic design was fabricated where cells were mixed with a hydrogel and delivered using an additional printing head by dual head 3D printing. To reproduce the elastomeric nature of native trachea, two elastomeric materials were synthesized and fabricated into tracheal scaffold. The elastomeric copolymer poly caprolactone-co-lactide (PLCL) was found to be suitable for 3D printing whereas, the polyurethane urea (PUU) was found to be suitable for electrospinning. PLCL was 3D printed into a biphasic tracheal scaffold where chitosan-HDA hydrogel was used for delivering cells and PLCL framework provided the mechanical strength. When the electrospun PUU and 3D printed PLCL tracheal scaffolds were compared, the 3D printed scaffold had better cell distribution and formed a three-

dimensional cartilage, whereas in electrospun scaffold the cells were grew in monolayer.

## 3. *Insulin producing organoids differentiated from mesenchymal stem cells in polymer encapsulated 3D scaffold to treat diabetes*

The present study focused on the development of a tissue-engineered construct with stem cell differentiated islet-like clusters (ILCs) seeded on a 3D scaffold made of gelatin and dextran, and further coated with alginate for mitigating foreign body response in vivo and the whole system was encapsulated in a 3D printed polymeric PU-PVP immunoprotection bag for further immunoisolation from the host system. The construct was implanted into the intraperitoneal space of wistar rats treated with streptozotocin, which is an animal model for chemically-induced type1 diabetes. The scaffolds were further coated with collagen IV and laminin to increase the insulin secretion. Modified 3D scaffold supported the growth and differentiation of MSCs into ILCs in vitro (Figure 16). For the in vivo experiments animals were divided in to five groups. The observation period was 2 months. Blood glucose and body weight was monitored every 7 days after the implantation. At mid-point of the study period post-transplantation, blood for plasma was collected through retroorbital vein. The insulin and c-pep in this plasma were quantified using ELISA technique and intra peritoneal glucose tolerance test was also conducted at mid-point of the study period post transplantation to analyse the area under the curve of glucose clearance.

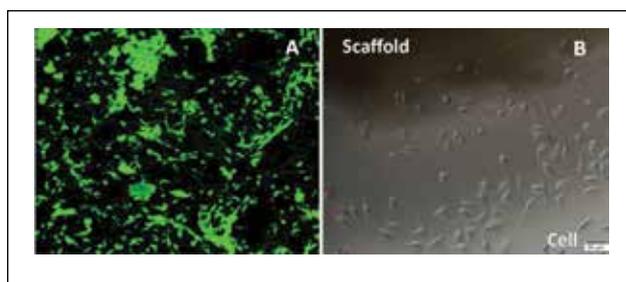


Figure 16. A) shows the live dead image of ILCs on modified 3D scaffold, B) immunofluorescence image of ILCs expressing insulin protein on modified 3D scaffold.



After the implantation period, the animals were euthanized and transplanted construct and organs were retrieved for further histological analysis which was underway.

#### 4. *Bilayered 3D-printed scaffolds for osteochondral tissue engineering*

The study devised an effective strategy of 3D printing for fabricating bioactive factors-loaded biphasic and integrated scaffolds. Herein, the suitability for 3D printing of osteochondral-like substitutes using chondroitin sulfate and TCP- incorporated inks for cartilage and bone phase, respectively were evaluated. This work documents the possibility of blending PCL with hydrophilic polymers and biofactors, followed by complexation in fabricating the gradient scaffolds with interconnected pores and gradient pore geometry. The ability of the developed biphasic scaffold (BPS) to repair osteochondral tissues were tested in a rat osteochondral defect with or without MSCs. BPS of dimension 1.5mm (H) and 1.5 mm (D) with a hierarchical pattern was used. No evidence of an immune response was seen either to the allogeneous cells or to the polymer-based BPS. In addition, hyaline-like cartilage formation and integrated subchondral bone without voids or cysts in the BPS+cells were observed, demonstrating that the implanted BPS with cells was beneficial for tissue repair. Also, regenerated tissue consisted of thicker hyaline-like cartilage with intense Safranin O and Alcian blue staining suggesting improved proteoglycan formation in MSC-seeded BPS group. In BPS+cells group, the staining revealed good integration of the newly formed bone with the neighbouring native bone, which contributed to the secure attachment of the implant within the defect, followed by replacement of the scaffold material with the regenerated tissue. Thus, the osteochondral scaffold designed to simultaneously enhance the repair and regeneration of cartilage and subchondral bone showed enhanced subchondral integration which provided strong support for the overlying regenerated cartilage (Figure 17). These findings demonstrated that 3D printed PCL blended with water-soluble polymer provides important

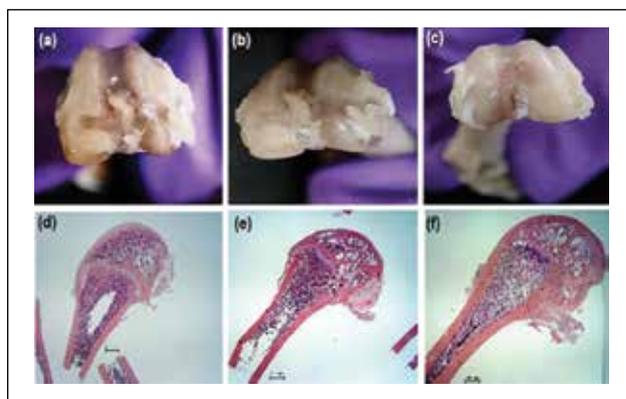


Figure 17. Photographs of the gross appearance of repair tissue at osteochondral defects in rat knees after 3 months of implantation. (a) sham, (b) BPS (c) BPS+cells. At 12 weeks, the surface area of repair tissue in the BPS+cells is more consistent and congruous with normal surrounding articular cartilage than in the BPS and control defects. Histological examination of regenerated osteochondral tissue using H & E in (d) sham, (e) BPS and (f) BPS+cells group respectively after 3 months of implantation.

insights for osteochondral tissue engineering applications.

#### 5. *Influence of the stiffness of photo-crosslinkable hydrogels on the encapsulation efficiency of chondrocytes:*

This study was to evaluate the effect of the various photo-crosslinkable hydrogels on the viability and functional characteristics of chondrocytes over a range of culture periods. Some of the major challenges in the development of a hydrogel system for chondrocyte encapsulation has been the ease of preparation for non-invasive delivery intended for immediate use in surgical interventions and the maintenance of viability, stable phenotype and functionality of the chondrocytes that are encapsulated within the hydrogel environment. Gels were prepared via methacrylation of natural biomaterials and blending with polyethylene glycol diacrylate.. The stiffness and mechanical characterisation of the gels were performed by atomic force microscopy and rheological studies. 3D printing of these gel systems was also being explored.

## Testing and Evaluation

Informally extended the Contact Angle Analysis Facility on request on a free/ complimentary basis to other labs on campus and external labs such as NIIST, IISER, IIST at TVM, NPOI and CUSAT, Cochin and NIT Calicut. Other free testing services provided included: inverted and upright fluorescence microscopes, lyophiliser, viscometer, AFM. Testing samples were received for the following instruments: FTIR, Contact angle, Atomic Force Microscopy (AFM), Microplate Reader and Microtome

The samples tested during the year are as below:

1. FTIR - 10
2. Contact angle - 5
3. Atomic Force Microscopy - 3
4. Microplate Reader - 14
5. RT-PCR - 15

## Academic Activities

1. Rahul V G, PhD student of Dr Prabha D Nair defended his PhD on 28 March 2022.
2. The colloquium of Dr Amrita Natarajan, PhD student of Dr Prabha D Nair was successfully completed on 27 December 2021.

## Awards and Honours

1. Dr Prabha D Nair, Scientist G (Senior Grade), was nominated to the National Advisory Committee by the Chairman, Governing Body for regular monitoring of the Technical Research Centre for Biomedical Devices.
2. Dr Amrita Natarajan, PhD scholar received 2nd best poster award for the poster entitled "Efficacy of 3D printed personalized biomimetic substitutes for osteochondral tissue regeneration: An in vivo study" at the 11th India-Japan Science And Technology Seminar- Nobel Laureate S&T Seminar Series" organized by Indian JSPS Alumini association (IJAA) and SCTIMST on 6-7 December 2021.
3. Dr Amrita Natarajan, PhD student received the

best oral presentation award for presentation entitled "Recapitulating the microarchitecture of native tissues: Customizable 3D printed biphasic substitutes for augmenting osteochondral tissue regeneration at the International Conference on Polymeric Materials in Medicine (ICPMM 2022) held on 25 - 26 February 2022.

## DIVISION OF THROMBOSIS RESEARCH

The Division of Thrombosis Research conducts cutting edge research and development activities, provides technical support for the product development and contributes to the academic programmes of the Institute. In research and development, our focus is 3D bioprinting of tissue construct, combinational matrices for wound healing, cost-effective PRP isolation devices and blood-derived products. The Division offers blood compatibility testing as per the ISO/IEC 17025 quality platform. The Division is accredited with COFRAC, France, with more than 26 accredited tests for blood-material interaction studies for medical devices and provides testing services for national and international medical device industries and researchers.

### Developmental Activities

#### 1. 3D bioprinted skin tissue construct

Previously optimized bioink formulation was used for skin 3D printing. Dual layer skin tissue construct were printed and in vitro and in vivo evaluations were carried out. Constructs were analyzed for histology and functional markers. In vivo analysis was carried out for analyzing wound healing. Printed construct showed better wound healing.

#### 2. Development of stabilized blood controls

In order to ensure the accuracy and reliability of test results, various regulatory authorities have prescribed the use of stabilized blood controls routinely. Stabilized blood controls are usually supplied by the auto analyzer companies thereby making them equipment-specific and incapable of being used with analyzers from other manufacturers and also costly. We initiated the preparation of indigenous stabilized blood controls. Experiments were carried out to



develop a universal stabilized blood controls from blood cells using different cell-specific fixatives. We compared the effect of concentration of different fixatives for individual cells in the blood and their role in enhancing the shelf-life and maintaining the morphology of the cells when suspended in plasma or a buffer post-fixation. One manuscript from the work was submitted for publication. 3. Cost-effective PRP isolation device. A cost-effective model of a PRP isolation device was developed and isolation

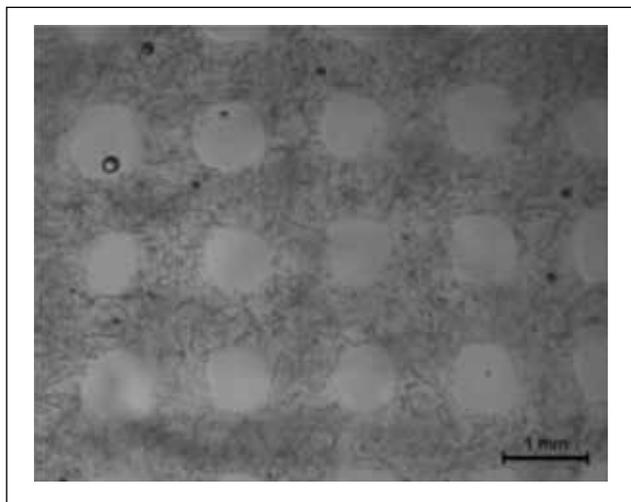


Figure 18. Evaluation of printability of bioink - Stereomicroscopic image of a single layer of printed construct

methodology was standardized and compared with commercially available devices. The TDF Project was completed and proof-of-concept was established. 4. Development of bioink for printing cancer tissue construct for drug testing Bioprinting technology is making advances in the field of organ development and drug testing. The choice of bioink is critical for bioprinting of different tissue constructs. A novel, multicomponent bioink composed of alginate, diethylaminoethyl cellulose, gelatin and collagen peptide was developed to generate a 3D bioprinted cancer tissue construct. The bioink was characterized for its cytocompatibility, rheological characteristics and printability. The bioink showed cytocompatibility, shear thinning property and excellent printability (Figure 18). The developed tissue construct also responded to drugs in a dose-dependent manner.

#### 5. *Development of blood-derived products: albumin and IgG*

As part of TRC Project, albumin and IgG purification process in clean room was carried out and two batches of albumin and IgG from plasma were prepared. Quantification of isolated albumin and IgG was carried out and SDS gel was run for comparison with commercial products.

#### 6. *PT/INR device development*

The device was improved to meet the specifications and accuracy requirement of industrial partner. The working concept of the device was also modified and a simplified system was prototyped. Assays for different INR ranges were carried out and process parameters were optimized. Validation of the device was ongoing.

#### 7. *Precursor (NT-ProBNP) from blood samples*

Europium chealate was tagged with NT-Pro BNP antibody and binding efficiency was evaluated. Detection limit of the system was analyzed using antigen concentration ranging from 50pg to 12000pg. Blood samples were spiked with the known concentration of antigen and analysis was carried out. Optimization of buffering system was ongoing for improving the sensitivity of detection.

### **New Initiatives**

Development of collagen peptide-incorporated Gelatin/Chitosan fibrin sealant patch was initiated as a spinoff from the ongoing product development activities as an advanced cost-effective wound regeneration matrix for effective wound healing and hemostasis. Optimization of collagen peptide concentration was carried out. Preliminary studies were carried out to evaluate the feasibility of the development of collagen peptide-gelatin-fibrin sealant patch and collagen peptide-chitosan-fibrin sealant patch.



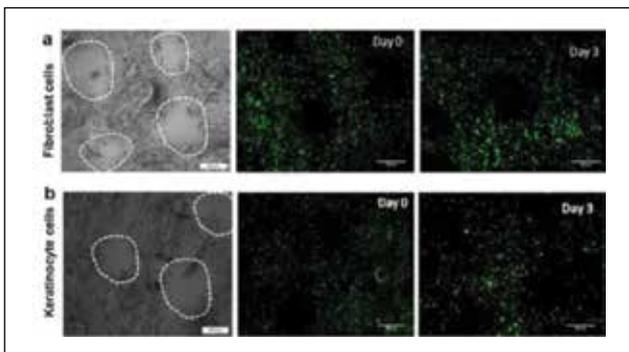


Figure 19. Live dead analysis of 3D printed skin construct

## Research Programmes

### 1. Preclinical evaluation of skin tissue construct

After optimizing the cell seeding density of keratinocytes and fibroblasts (Figure 19), dual layer printed constructs were evaluated for printing accuracy, mechanical strength, cytocompatibility, haemocompatibility, gene expression analysis, extracellular matrix synthesis, immunohistochemistry of functional markers like CK14 and histological analysis in vitro and in vivo. Bioink was formulated with and without fibrinogen and was evaluated for skin regeneration. Data from our study clearly indicated the efficacy of the skin substitute in skin regeneration.

### Testing and Evaluation

1. Various COFRAC-accredited tests were offered to evaluate materials/components used for blood-contacting devices undertaken by various investigators as part of TRC Programmes. During the year 2021-22, a total 114 test reports were issued (23 accredited, 91 non-accredited). Several samples were tested for platelet function, submitted by internal and external patients as special service. The testing laboratory supported quality control programme of the Institute's Blood Bank by testing components such as cryoprecipitate for factor VIII, fibrinogen and platelet-rich plasma for aggregatory response. The Laboratory participated in Inter-laboratory comparison with an accredited laboratory.

2. Blood material interaction studies were carried out as per ISO 10993. The tests carried out are summarized in the Table below:

Test	Number
Complete blood count	280
Coagulation	180
Platelet Aggregation	153
Biochemistry	126
Plasma Haemoglobin	203
C3a	50
ATP analysis	30
2,3 DPG	40

3. Blood Bag Study: Blood bag storage and post-transfusion recovery study was done for two sets of blood bags with five numbers each for industrial customer. 15 Rabbits were used for CPDA bags (three time points of five bags) and 20 Rabbits for CPD SAGM bags (four time points for five bags) for the chromium 51 isotope labelling study. Chromium 51 (Cr51) isotope-labelled and washed cells were transfused into the animals and the pre- and post-transfusion recovery of Cr51 was measured.

### Training/Outreach Programmes

1. Organized four lecture series, one quiz programme and one science magic show for school and college students on in July and August 2021 as part of Azadi ka Amrut Mahotsav celebrations of the institute.
2. Mentored two summer training students in the Division as part of the DST sponsored SC/ST Student Empowerment Program held at SCTIMST.

### DIVISION OF TOXICOLOGY

Toxicology Division is the premier laboratory in the country in the field of biomaterial toxicology and is accredited by COFRAC, France as per ISO 17025. The Division has full-fledged facility for the pre-clinical safety and toxicity evaluation of various materials and



medical devices as per International Standards such as ISO, USP and ASTM. The toxicological studies are an integral and indispensable part of development of medical device technology. The main aim of the Division is the toxicity/biocompatibility evaluation of materials, medical devices, tissue-engineered products intended for the fabrication of medical products and investigation of potential safety/biological hazards of nanomaterials used for health care applications.

### Developmental Activities

1. Development of Human-on-a-Chip device was an ongoing initiative (Funding Agency: DST).
2. Development of anti-microbial peptide-loaded multifunctional 3D collagen scaffold for vascularised bone tissue regeneration was a new initiative under the Indian-Japan Co-operative Science and Technology Programme.
3. Validation of "A kit for the evaluation of pyrogenicity and a methodology of preparing the same".

### New Initiatives

- 1 Human-on- a-Chip for biological evaluation.
- 2 Vascularised multiorgan-on-a-chip for biological evaluation.
- 3 Multi-organ-on-a-chip with radial fluidic channel for biological evaluation.

### Testing and Evaluation

- 1 Total samples received for testing/studies: 46
- 2 Total number reports released: 59
- 3 Number of Accredited test reports: 38
- 4 Number of Non-Accredited test reports: 21

The details of tests carried out are summarized in the Table below:

Test	Number
<b>Accredited tests</b>	
Maximization test for delayed hypersensitivity	6
Closed Patch test for delayed hypersensitivity	1
Animal Intracutaneous reactivity Test	8
Acute systemic toxicity test - Intravenous	5
Acute systemic toxicity test - Intraperitoneal	5
Pyrogen Test	2
Muscle implantation	7
Subcutaneous implantation	2
Bone Implantation	2
Animal irritation	1
Haemolysis	1
Penile irritation	1
Vaginal Irritation	1
Chromosomal aberrations	1
Micronucleus test	1
<b>Non-accredited tests</b>	
Physico-chemical analysis of potable water	18
Haematology analysis	20
Biochemical analysis	20
In vitro genotoxicity (micronuclei and chromosomes)	2
Wound healing assay	1
Toxico-kinetic study	1



### Quality system improvement activities:

Actively participated in the quality system improvement activities:

- Successfully completed the COFRAC (France) inspection without any noncompliance/ observations
- 13 accredited work procedures revised/reviewed
- 3 non-accredited Work procedures revised/ reviewed
- 2 corrective and preventive actions generated and closed.

### Training/Outreach Programmes

Dr Mohanan P V gave lecture/class at the following programmes:

- "GLP Data Integrity and „Roles and responsibility of GLP functionaries" at the GLP training organized by M/s Dabur Research Foundation, New Delhi, held on 17 December 2021
- Indian Dairy Industry: Emerging Trends and Impact of COVID-19, in connection with UN-World Milk Day, organized by the National Academy of Sciences, India (NASI) Kerala chapter on 1 June 2021.

### Awards and Honours

1. Dr P V Mohanan, Scientist G, was nominated as a Member in: (i) the Expert Committee on RCGM (Review Committee on Genetic Manipulation), DBT; (ii) the Empowered committee on the 'Rapid Response Regulatory Framework for COVID-19 to deal with applications for development of vaccines, diagnostics, prophylactics and therapeutics', DBT; (iii) Scientific Advisory Committee, ICMR-National Animal Resource Facility for Biomedical Research, Hyderabad ; (iv) Project Evaluation Committee (PEC) to recommend CSIR-Fundamental & Innovative Research in Science of Tomorrow. CSIR-FIRST, Government of India; (v) Expert Committee for approval and review of Core Support Proposal/ projects and other projects having a budget

of over One Crore, SEED Division, DST; (vi) Expert Committee for review, evaluation & monitoring of proposal/projects and evaluation of SSP-TARA programme under SEED Division, DST (vii) Project Completion Report Evaluation Committee, Young Scientist Fast Track Scheme-Life Sciences – 2021; (viii) Expert Committee on Scheme for Young Scientists and Technologists (SYST), DST; (ix) Expert Committee on Technology Interventions for Addressing Societal Needs (TIASN), Department of Science & Technology, New Delhi; (x) Expert Committee on Fast Track Young Scientist (FT YS) Scheme of the SERB for the implementation of Early Career Research Award (ECRA) and National Postdoctoral Fellowship (NPDF), SERB; (xi) Working Group to Review the current Biosimilar guidelines, DBT; (xii) Expert group for subject of Toxicology for the Basic Medical Sciences (BMS) Division at ICMR; (xiv) Scientific Panel on Food Additives, Flavorings, processing aids and materials in contact with food. Food Safety and Standards Authority of India (FSSAI), Government of India; (xv) Selection board as the Chairman for the scrutinizing the candidates for Masters and PhDs in Biotechnology under MEXT Scholarship, Japan (2016-2021).

2. Mr Joseph Xavier, Research Scholar, Toxicology Division was awarded the Commonwealth Split-Site (PhD) Scholarship of the Commonwealth Scholarship Commission, UK, under the mentorship of Dr Jorge Bernardino, National Heart and Lung Institute, Imperial College, London, for a period of 1 year. The scholarships are funded by Commonwealth Scholarship Commission, United Kingdom.
3. Dr Megha K B, Research Associate, Toxicology Division, won the Certificate of Recognition/Best Oral presentation award for her research work entitled „Detection of inflammatory cytokines using indigenously developed ELISA method at the Society of Young Biomedical Scientist, India, 3rd National Biomedical Research Competition (NBRCOM 2021) during 6-10 December 2021.
4. Ms Arathi Ashok, Junior Research Fellow, Toxicology Division, won the 2nd Best Poster



Presentation award, for the poster entitled 'Organ-on-a-chip, a novel approach for predicting cytotoxicity', at the 4th Annual Conference of Society for Alternatives to Animal Experiments (SAAE-India) organized by Delhi Pharmaceutical Sciences and Research University, New Delhi on 11-12 December 2021.

5. Mr Joseph Xavier, Research Scholar, Toxicology Division, won the Best Poster Presentation award, for the poster entitled 'Microfluidic synthesis of gelatin nanoparticles conjugated with nitrogen-doped quantum dots and its biological application' at 'Nobel Laureate S&T Seminar Series and India-Japan Science and Technology Seminar' organized by Indian JSPS Alumni Association and SCTIMST on 6-7 December 2021.
6. Mr Akhil Venugopal, Junior Research Fellow, Toxicology Division, won the Best Paper Presentation award, for the paper entitled 'Synthesis, characterization and cellular responses of a novel hydrogel for biomedical application' at International Webinar on „Phytochemistry-Impacts and Applications , organized by Kerala Academy of Sciences, Trivandrum on 27-28 September 2021.

### Events Organized

Dr P V Mohanan, Scientist G, organized the 'Nobel Laureate Science & Technology Seminar Series and India-Japan Science and Technology seminar' at SCTIMST on 6-7 December 2021.

### DIVISION OF IN VIVO MODELS AND TESTING

The primary aim of the Division is to support medical devices development by developing animal models and by conducting preclinical animal evaluation of medical devices and biomaterials. As secondary aim, the Division also supports Indian medical device industry by conducting animal studies.

To achieve the above aims, the Division focuses on objectives such as: conduct of preclinical animal evaluation of medical devices and biomaterials using

physiologically normal animals or disease-induced animal models under GLP compliant documentation. This is accomplished in either large animal or small animal models simulating actual clinical use in human patients for assessing functional safety and performance. The Division is equipped with qualified and trained staff, infrastructure such as well-equipped operation theatre, catheterisation OT, clinical and research laboratories, acute care rooms, animal preparation/explantation rooms and CPCSEA -registered large animal house which provides healthy, traceable large experimental animals such as pigs and sheep. The Division conducts research, is involved in the development of tissue-based medical devices and guides PhD students to achieve the research objectives.

The Division of In vivo models and testing strives for:

- Worldwide acceptance of animal research data generated here by implementing the best practices
- Development of novel animal models and evaluation techniques required for safety/efficacy evaluation of emerging medical devices
- Training of manpower required to sustain core activities
- Research enabling replacement to regeneration of diseased organ

### Developmental Activities

Division is involved in the TRC funded project "Development of Bioprosthetic heart valve". During the year, explantation of two prototype bioprosthetic heart valves was done in sheep model on completion of 6 months. The explanted valves showed excellent healing and minimum calcification (Figure 20). One sheep in this category is completing 9 months duration without any adverse clinical events. Two heart valve prototype models were developed in this project. Both the models completed 200 million cycles accelerated durability testing as per ISO 5840, which is an important milestone in the project.



The 'GMP Tissue Harvesting facility for Medical Devices' at MPI Ltd., Edayar Koothattukulam, established as part of this project is supplying biomedical quality bovine pericardium and 25 batches were received so far.

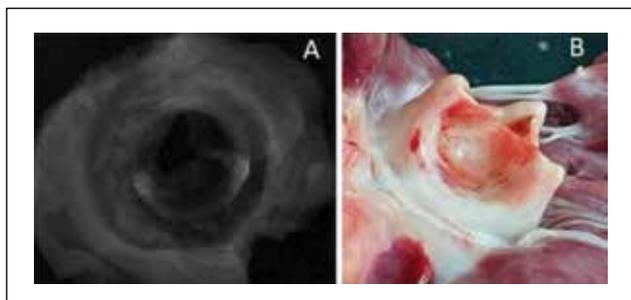


Figure 20. A. X ray radiograph of 6 month explanted valve showing no appreciable calcification of leaflets. Mild calcification can be noticed at stent posts. B, Bioprosthetic valve explant at 6 months duration in sheep mitral implantation showing excellent healing.

## New Initiatives

Experiments were underway for use of decellularised porcine pericardium developed under the TDF Project was tried for fabrication of pulmonary valve conduit.

## Testing and Evaluation

### 1. Support for TRC projects

- Bioprosthetic valve evaluation was done in sheep orthotopic implantation model for the Project “Development of bioprosthetic heart valve”. The programme was ongoing.
- Explantations were completed for the Project “Development and evaluation of radiopaque liquid embolization device by chemical grafting of iodinated compounds onto the ethylene vinyl alcohol copolymer – Preclinical evaluation in Swine model”.
- Improved LVAD design was tested in sheep for 6 hours circulatory support.
- Initiated the animal evaluation for the Project “Development of TiN coated coronary stent system” in Swine models.

### 2. Support for TDF Projects

- Sheep studies for the Project “Multi-layered wrap knitted polyester in strengthening valve annulus after valve repairs” was completed.
- Animal implantations for the study entitled “Alginate dialdehyde – gelatin as a post-surgical adhesion prevention material in thoracic surgery – A proof-of- concept study in swine models” was initiated.
- Animal implantations for the study “Developing decellularised porcine pericardium with enhanced strength for paediatric cardio-vascular application” were initiated.

### 3. Support for other extramural Projects

Experiments were performed in Rat myocardial infarction model for the Project “Role of connexin in cardiac fibroblast phenotypic transformation and extra cellular matrix synthesis in cardiac diseases”.

### 4. Industry Support

- Evaluation of PA catheter was completed.
- Completed the pilot study entitled “Functional safety evaluation of a combinational drug-eluting covered stent system in adult porcine coronary artery”.
- Completed the study entitled “In vivo safety evaluation of surface modified magnesium bone plates in the long bones of Sheep model.”
- Completed evaluation of magnesium-based bone plates in Rabbit model.
- Study entitled “In vivo safety evaluation of surface modified zinc bone plates in calvarium of rabbit model” was completed.

### 5. Animal models developed

- Osteochondral Defect Model in Rats for the study entitled “Designing of 3D printed cell-free biphasic matrices loaded with an admixture of biomolecules for enhanced progenitor cells recruitment and improved osteochondral regeneration”.



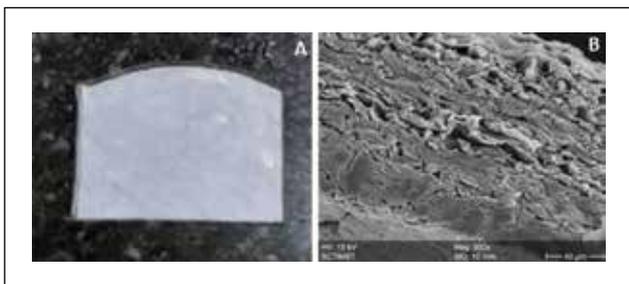


Figure 21. A. laser cut silk fibroin-impregnated decellularised porcine pericardium of 0.13mm thickness; B Scanning electron microscope picture of the cut edge of silk fibroin impregnated decellularised porcine pericardium showing silk fibroin inbetween and on the surface of collagen bundles of pericardium.

- Standardized echocardiography technique in Rats for a study entitled “Role of connexin in cardiac fibroblast phenotypic transformation and extracellular matrix synthesis in cardiac diseases”.
- A Sheep model for evaluation of biodegradable bone plates.
- A Rabbit model for evaluation of degradable bone plates 2021.



Figure 22. ADA-gelatin hydrogel sheet placed over the heart with epicardial injury

## Research Programmes

### 1. *Developing decellularised porcine pericardium with enhanced strength for paediatric cardiovascular application*

Under this TDF Project, a method for improving the mechanical strength of decellularised porcine pericardium by impregnation and in-situ precipitation of silk fibroin was standardised (Figure 21). Indian patent was filed for this work. This process improved tensile strength of decellularised porcine pericardium for over 300% and suture retention strength by over 80%. It was degradable and produced un-detectable calcification in 60 days juvenile rat subcutaneous implantation model. Rat full thickness abdominal defect model showed intact implant at the end of 90 days.

### 2. *Dialdehyde-gelatin as a post-surgical adhesion prevention material in thoracic surgery: A proof-of-concept study in a swine model*

This study aimed to evaluate the ability of ADA-gelatin hydrogel sheets of larger dimensions in the prevention of post-surgical adhesions in porcine models of thoracotomy and epicardial injury for a period of 6 months. Pig implantations were completed for this study (Figure 22) and histopathology report was awaited.

## Awards and Honours

Dr P R Umashankar, Scientist G, was promoted to Lead Inspector for the National GLP Compliance Monitoring Authority, Government of India.

## Staff

### Faculty

Dr A Maya Nandkumar  
Scientist G and Head of the Department  
Dr Prabha D Nair, Scientist G (Senior Grade)  
Dr. Mohanan P V, Scientist G  
Dr Anoopkumar Thekkuveetil, Scientist G  
Dr T V Anilkumar, Scientist G  
Dr P R Umashankar, Scientist G  
Dr Sachin J Shenoy, Scientist F  
Dr Kamalesh K Gulia, Scientist F  
Dr A Sabareeswaran, Scientist F  
Dr Anil Kumar P R, Scientist F  
Dr Anugya Bhatt, Scientist F  
Dr V S Harikrishnan, Scientist E  
Dr Lynda V Thomas, Scientist E  
Dr Remya N S, Scientist C  
Dr Naresh Kasoju, Scientist C  
Dr Renjith P Nair, Scientist C

## Technical

Dr Geetha C S, Junior Scientific Officer (Lab)  
Mr Pradeep Kumar S S Junior Scientific Officer (Lab)  
Mr Anil Kumar V, Senior Scientific Assistant (Lab)  
Mr Joseph Sebastian Senior Scientific Assistant (Lab)  
Ms Sreeja K R, Senior Technical Assistant (Lab)  
Ms. Priyanka A, Senior Technical Assistant (Lab)  
Mr Prem Mohan M Senior Technical Assistant (Lab)  
Ms Smitha P, Technical Assistant (Anaesthesia) - B  
Mr Ranjith S, Technical Assistant (Lab) - B  
Mr Sarath Kumar R S, Technical Assistant (Lab) - B  
Ms Deepa K Raj, Technical Assistant (Lab) - B  
Mr Vinod D, Technical Assistant (Lab) - B  
Mr Vishwanatham Naik Technical Assistant (Lab) - A  
Ms Vandana Unnikrishnan Technical Assistant (Lab) - A  
Mr Seenuvasan R, Technical Assistant (Lab)  
Mr Manoj M, Animal Handler - B  
Mr Sunil Kumar M, Animal Handler - B  
Mr Harikumar G, Animal Handler - B  
Mr Sunil L, Animal Handler - A  
Mr Shaji S, Laboratory Animal Caretaker - C  
Mr Biju V, Laboratory Animal Caretaker - B  
Mr Manoj Kumar K, Laboratory Animal Caretaker - B  
Mr Pradeep Kumar B, Lab Animal Attendant  
Mr Sudheesan D, Unit Assistant



# DEPARTMENT OF BIOMATERIALS SCIENCE AND TECHNOLOGY

The Department focuses on the development of novel biomaterials and the translation of these technologies into viable and affordable products. The research teams are pursuing state-of-the-art developmental work related to nanobiomaterials, bone graft substitute materials, bioceramic coatings, drug eluting ceramic structures, advanced polymeric compositions, nano/micro delivery systems, bioactive cements and glass-ionomer cements. These are being explored for various applications like bone tissue engineering, regenerative dentistry, drug and biologics delivery, photodynamic and photothermal therapy and biomaterials-based sensors and diagnostic devices. Products being designed include bioceramics-based graft materials, biocompatible and resorbable polymer scaffolds for tissue engineering and wound healing, and organically modified composites.

The Department of Biomaterial Science and Technology was instituted with a vision of being a Centre in the country for the synthesis and evaluation of biomaterials for various biomedical applications. It consists of the following Divisions:

1. Division of Bioceramics
2. Division of Biophotonics and Imaging
3. Division of Biosurface Technology
4. Division of Dental Products

## DIVISION OF BIOCERAMICS

The Division is engaged in developing bioceramics-based tissue repair materials for orthopaedics and dentistry. The research team is engaged in design of related products, their evaluation and technology transfer. Current research areas of interests are bone graft substitute materials, bioceramic coatings, drug delivery systems and regenerative dentistry.

## Developmental Activities

### 1. *Slurry feed technique for making nanostructured coating of hydroxyapatite on metallic implants*

Plasma spray coating is applied to obtain an adherent layer of bioactive calcium phosphate phases onto the metallic bone implants so as to help their integration with the host bone. In conventional plasma spray, the material for coating is fed as fine powder to the plasma flame which melts due to temperature and hit the substrate due to kinetic energy to form a coating. The coatings formed are thick and highly crystalline and hence show less biological activity. Nano-structured bioactive coatings are considered more favourable for metallic implants. Feeding of nanoparticle slurries are suggested to achieve nano-structured bioactive coatings.

An attachment to plasma spray system was devised to generate nano-level particles of calcium phosphate phases (mainly „hydroxyapatite , the bone mineral) in the flame space so as to obtain nano-structured coatings (Figure 23). The main part was an annular assembly with a set of spray nozzles, to which the calcium phosphate slurry was fed along with carrier gas and/or air flow. The mist generated radially inside the assembly from the nozzles generated calcium phosphate nano-particles in the temperature gradient in the plasma flame. They traversed through the plasma flame and got deposited over the metallic substrate placed at the end of the flame to form the coating. The phase of the nanoparticles could be changed by feeding appropriate slurry form and multi-phase coating as well as multi-layer coating could be obtained.



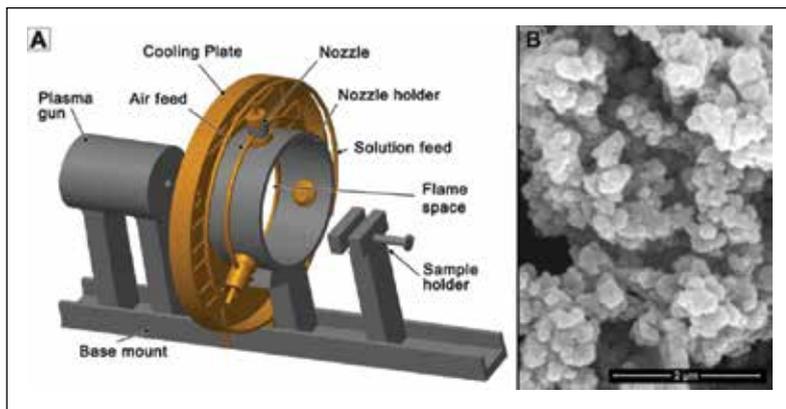


Figure 23. A. Schematic diagram of the slurry feed attachment designed for plasma spray B. SEM of hydroxyapatite coating obtained by the slurry feed technique, at a magnification of 50,000X, in which porous nano-structure is seen.

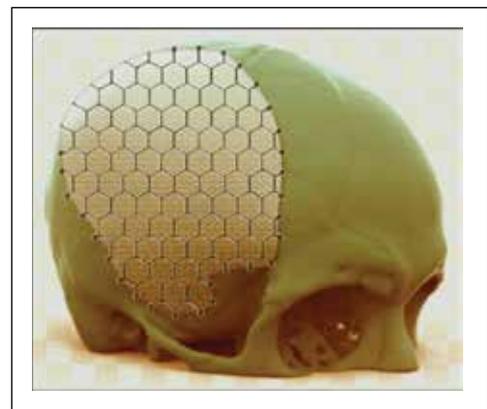


Figure 24. Representative diagram for the cranioplasty closure system

## 2. Customizable Cranioplasty Closure System

Closure of a large area of cranial bone damage is a challenge because of the need for protecting the brain as well as to keep the contouring for cosmetic appearance. The lapse of closure will lead to the condition “syndrome of the trephined”. Conventional ceramic bone graft substitutes will fail when made in large size and contoured shaping is difficult. Polymer composites could be made in large size and in the required contour, but it is difficult to make them integrate to host bone leading to imperfect closure. A workable solution is to make a tiling system of ceramic with a metallic support structure matching with the large cranial defect. Small-sized ceramic tiles will be arranged onto the metallic supports that are custom made for patient-specific contours (Figure 24). Sub-systems for small area closure is also supported. The Cranioplasty Closure System with titanium support structure and dense hydroxyapatite ceramic tiling was under development by the team of bioceramic experts, biomedical design engineers and neurosurgeons at the Institute.

## 3. Bioceramic grafts with ordered array structure

Bone graft substitutes with hydroxyapatite ceramic and bioactive glass are widely used for bone defect management. These are supplied as homogeneously porous bodies considering the viability for manufacture. However, many of the grafting applications need specific microstructure of the graft to align with the cortico-cancellous structure of the local bone. The possibility of making grafts with ordered array of ceramic strands was explored.

Bioceramic material slurry was extruded in specific size and aligned in an ordered manner with computer-controlled printing mechanism. Alignment systems were ascertained to retain the structure during the final heat-treatment called sintering. Extrusion was carried out using a custom-designed pneumatic extruder feeding a screw-based dispenser which provided fine control over strand extrusion at starting, feed and stopping conditions. A pre-designed architecture with the required porosity distribution could be obtained by this method (Figure 25). The bioceramic will have controlled degradation and faster integration at implant sites. The process could be automated for the manufacture of bioceramic grafts on limited or large scales.



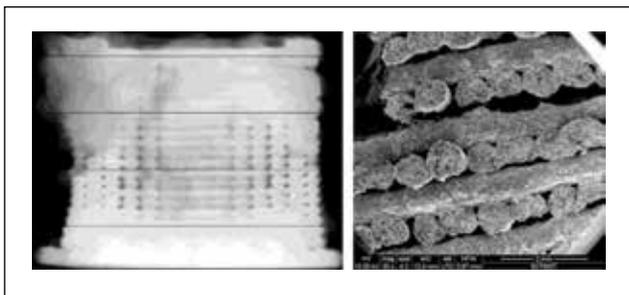


Figure 25. Bioceramic grafts with ordered structure (A) Micro CT image of the printed graft after heat treatment. (B) Scanning Electron Micrograph showing stacking and orientation of ceramic subsystems after sintering

## New Initiatives

### *Hydroxyapatite-collagen composite for bone filler applications*

The natural bone matrix is a combination of inorganic (calcium phosphate) minerals and organic polymers. The collagen type 1 system forms the main organic polymer in bone. Collagen composite systems with apatite mineral will mimic natural bone systems and can enable rapid healing and integration at defect sites. Collagen provides a wide array of native biomolecules that signal cell adhesion and differentiation into desired lineages. A collagen-based bone graft system with good mechanical strength and bone inducing capacity is a challenge.

Hydroxyapatite mineral developed in the Division was combined with collagen through mixing and precipitation routes to generate biocompatible composites with a high degree of bone-inducing and bone-binding abilities. The samples generated were characterized using scanning electron microscopy. The open porous foamy architecture which was visualized will be conducive to the loading of signalling molecules or drug delivery.

### Technology Transfer Activities

1. The technology training for the production of bioactive ceramic composite and bioactive cement, subsequent to the technology transfer to M/s Prevest DenPro, Jammu, was carried out.

2. Expression of Interest was received from M/s Onyx Medicals, Meerut, Uttar Pradesh, regarding drug-eluting calcium sulfate cement. The technology transfer process was in progress.

## Research Programmes

1. *Polyvinyl alcohol -based functionally-graded bioactive composites through thiol-ene click reaction*

Functionally graded materials (FGM) made with polymer matrix having embedded calcium phosphate particles are preferred for bone tissue engineering because they can mimic the hierarchical and gradient structure of bone. In this work, the development of a FGM for bone grafting based on polyvinyl alcohol (PVA) and nano-hydroxyapatite (nano-HA), was demonstrated which possessed the unique combination of graded bioactivity, cell compatibility and degradability.

The polymer matrix contained cross-linked polyvinyl alcohol with ester and thioether linkages (TPVA) made through a thiol-ene „click crosslinking reaction. It avoided undesired additives and by-products, thereby ensuring biocompatibility. Freshly precipitated and spray-dried HA mixed with the TPVA gel and layers of varying concentrations were cast consecutively. The gel layer structure yielded porous sheets of graded composite of TPVA and nano-HA, upon lyophilisation process (Figure 26). The FGM structure showed higher values of tensile strength and in vitro degradation in SBF, compared to bare TPVA. The bioactive nature was confirmed by in vitro bioactivity studies in simulated body fluid. The material was found cytocompatible to human periodontal ligament cells in the in vitro cell culture studies. The composition, mechanical properties, bioactivity and cytocompatibility of the TPVA-HA composite support its utility as guided bone regeneration (GBR) membranes.

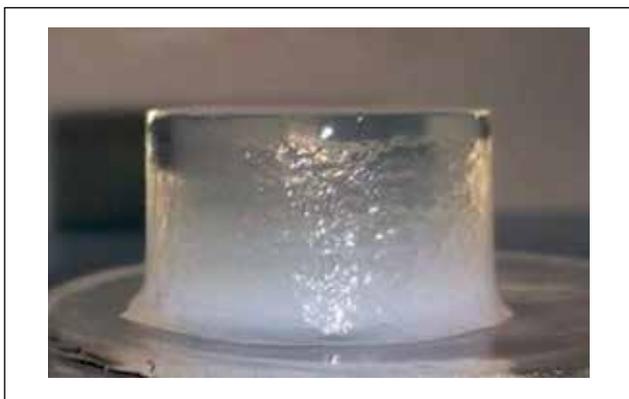


Figure 26. Gel construct of cross-linked polyvinyl alcohol having ester and thioether linkages with graded layers carrying nano-hydroxyapatite

## 2. The role of stem cells from human exfoliated deciduous teeth in the cytocompatibility evaluation of bioceramic materials

The *in vitro* cytotoxicity evaluation of biomaterials routinely utilize commercially available cell lines which are genetically altered and immortalized. Such investigations may not recapitulate the original biological responses of native host cells. Isolated and characterized primary cells, preferably native to the tissue of interest, are more appropriate to test the bioceramics-based regenerative materials *in vitro*.

With the aim of developing an appropriate cell culture system for bioceramic materials used in dentistry, primary cells were isolated through an explant culture method from the remnant tissues of exfoliated deciduous teeth. The tissues yielded a healthy heterogeneous population of SHED (Stem cells from Human Exfoliated Deciduous teeth), with fibroblastic morphology and fibroblast marker expression (Figure 27). The characterization using specific marker proteins revealed the presence of a progenitor cell population within the predominantly fibroblast cells.

The suitability of these cells for dental biomaterial evaluation was tested using sintered hydroxyapatite (HA) and bioglass

(BG). The cytotoxicity tests were done in direct contact mode and the cytocompatibility of HA and BG were evaluated by analyzing the osteogenic differentiation of SHED cells. In the direct contact cytotoxicity evaluation, the cells maintained their morphology without evidence of cell death, in the test groups. The compatibility of SHED for biological screening was confirmed by the mineralization potential of the cells in the presence of the test materials. The results substantiated the utility of SHED for the biological evaluation of regenerative dental materials. Since these cells are native to the site of application, they give a better simulation of host cellular responses, like osteogenic property, *in vitro*.

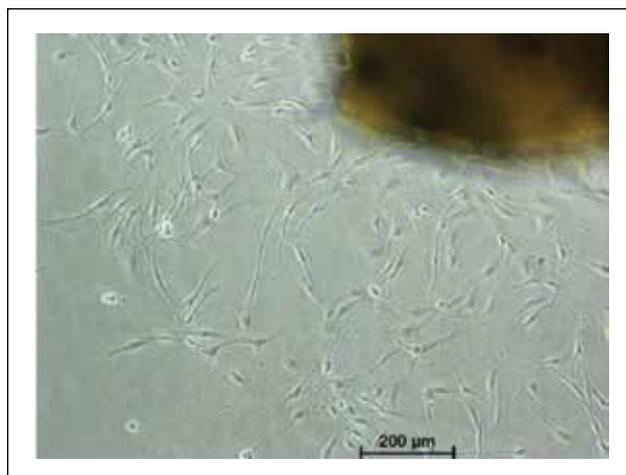


Figure 27. SHED growing out from the explant tooth segment

## Testing and Evaluation

The Division provided testing services for material characterization:

1. X-Ray Diffractometry
2. Microhardness testing
3. Infrared spectrometry
4. Elemental analysis using AES-ICP.



## DIVISION OF BIOPHOTONICS AND IMAGING

Main objective of the Division is to take up and ensure high standard research in the field of nanomaterials for bionanophotonics for biomedical applications. The key areas of the lab research include development and application of biomaterials for optical imaging, photodynamic and photothermal therapy and development of different sensor platforms for the detection of biomarkers in different pathological conditions. The Division also works on different spectroscopic techniques and spectral mapping and imaging for the early diagnosis of various diseases and the classification and discrimination of different pathologies using these techniques. The work focuses on the hypothesis that the concept of optical pathology will be practical in the near future. The Division is committed to train students in the above fields, with international standards and strives to publish the outcome in platforms of international repute. We are also working towards the development of technologies related to the above fields for their biomedical application.

The Mission of the Division is to support biomedical research and development in the fields of bionanophotonics and biomaterials including biosensors, *in vitro* diagnostics and theranostics.

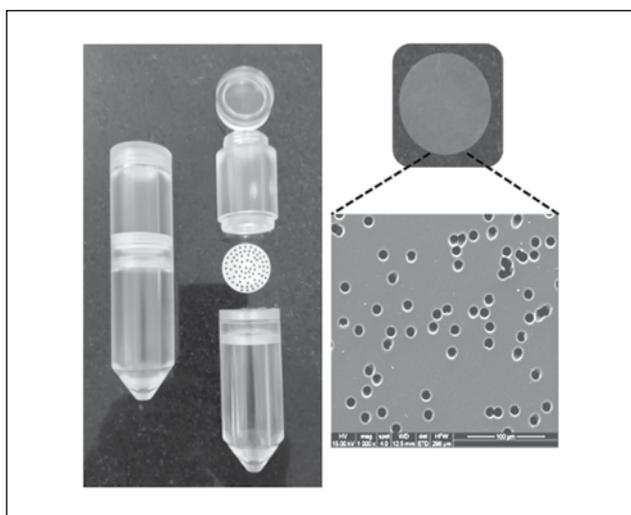


Figure 28. Centrifugal prototype for capturing CTCs (A) and the fluorescence microscopic images of CTCs (B)

## Developmental Activities

To realize circulating tumor cell (CTC) isolation platform that can be readily adapted to clinical settings, the laboratory had previously developed a custom-designed portable centrifugal prototype-based lab-on-a-filter CTC detection system. In continuation of the work initiated last year, the centrifugal prototype which comprised three independent chambers was modified for whole blood sample loading, CTC filtration and waste residual blood storage in a new filter. This enabled immuno fluorescent assay for the quantitative detection of the CTCs captured into it (Figure 28). The system was made easier to use in a clinical set up compared to our original effort to use the technique of Raman spectroscopy for the same.

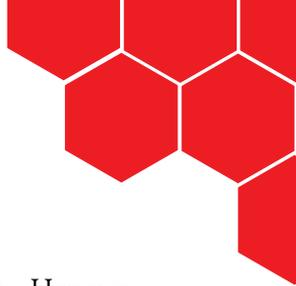
## New Initiatives

1. A study on the detection of the blood-based biomarker for Alzheimer's disease using the biosensor developed in the Division was initiated in collaboration with the Neurology Department. Around 50 patients, 20 controls and 25 cases was completed successfully with promising results.
2. A study on the development of radiation sensor and radiation sensitizer was initiated.
3. Lateral flow-based assay kit development for the detection of Alzheimer's disease was initiated.

## Research Programmes

1. **Blood-Brain-Barrier permeable nanocarriers for diagnosis and therapy neurodegenerative diseases**

The aim of this DBT-funded project is the design of highly potent therapeutic agents that cross the BBB, which is a challenging field of advanced research and will facilitate better treatment for neurodegenerative diseases. The work focused on a theranostic approach towards Alzheimer's disease, which is one of the most common neurodegenerative diseases affecting the aged population. With encouraging results from the *in vitro* studies, we started testing the developed material in *in vivo* models and the experiments were ongoing.



2. **Development of ultra-sensitive surface for the detection of biomarkers of Alzheimer’s disease**

On developing an ultra-sensitive surface for the detection of biomarkers of Alzheimer’s disease (AD), the work was started on clinical samples. The fingerprint characteristics and band intensities in SERS spectra were used to identify different blood-based AD biomarkers with excellent sensitivity and specificity.

3. **An easy and rapid detection platform for viral diseases from saliva: COVID- 19 and beyond**

This DST-SERB funded project was completed. A sensitive sensor platform based on the lateral flow assay technique was developed (Figure 29) under this project.

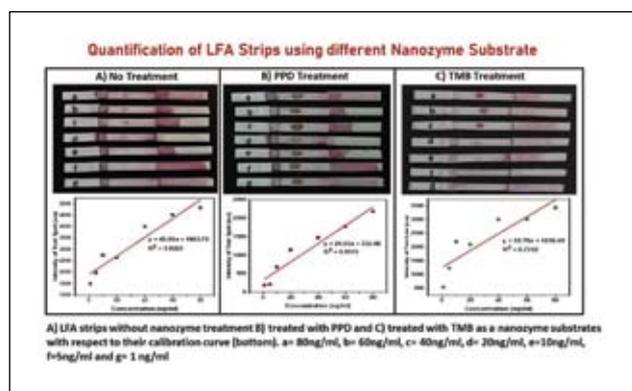


Figure 29. Lateral flow assay for detection of viral diseases from saliva

**Training/Outreach Programmes**

1. Dr Jayasree R S delivered the lecture on “Fundamentals and Applications of Biophotonics” for the MSc students of colleges of Tamil Nadu on behalf of the Academy of Chennai on 23 July 2021
2. Dr Jayasree R S handled a session on "Biophotonics: Fundamentals, Advances and Applications" during AICTE and TEQIP II supported Faculty Development Program on Emerging Trends in Photonics organized by Department of Sciences, IIITDM Kurnool, Andhra Pradesh on 12 July 2021.

**Awards and Honours**

Dr Jayasree R S was: (i) Conferred with the Honorary Fellowship of Indian Society of Analytical Scientists in 2022 (ii) DST nominee during the 3rd Meeting of the BRICS Working group on Material Science and Nanotechnology held during 26-28 October 2021 (iii) Nominated Member of the SERB- International Research Experience (SERB-SIRE) Scheme by the Secretary, SERB (iv) Co-opted as Member of Program Advisory Committee, Inorganic & Physical Chemistry, SERB, DST (v) Special invitee during the DST SERB SRG-NPDF selection committee-Life Sciences, 2021 (vi) Expert Panel Member for the semifinals of Swadeshi Microprocessor challenge organized by MeitY and Government of Kerala 2021 (vii) Member of Task force on Empowerment and Equity Opportunities for Excellence in Science, SERB, DST (viii) Member, Expert Committee of SUPRA scheme of SERB (ix) Member, Technical Review and Advisory Committee (TRAC) of the NNetRA Project (Funding of 300 Crore) of Ministry of Electronics & Information Technology, Government of India (x) Member, SERB-TETRA AWARD selection Committee, 2021 (xi) Member, National Science Advisory Group, Nanomission, DST (xii) Member, Expert Committee on Intensification of Research in High Priority Areas (IRHPA) in the area 3D bioprinting, SERB, DST (xiii) Member, Human Ethics Committee of Regional Cancer Centre, Trivandrum; (xiv) Member, BOS, MSc and MTech Programme in Molecular Medicine and Nanotechnology, Amritha Vidhyapeeth, Kochi (xv) Member, Board of Studies of Nanoscience, University of Kerala (xvi) Member, Board of Studies of Physics, Mar Ivanios College, Thiruvananthapuram.

**DIVISION OF BIOSURFACE TECHNOLOGY**

The main research focus is on development of biomaterials and drug delivery systems for various therapeutic applications. Main thrust is on translational research towards product development in the area of advanced wound care focussing on controlled nano/microparticle-based drug delivery system for biologically active molecules and drugs with polymeric scaffold. Mission of the Division is to develop and translate biomaterial-based therapeutic delivery systems for clinical applications.



## Developmental Activities

### 1. Wound Dressing

As part of developing advance wound care biomaterials for treating chronic wounds, chitosan-based sponges were developed and evaluated (Figure 30). The technology is now ready for transfer.

### 2. Hemostatic wound dressings



Figure 30. Chitosan-based sponge

3. Cell/tissue interaction with wound healing biomaterials and modulation of microenvironment for better wound healing.

### New initiatives

Chitosan graft materials for drug delivery applications

### Research Programmes

#### Wound healing materials

Chronic wound management is a very challenging health concern. One of the most widely used biopolymer for wound management is alginate. However, alginate-based commercially available wound care materials exhibit poor mechanical strength and tend to dissolve or disintegrate and adhere to the wound bed. The lab has developed alginate-grafted methacrylate-based xerogels for wound healing application with an objectives of improving its mechanical strength, prevent dissolution in the wound site and also as a drug delivery matrix. Alginate xerogels were prepared by grafting with different

monomers such as alginate-g-poly(methacrylic acid) (AGMS), alginate-g-poly(PEGMA) (AGPMS) and alginate-diamine PEG-g-poly(PEGMA) (ADPMS). The strontium crosslinked xerogels were named as AGM2S3, AGPM2S2 and ADPM2S2.

While comparing with the commercial wound dressing materials, the xerogels showed good mechanical strength in both dry and wet conditions. The lab was also able to reduce the bioadhesive nature, which would help in the pain-free removal from the wound surface.

The evaluation of physico-chemical characteristics showed that, among xerogels, ADPM2S2 had better properties. The material also offered good strontium ion release, which was effective in *in vitro* wound healing. Biomolecule delivery to the wound site was another objective of this research work. The efficacy of the xerogels for insulin, glucose oxidase/oxidase and simvastatin delivery was evaluated. *In vitro* scratch wound assay on fibroblasts and keratinocytes were evaluated and the optimised xerogel showed promising results under *in vitro* conditions. *In vivo* experiments were planned in diabetic rats.

## DIVISION OF DENTAL PRODUCTS

The aim of the Division is to develop and translate innovative and affordable dental healthcare technologies and to generate highly competent biomaterial scientists through education, training and research. Currently the laboratory is engaged in the development of nano and organically modified ceramic composites for dental/orthopedic applications, biodegradable micro-needles, cell encapsulated click gels as bioinks for 3D Bioprinting, modified GIC and polymer scaffolds for tissue engineering. Our Mission is to become an internationally recognized team in developing and translating affordable healthcare technologies for the prevention of life style diseases through dental care, training, education and innovative research.



## Developmental Activities

1. Indigenous bone graft expanders for Masquelet-induced membrane technique (TDF Project): development activities were ongoing with good progress.
2. Various dental restorative composite material formulations optimized for bioactivity, radiopacity and antimicrobial properties.
3. *In vivo* osteogenesis experiments of the bioactive composite material for bone defect management using rat model continued.
4. The technology for Bioink was ready for transfer. The Expression of Interest for this material was published and talks with industry were ongoing.
5. **Micro-needles technology**  
An NDA was signed with Central Manufacturing Technology Institute, Bangalore, to explore the possibilities of fabricating micro-needles on a scalable basis. MoU was under process.
6. The technology for using 3D bioprinted liver as an *in vitro* toxicity model for drug screening was developed and Vipragen Mysuru Ltd., was partner for further studies. NDA was signed with this industry and a MoU was in progress.
7. Mechanically improved glass ionomer cement using nanogel additives (Funding Agency: Start up Research Grant, SERB).
8. A saliva absorption pad using biodegradable superabsorbent sponge.
9. Mucoadhesive Bandages under TDF Scheme.

## New Initiatives

1. Development of antimicrobial composite/membrane for prevention of gingivitis and periodontitis.
2. A project entitled „Pre-validation of *in vitro* hepatotoxicity test of drugs using 3D bioprinted liver construct was initiated under the TDF Scheme.
3. The project entitled "Efficacy evaluation of 3D bioprinted liver constructs established from niche specific bioink and stem cell-derived

hepatocyte-like cells", was sanctioned (Funding Agency: CRG Scheme, SERB).

4. Plasticizer-free acrylic denture soft liners (Funding Agency: HarGobind Khorana-Innovative Young Biotechnologist Award, DBT).

## Technology Transfer Activities

### *Development of two liver-specific bioinks*

Bioinks are polymeric hydrogels that are used to construct living tissues/organs in 3D Bioprinter. We developed liver-specific bioinks that could be used for printing functional liver. Expression of Interest for these materials was invited.

## Research Programmes

1. **Shell nacre powder is prepared from the shells of *Pinctadafucata***

Chemical characterisation, non-cytotoxic nature, cytocompatibility and *in vitro* osteogenesis (with rat bone marrow mesenchymal stem cells) proved the eligibility of the material for orthopaedic application. Shell nacre containing siloxane methacrylate resin was synthesised and characterised. Shell nacre cement and shell nacre powder were formulated with the above synthesised resin. Low linear polymerization shrinkage, radio-opacity, good mechanical properties and non-cytotoxic nature were the highlighting properties of the cement. Biocompatibility evaluation included acute systemic toxicity, pyrogen test and irritation test. Implantation in 2mm defect at midshaft of femur of Sprague Dawley rats proved the osteoconductivity of the cement. This cement can be used to fill any irregular bone voids or defects of load bearing sites.

2. **Development of composite membrane based on soybean oil and soy protein concentrate for dental material application**

- Preparation and characterization of membrane with soy protein isolate, PVA and glycerol (SPG) for periodontal GTR application.



- In vitro characterisation of SPG membrane for cytotoxicity, live/dead assay and cell adhesion.
- Preparation and characterisation of membrane with soy protein isolate, PVA, glycerol and genistein (SPGen) for periodontal GTR application.
- In vitro characterisation of SPGen membrane for cytotoxicity, live/dead assay and cell adhesion.

### 3. *Development of tissue-specific bioinks*

Two kinds of liver-specific bioinks were underway. A variety of gelatin modifications using different cross-linking chemistry was investigated. Liver ECM was incorporated into modified gelatin systems and liver constructs were bioprinted using HepG2 and primary hepatocytes.

### 4. *Simulation studies of an organ-on-a chip design*

Though the organ-on-chip technology is impressive, the handling of the device is rather difficult and may require the use of microscopic techniques. Further, microfluidic flow optimization is quite difficult and requires careful control of several parameters. The ratio of the size of the cultured tissue to the size of the channels should be in congruence with the size of the organ and the blood vessels connecting those tissues. In order to overcome these challenges, a design innovation was performed in the conventional microfluidic organ-on-chip design, wherein a larger flow system with dedicated cell culture chambers were used to bring the simulation closer to the actual in vivo conditions. Due to the uniqueness of the design stagnant zones were minimized in the cell culture chambers which ensured that the media is completely recycled so as to maintain the viability of the cells.

### 5. *Development of plasticizer-free acrylic denture soft liners using nanogel additives*

Denture soft liners have been widely used in dentistry. One of the major concerns of acrylic-based denture soft liners is the use of

high concentrations of plasticizers, especially phthalate esters. The plasticizer migration from these polymer networks can cause changes in mechanical properties of soft liners and compromise elasticity. So, acrylic soft liners are used only for a short period of time. In addition, toxicity related to phthalate ester plasticizers that diffuse out from the bulk of denture soft liners at regular intervals is a major concern. The proposed study aims to develop acrylic denture soft liner formulation using nanogel additives without incorporating any small molecule plasticizer such as phthalate esters.

### 6. *Development of modified Glass Ionomer Cement to improve mechanical properties*

Glass-Ionomer Cement (GIC) has many advantages over other dental composite restorations including strong adhesion and anti-carcinogenic properties, thermal compatibility with tooth enamel and biocompatibility. In addition to unique physiochemical characteristics, GIC can favour remineralisation, increase enamel and dentine resistance to demineralisation, and prevent secondary lesions. However, conventional GICs have many disadvantages including inferior mechanical properties, brittleness, low abrasion resistance and inadequate surface properties. Proposed study aims to improve the mechanical properties of GIC using reactive nanogel additives.

### 7. *Development of mucoadhesive bandages for oral drug delivery applications*

Multiple gel formulations for the treatment of various stages of desquamative gingivitis are available in the market. However, the retention of these drugs at the target gingival region is challenging as these common gel formulations can be easily wiped away from the oral moist environment by food, liquids and even saliva. As there is a massive need for formulations that can enhance the retention of drugs in the target gingival region, the proposed project aims



to develop mucoadhesive bandages that can simultaneously deliver triamcinolone acetonide and lidocaine for a period of 24-72h to treat or ease symptoms of desquamative gingivitis.

### **Testing and Evaluation**

Testing facilities in the Division was extended to the external and internal customers. Micro CT analysis, DLS particle size analysis, and compressive strength testing of samples including internal and external were completed/ test report issued.

### **Training/Outreach Programmes**

Dr Shiny Velayudhan delivered a talk on "Injectable hydrogels for Bioprinting" in the 5-day Seminar Series on Advanced Biomaterials for Biomedical Applications organized by BMS College of Engineering and BMT Wing of SCTIMST.

### **Awards and Honours**

Dr Lizymol P P, Scientist F, won the Kerala State Science Literature Award - 2020 under the category Science Book (Children s Literature). The award instituted by KSCSTE was presented by the Hon'ble Chief Minister of Kerala in January 2022.

### **Staff**

#### **Faculty**

Dr Manoj Komath, Scientist G and Head of the Department

Dr Jayasree R S, Scientist F

Dr Lizymol P P, Scientist F

Dr Rekha M R, Scientist F

Dr Shiny Velayudhan, Scientist D

Dr Manju S, Scientist D

Dr Francis Fernandez, Scientist C

#### **Technical**

Dr S Sureshababu, Scientific Officer - Instruments

Dr Nishad K V, Scientific Assistant (Instruments)

Ms Susan Mani, Technical Assistant (Lab) - A

Mr Sajin Raj R G Technical Assistant (Instruments) - B

Dr Deepu D R, Technical Assistant (Instruments) - A

Dr Remya K R Technical Assistant (Instruments) - A

Mr Jijo P T Technical Assistant (Instruments) - A



# DEPARTMENT OF MEDICAL DEVICE ENGINEERING

The Department focuses on the research and development of medical devices, covering the entire life cycle from conceptualization to technology transfer, including empirical design, computer-aided modelling, in silico evaluation, fabrication, prototyping and functional evaluation. The Department has five Divisions, four of which established their own domains of medical devices development; while the fifth Division strongly supports the device development activities in precision fabrication of prototype devices

The Department consists of the following Divisions:

1. Division of Artificial Internal Organs
2. Division of Extracorporeal Devices
3. Division of Medical Instrumentation
4. Division of Polymeric Medical Devices
5. Division of Precision Fabrication

The department also extends support services to other internal divisions and external customers such as regulatory affairs, rapid prototyping, ethylene oxide sterilization, package validation, material characterization and computer-aided design and analysis.

## DIVISION OF ARTIFICIAL INTERNAL ORGANS

The Division is executes research and development projects aimed at development of high-risk medical devices. The Division has its core competence in the areas of design, prototyping, in vitro evaluation, process development and technology documentation for medical devices. We are also working in new areas like orthotics and in vitro diagnostics.

### Developmental Activities

#### 1. Aortic Stent Graft

The prototypes of the device were made and

deployed in aneurysm models. The finite element analysis of the prongs was performed and design parameters optimized (Figure 31). A mould for realising the atraumatic tip was designed and fabricated. Critical mechanisms were rapid prototyped using ABS. An industrial partner has expressed interest in commercialising the technology and MOU was under negotiation.

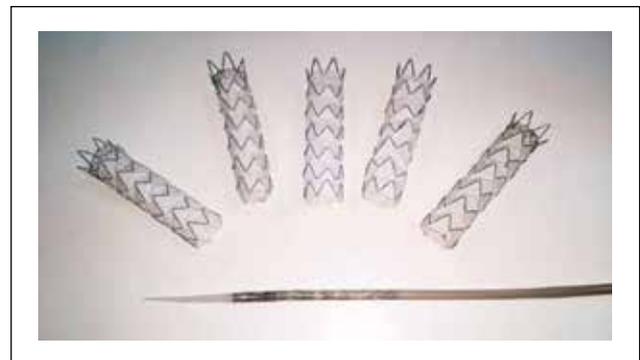


Figure 31. Aortic stent graft – device and delivery system prototypes

#### 2. ASD Occluder

Five prototypes of the occluder were fabricated and heat set at CSIR-NAL. The delivery system components were outsourced which included a coiled filar tube with an outer polymer coating and an inner PTFE coating (Figure 32).

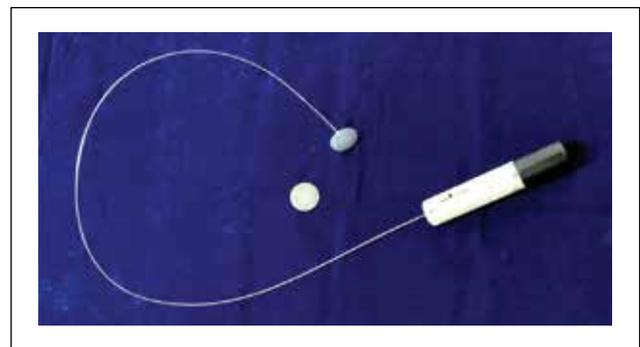


Figure 32. ASD Occluder – device and delivery system prototypes

### 3. Flow Diverter Stent

Ten prototypes of the flow diverter stent with the novel checker-board pattern was fabricated and heat set at CSIR-NAL. The pusher wire and stent retainer components were outsourced. The retainer was successfully welded to the pusher wire. An atraumatic tip using tantalum powder and resin was fabricated.

Radiopacity of the tip and device was demonstrated. *In vitro* tests such as flexibility and porosity were done and loading of the device to the delivery system was completed.

### 4. TiN-coated coronary stent

Proof-of-concept animal studies of two TiN-coated coronary stents (Figure 33) were completed in porcine animal model. At six months after implantation, the vessels were fully patent on angiograms.

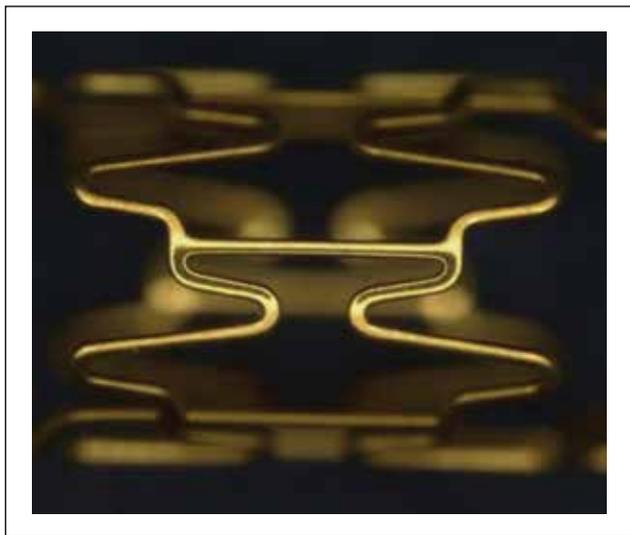


Figure 33. TiN coated surface of stent

### 5. Annuloplasty ring

All components in the proof-of-concept phase were completed and pilot production of 3 sizes of the device (5 numbers each) was carried out. One animal was implanted with the device and implantation was ongoing in the remaining 4 animals.

### 6. OA knee brace

SCTIMST-TYNOR co-development project on development of rigid knee brace for osteoarthritis completed the preliminary design review. The industry partner started manufacturability studies on minimum viable prototype (Figure 34).



Figure 34. (a) Digital prototype of OA Knee brace design (b),(c) MVP in progress by TYNOR

### 7. Spinal fixation system for thoracolumbar stabilization

The fixation system is high-risk medical implant for spinal deformity, fracture, tumor, and degenerative conditions. The treatment of these clinical conditions involves non-surgical and surgical procedures, surgical procedure makes use of screw, connectors, rod, locking cap and instrumentation (Figure 35). Under this project, implants and instruments were being developed. The project had reached the metal prototyping stage and in vitro testing for pedicle screw had commenced.

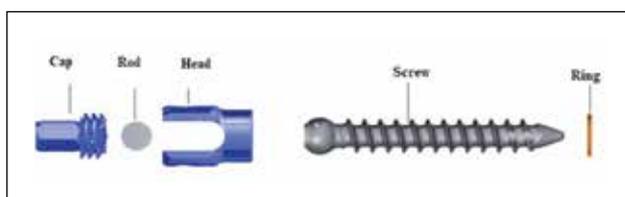


Figure 35. Components of spinal fixation devices



8. **Cavity conformable self-retaining stent retractor:  
Design and proof-of-concept**

Retractors are used for optimum exposure to operating site during surgery. The existing retractors are bulky and have reported incidents of retractor-induced complications. The proposed design overcomes these limitations. The retractor was metal prototyped (Figure 36).



Figure 36. Metal prototype of cavity conformable retractor

9. **Bioprosthetic Heart Valve**

Durability studies on 27 mm size valve were completed on 12 samples. The valves completed 200 million cycles (equivalent to 5 years lifetime) without any structural dysfunction. Performance characterisation, prior to, and after the durability studies also showed promising results. Pilot production of valves for animal trials was progressing.

10. **Sepsis Rapid diagnostic test kit**

Immunochromatography assay is commonly used for the detection of biomarkers. In this programme, the aim was to develop a device for semiquantitative kit which will be helpful in sepsis diagnosis. The project was in the design stage.

11. **Chlamydia trachomatis rapid diagnostic test kit**

*Chlamydia trachomatis* is an obligate intracellular parasite with elementary bodies as its infectious stage. The objective of this project was to develop an antigen detection platform using the immunochromatographic method to

detect chlamydia as a point-of-care test. Both these projects for test kits are co-development programmes between SCTIMST and M/s Biogenix Inc, Lucknow.

12. **N-terminal ProBNP (NT-proBNP) device**

The project intends to develop a device for measuring NT-proBNP levels from blood samples.

13. **Clot Retriever Stent**

Two novel concepts of braided stent retrievers were developed. The braided stent retriever consisted of a braided distal basket, two planar tails and a braided clot interacting body. A total of 34 samples were produced till date which involved a variation of the two braided concepts and 3 different diameter wires (80 $\mu$ m, 100 $\mu$ m, 150 $\mu$ m). *In vitro* simulations using thrombus simulant and silicone vascular model were performed. The project was completed and report submitted to DBT.

14. **Voice Prosthesis**

Two novel concepts were generated one using four flap valves and another with a single flap valve with a button. An FSI study was also performed to optimize the geometry. Delivery systems for both anterograde and retrograde insertion were designed and were being prototyped. The test results showed promising forward flow characteristics.

15. **Programmable Hydrocephalus Shunt**

The hydrocephalus shunt is a device to drain the excess cerebrospinal fluid through the catheters via a pressure valve which opens at minimum intracranial pressure to other body cavities. The shunt valve structure (Scaled up version) underwent pressure flow evaluation, and the results were compared with analytical/ CFD results.

16. **Fontan surgical planning**

The purpose of this study was to develop a methodology for the prediction of passage which has low energy loss using CFD based on the



vascular structure of the patient for bidirectional Glenn procedures, as well as the various types of completion Fontan operations. Patient-specific 3D vascular model was taken using MRI scanning. Optimum path was predicted based on various parameters and the same was verified using the post-operative data.

#### 17. *Process development for Ti6Al4V castings*

A process for heat treatment of Ti6Al4V castings which offer tensile yield strength enhancement of up to 25% was underway. Also, a process map for a lower temperature distortion correction/shaping treatment was also under development. Application of these processes in the realisation of anterior cervical plate was ongoing.

#### **New Initiatives**

##### 1. *Orthotics and rehabilitation*

Multiple programmes of offloading devices, knee brace, prosthetic foot were initiated with funding from DST and industries such as TYNOR, FUPRO and TATA Steel.

##### 2. *Development of pedicle screw-based dynamic stabilisation systems for degenerative diseases of lumbosacral spine*

Dynamic stabilisation system is high-risk implant system for various spinal diseases. The project supported by DST.

#### **Technology Transfer Activities**

##### 1. *ASD closure device*

Training was given to M/s Biorad Medisys, Pune. Design dossier, technology transfer documents and test protocols were in the final stages of preparation.

##### 2. *Flow diverter stent*

Technology transfer documents were provided to Biorad Medisys, Pune. Design dossier, technology transfer documents and test protocols were in the final stages of preparation.

#### **Research Programmes**

##### 1. *Functional Near Infrared Spectroscopy*

Research was initiated using Functional Near Infrared Spectroscopy (FNIRS) to classify the brain state into rest, left motor active and right motor active using machine learning techniques. PCA and ICA components were included in the feature space which improved the classification accuracy by more than 10% to about 85%. Further improvement in the classification was achieved using deep learning techniques to above 95%. A TDF Project was initiated to translate these concepts to develop a brain-computer interface for controlling a computer cursor in the first phase.

##### 2. *Percutaneous homograft valve*

A project was initiated for endovascular delivery of a homograft valve. Human homograft is used for surgical pulmonary valve replacement and reconstruction of right ventricular outflow tract. The project aims to develop a technique for trans-catheter valve replacement using human homograft, which will improve the durability of the replaced valve and substantially bring down the cost of procedure. The project was funded by BIRAC.

#### **Awards and Honours**

Subhash N N won top 5 Indian Young Scientist in Healthcare theme at the 6th BRICS Young Scientist Conclave 2021. As a part of Indian delegation, he presented "An Institution making a difference" on 15 Sep 2021 where the SCTIMST ecosystem-bringing life to innovation was highlighted to the BRICS YSC delegations from all BRICS Nations.

#### **DIVISION OF EXTRACORPOREAL DEVICES**

The Division is engaged with the research and development of extracorporeal medical devices mainly focusing on the cardiopulmonary system. The major ongoing activities in the Division include developing left ventricular assist device, implantable infusion pumps, membrane oxygenators, cerebral



micro-dialysis device and transcutaneous energy transfer system. The Division also supports various projects of the Institute for rapid prototyping as well as for sterilisation requirements.

Scientists of the Division support the research teams and industrial partners of the institute for a range of regulatory activities. The faculty also take part in the Materiovigilance Programme of India (co-ordinated by Indian Pharmacopeia Commission, Ghaziabad) monthly partners meeting as expert members for providing the technical support in the causality assessment of medical device adverse events reported by the manufacturers and other healthcare professionals across the country.

The services of ethylene oxide sterilisation and rapid prototyping were extended to other Departments and Divisions of the institute as part of various research and development programmes.

## Developmental Activities

### 1. *Paracorporeal left ventricular assist device*

Ventricular Assist Devices (VADs) are circulatory support devices that help to maintain a nominal cardiac output for various physiological functions of the human body in end stage cardiac failure patients. The Chitra pLVAD is a magnetically levitated third generation LVAD composed of a centrifugal blood pump with a miniature brushless DC motor, a controller, battery packs, battery charger and a drive line connecting controller to the pump. The technology was transferred to M/s Meril Lifesciences Pvt. Ltd., Gujarat.

Ex-vivo evaluations were carried out in animal models to establish the safety, efficacy and performance of the device (Figure 37). Safety evaluation involved connecting and running the Chitra pLVAD ex-vivo in sheep model up to 6 h and to study its effect on the animal. The device was connected to extra/para-corporeally in parallel with the left atrial appendage as in flow and descending aorta as out flow from the device. Performance study focused on the pumping

efficiency of the device under this condition. The physiological effects of LVAD on living subjects from survival analysis were also carried out. The animals were monitored for 72 h post-perfusion and sacrificed for physiological examination at the end of the observation period. Improvements in the design were being investigated. Multiple industrial training sessions were conducted for the industrial partner. Multiple units were being fabricated by the industrial partner as part of the scale up activities.



Figure 37. A. Chitra pLVAD ex vivo evaluation setup B. Ex vivo connected Chitra pLVAD

### 2. *Implantable microinfusion pump*

In this project, an implantable device for precisely delivering drugs such as baclofen/morphine/insulin to targeted portions of the body is being developed. The device has a storage reservoir, a driving unit with associated electronics to deliver

drugs (Figure 38). The device has advanced state-of-the-art technologies to deliver basal, bolus dosages of the drug. The device can be programmed with the use of an App loaded on an Android phone. The device will be placed subcutaneously and the catheter will be placed into the region of interest such as peritoneal cavity or spinal cord. The drug sufficient for up to three months can be loaded into the device using an ordinary syringe by puncturing the septum. The device employs wireless recharging of the implanted battery for enhancing longevity. Two prototypes were developed and discharge performance was checked using gravimetric and HPLC techniques as per ISO standards. Various in vitro tests to establish the safety, efficacy, durability and performance of the subsystems were conducted as per ISO14708-4. Performance at par with the commercially available devices was obtained. Protocol for preparation of the catheter and the device in clean room facility was prepared. Multiple units were being fabricated for in vivo animal evaluation.

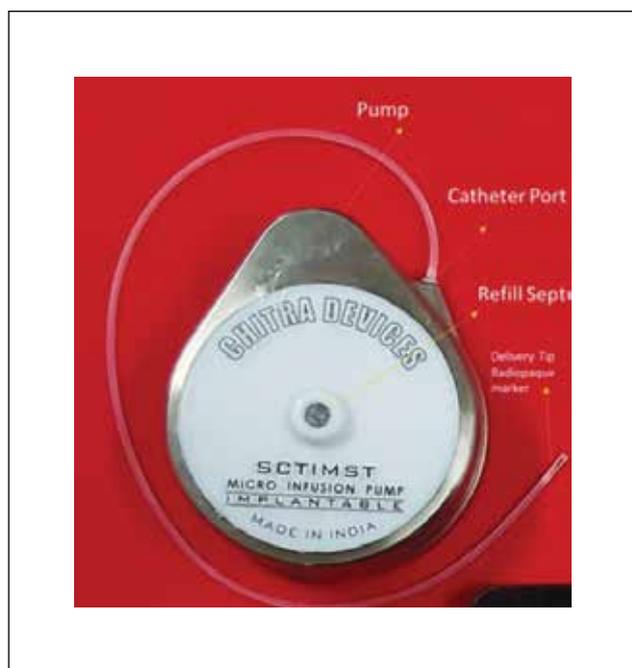


Figure 38. Implantable micro infusion pump prototype with catheter

### 3. Flow meter

A portable, blood flow meter measures the velocity of the blood flowing through the tubing and displays the fluid flow rate in litres/minute. Blood flow meter technology was transferred to M/s enProducts Pvt. Ltd., Kochi. Training was imparted to the industrial partners. An industrial model was prepared as part of the scale up activities and tested in accordance with the protocols given in the technology transfer (TT) document (Figure 39). The industrial unit was found to be compliant to the requirements given in the TT document. The industrial partner is in process of fabricating more units and preparing for submission for regulatory clearance and subsequent clinical trials.



Figure 39. A. Prototype of Blood flow meter manufactured by industrial partner and B. testing of industrial unit

### 4. Portable ICU ventilator

Considering the need for reliable and affordable mechanical ventilators in India, a turbine-based, general purpose ICU ventilator is under development in the division. This is a simple, compact, reliable and cost-effective equipment for adult and paediatric use including in ambulances, public places, as well as for ambulatory use. The device is provided with TFT display with graphical user interface for displaying ventilator parameters (Figure 40). Different controls for variable tidal volume,



respiratory rate control, SIMV respiratory rate, PEEP, pressure support/PC level, breath cycle time (SIMV), I:E ratio, variable FiO<sub>2</sub> concentration, pressure trigger, alarms, battery backup are also provided. Proof-of-concept was completed and multiple prototypes were fabricated. *In vitro* tests were completed on the prototypes as per various international standards. Technology business Division was in the process of selecting the most suitable industrial partner.



Figure 40. Portable ICU ventilator

the aortic annulus region which aids in the exposure of aortic annulus and maintaining natural anatomy for aortic valve replacement or repair procedures. The developed device consists of reusable retractor with handle and a disposable suction tip (Figure 41). Prototypes were fabricated and preliminary *in vitro* testing was completed to establish the performance.



Figure 41. Suction retractor device for aortic valve replacement

#### 5. Development of cerebral microdialysis device

Under the project titled “Design and development of microdialysis set-up for cerebral applications” under BDTD Programme of DST, actual-size prototypes of cerebral microdialyser were developed. The *in vitro* test results showed that recovery rate of more than 60% was achieved for glucose transport with the current parameters. In addition, a custom-built extruder was procured to develop hollow fibres for dialysis and related applications.

#### 6. Suction retractor device for aortic valve replacement

The development of a device for aortic valve replacement in adult cardiac surgery, which supports both retraction and suction was completed. The device helps in retracting aortic annulus for easy access to surgical area and also for removal of blood and any other fluids from

#### 7. Automatic contrast agent injector

Contrast agents are used to help diagnose and evaluate blood vessel disease or related conditions, such as aneurysms or blockages. Generally, a performing physician aspirates angiographic contrast into a syringe and injects it through the catheter into the coronary artery and simultaneously do fluoroscopy to acquire the cine-run. Manual aspiration of the contrast is time consuming, adds burden to the operator and can also lead to presence of air bubbles in the system, which can lead to coronary air embolism, unless the operator is careful in removing them. A TDF project titled “Development of a semi-automatic angiography system for facilitating coronary angiography and angioplasty” was initiated which can automatically deliver precise amount of contrast agent to the blood vessel. The device consists of a disposable flow divider and a portable hand held actuator as shown in Figure 42.

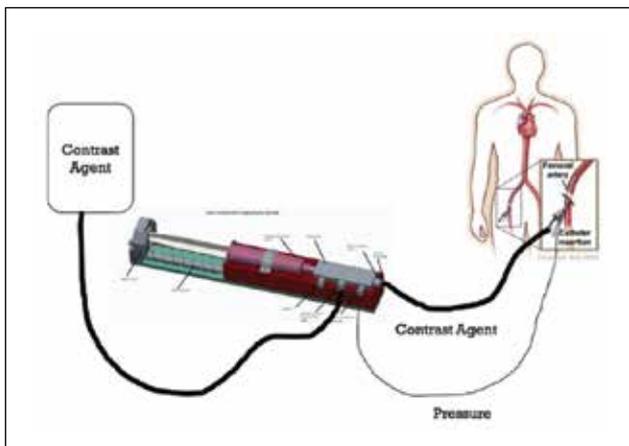


Figure 42. Automatic contrast agent injector for coronary angiography and angioplasty

### New Initiatives

1. Mr Sarath initiated a TDF project titled "Development of a semi-automatic angiography system for facilitating coronary angiography and angioplasty".
2. Ms Amrutha started a bimonthly newsletter to stay updated in national and international regulatory news (Figure 43).



Figure 43. Newsletter – Regulatory Focus

### Technology Transfer Activities

1. MoU was executed with Keltron, Government of Kerala, for the Technology Transfer (TT) of Infant Warming Bassinet and Wrapper on 28 October 2021 and TT documents were transferred to them. Sarath S Nair conducted the TT training to Officials of Keltron from 22-24 November 2021.
2. The technology transfer document of Left Ventricular Assist Device (LVAD) was transferred to industry partner M/s Meril Life Sciences Pvt. Ltd., Gujrat. Sarath S Nair, Nagesh D S and Vinodkumar V conducted the Technology Transfer Phase III Training of LVAD to Officials of Meril Life Sciences Pvt. Ltd., Gujrat from 16-19 November 2021.
3. The technology transfer document of Blood Flow Meter was transferred to industry partner M/s enProducts Pvt. Ltd., Kerala.

### Research Programmes

1. **Development of Transcutaneous Energy Transfer System**

Mr Sarath S Nair has initiated research on developing Transcutaneous Energy Transfer System for powering implantable medical devices such as LVAD, TAH and implantable infusion pumps as part of his PhD research work. Mathematical modelling followed by simulations were carried out to study the effect of various parameters. Coils of proper specifications for power transfer to an implantable medical device were developed and fabricated. A prototype model was designed and developed for charging the implantable battery in the infusion pump. The performance of the system was verified with various *in vitro* studies.

2. **Modelling/*In silico* simulation and validation studies**

This was carried out to improve the performance of the LVAD. The studies included the effect of splitter vanes, inlet cones in the eye of the impeller, effect of channels in the hydrodynamic



bearings. Studies were also performed to reduce the chances of blood damage and thrombus formation in impeller. Fault tree analysis and Fish bone-based techniques were adapted to improve the design for long term implantation.

### Testing and Evaluation

Various testsetup for evaluation of devices like left ventricular assist device and implantable micro infusion pumps according to ISO 14708 were set up in the Division which included:

1. LVAD Motor Torque Measurement setup
2. Accelerated ageing test setup for implantable infusion pump

### Training/Outreach Programmes

1. Shri Nagesh D S, Vinod Kumar V and Amrutha C attended the 18th MvPI Partners Meeting on 25 March 2022. Review of medical device adverse events causality was performed and comments were submitted to IPC, Ghaziabad.
2. Ms Amrutha C delivered a lecture on “Causality assessment of medical device” at the 7th Induction-cum-training programme for medical device adverse event monitoring centres, organized by IPC, Ghaziabad on 25 February 2022.
3. D S Nagesh was the expert member of the Technical Appraisal Committee for National Health Innovation Portal, Ministry of Health and Family Welfare organised by National Health Systems Resource Centre, New Delhi on 24 January 2022.
4. Vinodkumar V and Amrutha C prepared an educational video on Indian Medical Device Rule 2017 for Vocational Higher Secondary students of Kerala.
5. Mr Sarath S Nair was part of expert panel for the Semifinal Evaluation Round under the Swadeshi Microprocessor Challenge conducted jointly by MeiTy and Maker Village Incubator on 5 August 2021.

6. Mr Sarath S Nair gave a lecture on “Electrical Properties of Tissues” to students of Touch Lab, IIT Madras on 2 July 2021.
7. Sri D S Nagesh attended Brainstorming Meeting on “Addressing COVID Resurgence - S&T Perspective” organised by TIFAC, New Delhi, on 10 May 2021.

### DIVISION OF MEDICAL INSTRUMENTATION

The Division's s core activities focus on the development of active implants like deep brain stimulators, cardiac defibrillators, spinal cord stimulators and various kinds of sensors and electrodes such us subdural and depth electrodes. The Division is equipped with basic facilities required for research and development in medical instrumentation and its activities.

### Developmental Activities

#### 1. *Deep Brain Stimulator System for Movement Disorders*

Deep brain stimulation (DBS) involves implanting electrodes within certain areas of brain to treat a number of neurological conditions, such as essential tremor, Parkinson's disease and dystonia. This project was being executed with Bhabha Atomic Research Centre as partner. The first sets of prototypes were being evaluated for safety and performance (Figure 44).

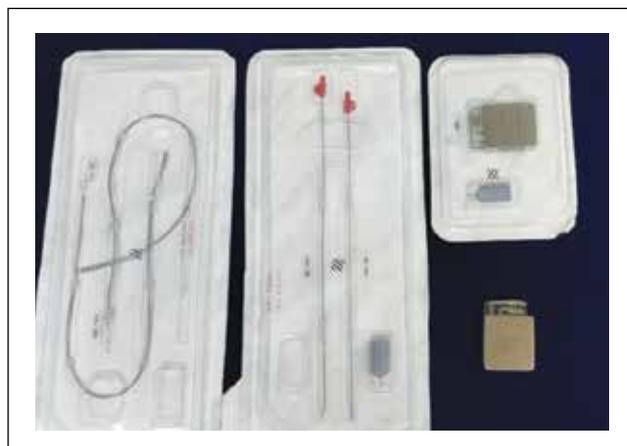


Figure 44. First prototype of DBS system



## 2. *Automated Implantable Cardioverter Defibrillator*

Implantable cardioverter defibrillator is an active medical electronic device used to revive a patient from life threatening arrhythmias. The automated implantable cardioverter defibrillator will automatically sense and classifies the arrhythmia into shockable or non-shockable. On detecting a shockable arrhythmia, the device generates a high voltage and delivers a shock to the cardiac muscles to bring the heart back to normal rhythm. This project was being executed with M/s Shree Pacetronix Ltd., Indore as partner. Development of arrhythmia detection algorithm and high voltage circuits was completed.

## 3. *Intra Cranial Electrode*

Intracranial electrodes are used during large craniotomies for localising the seizure-generating zones in brain. Production of final prototypes was completed and preclinical animal evaluation was ongoing.

## 4. *Automated External Defibrillator*

Automated external defibrillator (AED) is used to prevent sudden cardiac death. The device automatically senses the cardiac signals and detects whether there is a life threatening arrhythmia. Subsequently, the high voltage circuit incorporated in the device charges a capacitor to high voltage levels. This stored energy is then discharged in to the patients heart to bring back the normal sinus rhythm. AEDs are normally placed in public places like airports, railway stations, ambulances etc. Design and hardware development of high voltage charging / discharging circuits were completed. Technology transfer process was initiated.

## 5. *Spinal Cord Stimulator*

Spinal cord stimulation (SCS) therapy employs a small device, similar to a pacemaker, delivers electrical pulses to the spinal cord for helping people better manage their chronic pain and reduce their use of opioid medications. Spinal cord stimulators allow patients to send the

electrical impulses using a remote control when they feel pain. Both the remote control and its antenna are placed outside the body.

### **Technology Transfer Activities**

The technology for External Pneumatic Compression Equipment was transferred to M/s Enproducts Ltd., Kochi. The device was undergoing scaling up and evaluation by the industry.

### **Research Programmes**

Research on a novel signal steering strategy for implantable electrodes along with feedback control of stimulation signal for the deep brain stimulation system was initiated.

### **Training/Outreach Programmes**

Mr Jithin Krishnan delivered a talk at the International Level FDP on “Emerging techniques in Biomedical Instrumentation” organised by the Department of ECE, K L University, Vijayawada, Andhra Pradesh. The event was held from 28 July 2021 to 3 July 2021.

## **DIVISION OF POLYMERIC MEDICAL DEVICES**

The Division focuses on the development of new polymers, polymeric formulations, composites and devices suitable for different biomedical applications. The laboratory is equipped with facilities for compounding/mixing, moulding, electrospinning and parylene coating. Facilities for static mechanical testing, dynamic mechanical analysis of polymeric materials and polymer synthesis are available.

### **Developmental Activities**

#### **1. *Short coir fibre-reinforced biodegradable composites for orthotic assist devices***

This project, started in collaboration with Tata Steel Ltd., aims to develop an orthotic wrist support device from environmentally-friendly polymeric composite material comprising of natural short coir fibre reinforcements and biodegradable polymer matrix (Figure 45). These alternative materials are expected to have



mechanical properties at par with conventional non-degradable engineering plastics, and are biodegradable at the end of their life cycle thus



Figure 45. Development of orthotic assist device

contributing to sustainable development.

## 2. Parylene coating for medical devices

The Parylene-C coating was successfully carried out on metal and polymer samples. The process for coating Parylene-C over ultrahigh molecular polyethylene sample was optimised and the toxicological evaluation of the same was completed.

## 3. Development and evaluation of dura substitute

The histopathology evaluation of the retrieved samples of electrospun polycarbonate urethane dura substitute from rabbits after six months of implantation was completed and the results were promising.

## 4. Development of radiopaque liquid embolic agent

In this TRC-funded project, an injectable radiopaque liquid embolic composition free of metal particles was developed. The device was intended to use for the treatment of arteriovenous malformations in brain. Toxicokinetic studies

of the material were conducted successfully. Preclinical evaluation of the device was performed in a pig model by injecting the liquid embolic agent into its rete mirabile and tested for radiopacity, injectability and flow behavior under fluoroscopic conditions. The implantation period was 3 months. The performance of the material was evaluated by comparing with a commercial device as control. Overall performance of the material was found to be comparable with the control. Samples were retrieved after sacrificing the animal and evaluated histologically. The overall results were promising. Technology transfer activities were also initiated.

## 5. Development of radiopaque polymeric microspheres for embolization therapy

This was another TRC-funded programme initiated with the objective of developing polymeric radiopaque microspheres for embolizing arteries. Since mild toxicity was observed for the initially developed compositions, process steps were modified and the resultant material composition was tested for their properties such as radiopacity and cytotoxicity. The programme was continuing as PhD work.

## 6. Design and fabrication of a head phantom for the dosimetric evaluation of radiotherapy treatment plans

This is a collaborative programme between Regional Cancer Centre, Trivandrum and SCTIMST. The programme was funded by Kerala State Council for Science Technology and Environment. As the outcome of this project a polymer composite formulation with better computed tomography number than the commercially available phantom was developed. The production process was scaled up to a semi-industrial scale at CIPET Kochi and the samples produced were tested at RCC with promising results.

## New initiatives

1. SCTIMST signed MoU with M/s VST IOT Solutions Pvt Ltd., on 13 September 2021, for the joint development of antimicrobial coatings. These coatings, when applied on material surfaces

are expected to offer enhanced protection from bacteria and viruses.

- MoU was signed with M/s Tata Steel Ltd. on 14 February 2022 for collaborative research on: a) Developing process parameters for controlling the length and surface treatment of coir fibres to enhance interfacial adhesion of coir and polylactic acid polymer for improved mechanical properties; and b) Prototyping the orthotic support device from coir-PLA composite. Dr Ajith Kumar V K, Director, SCTIMST and Dr Debashish Bhattacharjee, Vice-President, Technology and New Materials Business, signed the MoU. Technology Transfer Activities Notified the Expression of Interest to transfer the technology of liquid embolic device in the media and discussions were ongoing with interested industrial partners.

### Research Programmes

#### 1. Alginate-based injectable hydrogel scaffold for meniscal repair

In this research programme, an injectable hydrogel system, based on oxidized alginate and gelatin (with and without platelet rich plasma (PRP) was formulated for the repair of meniscal tears that occur among athletes. A series of gel forming compositions were developed and tested for their physicochemical properties, gelation behaviour and cell-material interactions in vitro. A selected formulation was injected into meniscal tear created in rabbit model and evaluated for its performance in vivo. In vivo implantation of hydrogel in the meniscal tear of rabbits showed good healing. Histology showed good integration of hydrogel with the surrounding meniscal tissue. When PRP incorporated hydrogel was injected, better cellular infiltration into the torn area was observed and the regenerated tissue was found to be similar to the native meniscal tissue.

#### 2. Gallium-curcumin nanoparticle conjugate for fighting antibiotic resistance

In this programme, gallium-curcumin nanoparticle (GaCurNP) conjugate was developed as a prospective candidate to fight

*P. aeruginosa*. The synthesised GaCurNPs were analyzed spectroscopically to deduce the nature of interaction between gallium and curcumin. The conjugate formation with gallium was found to improve the stability of curcumin at the physiological pH. The minimum inhibitory concentration (MIC) of GaCurNPs was found to be  $82.75 \mu\text{g/mL}$  for *P. aeruginosa* (ATCC 27853). GaCurNPs exhibited excellent biofilm inhibition at 4MIC concentration. GaCurNPs were found to be capable of disrupting the cell membrane integrity, membrane lysis and cell structure

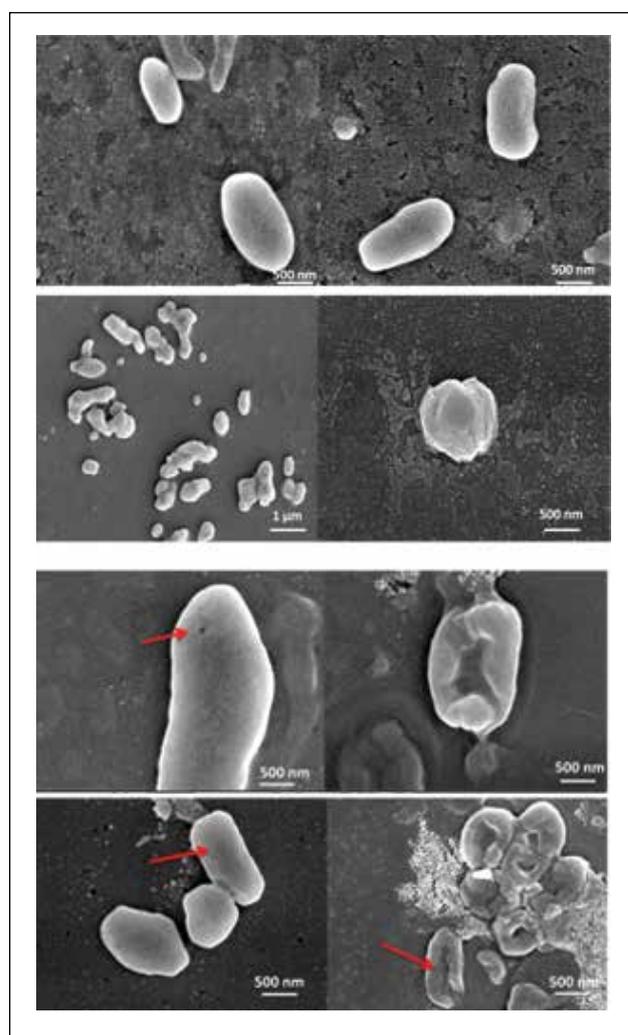


Figure 46. Scanning electron microscopy images of *Paeruginosa*: a) untreated b) treated with MIC of ciprofloxacin (control) for 3 hours c) treated with MIC of curcumin for 3 hours d) treated with MIC of GaCurNPs for 3 h



damage of *P. aeruginosa*, within 3 h of contact (Figure 46).

### 3. *Electrospun mucoadhesive fibroporous polymer membranes*

Electrospun zein membranes are suitable for various biomedical applications. Blending with poly ethylene oxide (PEO) improves the mechanical properties. Post-crosslinking of electrospun samples was done by UV irradiation to further improve mechanical property and water stability. The crosslinking in the UV-irradiated sample was attributed to the change in protein conformation from an  $\alpha$ -helix to a  $\beta$ -sheet. UV crosslinking caused breakage of disulfide bond in the end terminal of zein and released more thiol groups free for interaction. Thiol functional groups facilitated mucoadhesion via disulfide bond formation with the cysteine residues of mucin. Hence UV-crosslinked Zein/PEO is a promising candidate for mucoadhesive applications.

### 4. *Antimicrobial spray coatings*

This project, in collaboration with M/s VST IOT Solutions Pvt. Ltd., aims to develop an antimicrobial spray coating that can be applied onto surfaces. The spray coating leaves a thin film of alkylated bronsted-acid type surfactant molecules on surfaces with anti-microbial properties. Preliminary results showed that the surfactant films spray-coated on mineral glass showed 6-log reduction of bacterial activity on the surface.

### Testing and Evaluation

The Division is equipped with polymer processing and testing facilities. The processing facilities available are: polymer compounding, microinjection moulding, compression moulding, parylene coating and electrospinning. Testing facilities include: mechanical testing using universal testing machine, dynamic mechanical analysis, impact testing and falling-ball micro-viscometer among others. These facilities were

extended to internal and external customers for their material processing and characterisation.

### Mechanical testing of acrylic view port of Indian Navy

The Division received inquiries from Indian Navy to test mechanical properties of Acrylic View Port. Regarding this, Vice Admiral A K Chawla, Naval Base, Kochi, visited the Division on 17 June 2021 (Figure 47) and later sent Acrylic View Port sample from Diving School, Naval Base, INS Venduruthy, Kochi. ISO test specimens, tensile (ISO 527-2) and flexural (ISO 178), were machined from the view port



Figure 47. Officers of Indian Navy visiting the Division

sample and evaluated for its mechanical properties on the universal testing machine. Detailed test report of the samples was submitted to the Indian Navy.

### Training/Outreach Programmes

#### 1. *DST-SCTIMST summer training for SC and ST students*

Summer training was offered to students belonging to SC and ST communities who are studying or completed +2/UG/PG courses. Duration of the training was up to two months. They were offered scholarship from project funds received from the Scheduled Class Sub Plan (SCSP) and Tribal Sub Plan (TSP) schemes of SEED Division, DST. About 25 students were trained during the year in batches (Figure 48).

#### 2. *Chitrajalakam 2022*

Organized a one-day lab visit to 42 SC/ST girl students studying at Dr Ambedkar Model Residential School, Kattela, Trivandrum on 13-14 January 2022. Each batch had 21 students and

on 21 July 2021 and Cdr Varghese P George from Head Quarters Southern Naval Command, Indian Navy visited the Division on 24 August 2021.

### Awards and Honours

1. Dr Gijo Raj, Scientist C, received the “Programme Coordinator s Award” (Figure 49)



Figure 48. DST-SCTIMST summer training for SC and ST students

their teachers. Financial support was provided for their travel, snacks, lunch and welcome pack from the projects. The programme was called Chitrajalakam 2022.

3. Lt CMDR Ashish Daultani from Southern Naval Command of Indian Navy visited the Division



Figure 49. Dr Gijo Raj receiving the Programme Co-ordinator's Award

during the 20th Foundation Training Programme for Scientists and Technologists, Government of India from 6 December 2021 to 28 January 2022 held at the Indian Institute of Public Administration, New Delhi.



Figure 50. Team SCTIMST at MaterialNext 2021



- Team SCTIMST emerged as Pre-finalist in the MaterialNext 2021 (Figure 50), National level Innovation Challenge organized by Tata Steel Limited on 25 June 2021.

## DIVISION OF PRECISION FABRICATION

This Division provides the service support to the scientific/technical labs of the Institute in fabricating dies, jigs, fixtures and machining of prototype components. These services were provided to various projects by utilizing the CNC and conventional machines available in the Division with a mission to deliver high precision fabrication work for the research programmes of the Institute. Precisely fabricated ferrous, non-ferrous and polymeric components were delivered to various research and TRC projects of the Institute.

Major support was provided for the TRC Projects like paracorporeal left ventricular assist device, bioprosthetic heart valve, micro infusion pump and intracranial electrodes among others.

From the Division of Precision Fabrication, nearly 101 work orders (72 major work orders and 29 minor work orders) related to fabrication, machining of test setups and prototypes were executed and delivered to various projects during the year 2021-22.

### New Initiatives

5-Axis CNC Milling Machine (Mikron-Mill S 400U) from GF Machining Solutions, Switzerland was



Figure 51. 5-Axis CNC Milling Machine

installed and commissioned in the Division (Figure 51). This machine is utilised for machining intricate shapes/prototypes from ferrous, non-ferrous and polymeric materials.



Figure 52. Completed the fabrication of aluminium bearing holder for the Division of Dental Products, Ti CP-2 IIP CAM bottoms, CAM top covers, rollers and needle stoppers for the TRC project P8138 of ECD Lab and Four point-bending fixture for the TRC Project 8221 of AIO lab.



Figure 53. Completed the machining of Ti CP-2 top thrust magnet holders and Ti CP-2 magnet holder caps for the pLVAD project P8123 of ECD Lab, SS ASD occluder shaping mould for the TRC project 8150 of AIO Lab and Delrin and Brass spacers for the ball screw mechanism of Raman confocal microscope for the TDF project 6244 of CAF Lab.



Figure 54. Completed the machining of Pushability test setup for ASG Delivery system, for the TRC project 8124 of AIO Lab

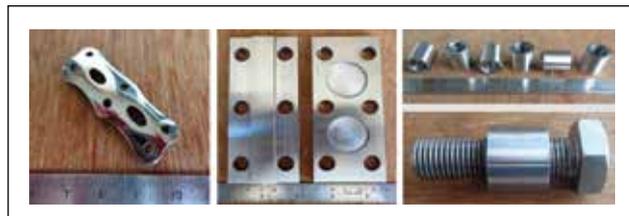


Figure 55. Completed the machining of Ti 6Al-4V implant prototype and SS stress relief fixture for the TRC project 8221 of AIO Lab



Figure 56. Completed the machining of acrylic test samples (ISO 527 & ISO 178) for PMD and SS tensile grips for the TDF project 6244 of CAF



Figure 57. Completed the machining of polycarbonate annuloplasty ring holders and SS marker fixtures - sizes 24, 26 and 28 for the TRC Project 8128 of AIO Lab



Figure 58. Completed the machining of pLVAD impeller for the TRC Project 8123 of ECD Lab, SS mould for cell culture activities for the TDF Project 8198 of DEP Lab, SS contact strip mould for the TRC project 8132 of MEI Lab



Figure 59. Completed the fabrication of Ti-6Al-4V IIP bottom casings, Delrin IIP Bottom casings and Delrin IIP Tube connectors for the TRC Project 8138 of ECD Lab.



Figure 60. Completed the fabrication of Pusher System for the TRC Project 8150 of AIO Lab, Polypropylene LVDT clamp and Polycarbonate LVDT support disc for the TRC Project 8221 of AIO Lab.

## Service Activities

Some of the service activities carried out during 2021-22 are shown below (Figures 52-60) :

### Staff

#### Faculty

Dr Roy Joseph, Scientist G and Head of the Department

Mr Muraleedharan C V, Scientist G (Senior Grade)

Mr D S Nagesh, Scientist G (Senior Grade)

Dr P Ramesh, Scientist G

Mr Vinodkumar V, Engineer G

Dr Sujesh Sreedharan, Engineer G

Mr Ranjith G, Engineer F

Mr Sarath S Nair, Engineer F

Dr Manoj G, Scientist E

Dr Sivakumar K G V, Engineer E

Mr Sarath G, Engineer D

Mr Jithin Krishnan, Engineer C

Dr Gijo Raj, Scientist C

Mr Anoop Gopinathan, Engineer C

Mr Subhash N N, Engineer C

Mr Arvind Kumar Prajapati, Engineer C

Dr Chhavi Gupta, Engineer C

Mr Saurabh S Nair, Engineer C

Ms Amrutha C, Engineer C

Ms Neethu S, Engineer B

#### Technical

Mr Rajeev A, Senior Scientific Assistant

Ms Jasmin Joseph, Scientific Assistant - A

Mr Subhash Kumar M S, Technical Assistant - B

Ms Sreedevi V, Technical Assistant - B

Mr Biju Benjamin, Technical Assistant - B

Mr Prathyush M, Foreman (Tool Room)

Mr Reji Kumar S, Technical Assistant - A

Dr M Chandra Shekhar Nayak, Technical Assistant - A

Mr Jiji Kumar R S, Junior Technical Assistant - A

Mr Vijesh S S, Junior Technical Assistant - A

Mr Sinulal M V, Junior Technical Assistant - A



# DEPARTMENT OF TECHNOLOGY AND QUALITY MANAGEMENT

The Department of Technology and Quality Management (DTQM) co-ordinates transfer of technology, intellectual property management of various projects, management of quality system activities and accreditation (COFRAC, France for testing and NABL, India for calibrations), network/communication systems and engineering services in the BMT Wing Campus. Construction Wing organises major civil /construction activities for the Campus. DTQM also includes Central Analytical Facility for characterisation of medical devices and materials and an NABL- accredited Calibration Facility.

The following Divisions are included in the Department:

1. Calibration Cell
2. Central Analytical Facility
3. Engineering Services including
  - Network services
  - Electrical Maintenance
  - Water supply
  - Air-conditioning (MRAC)
4. Technology Business Division including
  - Intellectual Property Cell
  - Customer Service Cell
5. Quality Cell

## CALIBRATION CELL

Calibration Cell (CAC) is an in-house Facility to maintain traceability of measurement in reporting results at SCTIMST. Relevant calibration procedures are accredited by National Accreditation Board for Test and Calibrations (NABL). Measurement results are being made traceable to the SI units either through calibrations or with the use of Reference Materials (RM). CAC supports the testing labs in implementing quality control measures such as Inter-laboratory comparison and uncertainty estimation. CAC

executes system validations for external customers on payment basis. Calibration Cell is committed to establish traceability of measurement results with the use of reference standards traceable to national/international standards to satisfy the requirements of accreditation bodies.

## Developmental Activities

### *Preparation and standardization of reference materials for biological evaluations*

The increasing demand for safe medical devices has led to the inevitable need for preclinical evaluation of the biomaterials and medical devices prior to the regulatory approval. Traceability by accredited calibrations using reference standards cannot be achieved for qualitative characteristics, especially for biological evaluations based on ISO 10993 standards. In such cases, use of reference material (RM) has become an essential tool. Indigenous development of ready-to-use RMs can ensure the availability of RM in a cost-effective manner in the country. A batch of 1000 numbers was prepared and used in the preclinical evaluation of products developed under Technical Research Centre Funding Scheme.

## Research Programmes

Study projects were initiated with the following partners during the year:

1. M/s TTK Healthcare Ltd.
2. M/s Government Analysts Lab, Thiruvananthapuram

## Testing and Evaluation

Mechanical, thermal and electro-technical calibrations carried out by Calibration Cell are accredited by NABL, India as per ISO 17025:2017. Mechanical calibration includes calibration of volumetric glassware, micropipettes, electronic balances, mass sets and rotational speed. Calibration of relative humidity monitors, thermometers and temperature chambers like incubators are included





in thermal calibrations. Summary of calibrations and measurements performed during the year are summarized in the Table below:

Parameter	Number
Calibrations	571
Surface profile Measurements	153

### CENTRAL ANALYTICAL FACILITY

Central Analytical Facility (CAF) is the analytical service division of BMT Wing equipped with facilities to carry out physicochemical evaluation of biomaterials and biomedical devices. CAF is equipped with analytical instruments such as FT-IR spectrophotometer, UV-Visible spectrophotometer, Spectrofluorometer, Thermogravimetric analyser, Differential scanning calorimeter, High Performance Liquid Chromatograph, Gel permeation chromatograph, Gas Chromatograph, Confocal Raman microscope, Textural analyser, Luminescent image analyzer, Universal Testing Machine among others. In addition to the test services offered to customers, the Division supports various projects of the institute by providing technical advice and guidance wherever needed. It also undertakes study mode projects sponsored by external and internal customers for the physicochemical characterisation of biomedical devices or materials. CAF assists M Tech and PhD students in their lab modules or internships. The Division also organizes technical sessions and supports academic activities of the institute by giving lab demonstrations to students and personnel from industry.

In CAF, the testing activities are carried out under the quality management system as per the guidelines of ISO 17025. The Lab maintains quality, confidentiality and impartiality in all of its testing activities. CAF is capable of performing most of the physicochemical analyses of materials outlined in the international standards for material evaluation. It is the only Test Service Facility in Kerala accredited by NABL for conducting residual ethylene oxide analysis of biomedical devices and materials. CAF also offers NABL-accredited test reports on the thermal analysis of materials. These tests are compositional analysis using thermogravimetry, determination of glass transition temperature, and enthalpies of fusion and

crystallization using differential scanning calorimetry. Onsite assessment of the Lab by NABL assessors was completed in January 2022 and the accreditation was extended up to January 2023.

### New Initiatives

- The following mechanical tests were introduced in line with International standards:
- Determination of tensile strength and elongation of non-woven fabrics (EN 29073-3)
- Determination of Tear resistance of non-woven fabrics (trapezoidal method) (EN 9073-4)
- Tearing Strength of Fabrics by the Tongue (Single Rip) procedure (ASTM D2261)
- Water vapor transmission rate (ASTM E96)
- Determination of tensile strength and elongation of medical gloves for single use (EN 455-2).

These tests will be offered to the customers through Customer Service Cell (CSC) shortly.

### Research Programmes

In research, CAF focuses mainly on the development of analytical methods for the estimation of biologically relevant analytes. In addition CAF collaborates with other Divisions in their research programmes and provides analytical support in characterising their materials.

### *Development of tests for personal protective equipment*

A TDF Project entitled “Augmentation of Central Analytical Facility with tests on personal protective equipment for medical use” was nearing completion. The primary aim of the project was to design, develop and validate test methods for the quality evaluation of personal protective equipment (PPE) according to relevant international standards. As part of the project, an apparatus, Chitra Liquid Penetration Tester (Figure 61) was developed for the synthetic blood penetration test of PPE in line with international standards (ASTM F1670).





Figure 61. Chitra Liquid Penetration Tester for synthetic blood penetration test.

### Testing and Evaluation

- During the year 2021-22, six new tests using the Force Tensiometer (KSV instruments) were offered to the customers through CSC:
  - Surface tension of liquids (Du Nouy ring method or Wilhelmy plate method as per ASTM D1331)
  - Interfacial tension of liquids (Du Nouy ring method or Wilhelmy plate method as per ASTM D1331)
  - Dynamic contact angle of solids
  - Critical Micelle Concentration of surfactants (surface tension method)
  - Wettability and contact angle of powders
  - Surface free energy of solids
- About 1444 samples submitted by external and internal customers with or without work orders were analysed at the CAF using various instruments available.
- NABL accreditation for performing three physicochemical tests was extended up to January 2023 after onsite assessment by NABL. These tests were: (a) Estimation of residual ethylene oxide (EtO) in EtO sterilized materials, (b) Compositional analysis of materials using Thermogravimetric analysis, and (c) Determination of glass transition temperature and enthalpies of fusion and crystallization of materials using differential scanning calorimetry.

### Training/Outreach Programmes

Dr Renjith S conducted science quiz as part of the “Azadi Ka Amruth Mahotsav” programme organized by SCTIMST to commemorate the 75th anniversary of Indian independence in July and August 2021.

### Events Organized

Dr Roy Joseph (Chairman, Organizing Committee), Dr Renjith S (Convener) and Mr Willi Paul (Member) were involved in the organization of International Conference on Polymeric Materials in Medicine (ICPMM 2022), held virtually during 25-26 February 2022. The conference was organized jointly by SCTIMST and Society for Polymer Science India (SPSI) Thiruvananthapuram Chapter.

### ENGINEERING SERVICES

The Division is dedicated to deliver technical support for general maintenance of equipment and environment at various facilities and the management of utilities in the Campus. The Division is looking after power supply, information technology connectivity, water supply, maintenance of waste incinerator, and sewage systems. Electrical service maintains the 11 kV supply system and the diesel generator for power backup.

#### The major installations completed were:

- Installed new IP-PBX telephone exchange
- Augmentation of network connectivity from MSV server room to Reception building
- Commissioned a HVAC system for Small Animal Facility at DLAS. Environmental conditions are controlled in the Facility as per ILAR guidelines.
- Installed a new biogas plant at canteen premises.
- Installed sanitary napkin incinerator at three locations of BMT Wing Campus as part of Swachhta Pakwada celebrations.

### TECHNOLOGY BUSINESS DIVISION

The Technology Business Division (TBD) incorporates Customer Service Cell and Intellectual Property Rights Cell.



TBD focuses on the following activities of the Institute:

- Institute-industry interactions related to technology transfer and research project collaborations.
- Intellectual Property Rights of the Institute like patent, design and trademark registration.
- Testing services and specific protocol-based study requests from the industry and academia for medical devices and biomaterials.
- Training, problem solving and consultancy activities of the Institute through the Industry-Institute Partnership Cell
- Internal research project funding of the Institute comprising Technology Development Fund Scheme, internal review of the project applications and interim status reviews of projects.
- Reports/questions for submission to external agencies such as DST, DSIR, ICMR on the activities of Institute
- Outreach Programmes: giving exposure to students from different institutions across India at the institute and outside on development of medical devices.
- Clinician discussions on the future projects and under development

### Technology Transfer Activities

#### 1. *Expression of Interest*

Expression of Interest was invited for the following products during the year:

- Multiplex RT-PCR kit
- Radiopaque Liquid Embolization Device
- Implantable Micro Infusion Pump
- Bioink for 3D Bioprinting
- Automatic Smart Trash Bin for Disinfection using UV-Enabled Microwave (Astra).

#### 2. *Technology Transfer Committee*

In relation to the activities related to the technology transfer the Technology Transfer

Committee Meetings were held 5 times in April, July and November 2021 and January and February 2022.

#### 3. *Technology Transfer*

- Technology Transfer Agreements for multiplex RT-PCR kit were signed with the technology partners: M/s Huwel Lifesciences, Hyderabad, on 14 May 2021 and M/s Meril Diagnostics Pvt. Ltd., Gujarat, on 21 May 2021.
- Technology Transfer Agreement was signed with Kerala State Electronics Development Corporation (Keltron) on 27 October 2021 for the technology transfer of infant warming wrapper and bassinet.

#### 4. *Collaborative Product Development*

- MoU signed with M/s VST IOT Solutions Pvt. Ltd., Kochi on 13 September 2021 for the collaborative development of antimicrobial coating for applying on surface for enhanced protection from bacteria and viruses. The project was partly funded by the company.
- A research agreement with Tata Steel Limited was signed on 14 February 2022 for collaboration on the development of "Biodegradable orthotic wrist support device from short coir fibre reinforced polylactic acid biocomposite".
- A MoU was signed on 31 March 2022 with M/s Phraction Scientifics Pvt. Ltd. for the joint development of platelet concentrator and aggregator. Phraction was awarded funding under the Biotechnology Ignition Grant Scheme of BIRAC for the development.

#### 5. *Non-Disclosure Agreement*

A Non-Disclosure Agreement was signed with the Central Manufacturing Technology on 6 September 2021 for the feasibility of development of scalable technology for the fabrication of polymeric micro-devices for biomedical applications.

#### 6. *Product Launch*

The product launch of Chitra SARS CoV2



Multiplex COVID19 detection RT-PCR kit was held on 17 August 2021 via online mode (Figure 62). The technology developed by SCTIMST was approved by ICMR and transferred to M/s Huwel Lifesciences, Hyderabad, and now it is ready for commercial sale. The product was launched by Dr V K Saraswat, Hon ble President, SCTIMST and Member NITI Aayog. Messages from Dr Ashutosh Sharma, Secretary, DST and Smt Veena George, Hon'ble Minister for Health and Woman and Child Development, Government of Kerala were conveyed on the occasion. Dr Rachana Tripathi, Founder Director and CEO, Huwel Lifesciences also spoke on behalf of the company. Dr V K Ajit Kumar, Director, SCTIMST, Dr Harikrishna Varma, Head, BMT Wing, Dr Anoopkumar T, Scientist G, Division of Molecular Medicine and Mr Balram S, Scientist G, Technology Business Division, were present at the event.



Figure 62. Product launch of Chitra SARS CoV2 multiplex COVID-19 detection RT-PCR kit

### INTELLECTUAL PROPERTY RIGHTS CELL

#### Details of the Patents

Total number of patents granted (India)	18
Total number of patents filed (India)	16
Total number of patents granted (Foreign)	01
Total number of patents filed (Foreign)	09

### CUSTOMER SERVICE CELL

Customer Service Cell co-ordinates the internal and external testing services and also study projects for the evaluation of medical devices and biomaterials. The summary of the testing services is as follows:

Description	External			Internal		
	2019-2020	2020-2021	2021-2022	2019-2020	2020-2021	2021-2022
No. of work orders	565	679	433	374	288	270
No. of test materials	978	1062	983	1030	1275	1290
Income (Rs)	4304180	5116440	4518429	2973300	3290800	4149780

### INDUSTRY INSTITUTE PARTNERSHIP CELL

#### Training/Outreach Programmes

Industry-Institute Partnership Cell conducted the following workshops/programmes during the year:

1. A Workshop on “An Insight into Analytical Instruments for Research” was conducted on 16-17 September 2021.
2. Workshop on “Indian Medical Device Regulation” conducted on 10-11 February 2022 had around 60 participants from the medical device industry. The speakers were from the DCGI, industry and the institute. The inaugural session was by Dr Ravikant Sharma, Deputy Drugs Controller of India.



Figure 63. SCTIMST at India International Science Festival

3. Sensitization Program on Science, Technology and Innovation conducted for school teachers on 19 February 2022.

### India International Science Festival

SCTIMST participated in the 7th edition of the four-day India International Science Festival (IISF) held in Panaji, Goa, from 10 to 13 December 2021 (Figure 63). The festival theme was “Celebrating Creativity in Science, Technology and Innovation for Prosperous India”. The festival was organised jointly by Departments of Atomic Energy (DAE), Science and Technology (DST), Biotechnology (DBT), and Space (DoS) and the Council for Scientific and Industrial Research (CSIR).

### QUALITY CELL

Activities of Quality Cell include the implementation, maintenance and continual improvement of Quality Management System (QMS). This includes, but not limited to ensuring that the facilities, equipment, personnel, methods, practices, records and its control are in conformance to the requirements of international standards.

Quality Cell is involved in supporting all testing and calibration laboratories as well as the auxiliary support services/sections in maintaining the Quality Management System.

Major activities of the Quality Cell during the year were:

#### 1. COFRAC surveillance assessment

The surveillance assessment of COFRAC, the external accreditation service provider for testing services based on ISO/IEC 17025:2017 was conducted online on 8-9 December 2021. The current accreditation is valid till 31 May 2023.

#### 2. National Accreditation Board for Testing and Calibration Laboratories (NABL) assessment:

- NABL assessment for accreditation of testing facility at Central Analytical Facility was conducted online on 22-23 January 2022. The accreditation is valid till 3 January 2023.

- NABL Desktop surveillance for Calibration Cell was done during December 2021. NABL extended the accreditation in accordance with ISO/IEC 17025:2017 as per the existing scope in the disciplines of Electrotechnical, Mechanical and Thermal Calibration till 13 February 2023.

#### 3. Management Reviews

- Management Review Committee meeting chaired by the Director was held on 6 January 2022.
- Two Technical Management Committee meetings chaired by Head BMT Wing were held on 14 July and 30 November 2021.

#### 4. Internal Audits

Two internal audits were carried out during the period. First internal audit (IABMT100.Y21) was conducted during August-October 2021 and the second (IABMT200.Y21) during November 2021. Corresponding post-audit meetings were completed.

#### 5. Documents initiated/revised

- A total of 34 system procedures, 111 work procedures and 3 guidelines were revised/issued to different laboratories under QMS.
- 41 corrective actions (CA) were generated by different laboratories. For 33, CA were verified and closed. For the others, corrective actions were ongoing.

#### 6. ISO 13485:2016 QMS implementation

An order constituting a committee for smooth implementation of the standard ISO 13485:2016 was issued on 4 October 2021 and the activity was ongoing.

#### 7. Trainings attended

- Three personnel attended Laboratory System and Internal Audit as per ISO/IEC 17025:2017 online training conducted by Quality Council of India on 29-30 April 2021.
- 7 personnel attended online training on “Estimation of uncertainty in engineering



and chemical measurements” conducted by Quality Forum on 20-22 January and 8-10 February 2022.

#### 8. CDSCO-Medical Device Testing Laboratory

For maintaining the registration, communications regarding change in personnel were intimated to Central Drugs Standard Control Organization on time with concurrence from the concerned Nodal Officer.

#### Training/Outreach Programmes

Competency Development Cell (CDC) conducted three training programmes during the year. All the training programmes were organized strictly in line with COVID guidelines. These include one induction training for the newly joined staff of BMT Wing and two other competency development training programs.

- CDC organized induction training for 29 newly joined staff on 9 April 2021. They were trained on topics related to quality management system, IP rights, administrative procedures of the institute, internet services, biosafety, chemical safety, electrical safety and fire safety.
- One-day Workshop on “Project proposal writing” on 28 July 2021. Er. Muraleedharan C V, Er. Nagesh D S., Er. Amrutha C, Dr Manoj Komath, Dr Sachin J Shenoy and Dr R S Jayasree were the resource persons for the programme. 47 participants attended this online training programme.
- CDC organized a half-day training programme on “Noting and drafting” on 13 October 2021. Adv Mohana Nadha Babu N (Former Additional Secretary to Government. of Kerala) was the resource person. Around 32 participants attended this training programme.

#### Staff

#### Faculty

Mr S Balram Scientist G and Head of the Department  
Dr Roy Joseph, Scientist G  
Dr Ramesh P, Scientist G, Quality Manager  
Mr Vinodkumar V, Engineer G, Deputy Quality Manager (Medical Devices)  
Ms Leena Joseph Engineer F, Deputy Quality Manager  
Dr Anugya Bhatt Scientist F, Deputy Quality Manager (GLP Studies)  
Ms Sandhya C G, Engineer F  
Mr Rajkrishna Rajan, Engineer F  
Dr Arun Anirudhan V Engineer D, Network Service Cell  
Mr Sajithlal M K, Engineer E, Network Service Cell  
Dr Renjith S, Scientist B

#### Technical

Dr Radhakumary C, Scientific Officer  
Mr Willi Paul, Scientific Officer  
Mr Arumugham V, Scientific Officer  
Mr Sreekanth S L, Senior Scientific Assistant  
Mr Rajesh R P, Senior Scientific Assistant  
Ms Nimi N, Scientific Assistant  
Dr Sasikala T S, Technical Assistant (Instruments) - A  
Mr Sajid A, Technical Assistant (Instruments) - A  
Ms Asha Rani V, Technical Assistant (Instruments) - B  
Mr Krishna Prasad K, Technical Assistant  
Mr Ranjith Kumar R, Technical Assistant  
Mr Erlan Benanson, Technical Assistant (Electrical) - A  
Mr Binu A U Technical Assistant (Network Service Cell)  
Mr Dilu P, Technical Assistant (Electrical) - A  
Mr Baiju S, Technical Assistant (Electrical) - A  
Mr Binu C P, Junior Engineer  
Mr Sabu K S, Junior Engineer  
Ms Deepa G K, Junior Engineer  
Mr Suresh N B, Junior Engineer  
Mr Sajimon B, Junior Technical Assistant (Electrical)  
Mr Manu M H, Junior Technical Assistant (Electrical)





**ACHUTHA MENON  
CENTRE FOR  
HEALTH SCIENCE  
STUDIES**

# ACHUTHA MENON CENTRE FOR HEALTH SCIENCE STUDIES

Achutha Menon Centre for Health Science Studies (AMCHSS) is engaged in teaching and training in health sciences especially in Public Health through a 2-year full-time Master of Public Health (MPH) course, one-year Diploma in Public Health (DPH) and PhD in Health Sciences (for both full-time and part-time students). AMCHSS also engages in research projects and consultancies funded by national and international agencies in non-communicable diseases, environmental health, tribal health and health systems. AMCHSS participates in several advisory committees in governmental and non-governmental agencies that are engaged in health-related research and policy formulation.

## Activities

### Research Activities

#### Newly-initiated Research Projects

1. *Team-based collaborative care model, facilitated by a mHealth enabled and trained nurse, for management of heart failure in India (TIME-HF) (PI: Dr Jeemon Panniyammakal, Funding Agency: Wellcome Trust-DBT-India Alliance)*

As part of TIME-HF, we propose a team-based collaborative care model (CCM), facilitated by a trained nurse to rationalise the management of heart failure (HF). The patient-centred approach proposed in our study may improve uptake of guideline- directed therapies, reduce hospital re-admissions and mortality. The specific aims are: Aim 1: To conduct stakeholder analyses to identify barriers and facilitators for implementing the CCM for HF management. Aim 2: To assess the effectiveness of the CCM in improving the number of days alive and out of hospital (DAOH) at two-year in comparison to 'usual care'. Aim 3: To inform the state-level scalability of the intervention model. The three

design approaches include: Aim 1, formative qualitative research; Aim 2, a cluster randomized controlled trial; and Aim 3, cost-effectiveness and evaluative qualitative research. We will use qualitative methods to develop the intervention strategy and understand acceptability, reach and impact of interventions. In the proposed cluster RCT, we will develop and test the effectiveness of a comprehensive intervention in 1200 adult HF patients at 20 units in India. Incremental Cost-Effectiveness Ratios (ICER) will be calculated from a health system and societal perspective. The project is likely to impact the practice of management of HF in low resource settings.

2. *Digital platforms for disease surveillance and control: Best practice case studies from Asia (DMgtAsia)(PI: Dr Biju Soman, Funding Agency: Norwegian Agency for International Corporation and Quality Enhancement in Higher Education)*

A collaborative project submitted by Dr Biju Soman, along with the Department of Informatics, University of Oslo (Norway), BITS Pilani (India), JNU (India), Korea Advanced Institute for Science and Technology (KAIST-Korea), Society for Health Information Systems Programs (HISP-India) and SHE-Health Education (SHE-UiO, Norway) was approved. Subsequently, a collaborative agreement was signed by the Director of SCTIMST with the Head of Informatics of Oslo University, Norway, on 5 November 2021.

3. *Transforming COVID-19 testing data into actionable evidence for public health decision-making using epidemiological, spatiotemporal, and data-science methods (PI: Dr Biju Soman, Funding Agency: ICMR)*





4. *Adapting surveillance (Nikshay) data to create decision support systems for tuberculosis elimination in Kerala using spatial epidemiology ((PI: Dr Biju Soman, Funding Agency: Central TB Division of the Ministry of Health and Family Welfare, Government of India)*

#### Ongoing Research Projects

1. *Scaling up interventions to improve the control of hypertension and diabetes in partnership with the governments of Kerala and Tamil Nadu: Leveraging India's national Non-Communicable Disease Program (PI: Dr Jeemon Panniyammakal, Funding Agency: National Health and Medical Research Council, Australia)*

This proposal will demonstrate, in the two Indian states of Kerala and Tamil Nadu, how low and middle-income countries can achieve reach, adoption and sustainability of primary care interventions to improve diabetes and hypertension outcomes. Our research will develop an evidence-based approach that better links and integrates prevention with disease management at both community and systems levels. Our approach will integrate with and strengthen both state governments current efforts by building the capacity of the existing health workforce and supporting health systems strengthening. Our findings will also inform decision makers about: (1) How to allocate resources to different implementation strategies; (2) How to market the strategies and to whom; and (3) How much value the strategies will provide (return on investment).

2. *Systems thinking approach to developing an integrated and patient-centred intervention model for multimorbidity care in primary care settings in India (PI: Dr Jeemon Panniyammakal, Funding Agency: Medical Research Council UK)*

This proposal will use a systems thinking approach and causal loop model to conceptualize how health systems manage patients with multi-

morbidity in primary health care settings in India. We will also look into ways in which the care for people with multiple chronic conditions can be organised and integrated within the community through community health workers.

3. *Understanding disease clustering (Multimorbidity) in the tribal population of Kerala (PI: Dr Jeemon Panniyammakal, Funding Agency: SCTIMST (Intra-mural), Government of India)*

In this proposal we will conduct a detailed assessment of multimorbidity at the individual and family level in disadvantaged tribal populations in Kerala.

4. *The long-term effects of a peer-led lifestyle intervention program on diabetes progression, multimorbidity, and cardiovascular risk: The Kerala Diabetes Prevention Program (PI: Dr Jeemon Panniyammakal, Funding Agency: National Health and Medical Research Council, Australia)*

The Kerala Diabetes Prevention Program (K-DPP) is one of the first peer-led structured lifestyle modification (SLM) programme for chronic disease prevention developed exclusively for people living in rural areas with limited resources and minimum additional support. The K-DPP model resulted in a non-significant reduction in diabetes incidence at 2-year of follow-up. The current study is proposed to evaluate the effectiveness of K-DPP in terms of 7-year diabetes and cardiovascular risk-related outcomes. The major objectives are as follows: (1) To understand the impact of a life style modification programme on cardiometabolic risk factors and preclinical changes in the microvasculature (retinal microvasculature and albumin-to-creatinine ratio), the reversibility of key CVD risk factors and the impact on predicted 10-year CVD risk, using the recently developed risk equation for Indians, Globorisk, (2) To undertake economic analysis to justify investments in CVD and related chronic prevention programmes and (3) To measure community engagement and programme sustainability of KDPP.





**5. A worksite-based lifestyle program for reducing diabetes and cardiovascular disease in India (Lead Investigator: Dr Jeemon Panniyammakal, Funding Agency: National Heart Lung and Blood Institute, USA)**

In this project, we will implement and evaluate the acceptability, delivery, effectiveness and cost-effectiveness of a worksite-based lifestyle improvement package in India. The study aims are: Aim 1: To measure the success of implementation and inform the scalability of this intervention program by evaluating: (a) program adoption by assessing participation and changes in weight and diet and physical activity behaviors among lifestyle class participants (b) fidelity to the programme by assessing activities of study-affiliated worksite staff; changes to the food options at the worksite canteen; management support for the programme; and changes in the worksite environment and (c) acceptability of the programme. Aim 2: To measure the effectiveness of the programme among participants by evaluating the change in number of individuals reaching two or more of cardiometabolic risk goals, namely reductions in blood pressure, triglycerides and HbA1c (the primary outcome), and through changes in secondary outcomes including rates of diabetes incidence and regression to normoglycemia. Aim 3: To measure the value and return on investment of the intervention for employers by assessing programme cost and cost-effectiveness and changes in staff productivity, absenteeism, health status and quality of life.

**6. A family based randomized controlled trial of cardiovascular risk reduction in individuals with family history of premature coronary heart disease in India (PI: Dr Jeemon Panniyammakal, Funding Agency: DBT-Wellcome Trust India Alliance)**

In this proposal, we used mixed methods (qualitative research, randomized control trial and cost-effectiveness) to integrate cardiovascular risk management in families with positive history of premature CHD. We assessed the effectiveness

of an integrated cardiovascular risk management strategy (consisting of screening for risk factors, lifestyle education and linkage to primary care for cardiovascular risk factor management) on risk factor clustering in families, and changes in blood pressure, lipids, glucose, smoking and physical activity. This study demonstrated that a family-based approach can make the adoption of cardiovascular health promotion interventions easier in high-risk families. The reduction of total cardiovascular risk observed after the intervention could have significant public health impact in preventing future cardiovascular events. The impact of the intervention need to be considered in the context of 1.5 million annual deaths due to CHD in India. It has been estimated that the benefits accumulated from this novel model will have the capacity to prevent approximately 2,00,000 deaths annually from coronary heart disease in India if expanded as part of the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke.

**7. Primary health care preparedness and LSGI response in the context of COVID-19 in Kerala (PI: Dr Mala Ramanathan, in collaboration with Kerala Institute for Local Administration, Thrissur and Centre for Migration in Development, Kochi)**

A collaborative documentation of experiences of LSGIs in terms of implementing the various responsibilities with respect to prevention, health promotion and mitigation of distress within their communities and informational environment in which it happened.

**8. Provision and promotion of spacing methods under Family Planning Program in Bihar (Co-PI: Dr Mala Ramanathan)**

The project was started in collaboration with Prof. William Joe, Institute of Economic Growth, Delhi, with funding from the Institute of Economic Growth.

**9. Delineating the role of DNA methylation in insulin resistance driven breast cancer**



***development and progression (PI: Dr Srikant A, Funding Agency: DBT)***

The standardization of cell culture methods and developing cell culture medium for insulin resistance was initiated. We have completed standardization of conditions for developing insulin resistance in mammary epithelial cell line MCF10A and are currently working to standardize insulin resistance development in breast cancer cell lines ZR-75 and BT-474. In parallel, we have developed the standard operating processes to collect samples from patients, isolate nucleic acid and store them. The study was approved by the Institute Review Board of the Regional Cancer Centre (RCC), Trivandrum. A MoU was signed between RCC, Trivandrum and SCTIMST to facilitate the sample collection.

10. ***Triaging high-risk HPV-positive women for cervical cancer screening in tribal populations from Kerala: A feasibility study (PI: Dr Srikant A)***
11. ***Documenting cause of death among tribal population through automated verbal autopsy using Information and Communication Technology (PI: Dr Jissa V T, Funding Agency: DST Tribal Component Plan)***
12. ***Social, Economic and Health Impact of Industrial Pollution in Dindigul District, Tamil Nadu (PI: Dr Srinivasan Kannan, Funding Agency: Indian Council of Social Science Research, Ministry of Human Resource Development, Government of India)***

This study is on the impact of industrialization on the rural environment and population health. The objectives of the study are: (1) Study water contamination caused by the tannery pollution and its effects on health, environment and society in Dindigul District. Specifically, the study will focus on the following: (1) Effects on livestock, agriculture, water and soil, (2) Long-term consequences of industrial pollution on the rural environment in terms of social structure, the land owning and other economic wellbeing in the surrounding areas of tanneries.

(3) Specific consequences such as illnesses, deaths and other events in the villages. It is a cross-sectional study conducted using both quantitative and qualitative methods from the villages surrounding the tanneries in Dindigul.

### **New Initiatives**

1. A MoU was signed between SCTIMST and Health Systems Transformation Platform for faculty collaboration in teaching programmes for the HSTP India Programme (PI: Dr Rakhal Gaitonde).
2. Dr Biju Soman received a consultancy from Kerala Medical Services Corporation Limited, a Government of Kerala undertaking to undertake an audit of their KANIV 108 Ambulance Services in the state. Subsequently, a Memorandum of Agreement was signed between the Director of SCTISMT and the Managing Director of the KMSCL, on 1 November 2021.

### **Events Organized**

1. MPH and PhD students of AMCHSS carried out a competency assessment of staff of Primary Health Centres (currently called Family Health Centres) in Kerala as part of the Health Care System in India Course. Students and concerned faculty members were part of a multidisciplinary team comprising experts from National Health Mission, Kerala, State Health Systems Resource Centre, Kerala, Government Medical Colleges Thiruvananthapuram and Kollam, and Amrita Institute of Medical Sciences, Kochi. The students visited 18 Primary Health Centres in five districts in Kerala and performed the Competency Mapping Exercise (Figure 1). AMCHSS is contributing to the data analysis. The findings will be very useful for deciding priorities in the training programmes in the state.
2. A screening camp was organised at Trivandrum, by Public Health Students Forum, on the occasion of World Diabetes day.



## Awards and Honours

1. Dr Jeemon Panniyammakal was the recipient of the prestigious Shanti Swarup Bhatnagar Prize in Medical Sciences, CSIR for 2021.
2. Dr Jeemon Panniyammakal was named in the World's top 2% scientist, 2021 list by the Stanford University USA.
3. Dr Jeemon Panniyammakal received the Best Investigator Award 2022 (low and middle-income country) from the International Behavioral Trials Network and University of Quebec at Montreal, Canada.
4. Dr Jeemon Panniyammakal received the Wellcome Trust-DBT-India Alliance Senior Clinical Fellowship (2021-2026).
5. Dr Rakhal Gaitonde was invited to be a member of the Kerala State COVID Expert Committee chaired by Dr Ekbal and appointed by the Chief Minister of Kerala.
6. Dr Rakhal Gaitonde was invited to be a member of the Tamilnadu State Planning Commission Committee on the Right to Health. Dr Gaitonde contributed to the development of a draft Policy on Right to Health submitted to the Tamilnadu Government.
7. Dr Rakhal Gaitonde was invited to be a member of the Health Working Group of the Kerala State Planning Board to develop the background paper for health in the 14th state 5-year Plan.
8. Dr Biju Soman was nominated Member of the School Board for the School of Public Health under the Kerala University of Health Sciences by the Vice-Chancellor in April 2021. The tenure for the position is three years.
9. Dr Mala Ramanathan was nominated for the Advisory Board for Population Research Centre Development and publication of Editorial on Infertility.



Figure 1. MPH and PhD students interacting with Primary Health Centre staff as part of competency mapping exercise

## Staff

### Faculty

Sankara Sarma P, Professor and Head of the Department

Dr Mala Ramanathan, Professor

Dr Biju Soman, Professor

Dr Srinivasan K, Professor

Dr Rakhal Gaitonde, Professor

Dr Ravi Prasad Varma P, Additional Professor

Dr Jeemon Panniyammakal, Associate Professor

Dr Srikant K., Assistant Professor

Dr Manju R Nair, Scientist D

Dr Jissa V T, Scientist C



# **DIVISION OF ACADEMIC AFFAIRS**

# DIVISION OF ACADEMIC AFFAIRS

The Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum continues to be a much sought-after destination for super speciality courses leading to DM or MCh Degrees in Cardiac and Neurosciences. This is also one of the few institutions that offer Post-doctoral Fellowship programmes in subspecialty areas of Cardiac and Neurosciences. In addition, the Institute offers Masters and PhD courses in Medical, Biomedical, and Health Sciences and, Diploma and PG Diploma courses in related areas.

## Activities

### Programmes offered during the year 2021-22

#### Post-doctoral Programmes

1. DM Cardiology
2. DM Neurology
3. DM Neuroimaging and Interventional Neuroradiology
4. DM Cardiovascular Imaging and Vascular Interventional Radiology
5. DM Cardiothoracic and Vascular Anaesthesia
6. DM Neuroanaesthesia
7. MCh Cardiovascular and Thoracic Surgery
8. MCh Vascular Surgery
9. MCh Neurosurgery
10. Post-doctoral Fellowship (Post DM/MCh/DNB)

#### PhD/Master's Programmes

1. MD in Transfusion Medicine
2. Master of Public Health (MPH)
3. PhD (Full Time) and (Part-Time)

#### Diploma Programmes

1. Diploma in Public Health
2. Diploma in Cardiovascular and Thoracic Nursing

3. Diploma in Neuro-Nursing
4. Diploma in Operation Theatre and Anaesthesia Technology
5. Diploma in Advanced Medical Imaging Technology

#### PG Diploma Programmes

1. Cardiac Laboratory Technology
2. Neuro-Technology
3. Medical Records Science
4. Clinical Perfusion
5. Blood Banking Technology

#### Other Programmes

Joint Programmes with other institutions (IIT Madras and CMC Vellore)

1. M Tech. (Clinical Engineering)
2. PhD (Biomedical Devices and Technology)

#### Affiliated Programmes conducted at other Centres

##### A. National Institute of Epidemiology, Chennai

1. Master of Public Health (Epidemiology and Health Systems)

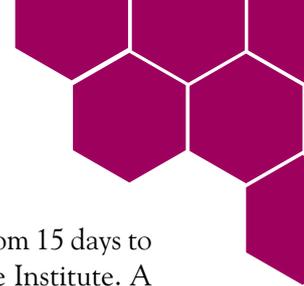
##### B. Christian Medical College, Vellore

1. MS Bioengineering
2. PhD in Bioengineering/Biomedical Sciences
3. Master of Public Health (MPH)

##### C. Indian Institute of Information Technology and Management, Trivandrum

1. PhD (Imaging Sciences and Technology)





The annual selection process for admission to various programmes was carried out in the months of November and December. The selection for PhD (Fellowship holders) and MPH/DPH was conducted in June 2021. The newly-admitted students were welcomed at a function held on 5 February 2022 where the Director, Dean, and various senior faculty members addressed them. The Orientation Programme regarding Biomedical Technology for the Senior Residents was conducted online from 25-29 October 2021.

### Admission Process

Admissions to various programmes of study is regulated by policy and procedures approved by the Academic Committee of the Institute from time to time. The admission announcement were published through advertisements in leading newspapers during 1st week of September every year and on the Institute website. The assessment and interviews for admission to DM/MCh/MD programmes were conducted through INI-SS/INICET and Post Doctoral Fellowship, postgraduate and diploma programmes were held in the Institute during the months of November/December. Admissions to PhD (Fellowship holders), Master of Public Health and Diploma in Public Health were carried out during July/August.

### Number of students enrolled from 01.04.2021 to 31.03.2022

In total, 160 students joined in the academic year 2020-21. The details of the students/residents admitted from April 2021 to March 2022 were as shown in the Table.

### Short Term Training/Observership

The Institute provided short-term training/observership to candidates sponsored by Government/Autonomous Institutions, Health Sector Organizations, Approved Medical/Dental/Nursing/Engineering Colleges, and other Paramedical Institutions. The training/observership was arranged in consultation with the respective Department/Discipline. Observers from various institutions all

over the country spent varying periods from 15 days to 3 months in different departments of the Institute. A total of 137 candidates completed their observership/internship/project work/training at SCTIMST during the year.

Programme	Number of students
DM	25
MCh.	11
PDF	12
MD	1
M Tech	8
MPH (SCTIMST)	25
MPH (NIE)	24
PhD (BMT/Hospital/AMCHSS)	18
Diploma/PG Diploma/Certificate	36

### Workshop

A two-day Workshop on „Handling Scientific Images for Publication: Techniques and Ethics (SITE-22)” was conducted in March 2022 for faculty, senior residents, and students of SCTIMST. Dr Anilkumar P R, Scientist F, BMT Wing, Dr Manoj Komath, Scientist F, BMT Wing, and Dr Naresh K, Scientist F, BMT Wing were the resource persons. Twenty participants attended the Workshop.

### Annual Convocation

Due to COVID-19 pandemic, the Annual Convocation ceremony of the 37th batch of graduates in 2021 was conducted through online mode. In total, 162 students received their degrees/diplomas/certificates during the year 2020-2021.



## Degrees/Diplomas/Certificates Awarded during the year 2021-2022

198 students were found eligible to receive degrees/diplomas/certificates during the period 2021-2022 as indicated in the Table below:

Programme	Number of students
DM	26
MCh.	8
PDF	13
PDCC	5
MD	1
DPH	1
MPH (SCTIMST)	20
MPH (IIPH)	38
MPH (CMC, Vellore)	11
MPH (NIE)	17
PhD (BMT/Hospital/AMCHSS/IIITMK)	18
M Phil (SCTIMST)	6
MS Bioengineering	5
Diploma in Cardiovascular and Thoracic Nursing	8
Diploma in Neuro nursing	6
PG Diploma in Blood Banking Technology	2
PG Diploma in Clinical Perfusion	2
PG Diploma in Cardiac Laboratory Technology	2
PG Diploma in Medical Records Science	1
Diploma in Advanced Medical Imaging Technology	3
Diploma in Operation Theatre and Anaesthesia Technology	1
PG Diploma in Neuro Technology	2
ACP in Physiotherapy in Cardio-vascular Sciences	2

## National Science Day 2022 Celebrations

The National Science Day 2022 was celebrated at the Biomedical Technology (BMT) Wing (Figure 1). The theme of this year's National Science Day was „Integrated Approaches in S&T for Sustainable Future with emphasis on the application of science for a sustainable future. Around 105 students from Saraswathy Vidyalayam, Kattakada, Government. Arts College, Trivandrum, and VTM NSS College, Trivandrum participated in the programme. The function was presided over by Prof Ajit Kumar V K, Director of the Institute. He highlighted the relevance of integrated approaches in S&T for efficient tackling of future challenges. The chief guest, Prof Jayaraj M K, Hon ble Vice-Chancellor, Calicut University, delivered the Science Day Message. He stressed the importance of the Raman Effect and its increasing applications in various fields of Science and Technology. Dr Unnikrishnan Nair S, Director, VSSC, Trivandrum and Human Space Flight Centre, ISRO, Bangalore was another chief guest and delivered the Science day talk "Science in Gaganyaan". He inspired the audience with recent advances in Indian space research and discussed various technical approaches towards Gaganyaan Mission. He also emphasized the importance of an integrative approach to bioastronautics. The inaugural programme was followed by a Science Quiz, Magic in Science, and laboratory visits.

## Empowerment Programmes for SC and ST students

Transmission of knowledge through education and training to various sections of the society would improve the human condition, especially that of the less privileged scheduled caste (SC) and scheduled tribe (ST) communities. Science for Equity Empowerment and Development (SEED) Division, Department of Science and Technology, Government of India granted two projects to SCTIMST entitled, "Extending benefits of biomedical science and technology to SC and ST communities through all level participatory engagement – SC/ST components." These projects aim to bring an impact on the education, skill development, employability, and health of Scheduled Caste and Scheduled Tribe





Figure 1. National Science Day Celebration 2022

communities in the country through a series of interventions. The activities carried out as part of the above projects are described below:

- **Support to carry out post-doctoral research in biomedical technology**

Post-doctoral research award termed, „DST-SCTIMST Innovative Research Award was offered to two people (one person each from SC and ST communities) with support in terms of monthly fellowship, research equipment and consumables. The fellowship holders will be supported for a period of three years.

- **Support to carry out academic programs of the institute**

Six PhD students (3 each from SC and ST) were

supported with their monthly fellowships, research expenses, tuition fees, and reimbursement of expenses associated with attending conferences, etc.

- **DM/ MCh/ MPhil/ Master of Public Health/ PG Diploma/ Diploma courses**

The students admitted to these programmes were provided with their monthly stipend, reimbursement of tuition fees and research expenses. The number of students supported for each course is given below: DM – 1 (ST), MCh – 1 (ST), MPhil – 2 (SC), MPH – 2 (SC), PG Diploma – 2 (SC) and Diploma – 2 (SC).



- **One-day Lab visit programme**

One-day lab visit for SC and ST students attending +2 level classes was arranged. The programme was named „Chitrajalakam 2022 and was conducted on the 13-14 of January 2022 at Biomedical Technology Wing. The programme aimed to provide the students belonging to the SC/ST communities an opportunity to interact closely with scientists and engineers of SCTIMST who do research, development, and testing of biomedical materials/devices, and to gain an understanding of the different domains of biomedical research. A total of 42 students from Dr Ambedkar Model Residential School, Kattela, Trivandrum, Kerala visited the institute on 13-14 January 2022 (Figure 2).

- **DST-SCTIMST Summer Scholarship Programme**

This training was offered to students who were undergoing/completed higher secondary, graduate, and post-graduate courses in the areas of science, engineering, or medicine. All the students who completed the training with 80% attendance were given monthly scholarships. Students admitted to this programme got the opportunity to interact with scientists/ engineers/ clinicians of the institute, visit R&D labs/clinics of SCTIMST, interact with PhD students, and do mini-projects in biomedical research under the mentorship of a faculty member. Students were admitted on a first-come, first-served basis. During the period from March 2021 to July 2021, 13 SC students and 5 ST students were trained. Training certificates were given to students who successfully completed the training (Figure 3).

- **Outreach Programmes for finding beneficiaries**

To ensure that the efforts of SCTIMST are reaching a maximum number of deserved students, several outreach programmes were conducted in different parts of Kerala. The programme was advertised on the website of the institute and in two newspapers (Mathrubhumi and Times of India). To spread the word to the targeted communities, awareness programmes



Figure 2. Lab visit by school students

were organized with the aid of flyers and brochures, and roll-up standees displaying the details in English and Malayalam. Various educational institutions were visited and Government officials were also contacted.

### Online Activities

In view of the COVID-19 pandemic, various activities such as examinations, setting up of question papers, thesis evaluations and answer sheet evaluations were conducted online. All admission procedures were made online. These online activities were carried out through indigenously developed software such as Moodle (for conduct of entrance examination online) and Examinator (Dissertation/thesis evaluation and answer sheet evaluation). Various other meetings in connection with academic activities are also conducted through online.



Figure 3. Trained batch of students with their certificates and presenting the brochure to Mr Vanidas, Joint Director Scheduled Tribe Development Office

### Use of Hindi

The Institute complied with the provisions relating to the Official Language Act, Rules and instructions, and directives of the Government of India. During the year, various competitions like calligraphy, Noting and Drafting, short story writing, and essay writing in Hindi was held for the employees. Hindi Fortnight/Hindi Day was observed (Figure 4). Hindi cell organized training/workshop on typing and drafting in Hindi for the institute staff. The Institute participated in the Town Official Language Implementation Committee (TOLIC) meetings. The institute staff of also participated in the TOLIC Rajbhasha Competition. SCTIMST organized quarterly Official Language Committee meetings and submitted the quarterly progress report to TOLIC and DST. SCTIMST received 15 Letters in Hindi during the year and replied to 5 letters in Hindi. All the technical terminologies and “Quotes of the Day” were

published in Hindi on the institute website to increase awareness among staff members. The name boards for various Departments and officials were updated to be bilingual. Creation of a bilingual website (Hindi and English) of the institute SCTIMST was in progress.



Figure 4. Hindi Fortnight Celebration





## **Faculty**

Prof Ajit Kumar V K, Director and Chairperson

Prof Kesavadas C, Dean of Academic Affairs

Prof Sylaja P N, Associate Dean (Student & Faculty Affairs)

Prof Harikrishnan S, Associate Dean (Research & Publication Cell)

Prof Manikandan S, Associate Dean (Examinations & Curriculum)

Dr Mohanan P V, Associate Dean (PhD Affairs)

Prof Srinivasan K, Associate Dean (Health Science Studies)

Dr Santhosh Kumar B, Registrar

Ms Radha M, Deputy Registrar

## **Staff**

Ms Chithra T S, Assistant Administrative Officer (Academic)

Mr Sarath Sam S S, Executive Assistant

Ms Smitha P M, Executive Assistant



# NURSING EDUCATION

The Division co-ordinates the nursing-related educational programmes of the Institute.

## Activities

1. During the year, 30 students, 16 Cardiovascular and Thoracic Nursing and 14 Neuro Nursing students were undergoing the speciality programme.
2. Organised a webinar on “Mechanical ventilation- from physiology to clinical practice” for nurses on 8-9 April 2021 in collaboration with the Department of Anaesthesiology, SCTIMST
3. The students completed a 4-day Course titled “Emergency Nursing and Nurse Essentials Course” conducted by Apex Trauma & Emergency Learning Centre under the Directorate of Medical Education, Kerala in collaboration with TATA TRUSTS, Warwickshire Medical University (U.K) and Care Institute of Health Sciences, Hyderabad.
4. As part of the World Heart Day Celebrations, the students made educational posters on “Prevention of Heart Disease”, “Home care after pacemaker implantation”, and “Patient education on patients taking conventional oral anticoagulants” and a short film on “Maintaining a heart healthy lifestyle” for public.

## 5. Clinical Observership

Twelve MSc Nursing students from 4 institutions within Kerala underwent Clinical Observership in various departments during the year.

## Awards and Honours

1. Ms Priyanka Sreekantan, Neuro nursing student won 1st Prize for the presentation titled “Incidence of hyponatremia among patients after transnasal pituitary surgery- A retrospective cohort study” at the National Conference on Neuronursing –Updates organized by Society of Indian Neuronurses.
2. Ms Anjana A, Neuro nursing student won 2nd Prize for the presentation titled “Assessment of oral health status of craniotomy patients before and after surgery” at the National Conference on Neuronursing –Updates organized by Society of Indian Neuronurses.

## Faculty

Mrs Suja Raj L, Lecturer in Nursing



## LIBRARY, HOSPITAL WING

The Hospital Wing library has a collection of 16004 books and 15900 back volumes of journals. During the year, the library subscribed to 110 journals. Electronic access to the journals subscribed to was activated and made available on both campuses. Being part of the National Knowledge Resource Consortium (NKRC), the library continued to have access to the full-text of selected journals from Elsevier, Wiley, Springer, Oxford University Press, American Chemical Society, Royal Society of Chemistry, Nature Publishing Group, Taylor & Francis, etc. and databases of Web of Science and ASTM Standards. The publications of our Institute from 1977 onwards have been listed on the library site with an interface to search by date, department, and author. The average impact factor of the journals in which the articles are published is also

available. Library-subscribed resources are available to our users through MyLOFT remote access software outside the campus since July 2021. New library management software (SCTIMST Granthalaya) and website developed by our Computer Division was launched by the Director, Dr V K Ajit Kumar on 21 December 2021.

### Staff

Ms Sudha T, Librarian-cum-Information Officer - A

Mr Anil Kumar C

Senior Librarian-cum-Documentation Officer - A

Mr Joy Vithayathil

Senior Librarian-cum-Documentation Assistant - B

Mr Jayamohan C S

Librarian-cum-Documentation Assistant - B

## LIBRARY, BMT WING

The library at the Biomedical Technology Wing has 11436 books, 6019 back volumes and subscribes to 51 journals. The library continued to subscribe to ASM Medical Materials Database, a comprehensive, peer-reviewed database providing a single relational resource to summarize scientific and engineering knowledge on implantable medical materials data to support surgical, cardiovascular, orthopedic, and neurological medical device design developed by ASM International. The library has a good collection

of standards and patents. The standards essential for the quality Management System and R&D activities of BMT Wing were updated regularly.

### Staff

Ms Dimple Gopi

Librarian-cum-Documentation Officer - A

Ms Seema S

Librarian-cum-Documentation Assistant - B



# MEDICAL ILLUSTRATION

Medical Illustration focuses on clinical photography, event photography and audiovisual aids in connection with academic and medical research activities. The Section documents and archives surgical and treatment procedures and patient progress for training purposes. In addition, the Unit also creates charts, posters, and other resources used for annual reports, journal publishing, education and research and development activities.

Computer-based audiovisual services such as web streaming, video conferencing, and live broadcast services were provided for Annual Convocation, national and international conferences and seminars.

## Staff

Mr Lijikumar G, Scientific Officer

Mr Viji Kumar N, Senior Projectionist



# PUBLICATIONS

1. Adhithyan R, Kannath S, Thomas B, Jayadevan E, Sylaja PN, Kesavadas C. Assessment of Collaterals Using Multiphasic CT Angiography in Acute Stroke: Its Correlation with Clinical Outcomes. *Neurol India*. 2021 Nov-Dec;69(6):1586-1591. doi: 10.4103/0028-3886.333473. PMID: 34979647.
2. Agarwal A, Valaparambil A, Nair KKM, Harikrishnan S, Bhattacharya D. Large Impending Paradoxical Embolus: Thrombotic Railroading from Right Ventricle to Left Ventricular Outflow. *J Cardiovasc Imaging*. 2021 Jul;29(3):284-286. doi: 10.4250/jcvi.2020.0143. Epub 2020 Nov 18. PMID: 33605097; PMCID: PMC8318808.
3. Anand N, Soman B, Prakash M. Epidemiological profiling of fatal road crashes in Puducherry, South Coastal India. *Indian J Public Health*. 2021 Apr-Jun;65(2):203-205. doi: 10.4103/ijph.IJPH\_1436\_20. PMID: 34135193.
4. Arathi A, Joseph X, Akhil V, and Mohanan P V.. L-Cysteine capped zinc oxide nanoparticles induced cellular response on adenocarcinomic human alveolar basal epithelial cells using a conventional and organ-on-a-chip approach. *Colloids Surf B Biointerfaces*. 2022 Mar;211:112300. doi: 10.1016/j.colsurfb.2021.112300. Epub 2021 Dec 28. PMID: 34974288.
5. Arun K, Nambiar PN, Kannath SK, Sreedharan SE, Sukumaran S, Sarma S, Sylaja PN. Prevalence of Aortic Plaques in Cryptogenic Ischemic Stroke: Correlation to Vascular Risk Factors and Future Events. *Neurol India*. 2022 Jan-Feb;70(1):182-187. doi: 10.4103/0028-3886.336332. PMID: 35263881.
6. Ashtami J, Anju S, Mohanan PV. Conformity of dextran-coated fullerene C70 with L929 fibroblast cells. *Colloids Surf B Biointerfaces*. 2019 Dec 1;184:110530. doi: 10.1016/j.colsurfb.2019.110530. Epub 2019 Sep 24. Erratum in: *Colloids Surf B Biointerfaces*. 2021 Nov;207:112033. PMID: 31574411.
7. Athira RK, Gayathry G, Anil Kumar PR, Harikrishna Varma PR, Naresh Kasoju, Manoj Komath. Hydroxyapatite cages with aligned pores for bone grafting – Seeding of human osteoblast-like cells in vitro and their response in dynamic culture mode, *Ceramics International*, Volume 47, Issue 21, 2021, Pages 30051-30060, ISSN 0272-8842, <https://doi.org/10.1016/j.ceramint.2021.07.181>.
8. Athira SS, Biby ET, Mohanan PV. Dextran stabilized fullerene soot induced toxicity on alveolar epithelial cells (A549 cells). *Environ Res*. 2020 Sep;188:109716. doi: 10.1016/j.envres.2020.109716. Epub 2020 May 26. Erratum in: *Environ Res*. 2022 Jan;203:111878. PMID: 32497874.
9. Babu, Veena, Injety, Ranjit, Jones, Stephanie, Sylaja, PN, Koirala, Amrit, Kuroski, Jennifer, Lightbody, Catherine Elizabeth, Oman, Hassan, Padma, Vasantha et al (2021) Clinical Staff perspective of post-discharge stroke care in south india. *Clinical staff perspective of post-discharge stroke care in south india. Cerebrovascular Diseases*. ISSN 1015-9770.
10. Baishya J, Menon RN, Ravish Keni R, Saraf UU, Varma RP, Radhakrishnan A, Cherian A, Thomas SV. Can occurrence of convulsive status epilepticus during video telemetry be predicted? Observations from an epilepsy monitoring unit. *Epilepsy Behav*. 2021 Oct;123:108252. doi: 10.1016/j.yebeh.2021.108252. Epub 2021 Aug 23. PMID: 34438130.
11. Balasubramanian AP, Kannath SK, Rajan JE, Singh G, Kesavadas C, Thomas B. Utility of silent magnetic resonance angiography in the





- evaluation and characterisation of intracranial dural arteriovenous fistula. *Clin Radiol*. 2021 Sep;76(9):712.e1-712.e8. doi: 10.1016/j.crad.2021.05.008. Epub 2021 Jun 16. PMID: 34144807.
12. Bhattacharya D, Namboodiri N, Valaparambil A, Valakada J, Mohanan Nair KK. Cardiac magnetic resonance imaging in right ventricular outflow tract arrhythmia: a retrospective analysis from a tertiary care centre in South India. *Acta Cardiol*. 2021 Nov;76(9):1019-1024. doi: 10.1080/00015385.2021.1965749. Epub 2021 Aug 20. PMID: 34412572.
  13. Bhattacharya D, Sasikumar D, Gopalakrishnan A, Anoop A. Ventricular septal defect with pulmonary arterial hypertension in an infant: Is there something more than what meets the eye? *Ann Pediatr Cardiol*. 2021 Oct-Dec;14(4):554-556. doi: 10.4103/apc.apc\_226\_20. Epub 2022 Mar 25. PMID: 35527760; PMCID: PMC9075548.
  14. Bhattacharya D, Sasikumar D, Kurup H, Krishnamoorthy KM. Left ventricular noncompaction in primary systemic carnitine deficiency: A rare association. *Ann Pediatr Cardiol*. 2021 Oct-Dec;14(4):521-523. doi: 10.4103/apc.APC\_152\_20. Epub 2020 Nov 19. PMID: 35527759; PMCID: PMC9075557.
  15. Biby TE, Prajitha N, Ashtami J, Sakthikumar D, Maekawa T, Mohanan PV. Toxicity of dextran stabilized fullerene C60 against C6 Glial cells. *Brain Res Bull*. 2020 Feb;155:191-201. doi: 10.1016/j.brainresbull.2019.11.014. Epub 2019 Nov 28. Erratum in: *Brain Res Bull*. 2021 Oct;175:263-264. PMID: 31786269.
  16. Biren P, Sreenath PR, Krishnakumar K, Easwer HV, Nair P. Complex split cord malformation with split conus. *Br J Neurosurg*. 2021 Nov 25:1-5. doi: 10.1080/02688697.2021.2005774. Epub ahead of print. PMID: 34823412.
  17. Boddu VK, Rebello A, Chandrasekharan SV, Rudrabhatla PK, Chandran A, Ravi S, Unnithan G, Menon RN, Cherian A, Radhakrishnan A. How does "locus of control" affect persons with epilepsy? *Epilepsy Behav*. 2021 Oct;123:108257. doi: 10.1016/j.yebeh.2021.108257. Epub 2021 Aug 20. PMID: 34425327.
  18. Bridget Jeyatha W, Willi Paul, Susan Mani, PP. Lizymol. Synthesis and characterization of ladder structured ormocer resin of siloxane backbone and methacrylate side chain, *Materials Letters*, Volume 310, 2022,131192, ISSN 0167-577X, <https://doi.org/10.1016/j.matlet.2021.131192>.
  19. Camfield CS, Camfield PR. Juvenile myoclonic epilepsy 25 years after seizure onset: a population-based study. *Neurology*. 2009 Sep 29;73(13):1041-5. doi: 10.1212/WNL.0b013e3181b9c86f. PMID: 19786695.
  20. Caroline D.S.M. , Rekha M.R. Exploring the efficacy of ethylene glycol dimethacrylate crosslinked cationised pullulan for gene delivery in cancer cells, *Journal of Drug Delivery Science and Technology*, Volume 68,
  21. Chandrababu K, Sreelatha HV, Sudhadevi T, Anil A, Arumugam S, Krishnan LK. In vivo neural tissue engineering using adipose-derived mesenchymal stem cells and fibrin matrix. *J Spinal Cord Med*. 2021 Jun 1:1-15. doi: 10.1080/10790268.2021.1930369. Epub ahead of print. PMID: 34062112.
  22. Chandrasekharan SV, Nair SS, Ganapathy A, Mannan AU, Sundaram S. Charcot-Marie-Tooth disease type 2S: identical novel missense mutation of IGHMBP2 gene in two unrelated families. *Neurol Sci*. 2022 Jan;43(1):719-722. doi: 10.1007/s10072-021-05668-3. Epub 2021 Oct 20. PMID: 34668123.
  23. Chandrasekharan SV, Sundaram S, Malaichamy S, Poyuran R, Nair SS. Myoneuropathic presentation of limb girdle muscular dystrophy R8 with a novel TRIM32 mutation. *Neuromuscul Disord*. 2021 Sep;31(9):886-890. doi: 10.1016/j.nmd.2021.06.003. Epub 2021 Jun 11. PMID: 34244021.



24. Chen CL, Shih YC, Liou HH, Hsu YC, Lin FH, Tseng WI. Premature white matter aging in patients with right mesial temporal lobe epilepsy: A machine learning approach based on diffusion MRI data. *Neuroimage Clin.* 2019;24:102033. doi: 10.1016/j.nicl.2019.102033. Epub 2019 Oct 23. PMID: 31795060; PMCID: PMC6978225.
25. Chennakeshavallu GN, Gadhinglajkar S, Sreedhar R, Babu S, Sankar S, Dash PK. Comparison of Three Ultrasound Views for Internal Jugular Venous Cannulation in Patients Undergoing Cardiac Surgery: A Randomized Trial. *J Med Ultrasound.* 2021 Feb 11;29(3):176-180. doi: 10.4103/JMU.JMU\_135\_20. PMID: 34729326; PMCID: PMC8515624.
26. Chennakeshavallu GN, Sankar S, Ponnaboyina S. Incidental Intraoperative Detection of Central Venous Catheter-related Internal Jugular Vein Thrombus in an Infant with d-Transposition of Great Arteries. *J Med Ultrasound.* 2021 Apr 23;29(4):296-297. doi: 10.4103/JMU.JMU\_128\_20. PMID: 35127414; PMCID: PMC8772474.
27. Cherian A, Chandarana M, Susvirkar AA, Divya KP, Saraf UU, Krishnan S. Abnormal Saccades Differentiate Adolescent Onset Variant Ataxia Telangiectasia from Other Myoclonus Dystonia. *Ann Indian Acad Neurol.* 2021 Jul-Aug;24(4):630-632. doi: 10.4103/aian.AIAN\_619\_20. Epub 2021 Apr 10. PMID: 34728979; PMCID: PMC8513963.
28. Cherian A, K P D, Paramasivan NK, Krishnan S. Pearls & Oysters: Levodopa-Responsive Adult NCL (Type B Kufs Disease) Due to CLN6 Mutation. *Neurology.* 2021 May 25;96(21):e2662-e2665. doi: 10.1212/WNL.0000000000011997. Epub 2021 Apr 19. PMID: 33875558.
29. Cherian A, Nandana J, Divya KP, Shetty SC. Expanding phenotype of ATP1A3 mutation. *Acta Neurol Belg.* 2021 May 20. doi: 10.1007/s13760-021-01706-1. Epub ahead of print. PMID: 34014491.
30. Cherian A, Priya L, Divya KP. "Cock-walk" gait and "horseshoe moustache" sign on MRI in inherited hypermanganesemia. *Neurol Sci.* 2022 Feb;43(2):1441-1445. doi: 10.1007/s10072-021-05793-z. Epub 2022 Jan 7. PMID: 34993656.
31. Cherian A, Shetty SC, Divya KP, Pavuluri H. Weekly methotrexate may reduce valproate levels causing relapse of genetic generalized epilepsy. *Epilepsy Behav Rep.* 2021 May 7;16:100457. doi: 10.1016/j.ebr.2021.100457. PMID: 34142078; PMCID: PMC8187960.
32. Cherian A. "Man in The Broken Mirror". *Ann Indian Acad Neurol.* 2021 Nov-Dec;24(6):931. doi: 10.4103/aian.aian\_692\_21. Epub 2021 Dec 17. PMID: 35359533; PMCID: PMC8965965.
33. Devarakonda BV, Babu S, Pan S, Gadhinglajkar S, Thomas D, Jagadish A. Three Guidewires Inside the Internal Jugular Vein as a Result of Side Lobe Artifacts During Ultrasound-Guided Central Venous Cannulation: Importance of Image Depth and Focal Point. *J Cardiothorac Vasc Anesth.* 2021 Jun;35(6):1905-1906. doi: 10.1053/j.jvca.2020.10.035. Epub 2020 Oct 22. PMID: 33183932.
34. Divya KP, Cherian A. Pearls & Oysters: Grisel Syndrome Presenting as Pseudodystonia: A Twist in the Neck. *Neurology.* 2022 Mar 15;98(11):462-465. doi: 10.1212/WNL.0000000000200023. Epub 2022 Jan 20. PMID: 35058340.
35. George J, Sandhya P, Sajitha KV, Sundaram S. Attention deficit hyperactivity disorder: a rare clinical presentation of L-2-hydroxyglutaric aciduria. *BMJ Case Rep.* 2021 Jul 30;14(7):e244038. doi: 10.1136/bcr-2021-244038. PMID: 34330727; PMCID: PMC8327819.
36. Giridhara P, Poonia A, Kumar DS, Ayyappan A, Krishnamoorthy KM, Sivasubramonian S, Valaparambil A. Postoperative Aortic Regurgitation in Outflow Ventricular Septal





- Defect:DeterminantsofOutcome.SeminThorac Cardiovasc Surg. 2022 Summer;34(2):680-688. doi: 10.1053/j.semtcvs.2021.09.006. Epub 2021 Sep 20. PMID: 34555492.
37. GJ M, Sreedhar R, Gadhinglajkar SV, A J, Babu S, Pitchai S. The Dampening Arterial Trace-A Rare Complication of Pruitt F3 Carotid Shunt Migration During Carotid Endarterectomy. *J Cardiothorac Vasc Anesth.* 2021 Jun;35(6):1909. doi: 10.1053/j.jvca.2020.10.046. Epub 2020 Oct 27. PMID: 33221154.
  38. Gohil J, Gowda A, George T, Easwer HV, George A, Nair P. Pituitary apoplexy and panhypopituitarism following acute leptospirosis. *Pituitary.* 2021 Dec;24(6):854-858. doi: 10.1007/s11102-021-01156-1. Epub 2021 May 21. PMID: 34021443; PMCID: PMC8139373.
  39. Gopalakrishnan A, Menon S, Sasikumar D, Kurup HKN, Krishnamoorthy KM. Hemianomalous pulmonary venous drainage and type IIb coronary sinus septal defect - Utility of subxiphoid and right parasternal views. *Echocardiography.* 2021 Oct;38(10):1833-1835. doi: 10.1111/echo.15176. Epub 2021 Sep 23. PMID: 34555184.
  40. Gopan GV, Susan KK, Jayadevan ER, Joseph R. Organic Compound with Potential for X-ray Imaging Applications. *ACS Omega.* 2021 Sep 16;6(38):24826-24833. doi: 10.1021/acsomega.1c03671. PMID: 34604664; PMCID: PMC8482459.
  41. Gulia KK, Sreedharan SE. Yogic Sleep and Walking Protocol Induced Improvement in Sleep and Wellbeing in Post-menopausal Subject: A Longitudinal Case Study During COVID Lockdown. *Sleep Vigil.* 2022;6(1):229-233. doi: 10.1007/s41782-021-00180-2. Epub 2021 Nov 12. PMID: 34786533; PMCID: PMC8588938.
  42. Harshith K, Anoop A, Jineesh V. A Rare Cause of Hemoptysis in West Syndrome-Isolated Aortopulmonary Collaterals in Structurally Normal Heart. *Indian J Radiol Imaging.* 2021 Oct 6;31(3):745-747. doi: 10.1055/s-0041-1735865. PMID: 34790328; PMCID: PMC8590566.
  43. Hrishi AP, Prathapadas U, Praveen R, Vimala S, Sethuraman M. A Comparative Study to Evaluate the Efficacy of Virtual Versus Direct Airway Assessment in the Preoperative Period in Patients Presenting for Neurosurgery: A Quest for Safer Preoperative Practice in Neuroanesthesia in the Backdrop of the COVID-19 Pandemic! *J Neurosci Rural Pract.* 2021 Sep 28;12(4):718-725. doi: 10.1055/s-0041-1735824. PMID: 34737506; PMCID: PMC8558970.
  44. Ismail S, Stanley A, Jeemon P. Prevalence of multimorbidity and associated treatment burden in primary care settings in Kerala: a cross-sectional study in Malappuram District, Kerala, India. *Wellcome Open Res.* 2022 May 4;7:67. doi: 10.12688/wellcomeopenres.17674.2. PMID: 35592547; PMCID: PMC9086527.
  45. Jain K, Cherian A, Divya KP, Poyuran R, Krishna S. Amidst the madness of genetic adult myopathies: a rare, treatable MADD. *Neurol Sci.* 2022 Jan;43(1):743-745. doi: 10.1007/s10072-021-05695-0. Epub 2021 Oct 29. PMID: 34714453.
  46. Jain K, Ramesh R, Krishnan S, Kesavapisharady K, Divya KP, Sarma SP, Kishore A. Cognitive outcome following bilateral subthalamic nucleus deep brain stimulation for Parkinson's disease-a comparative observational study in Indian patients. *Acta Neurol Belg.* 2022 Apr;122(2):447-456. doi: 10.1007/s13760-021-01778-z. Epub 2021 Aug 26. PMID: 34448152.
  47. Jain K, Ramesh R, Krishnan S, Kesavapisharady K, Divya KP, Sarma SP, Kishore A. Cognitive outcome following bilateral subthalamic nucleus deep brain stimulation for Parkinson's



- disease-a comparative observational study in Indian patients. *Acta Neurol Belg.* 2022 Apr;122(2):447-456. doi: 10.1007/s13760-021-01778-z. Epub 2021 Aug 26. PMID: 34448152.
48. Jamaluddin MA, Patel BK, George T, Gohil JA, Biradar HP, Kandregula S, Hv E, Nair P. Endoscopic Endonasal Approach for Giant Pituitary Adenoma Occupying the Entire Third Ventricle: Surgical Results and a Review of the Literature. *World Neurosurg.* 2021 Oct;154:e254-e263. doi: 10.1016/j.wneu.2021.07.022. Epub 2021 Jul 20. PMID: 34293521.
  49. Jibin K, Ramesh Babu V, and Jayasree RS. Graphene–Gold Nanohybrid-Based Surface-Enhanced Raman Scattering Platform on a Portable Easy-to-Use Centrifugal Prototype for Liquid Biopsy Detection of Circulating Breast Cancer Cells. *ACS Sustainable Chem. Eng.* 2021, 9, 46, 15496–15505.
  50. Jose D, Babu S, Jeevan R, Ramanan S, Kramadhari H, Sukesan S. Intraoperative Transesophageal Echocardiographic Diagnosis of an Unobstructed Supracardiac Total Anomalous Pulmonary Venous Connection in a Case of Single Ventricle Palliative Repair. *J Cardiothorac Vasc Anesth.* 2021 Jul;35(7):2132-2136. doi: 10.1053/j.jvca.2020.07.006.
  51. Jose J, Keni RR, Hassan H, Menon R, Sukumaran S, Cherian A, Radhakrishnan A. Predictors of outcome in super refractory status epilepticus. *Epilepsy Behav.* 2021 May;118:107929. doi: 10.1016/j.yebeh.2021.107929. Epub 2021 Mar 26. PMID: 33775578.
  52. Jose M, Poulouse P, Sundaram S, Radhakrishnan A, Nampoothiri S, Menon RN. Utility of clinical exome sequencing in progressive myoclonus epilepsy syndromes: An exploratory analysis. *Clin Genet.* 2022 Feb;101(2):270-271. doi: 10.1111/cge.14090. Epub 2021 Dec 9. PMID: 34888859.
  53. Jose P, Sundaram S, Varma RP. Buffering Effect of Spousal Support on Stress Levels in Mothers of Children with a Diagnosis of Autism Spectrum Disorder in Kerala, India. *J Neurosci Rural Pract.* 2021 Jul;12(3):535-542. doi: 10.1055/s-0041-1727559. Epub 2021 Jun 16. PMID: 34295109; PMCID: PMC8289558.
  54. Jose RL, Damayanathi D, Unnikrishnan KP, Suneel PR. A comparison of sevoflurane versus sevoflurane-propofol combination on renal function in patients undergoing valvular heart surgery-A prospective randomized controlled pilot study. *Ann Card Anaesth.* 2021 Apr-Jun; 24(2):172-177. doi: 10.4103/aca.ACA\_171\_19. PMID: 33884972; PMCID: PMC8253025.
  55. Joseph A, Valakkada J, Ayappan A, Dandhaniya D. Endovascular interventions in main renal artery pathologies: an overview and update. *Acta Radiol.* 2022 Jul;63(7):964-975. doi: 10.1177/02841851211019806. Epub 2021 Jun 9. PMID: 34107749.
  56. Joseph JE, Sekar S, Kannath SK, Menon RN, Thomas B. Impaired intrinsic functional connectivity among medial temporal lobe and sub-regions related to memory deficits in intracranial dural arteriovenous fistula. *Neuroradiology.* 2021 Oct;63(10):1679-1687. doi: 10.1007/s00234-021-02707-w. Epub 2021 Apr 10. PMID: 33837804.
  57. Joseph X, Akhil V, Arathi A, Mohanan PV. Microfluidic synthesis of gelatin nanoparticles conjugated with nitrogen-doped carbon dots and associated cellular response on A549 cells. *Chem Biol Interact.* 2022 Jan 5;351:109710. doi: 10.1016/j.cbi.2021.109710. Epub 2021 Oct 19. PMID: 34678297.
  58. Joseph, L., Ramesh, P., Remya, N.S, Arumugham V and Rajesh RP. Significance of Metrological Tools in an ISO 17025 Accredited Quality System for a Biological Evaluation Facility. *MAPAN* (2022). <https://doi.org/10.1007/s12647-021-00517-2>





59. Keerthi S, Vishnu Raj M, and Maya Nandkumar A. Role of Inflammasome-Mediated Pyroptosis as a Mechanism of Pathogenicity in *Pseudomonas* Biofilms. *Arch Microbiol Immunology* 2022; 6 (1): 20-38. doi: 10.26502/ami.93650074
60. Karthi S, Sukumari-Ramesh S, Geetha M, Appukuttan PS. High glucose removes natural anti- $\beta$ -galactoside and anti- $\beta$ -glucoside antibody immune complexes adhering to surface O-glycoproteins of normal platelets and enhances platelet aggregation. *Exp Ther Med.* 2022 Jan;23(1):82. doi: 10.3892/etm.2021.11005. Epub 2021 Nov 25. PMID: 34934451; PMCID: PMC8652397.
61. Kartik SV, Sasidharan B, Gopalakrishnan A, Kurup HKN, Krishnamoorthy KM, Sasikumar D, Thulaseedharan JV, Valaparambil A, Tharakan J, Sivasubramonian S. A Comparative Study of Invasive Modalities for Evaluation of Pulmonary Arteriovenous Fistula after Bidirectional Glenn Shunt. *Pediatr Cardiol.* 2021 Dec;42(8):1818-1825. doi: 10.1007/s00246-021-02670-6. Epub 2021 Jul 31. PMID: 34331559.
62. Karunakaran S, Thomas B, Menon R, Nair M, Nair SS, Sundaram S. Cerebral Dysgenesis, Neuropathy, Ichthyosis, and Keratoderma (CEDNIK) Syndrome with Brain Stem Malformation. *Ann Indian Acad Neurol.* 2021 Nov-Dec;24(6):979-981. doi: 10.4103/aian.AIAN\_673\_20. Epub 2020 Oct 7. PMID: 35359556; PMCID: PMC8965947.
63. Kawoos GM, Nair KKM, Sasidharan B, Valaparambil AK. Valvular and supra-valvular aortic stenosis fifteen years after coronary artery bypass grafting in a patient with familial hypercholesterolaemia. *Acta Cardiol.* 2022 Mar 3:1-2. doi: 10.1080/00015385.2022.2036486. Epub ahead of print. PMID: 35240937.
64. Kesavadas C. Mentoring Scientific Writing among Radiology Residents. *Indian J Radiol Imaging.* 2022 Jun 15;32(1):1-2. doi: 10.1055/s-0042-1749197. PMID: 35722642; PMCID: PMC9200458.
65. Kesavapisharady K, Divakar G, George T, E R J, Venkat Hariharan E. Compressive vertebral hemangiomas with neurological deficits: diagnosis, surgical strategies and long term outcome. *Br J Neurosurg.* 2021 Aug 26:1-11. doi: 10.1080/02688697.2021.1967878. Epub ahead of print. PMID: 34435527.
66. Kiran M, Misra S, Pr S, Babu S, Anand A, Koshy T. Quantification of Right Atrial-Indexed End-Systolic Volumes and Emptying Fraction in Children Undergoing Cardiac Surgery With Two-Dimensional Transesophageal Echocardiography: A Prospective Observational Study. *J Cardiothorac Vasc Anesth.* 2022 Jan;36(1):202-207. doi: 10.1053/j.jvca.2021.04.018. Epub 2021 Apr 18. PMID: 34006468.
67. Kochuvilayil A, Varma RP. Factors Associated with Screening Positive for Depression among Women Caregivers of Primary Palliative Care Patients in Kerala, India. *J Palliat Care.* 2022 Feb 9:8258597211069210. doi: 10.1177/08258597211069210. Epub ahead of print. PMID: 35138163.
68. Krishnamoorthy V, Babu S, Koshy T, Devarakonda BV, Palaniswamy N, Dharan BS. Left Ventricular Thrombus Formation During Cardiopulmonary Bypass Diagnosed by Intraoperative Transesophageal Echocardiography in a Case of Anomalous Left Coronary Artery From the Pulmonary Artery. *J Cardiothorac Vasc Anesth.* 2021 Sep;35(9):2751-2755. doi: 10.1053/j.jvca.2020.07.056. Epub 2020 Jul 24. PMID: 32798167.
69. Krishnamoorthy V, Gadhinglajkar SV, Palanisamy N, Sreedhar R, Babu S, Dharan BS. Transthoracic intracardiac catheters in perioperative management of pediatric cardiac surgery patients: a single-center experience. *Asian Cardiovasc Thorac Ann.* 2021 Oct;29(8):735-742. doi: 10.1177/0218492320983492. Epub 2020 Dec



25. PMID: 33356353.
70. Krishnan S, Shetty K, Puthanveedu DK, Kesavapisharady K, Thulaseedharan JV, Sarma G, Kishore A. Apraxia of Lid Opening in Subthalamic Nucleus Deep Brain Stimulation for Parkinson's Disease-Frequency, Risk Factors and Response to Treatment. *Mov Disord Clin Pract*. 2021 Apr 12;8(4):587-593. doi: 10.1002/mdc3.13206. PMID: 33981792; PMCID: PMC8088107.
  71. Kumar DH, Umesh SU, Sinchu MC, Savith K, Sarma SP, Sajith S. Pattern and Severity of Leukoaraiosis and Microvascular Resistance-Inputs from a TCD Study from South Asia. *Neurol India*. 2022 Mar-Apr;70(2):699-703. doi: 10.4103/0028-3886.344637. PMID: 35532642.
  72. Kurwale NS, Patil SB, Jagtap SA, Joshi A, Deshmukh Y, Nilegaonkar S, Bapat D, Chitnis S, Wadhvani N. Surgical outcomes for medically refractory epilepsy secondary to posterior cortex ulegyria as sequelae of perinatal insults. *Epilepsy Res*. 2021 Sep;175:106703. doi: 10.1016/j.epilepsyres.2021.106703. Epub 2021 Jun 25. PMID: 34214835.
  73. Linsha Mali A, Priya, SS, Rekha MR. Hydrophobic and hydrophilic modifications of polyethylenimine towards gene delivery applications. *J Appl Polym Sci* 2021, 138( 45), e51323. <https://doi.org/10.1002/app.51323>
  74. Lotlikar RS, Saikiran K, George J, Namboodiri N, Sylaja PN, Sreedharan SE. Predictors of Recurrence in Symptomatic Large Artery Atherosclerosis and Cryptogenic Strokes—A Comparative Study. *Journal of Stroke Medicine*. 2022; 5(1):21-25. doi:10.1177 /25166085221082403
  75. Lovhale PS, Gadhinglajkar S, Sreedhar R, Sukesan S, Pillai V. Intraoperative comparison of 2D versus 3D transesophageal echocardiography for quantitative assessment of mitral regurgitation. *Ann Card Anaesth*. 2021 Apr-Jun;24(2):163-171. doi: 10.4103/aca.ACA\_28\_20. PMID: 33884971; PMCID: PMC8253015.
  76. Megha KB, Seema A Nayar , Mohanan PV. Vaccine and vaccination as a part of human life: In view of COVID-19. *Biotechnol J*. 2022 Jan;17(1):e2100188. doi: 10.1002/biot.202100188. Epub 2021 Nov 21. PMID: 34665927; PMCID: PMC8646257.
  77. Mishra S, Gaitonde R. Challenges of informed consent during a political crisis: A case study of research with a marginalised group. *Indian J Med Ethics*. 2021 Jul-Sep;VI(3):1-5. doi: 10.20529/IJME.2020.130. PMID: 34287203.
  78. Mithun Sundar S, Swathi S, Kailash S. Prem & Chithrakumar V. K Thermal management system based on closed-loop pulsating heat pipe for electric motors. *Heat Mass Transfer* 58, 601–611 (2022). <https://doi.org/10.1007/s00231-021-03127-5>
  79. Mohammed S, Karunakaran J, Pillai VV. Outcomes Following Supracoronary Ascending Aortic Replacement with Aortic Valve Resuspension versus Modified Bentall's Operation for Acute Type A Aortic Dissection. *Braz J Cardiovasc Surg*. 2022 May 2;37(2):185-193. doi: 10.21470/1678-9741-2020-0147. PMID: 33656828; PMCID: PMC9054156.
  80. Mohammed S, Menon S, Gadhinglajkar SV, Baruah SD, Ramanan SV, Gopalakrishnan KA, Suneel PR, Dharan BS. Clinical outcomes of del nido cardioplegia and st thomas blood cardioplegia in neonatal congenital heart surgery. *Ann Card Anaesth*. 2022 Jan-Mar;25(1):54-60. doi:10.4103/aca.aca\_220\_20. PMID: 35075021; PMCID: PMC8865356.
  81. Mohanan Nair KK, Namboodiri N, Shafeeq A, Parashar NK, Valaparambil A. Absence of right bundle branch block morphology in V1 during left bundle branch pacing. What is the mechanism? *J Cardiovasc Electrophysiol*. 2021 Dec;32(12):3217-3220. doi: 10.1111/jce.15263.





Epub 2021 Oct 19. PMID: 34647673.

82. Mohanan Nair KK, Namboodiri N, Valaparambil A. "All that glitters is not gold". *J Arrhythm*. 2021 Oct 11;37(6):1572-1575. doi: 10.1002/joa3.12645. PMID: 34887966; PMCID: PMC8637090.
83. Mohanan Nair KK, Namboodiri N, Valaparambil A. Interesting phenomenon during programmed deep septal stimulation. What is the mechanism? *J Cardiovasc Electrophysiol*. 2022 Jun;33(6):1328-1331. doi: 10.1111/jce.15454. Epub 2022 Mar 31. PMID: 35304793.
84. Mohanan Nair KK, Namboodiri N, Valaparambil A. Palpitation in a young man with underlying preexcitation. What is the mechanism? *Indian Pacing Electrophysiol J*. 2021 May-Jun;21(3):198-199. doi: 10.1016/j.ipej.2021.01.008. Epub 2021 Jan 24. PMID: 33503471; PMCID: PMC8116730.
85. Mohanan Nair KK, Shafeeq A, Namboodiri N, Valaparambil A. Antidromic His capture during ventricular entrainment of an orthodromic AV re-entrant tachycardia. What is the mechanism? *J Cardiovasc Electrophysiol*. 2021 Sep;32(9):2546-2548. doi: 10.1111/jce.15183. Epub 2021 Aug 2. PMID: 34314074.
86. Mohanan Nair KK, Shafeeq A, Namboodiri N, Valaparambil A. Discordant responses to his refractory premature ventricular beats (PVBs) during a regular narrow QRS tachycardia. What is the mechanism. *Pacing Clin Electrophysiol*. 2021 Jun;44(6):1094-1096. doi: 10.1111/pace.14262. Epub 2021 May 24. PMID: 33974711.
87. Mohanan Nair KK, Shafeeq A, Namboodiri N, Valaparambil A. Interesting response of a narrow QRS tachycardia to a "concealed" late ventricular extrastimulus. What is the mechanism? *J Cardiovasc Electrophysiol*. 2021 Oct;32(10):2749-2751. doi: 10.1111/jce.15217. Epub 2021 Aug 24. PMID: 34411392.
88. Mohanan PV, Sangeetha V, Sabareeswaran A, Muraleedharan V, Jithin K, Vandana U, Varsha SB. Safety of 0.5% hydrogen peroxide mist used in the disinfection gateway for COVID-19. *Environ Sci Pollut Res Int*. 2021 Dec;28(47):66602-66612. doi: 10.1007/s11356-021-15164-y. Epub 2021 Jul 7. PMID: 34232429; PMCID: PMC8260351.
89. Murukendiran GJ, Gadhinglajkar S, Sreedhar R, Babu S, Sukesan S, Pillai V. Comparison of Four Different Techniques for Estimation of Left Ventricular Volumes Using Intraoperative Real Time Three Dimensional Transesophageal Echocardiography--A Prospective Observational Study. *J Cardiothorac Vasc Anesth*. 2021 Sep;35(9):2723-2731. doi: 10.1053/j.jvca.2020.12.012. Epub 2020 Dec 11. PMID: 33436281.
90. Nair KKM, Namboodiri N, Ganapathi S, Valaparambil A. Transition during radiofrequency ablation of manifest preexcitation. What is the mechanism? *J Electrocardiol*. 2021 May-Jun;66:49-53. doi: 10.1016/j.jelectrocard.2021.02.016. Epub 2021 Mar 9. PMID: 33770648.
91. Nair KKM, Parashar NK, Shafeeq A, Namboodiri N, Valaparambil A. Shorter post pacing interval during initiation of regular narrow QRS tachycardia. What is the mechanism? *J Electrocardiol*. 2021 Jul-Aug;67:71-72. doi: 10.1016/j.jelectrocard.2021.05.008. Epub 2021 May 25. PMID: 34090116.
92. Nair RS, Sobhan PK, Shenoy SJ, Prabhu MA, Rema AM, Ramachandran S, C Geetha S, V Pratheesh K, Mony MP, Raj R, Anilkumar TV. A porcine cholecystic extracellular matrix conductive scaffold for cardiac tissue repair. *J Biomed Mater Res B Appl Biomater*. 2022 Sep;110(9):2039-2049. doi: 10.1002/jbm.b.35058. Epub 2022 Mar 19. PMID: 35305082.



93. Nair SS, Sreedevi V, Nagesh DS. Warming of blood and intravenous fluids using low-power infra-red light-emitting diodes. *J Med Eng Technol.* 2021 Nov;45(8):614-626. doi: 10.1080/03091902.2021.1936675. Epub 2021 Jul 12. PMID: 34251967.
94. Nair SS, Sylaja PN, Pandian J, Srivastava MVP, Khurana D, Kaul S, Arora D, Sarma PS, Khatter H, Singhal AB. Impact of revascularization therapies on outcome of posterior circulation ischemic stroke: The Indo-US stroke project. *J Neurol Sci.* 2021 Aug 15;427:117499. doi: 10.1016/j.jns.2021.117499. Epub 2021 May 18. PMID: 34029753; PMCID: PMC8325629.
95. Nair SS, Vysakha KV, Menon RN, Sundaram S. Adult-onset subacute sclerosing panencephalitis. *Pract Neurol.* 2021 Apr 13;practneurol-2020-002880. doi: 10.1136/practneurol-2020-002880. Epub ahead of print. PMID: 33850035.
96. Nambiar P, Vinayagamani S, Sundaram S. Neuroimaging in 3-methyl-crotonylglycinuria. *Neurol India.* 2022 Mar-Apr;70(2):820-821. doi: 10.4103/0028-3886.344652. PMID: 35532678.
97. Nandana J, Nair SS, Girdhar S, Sundaram S. Recurrent painful ophthalmoplegic neuropathy: a cause for recurrent third nerve palsy in a child. *BMJ Case Rep.* 2021 Nov 11;14(11):e246179. doi: 10.1136/bcr-2021-246179. PMID: 34764123; PMCID: PMC8587473.
98. Narasimhaiah D, Sudhir BJ, Poyuran R. Balloons in Filum Terminale Ependymoma. *Neurol India.* 2021 Jul-Aug;69(4):1123-1124. doi: 10.4103/0028-3886.325343. PMID: 34507479.
99. Narasimhaiah D, Thomas B, Abraham M, Poyuran R. Mosaic Pattern of H3 K27M-Mutant Protein Expression in a Diffuse Midline Glioma-A Diagnostic Dilemma for the Pathologist. *J Neurosci Rural Pract.* 2021 Jul;12(3):596-598. doi: 10.1055/s-0041-1728231. Epub 2021 May 10. PMID: 34295118; PMCID: PMC8289546.
100. Nath AV, Ajit S, Sekar AJ, P R AK, Muthusamy S. MicroRNA-200c/429 mediated regulation of Zeb1 augments N-Cadherin in mouse cardiac mesenchymal cells. *Cell Biol Int.* 2022 Feb;46(2):222-233. doi: 10.1002/cbin.11724. Epub 2021 Nov 15. PMID: 34747544.
101. Nedunchezian AS, Hrishi AP, Ajayan N, Prathapadas U, Sethuraman M. Anesthetic Management of Hashimoto's Encephalopathy Presenting for Spine Surgery. *Neurol India.* 2021 Sep-Oct;69(5):1409-1411. doi: 10.4103/0028-3886.329609. PMID: 34747826.
102. Nedunchezian AS, Praveen R, Sethuraman M, Varma S. Anesthetic challenges in a child with hereditary hemorrhagic telangiectasia with coexisting pulmonary and cerebral arteriovenous malformations for intracerebral hematoma evacuation: A case report. *J Clin Anesth.* 2021 Nov;74:110430. doi: 10.1016/j.jclinane.2021.110430. Epub 2021 Jun 26. PMID: 34182262.
103. Nithiyandhan P, Suneel PR, Azeez AM, Pillai VV, Pitchai S. Intracardiac extension of intravenous leiomyomatosis in a patient with vascular pelvic tumor and prior hysterectomy: A case report. *Ann Card Anaesth.* 2021 Oct-Dec;24(4):483-486. doi: 10.4103/aca.ACA\_25\_20. PMID: 34747760; PMCID: PMC8617376.
104. Panicker VT, Sreekantan R, Lokanath N. Preoperative mitral annulus size - Can we get it right? *Ann Card Anaesth.* 2021 Jul-Sep;24(3):315-318. doi: 10.4103/aca.ACA\_91\_20. PMID: 34269261; PMCID: PMC8404588.
105. Patel BK, Gohil AJ, Nair P, H V E, A N D. Endoscopic Endonasal Excision of an Optic Pathway Cavernous Malformation: Technical Case Report. *Oper Neurosurg (Hagerstown).*



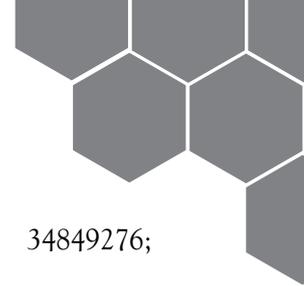


- 2021 Jul 15;21(2):E136-E142. doi: 10.1093/ons/opab094. PMID: 33825886.
106. Patel BK, Sreenath PR, George T, Shah Shreykumar P, Easwer HV, Nair P. Endoscopic Endonasal Excision of a Ventral Exophytic Brainstem Glioma: A Technical Case Report. *Oper Neurosurg (Hagerstown)*. 2022 Feb 1;22(2):e89-e94. doi: 10.1227/ONS.000000000000055. PMID: 35007265.
107. Pavuluri H, F A, Menon RN, Nair SS, Sundaram S. Pyruvate Dehydrogenase Complex Deficiency Due to PDHA1 Mutation-A Rare Treatable Cause for Episodic Ataxia in Children. *Indian J Pediatr*. 2022 May;89(5):519. doi: 10.1007/s12098-021-04068-x. Epub 2022 Feb 8. PMID: 35132535.
108. Pham PP, Balaji S, Shen I, Ungerleider R, Li X, Sahn DJ. Impact of conventional versus biventricular pacing on hemodynamics and tissue Doppler imaging indexes of resynchronization postoperatively in children with congenital heart disease. *J Am Coll Cardiol*. 2005 Dec 20;46(12):2284-9. doi: 10.1016/j.jacc.2005.08.036. PMID: 16360059.
109. Philip NT, Patnaik BSV, Sudhir BJ. Hemodynamic simulation of abdominal aortic aneurysm on idealised models: Investigation of stress parameters during disease progression. *Comput Methods Programs Biomed*. 2022 Jan;213:106508. doi: 10.1016/j.cmpb.2021.106508. Epub 2021 Nov 1. PMID: 34800807.
110. Pillai MN, Suneel PR, Menon S, Unnikrishnan KP, Baruah SD, Mathew T, Lovhale SP, Dharan BS. Intraoperative Three-dimensional Imaging of Ventricular Septal Defects in Children Using Epicardial Echocardiography: A Novel Approach. *J Cardiothorac Vasc Anesth*. 2021 Oct;35(10):2892-2899. doi: 10.1053/j.jvca.2020.10.051. Epub 2020 Oct 29. PMID: 33234468.
111. Ponnambath DK, Gopalakrishnan A, Pillai VV, Kaviyil JE, Raja K. Clinical Profile of Prosthetic Valve Endocarditis due to *Candida parapsilosis*: An 11-year Retrospective Observational Study from a Quaternary Cardiac Referral Institute in India. *Indian J Crit Care Med*. 2021 Aug;25(8):860-865. doi: 10.5005/jp-journals-10071-23915. PMID: 34733024; PMCID: PMC8559738.
112. Poyuran R, Chandrasekharan K, Easwer HV, Narasimhaiah D. Glioblastoma with primitive neuronal component: An immunohistochemical study and review of literature. *J Clin Neurosci*. 2021 Nov;93:130-136. doi: 10.1016/j.jocn.2021.09.004. Epub 2021 Sep 20. PMID: 34656236.
113. Poyuran R, Ponnambath DK, Vilanilam GC, Chandrasekharan K, Narasimhaiah D. Mycobacterial spindle cell pseudotumour of the brain in an immunocompetent adult. *Pathology*. 2021 Oct;53(6):782-785. doi: 10.1016/j.pathol.2020.11.013. Epub 2021 Apr 7. PMID: 33838921.
114. Prajapati A K and Komath M. Orthopaedic segment in India – from pandemic dormancy to a better future. *Current Science*. 2022 Feb 25;122(04):380-384
115. Prajitha N, Mohanan PV. Intracellular inflammatory signalling cascades in human monocytic cells on challenge with phytohemagglutinin and 2,4,6-trinitrophenol. *Mol Cell Biochem*. 2022 Feb;477(2):395-414. doi: 10.1007/s11010-021-04296-x. Epub 2021 Nov 13. Erratum in: *Mol Cell Biochem*. 2021 Dec 9;; PMID: 34775567.
116. Priya, L and Radhakrishnan, A. New onset seizures beyond sixties - Sexagenarians to Nonagenarians! *EPILEPSIA* 62 , pp.185-185
117. Raghuram K, Nair KKM, Namboodiri N, Valaparambil A. Tachycardiomyopathy managed



- by successful ablation of right ventricular outflow tract premature ventricular complexes. *Natl Med J India*. 2021 Jul-Aug;34(4):211-213. doi: 10.25259/NMJI\_433\_19. PMID: 35112544.
118. Raghuram K, Sasidharan B, Agarwal A, et al. TCTAP C-112 Trans Catheter Aortic Valve Replacement in the Presence of Starr-Edward Prosthesis in Mitral Position Using Balloon Expandable Prosthesis - Technical Challenges. *J Am Coll Cardiol*. 2021 Apr, 77 (14\_Supplement) S245-S247. <https://doi.org/10.1016/j.jacc.2021.03.286>
  119. Raj V, Nair A, Thekkuveetil A. Manganese exposure during early larval stages of *C. elegans* causes learning disability in the adult stage. *Biochem Biophys Res Commun*. 2021 Sep 3;568:89-94. doi: 10.1016/j.bbrc.2021.06.073. Epub 2021 Jun 29. PMID: 34198165.
  120. Raja J, Baruah SD, Santhosh V, Menon S, Dharan BS. An unusual cause of heparin resistance - A case report. *Ann Card Anaesth*. 2021 Jul-Sep;24(3):375-377. doi: 10.4103/aca.ACA\_197\_19. PMID: 34269273; PMCID: PMC8404596.
  121. Ramakrishnan R, Venkiteswaran K, Sreelatha HV, Lekshman A, Arumugham S, KalliyanaKrishnan L. Assembly of skin substitute by cross-linking natural biomaterials on synthetic biodegradable porous mat for critical-size full-thickness burn wound regeneration. *Biomed Mater*. 2022 Feb 28;17(2). doi: 10.1088/1748-605X/ac5573. PMID: 35168228.
  122. Ramanan S, Sundaram S, Gopalakrishnan A, Anija DV, Sandhya P, Jose DS, Baruah SD, Menon S, Dharan BS. Intermediate-term neurodevelopmental outcomes and quality of life after arterial switch operation beyond early neonatal period. *Eur J Cardiothorac Surg*. 2021 Dec 1;60(6):1428-1436. doi: 10.1093/ejcts/ezab223. PMID: 34151942.
  123. Remya NS, Syama S, Gayathri V, Varma HK, Mohanan PV. An in vitro study on the interaction of hydroxyapatite nanoparticles and bone marrow mesenchymal stem cells for assessing the toxicological behaviour. *Colloids Surf B Biointerfaces*. 2014 May 1;117:389-97. doi: 10.1016/j.colsurfb.2014.02.004. Epub 2014 Feb 28. Erratum in: *Colloids Surf B Biointerfaces*. 2021 Nov;207:112000. PMID: 24675277.
  124. Reshma VG, Rajeev KS, Manoj K, Mohanan PV. Water dispersible ZnSe/ZnS quantum dots: Assessment of cellular integration, toxicity and bio-distribution. *J Photochem Photobiol B*. 2020 Nov;212:112019. doi: 10.1016/j.jphotobiol.2020.112019. Epub 2020 Sep 12. Erratum in: *J Photochem Photobiol B*. 2021 Sep;222:112275. PMID: 32957068.
  125. Reshma VG, Sabareeswaran A, Rajeev KS, Mohanan PV. In vitro and In vivo toxicity analysis of zinc selenium/zinc sulfide (ZnSe/ZnS) quantum dots. *Food Chem Toxicol*. 2020 Nov;145:111718. doi: 10.1016/j.fct.2020.111718. Epub 2020 Sep 3. Erratum in: *Food Chem Toxicol*. 2021 Sep;155:112437. PMID: 32890689.
  126. Roopesh RP, Muthusamy S, Velayudhan S, Sabareeswaran A, Anil Kumar PR. High-throughput production of liver parenchymal microtissues and enrichment of organ-specific functions in gelatin methacrylamide microenvironment. *Biotechnol Bioeng*. 2022 Mar;119(3):1018-1032. doi: 10.1002/bit.28010. Epub 2022 Jan 7. PMID: 34931302.
  127. Rudrabhatla P, Nair SS, George J, Sekar S, Ponnambath DK. Isolated Myelitis and Intramedullary Spinal Cord Abscess in Melioidosis-A Case Report. *Neurohospitalist*. 2022 Jan;12(1):131-136. doi: 10.1177/19418744211025386. Epub 2021 Jun 16. PMID: 34950401; PMCID: PMC8689550.
  128. Rudrabhatla P, Sabarish S, Nair SS, George T, Divakar G, Sylaja PN. Superficial Siderosis





- Due to Spinal Myxopapillary Ependymoma Mimicking Idiopathic Intracranial Hypertension. *Ann Indian Acad Neurol.* 2022 Jan-Feb;25(1):156-157. doi: 10.4103/aian.AIAN\_186\_21. Epub 2021 Oct 11. PMID: 35342259; PMID: PMC8954308.
129. Rudrabhatla PK, Er S, Radhakrishnan A, Menon RN. Unmasking the entity of 'drug-resistant' perioral myoclonia with absences: the twitches, darts and domes! *Epileptic Disord.* 2021 Apr 1;23(2):313-324. doi: 10.1684/epd.2021.1265. PMID: 33851919.
130. Rudrabhatla PK, Reghukumar A, Thomas SV. Mucormycosis in COVID-19 patients: predisposing factors, prevention and management. *Acta Neurol Belg.* 2022 Apr;122(2):273-280. doi: 10.1007/s13760-021-01840-w. Epub 2021 Nov 24. PMID: 34820787; PMID: PMC8612391.
131. Rudrappan RB, Gupta D, Mohan L. A comparative analysis of factors influencing haemoglobin content in RBC units. *Transfus Apher Sci.* 2021 Dec;60(6):103214. doi: 10.1016/j.transci.2021.103214. Epub 2021 Jul 16. PMID: 34301488.
132. S L Easo, R Neelima and P V Mohanan. Toxicokinetics and biodistribution of dextran stabilized iron oxide nanoparticles in rats 2015 *Mater. Res. Express* 2 075401
133. Sambaturu VK, Kurup HKN, Gopalakrishnan A, Krishnamoorthy KM. Chylotamponade in Pediatric Primary Mediastinal Large B-Cell Lymphoma. *Indian J Pediatr.* 2022 Jun;89(6):597-599. doi: 10.1007/s12098-021-03986-0. Epub 2022 Jan 14. PMID: 35029806.
134. Santhakumar S, Lukas J, Unnikrishnan G, Thomas B, Kesavadas C. Treatable Hereditary Manganese Transport Disorder: Novel SLC30A10 Mutation and its Characteristic Neuroimaging Appearance in Two Siblings. *J Pediatr Genet.* 2020 Jul 23;10(4):305-310. doi: 10.1055/s-0040-1713853. PMID: 34849276; PMID: PMC8608476.
135. Santhakumar Syama, Willi Paul, Arumugam Sabareeswaran, Parayanthala Valappil Mohanan, Corrigendum to "Raman spectroscopy for the detection of organ distribution and clearance of PEGylated reduced graphene oxide and biological consequences" [*Biomaterials* 131 (2017) 121–130], *Biomaterials*, Volume 276, 2021, 121054
136. Sanukrishna SS, Jose Prakash M. Exploiting the thermal and rheological potentials of graphene-PAG nanolubricant for the development of energy efficient refrigeration systems. *Materials Today: Proceedings*, Volume 59, Part 1, 2022, Pages 7-14, ISSN 2214-7853, <https://doi.org/10.1016/j.matpr.2021.09.471>.
137. Saraf U, Chandarana M, Puthenveedu DK, Kesavapisharady K, Krishnan S, Kishore A. Childhood-Onset Dystonia Attributed to Aicardi-Goutières Syndrome and Responsive to Deep Brain Stimulation. *Mov Disord Clin Pract.* 2021 Apr 19;8(4):613-615. doi: 10.1002/mdc3.13205. PMID: 33981798; PMID: PMC8088118.
138. Saraf UU, Jose J, Krishnan S, Sreedharan SE. Mucopolysaccharidosis Type I Presenting as Bipolar Affective Disorder: A Case Report. *Neurol India.* 2021 Nov-Dec;69(6):1753-1755. doi: 10.4103/0028-3886.333455. PMID: 34979681.
139. Sasikumar D, Gopalakrishnan A, Kurup HKN, Dharan BS. Percutaneous Closure of Giant Aortic Pseudoaneurysm in a Child. *J Invasive Cardiol.* 2022 Jan;34(1):E65-E66. PMID: 34982728.
140. Sasikumar D, Valakkada J, Kramadhari H, Ayyappan A, Krishnamoorthy KM. Novel transcatheter treatment for staged closure of Abernethy malformation with portal hypoplasia. *Ann Pediatr Cardiol.* 2021 Jul-Sep;14(3):419-421. doi: 10.4103/apc.



- APC\_189\_20. Epub 2021 Aug 11. PMID: 34667420; PMCID: PMC8457293.
141. Sekar S, Kannath SK, Ramachandran S, Menon RN, Thomas B. Alterations in Resting-State Functional MRI Connectivity Related to Cognitive Changes in Intracranial Dural Arteriovenous Fistulas Before and After Embolization Treatment. *J Magn Reson Imaging*. 2022 Apr;55(4):1183-1199. doi: 10.1002/jmri.27936. Epub 2021 Sep 30. PMID: 34592019.
  142. Senthilvelan S, Sekar SS, Kesavadas C, Thomas B. Neuromitochondrial Disorders : Genomic Basis and an Algorithmic Approach to Imaging Diagnostics. *Clin Neuroradiol*. 2021 Sep;31(3):559-574. doi: 10.1007/s00062-021-01030-4. Epub 2021 Jun 9. PMID: 34106285.
  143. Shani SD, Sylaja PN, Sankara Sarma P, Raman Kutty V. Facilitators and barriers to medication adherence among stroke survivors in India. *J Clin Neurosci*. 2021 Jun;88:185-190. doi: 10.1016/j.jocn.2021.03.019. Epub 2021 Apr 14. PMID: 33992182.
  144. Singh G, Mitra A, Soman B. Development and Use of a Reproducible Framework for Spatiotemporal Climatic Risk Assessment and its Association with Decadal Trend of Dengue in India. *Indian J Community Med*. 2022 Jan-Mar;47(1):50-54. doi: 10.4103/ijcm.ijcm\_862\_21. Epub 2022 Mar 16. PMID: 35368491; PMCID: PMC8971875.
  145. Singh I, Shukla A, Thulaseedharan JV, Singh G. Contraception for married adolescents (15-19 years) in India: insights from the National Family Health Survey-4 (NFHS-4). *Reprod Health*. 2021 Dec 20;18(1):253. doi: 10.1186/s12978-021-01310-9.
  146. Soman S, Raghavan S, Rajesh PG, Varma RP, Mohanan N, Ramachandran SS, Thomas B, Kesavadas C, Menon RN. Relationship between Cerebral Perfusion on Arterial Spin Labeling (ASL) MRI with Brain Volumetry and Cognitive Performance in Mild Cognitive Impairment and Dementia due to Alzheimer's Disease. *Ann Indian Acad Neurol*. 2021 Jul-Aug;24(4):559-565. doi: 10.4103/aian.AIAN\_848\_20. Epub 2021 Apr 5. PMID: 34728951; PMCID: PMC8513975.
  147. Somasekharan LT, Raju R, Kumar S, Geevarghese R, Nair RP, Kasoju N, Bhatt A. Biofabrication of skin tissue constructs using alginate, gelatin and diethylaminoethyl cellulose bioink. *Int J Biol Macromol*. 2021 Oct 31;189:398-409. doi: 10.1016/j.ijbiomac.2021.08.114. Epub 2021 Aug 20. PMID: 34419550.
  148. Soumya VC, Ramachandran D, Sekar S, Sreedharan SE, Sylaja PN. PHACE Syndrome Presenting as Transient Ischemic Attack. *Neurol India*. 2021 May-Jun;69(3):766-767. doi: 10.4103/0028-3886.319227. PMID: 34169890.
  149. Sreedharan S, Arun KM, Sylaja PN, Kesavadas C, Sitaram R. Functional Connectivity of Language Regions of Stroke Patients with Expressive Aphasia During Real-Time Functional Magnetic Resonance Imaging Based Neurofeedback. *Brain Connect*. 2019 Oct;9(8):613-626. doi: 10.1089/brain.2019.0674. Epub 2019 Sep 10. PMID: 31353935; PMCID: PMC6798872.
  150. Sreedharan SE, Arun K, Kannath S, Jayadevan ER, Thulaseedharan JV, Sylaja PN. The Impact of Time to Reperfusion on Recanalization Rates and Outcome After Mechanical Thrombectomy: A Single Center Experience. *Ann Indian Acad Neurol*. 2022 Mar-Apr;25(2):256-260. doi: 10.4103/aian.aian\_909\_21. Epub 2022 Mar 25. PMID: 35693665; PMCID: PMC9175420.
  151. Sreedharan SE, Mitta N, Unnikrishnan KP, Paul R, Pillai V. Preoperative screening for obstructive sleep apnea in cardiovascular patients - How useful is STOP-BANG questionnaire in the Indian context? *Ann Card Anaesth*. 2021 Jul-Sep;24(3):308-312. doi: 10.4103/aca.ACA\_132\_20. PMID: 34269259; PMCID: PMC8404608.



152. Sudhadevi T, Vijayakumar HS, Hariharan EV, Sandhyamani S, Krishnan LK. Optimizing fibrin hydrogel toward effective neural progenitor cell delivery in spinal cord injury. *Biomed Mater*. 2021 Nov 19;17(1). doi: 10.1088/1748-605X/ac3680. PMID: 34736245.
153. Sudhir BJ, Karthikayan A, Amjad JM, Arun KG. Strategic tunnelling of superficial temporal artery during bypass surgery for moyamoya disease. *Acta Neurochir (Wien)*. 2022 Apr;164(4):1021-1025. doi: 10.1007/s00701-021-05084-8. Epub 2022 Jan 14. PMID: 35028745.
154. Sudhir BJ, Murali SH, Jamaluddin MA, Venkat EH. Superficial Temporal Artery Extended Interposition Graft to Anterior Cerebral Artery Bypass for the Treatment of a Large Fusiform Distal Anterior Cerebral Artery Aneurysm: 2-Dimensional Operative Video. *Oper Neurosurg (Hagerstown)*. 2021 Sep 15;21(4):E353-E354. doi: 10.1093/ons/opab239. PMID: 34195814.
155. Sudhir BJ. The Jai knot technique for deep microvascular surgery. *Acta Neurochir (Wien)*. 2022 Apr;164(4):1027-1029. doi: 10.1007/s00701-022-05150-9. Epub 2022 Feb 15. PMID: 35166904.
156. Sundaram C, Kartik S V, Namboodiri N, Ajitkumar VK. A Novel pacing option in patients with endomyocardial fibrosis: A case series. *Indian Pacing Electrophysiol J*. 2021 Sep-Oct;21(5):303-307. doi: 10.1016/j.ipej.2021.05.007. Epub 2021 May 24. PMID: 34044159; PMCID: PMC8414184.
157. Sundaram C, Namboodiri N, Ajitkumar VK, Mohanan Nair KK. Two pacing spikes on the T wave in a single-chamber pacemaker: What is the mechanism? *Indian Pacing Electrophysiol J*. 2022 Jan-Feb;22(1):42-43. doi: 10.1016/j.ipej.2021.09.003. Epub 2021 Oct 1. PMID: 34601109; PMCID: PMC8811285.
158. Sundaram S, Kumar PN, Sharma DP, Kesavadas C, Sreedharan SE, Prasad BA, Sylaja PN. High-Resolution Vessel Wall Imaging in Primary Angiitis of Central Nervous System. *Ann Indian Acad Neurol*. 2021 Jul-Aug;24(4):524-530. doi: 10.4103/aian.AIAN\_106\_21. Epub 2021 May 21. PMID: 34728945; PMCID: PMC8513955.
159. Tandon V, Senthivelan S, Sreedharan SE, Kesavadas C, Vt J, Sylaja PN. High-resolution MR vessel wall imaging in determining the stroke aetiology and risk stratification in isolated middle cerebral artery disease. *Neuroradiology*. 2022 Aug;64(8):1569-1577. doi: 10.1007/s00234-021-02891-9. Epub 2022 Feb 3. PMID: 35112218.
160. Varma S, Praveen R, Prathapadas U, Sethuraman M. Anaesthesia for ventriculoperitoneal shunt surgery in a craniovertebral junction anomaly patient with arrested hydrocephalus: Stability is safety. *Indian J Anaesth*. 2021 Nov;65(11):837-838. doi: 10.4103/ija.ija\_296\_21. Epub 2021 Nov 23. PMID: 35001958; PMCID: PMC8680417.
161. Vijayaraghavan A, Cherian A, Kalikavil Puthenveedu D, Krishnan S, Pavuluri H. Anti Zic4 Paraneoplastic Neurological Syndrome Presenting as Oscillopsia. *Mov Disord Clin Pract*. 2021 Sep 6;8(7):1134-1136. doi: 10.1002/mdc3.13331. PMID: 34631952; PMCID: PMC8485599.
162. Vilanilam GC, Venkat EH. Editorial. Ethical nuances and medicolegal vulnerabilities in robotic neurosurgery. *Neurosurg Focus*. 2022 Jan;52(1):E2. doi: 10.3171/2021.10.FOCUS21533. PMID: 34973672.
163. Saraf U, Chandarana M, Divya K P, Krishnan S. Oromandibular dystonia – A systematic review. *Ann Indian Acad Neurol* 2022;25:26-34.
164. Prabhu MA, Saravanan S, Valaparambil AK, Namboodiri N. Point density exclusion





- mapping-A useful tool for mapping arrhythmias arising from the endocavitary structures. *J Arrhythm.* 2021 Jul 23;37(5):1371-1373.
165. Unnikrishnan K, Thomas LV, Ram Kumar RM. Advancement of Scaffold-Based 3D Cellular Models in Cancer Tissue Engineering: An Update. *Front Oncol.* 2021 Oct 25;11:733652.
166. Kumar V, Ramachandran S, Sylaja PN, Pitchai S. Conventional Carotid Endarterectomy with Shunt versus Eversion Carotid Endarterectomy without Shunt does the Technique Influence the Outcome in Symptomatic Critical Carotid Stenosis. *Asian J Neurosurg.* 2021 May 28;16(2):321-325.
167. Vedartham V, Kesav P, Maniangatt S, Nagesh C, Sreedharan SE, Jayadevan ER, Sarma S, Sylaja PN. Hypodensities within Hematoma is Time-Dependent and Predicts Outcome after Spontaneous Intracerebral Hemorrhage. *Neurol India.* 2021 May-Jun;69(3):676-680.
168. Maramattom BV, Lotlikar RS, Sukumaran S. Central nervous system adverse events after ChAdOx1 vaccination. *Neurol Sci.* 2022 Jun;43(6):3503-3507.
169. Boddu VK, Rebello A, Chandrasekharan SV, Rudrabhatla PK, Chandran A, Ravi S, Unnithan G, Menon RN, Cherian A, Radhakrishnan A. How does "locus of control" affect persons with epilepsy? *Epilepsy Behav.* 2021 Oct;123:108257.
170. Thomas SV, Jeemon P, Pillai R, Jose M, Lalithakumari AM, Murali S, Sanalkumar A, Salini RA, Pavithran V. Malformation risk of new anti-epileptic drugs in women with epilepsy; observational data from the Kerala registry of epilepsy and pregnancy (KREP). *Seizure.* 2021 Dec;93:127-132.
171. Cherian A, Paramasivan NK, Prabhakaran PK, Puthanveedu DK. Redeemable "Progressive Supranuclear Palsy" Like Paraneoplastic Presentation in Carcinoma Breast. *Ann Indian Acad Neurol.* 2021 Sep-Oct;24(5):786-788.
172. Asranna A, Thomas SV. Metabolic Effects of Anti-Seizure Medications: A Time to Reevaluate Risks? *Neurol India.* 2021 Jul-Aug;69(4):964-965.
173. Patel BK, Darshan HR, Binu A, Easwer HV, Nair P. Endoscopic Endonasal Excision of a Complex Craniopharyngioma Operated Multiple Times by Transcranial Route. *Neurol India.* 2022 Jan-Feb;70(1):57-62.
174. Mohanan Nair KK, Namboodiri N, Valaparambil A. Narrow QRS Tachycardia: What Is the Mechanism? *J Innov Card Rhythm Manag.* 2021 Aug 15;12(8):4647-4648.
175. Sudhir BJ, Keelara AG, Venkat EH, Kazumata K, Sundararaman A. The mechanobiological theory: a unifying hypothesis on the pathogenesis of moyamoya disease based on a systematic review. *Neurosurg Focus.* 2021 Sep;51(3):E6.
176. Megha KB, Joseph X, Akhil V, Mohanan PV. Cascade of immune mechanism and consequences of inflammatory disorders. *Phytomedicine.* 2021 Oct;91:153712.
177. Sylaja PN, Nair SS, Pandian J, Khurana D, Srivastava MVP, Kaul S, Arora D, Sarma PS, Singhal AB. Impact of Pre-Stroke Antiplatelet Use on 3-Month Outcome After Ischemic Stroke. *Neurol India.* 2021 Nov-Dec;69(6):1645-1649.
178. S.S. Priya, M.R. Rekha, Intracellular delivery of p53 gene and drug using cationised pullulan thiomers lowers the effective therapeutic doses of chemotherapeutic drug in cancer cells, *Materials Today Communications*, Volume 30, 2022, 103-129.
179. Prajitha N, Mohanan PV. Intracellular inflammatory signalling cascades in human monocytic cells on challenge with phytohemagglutinin and 2,4,6-trinitrophenol. *Mol Cell Biochem.* 2022 Feb;477(2):395-414.
180. S.S. Athira, T.E. Biby, P.V. Mohanan, Effect of polymer functionalized fullerene soot on C6





- glial cells, *European Polymer Journal*, Volume 127, 2020, 109572
181. Walad S, Harikrishnan KN, Gopalakrishnan A, Sivasubramonian S, Sasidharan B. Technical considerations of coarctation stenting in double-barreled aorta - A persistent fifth arch mimic. *Ann Pediatr Cardiol*. 2021 Apr-Jun;14(2):201-203.
182. Sarathkumar E, Victor M, Menon JA, Jibin K, Padmini S, Jayasree RS. Nanotechnology in cardiac stem cell therapy: cell modulation, imaging and gene delivery. *RSC Adv*. 2021 Oct 26;11(55):34572-34588.
183. Harikrishnan VS, Palekkodan H, Fasaludeen A, Krishnan LK, Abelson KSP. Refinement of the spinal cord injury rat model and validation of its applicability as a model for memory loss and chronic pain. *Heliyon*. 2021 Jul 7;7(7):e07500.
184. Rudrabhatla P, Sabarish S, Ramachandran H, Nair SS. Teaching NeuroImages: Rare Adult-Onset Genetic Leukoencephalopathy. *Neurology*. 2021 May 18;96(20):e2561-e2562.
185. Murukendiran GJ, Dash PK, Azeez AM, Palanisamy N, Pitchai S. Symptomatic aberrant right subclavian artery-A case report and anesthetic implications. *Ann Card Anaesth*. 2022 Jan-Mar;25(1):81-84.
186. Shah SP, Gohil JA, Kesavapisharady K, Easwer HV. Revisiting Dandy-Walker Malformation with Associated Neurofibromatosis. *Asian J Neurosurg*. 2021 Dec 18;16(4):850-853.
187. Soumya Columbus, Diksha Painuly, Renjith P Nair, V. Kalliyana Krishnan, Role of PEGylated CdSe-ZnS quantum dots on structural and functional properties of electrospun polycaprolactone scaffolds for blood vessel tissue engineering, *European Polymer Journal*, Volume 151, 2021, 110430.
188. Sivadasan S, Poyuran R. Tumefactive Demyelination-A Rare Presentation of Anti-MOG Syndrome. *Ann Indian Acad Neurol*. 2022 Jan-Feb;25(1):138-140.
189. Ponnuru S, Radhakrishnan BK, Sudevan R, Karunakaran J. Outcomes of Coronary Artery Disease Patients with Severe Left Ventricular Dysfunction Undergoing Surgical Management. *Heart Surg Forum*. 2022 Mar 21;25(2):E204-E212.
190. Kiran M, Babu S, Dash PK, Shankar S, Pr S. Emergency Lung Isolation in a Child With Massive Pulmonary Hemorrhage in a Remote Location: Is a Cardiac Catheterization Suite a Boon or Bane? *J Cardiothorac Vasc Anesth*. 2021 Oct;35(10):3030-3034.
191. Ramesh G, Kaviyil JE, Paul W, Sasi R, Joseph R. Gallium-Curcumin Nanoparticle Conjugates as an Antibacterial Agent against *Pseudomonas aeruginosa*: Synthesis and Characterization. *ACS Omega*. 2022 Feb 17;7(8):6795-6809.
192. Nazeer SS, Sreedevi TP, Jayasree RS. Autofluorescence spectroscopy and multivariate analysis for predicting the induced damages to other organs due to liver fibrosis. *Spectrochim Acta A Mol Biomol Spectrosc*. 2021 Aug 5;257:119741.
193. B. J. Sudhir<sup>1</sup>, Anita Mahadevan and K. P. J. Reddy. Shock waves induce changes in meningiomas of the brain. *CURRENT SCIENCE*, VOL. 120, NO. 10, 25 MAY 2021
194. Ramachandran H, Pavuluri H, Sreedharan SE, Sylaja PN. If Nothing Goes Right, It Goes to the Left: A Case of Left Anterior Cerebral Artery Stroke Due to Right Internal Carotid Artery Stenosis. *Ann Indian Acad Neurol*. 2022 Mar-Apr;25(2):298-300.
195. Natarajan ABM, Sivadas VPD, Nair PDPD. 3D-printed biphasic scaffolds for the simultaneous regeneration of osteochondral tissues. *Biomed Mater*. 2021 Jul 29;16(5).
196. Shrivastava A, Nair S. Commentary: "Save

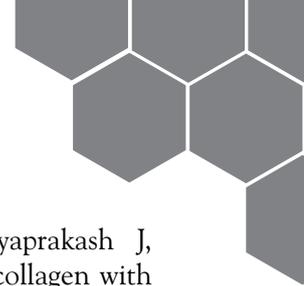




the Nerve": Technical Nuances for Hearing Preservation and Restoration in Vestibular Schwannoma Surgery: 2-Dimensional Operative Video. *Oper Neurosurg* (Hagerstown). 2021 Sep 15;21(4):E330-E331.

197. Chand S, Mani A, Amita R, Gupta D. Patient blood management in a neurosurgical patient with anti-e antibody. *Asian J Transfus Sci*. 2021 Jul-Dec;15(2):226-228.
198. Singh G, Soman B. Spatiotemporal epidemiology and forecasting of dengue in the state of Punjab, India: Study protocol. *Spat Spatiotemporal Epidemiol*. 2021 Nov;39:100444.
199. Anand R, Nimi N, Sivadas VP, Merlin Rajesh Lal LP, Nair PD. Dual crosslinked pullulan-gelatin cryogel scaffold for chondrocyte-mediated cartilage repair: synthesis, characterization and in vitro evaluation. *Biomed Mater*. 2021 Nov 11;17(1).
200. R. Dileepkumar, K. Anaswara<sup>1</sup>, V. Navya<sup>2</sup>, S. Beena<sup>3</sup>, A. Jacob<sup>4</sup>, L. Divya, A. S. Vijayasree, V. Deepthi<sup>5</sup>, G. Renganayaki<sup>6</sup>, P. R. Shidhi, M. A. Akbarsha<sup>7</sup>, K. P. Laladhas, Achuthsankar S. Nair, P.R. Sudhakaran and O. V. Oommen, Black palm squirrel (*Funambulus palmarum* Linn.) from India: association with a frame shift mutation in the MC1R gene. *CURRENT SCIENCE*, VOL. 121, NO. 2, 25 JULY 2021
201. Potnuri AG, Purushothaman S, Saheera S, Nair RR. Mito-targeted antioxidant prevents cardiovascular remodelling in spontaneously hypertensive rat by modulation of energy metabolism. *Clin Exp Pharmacol Physiol*. 2022 Jan;49(1):35-45.
202. Mohanan Nair KK, Namboodiri N, Valaparambil A. Interesting Response with the Delivery of Right Ventricular Extrastimulus of Increasing Prematurity. *J Innov Card Rhythm Manag*. 2021 Jul 15;12(7):4587-4588.
203. Unnikrishnan V, Venugopal A, Sivadasan SB, Boniface Fernandez F, Arumugam S, P R HV, Parayanthala Valappil M. Cellular and sub-chronic toxicity of hydroxyapatite porous beads loaded with antibiotic in rabbits, indented for chronic osteomyelitis. *Int J Pharm*. 2022 Mar 25;616:121535.
204. Philip PM, Kannan S. Patient Interval and Associated Factors in the Diagnostic Journey of Oral Cancer: A Hospital-Based Cross-Sectional Study from Kerala, India. *Asian Pac J Cancer Prev*. 2021 Oct 1;22(10):3143-3149.
205. Thomas E, Pawan SJ, Kumar S, Horo A, Niyas S, Vinayagamani S, Kesavadas C, Rajan J. Multi-Res-Attention UNet: A CNN Model for the Segmentation of Focal Cortical Dysplasia Lesions from Magnetic Resonance Images. *IEEE J Biomed Health Inform*. 2021 May;25(5):1724-1734.
206. Warriar S, Varma RP. On the "disciplinary sanctity" of palliative care within the folds of medicine and public health. *Palliat Support Care*. 2022 Feb;20(1):141-143.
207. Thomas SC. Dispelling hope and leaving couples in a state of "inbetweenness": Moral dilemmas in infertility research. *Indian J Med Ethics*. 2021 Jul-Sep;VI(3):1-9.
208. Sundar R, Joseph J, Babu S, Varma H, John A, Abraham A. 3D-bulk to nanoforms of modified hydroxyapatite: Characterization and osteogenic potency in an in vitro 3D bone model system. *J Biomed Mater Res B Appl Biomater*. 2022 May;110(5):1151-1164.
209. Mini GK, Thankappan KR. Reply to letter to the editor titled: Generalizability of hypertension risk factors and achieving blood pressure control in educator populations in India. *Indian Heart J*. 2021 Mar-Apr;73(2):255.
210. Sekar S, Rudrabhatla P, Selvasadan V, Thomas B, Kesavadas C. Teaching NeuroImages: Ohtahara Syndrome due to Unilateral Perisylvian Polymicrogyria. *Neurology*. 2021 May 11;96(19):e2456-e2457.
211. Rajalekshmi Resmi, Dr. Jayasree





- Parvathy, Ramakrishna Perumal Saravana, Dr. Gijo Raj, Dr. Roy Joseph. Biosynthesized Nanosilver from Alginate Dialdehyde: An In Vitro Evaluation. Volume 6, Issue 43, November 22, 2021, Pages 12007-12017.
212. Poonia A, Giridhara P, Sheoran D. Cutaneous Manifestations in Homozygous Familial Hypercholesterolemia. *Am J Med Sci*. 2021 May;361(5):e49-e50.
213. Poonia A, Giridhara P. Timing for repair in outflow ventricular septal defect with aortic insufficiency. *Ann Thorac Surg*. 2021 Sep 25:S0003-4975(21)01656-8.
214. Harikrishnan, V., Shenoy, S., Ranaraj, V., Sukhija, S., & Oloyo, A. (2022). A report on less-severe, long-duration persistent hind-limb ischemia surgical rabbit model. *Journal of the Hellenic Veterinary Medical Society*, 72(4), 3455–3462.
215. Nagendra V, Praveen R, Hrishikesh AP, Sethuraman M. Non-operating room anaesthesia for a child with Beckwith Wiedemann syndrome with a history of congenital laryngomalacia. *Indian J Anaesth*. 2021 Jul;65(7):559-561.
216. Thulaseedharan JV, Sarma PS, Thankappan KR, Soman B, Varma RP, Srinivasan K, Nair MR, Jeemon P, Kutty VR. Consumption of fruits, vegetables and salt in the context of control of type 2 diabetes and hypertension in Kerala, India. *J Family Med Prim Care*. 2021 Jul;10(7):2646-2654.
217. Vinayagamani S, Sekar S, Thomas B, Kesavadas C. Neuroimaging in CEDNIK Syndrome: A Rare Neuro-Ichthyosis. *Neurol India*. 2022 Mar-Apr;70(2):818-819.
218. Shrivastava A, Mishra R, Nair A, Nair S. Endoscopic-Assisted Microsurgery for Vestibular Schwannomas: Operative Nuances. *Neurol India*. 2021 May-Jun;69(3):578-581.
219. Ramasamy S, Muthusamy S, Nagarajan S, Nath AV, Savarimuthu JS, Jayaprakash J, Gurunadhan RM. Fabrication of collagen with polyhexamethylene biguanide: A potential scaffold for infected wounds. *J Biomed Mater Res B Appl Biomater*. 2022 Mar;110(3):535-546.
220. Chandarana M, Saraf U, Divya KP, Krishnan S, Kishore A. Myoclonus- A Review. *Ann Indian Acad Neurol*. 2021 May-Jun;24(3):327-338.
221. S. Niyas, S. Chethana Vaisali, Iwrin Show, T.G. Chandrika, S. Vinayagamani, Chandrasekharan Kesavadas, Jeny Rajan, Segmentation of focal cortical dysplasia lesions from magnetic resonance images using 3D convolutional neural networks, *Biomedical Signal Processing and Control*, Volume 70, 2021, 102951.
222. Mishra R, Konar SK, Shrivastava A, Agrawal A, Nair S. Systematic scoping review of papilledema in vestibular schwannoma without hydrocephalus. *Br J Neurosurg*. 2022 Feb 17:1-10.
223. G R, Wilson J, V Thomas L, Nair PD. Assessing the 3D Printability of an Elastomeric Poly(caprolactone-co-lactide) Copolymer as a Potential Material for 3D Printing Tracheal Scaffolds. *ACS Omega*. 2022 Feb 20;7(8):7002-7011.
224. Mani A, Mishra G, Kulkarni S, Gupta D. D-phenotype due to RHD-RHCE hybrid transcript in a case of severe haemolytic disease of newborn with anti-Rh 17(Hr) antibodies. *Transfus Med*. 2021 Oct;31(5):383-386.
225. Thomas SV, Jeemon P, Jose M, Amrithum LM, Bhaskar D, Nair MKC, George B. Differential impact of antenatal exposure to antiseizure medications on motor and mental development in infants of women with epilepsy. *Epileptic Disord*. 2022 Jun 1;24(3):531-540.
226. Rajalakshmi S, Varma RP. Financial incentives





and dietary modification for TB patients. *Int J Tuberc Lung Dis.* 2021 Jun 1;25(6):508-510.

227. Ajayan N, Hrishi AP. How balanced is the BALANCED delirium trial? Comment on *Br J Anaesth* 2021; 127: 704-12. *Br J Anaesth.* 2022 Apr;128(4):e274-e275.

228. Kachhara R, Nair S, Nigam P. Ophthalmic Segment Aneurysms: Surgical Treatment and Outcomes. *J Neurosci Rural Pract.* 2021 Sep 30;12(4):635-641.

229. Mini GK, Mohan M, Sarma PS, Thankappan KR. Multi-morbidity and blood pressure control: Results of a cross-sectional study among school teachers in Kerala, India. *Indian J Public Health.* 2021 Apr-Jun;65(2):190-193.

230. Chandrasekharan SV, Menon RN, Nanda S, Nair JS, Radhakrishnan A, Cherian A, Thomas SV. Does Etiology and Hypsarrhythmia Subtype Influence Outcome in West Syndrome? Challenges Encountered from a Referral Center Perspective. *Neurol India.* 2022 Jan-Feb;70(1):188-196.

231. Pandey HK, Gopalakrishnan A, Deepti AN, Saxena S, Radhakrishnan BK. An Intracardiac Pathology Mimicking Cardiac Tamponade. *Acta Cardiol Sin.* 2022 Jan;38(1):93-95.

232. Devarakonda BV, Garre S, Suneel PR, Babu S, Koshy T. To Be Removed or Not? Intraoperative Transesophageal Echocardiography Evaluation of Coronary Ostial Stent Protruding Into the Aorta. *J Cardiothorac Vasc Anesth.* 2022 Jan;36(1):226-230.

233. Dubey MK, Mani A, Ojha V. Causal Relationship of the Transverse Left Ventricular Band and Bicuspid Aortic Valve. *Sultan Qaboos Univ Med J.* 2021 Aug;21(3):403-407.

234. Biomarkers in the Prediction of Hemorrhagic Transformation in Acute Stroke: A Systematic Review and Meta-Analysis. Krishnamoorthy S.a , Singh G.b , Jose K J.c , Soman B.b , Foerch C.d, Kimberly W.T.e, Millán M.f, wito ska M.g, Maestrini I.h,I, Bordet R.i Malhotra K.j , Mechtouff L.k , Sylaja P.N.a *Cerebrovasc Dis* 2022;51:235–247.

235. Rajeswari Krishnankutty A, Najeema Sulaiman S, Sadasivan A, Joseph R, Komath M. Porous membranes of quaternized chitosan composited with strontium-based nanobioceramic for periodontal tissue regeneration. *J Biomater Appl.* 2022 Feb;36(7):1254-1268. (259)

236. Mol B, Beeran AE, Jayaram PS, Prakash P, Jayasree RS, Thomas S, Chakrapani B, Anantharaman MR, Bushiri MJ. Radio frequency plasma assisted surface modification of Fe<sub>3</sub>O<sub>4</sub> nanoparticles using polyaniline/polypyrrole for bioimaging and magnetic hyperthermia applications. *J Mater Sci Mater Med.* 2021 Aug 25;32(9):108. doi: 10.1007/s10856-021-06563-1.

237. Menon RN, Nambiar PN, Keni RR, Baishya J, Radhakrishnan A, Cherian A, Nampoothiri S, Madhavilatha GK, Kotecha UH, Thomas SV. Drug-resistant 'Non-Lesional' Visual Sensitive Epilepsies of Childhood - Electroclinical Phenotype-Genotype Associations. *Neurol India.* 2021 Nov-Dec;69(6):1701-1705.

238. Jeemon P, Harikrishnan S, Ganapathi S, Sivasankaran S, Binukumar B, Padmanabhan S, Tandon N, Prabhakaran D. Efficacy of a family-based cardiovascular risk reduction intervention in individuals with a family history of premature coronary heart disease in India (PROLIFIC): an open-label, single-centre, cluster randomised controlled trial. *Lancet Glob Health.* 2021 Oct;9(10):e1442-e1450.

239. Paul M, Sugath BS, P S, Np P, Nair SG, Rajasekharan R. Synchronous Primary Multifocal Skeletal Chondrosarcoma of Extremity: A Report of 2 Cases. *JBJS Case Connect.* 2022 Feb 16;12(1).





240. Indu PV, Beegum MS, Ka Kumar, Sarma PS, Vidhukumar K. Validation of Malayalam Version of Everyday Abilities Scale for India. *Indian J Psychol Med.* 2021 Jul;43(4):325-329.
241. KBM, Nayar SA, PVM. Vaccine and vaccination as a part of human life: In view of COVID-19. *Biotechnol J.* 2022 Jan;17(1):e2100188.
242. Nuzrath Jahan, Adarsha Brahma, Muthusamy Santhosh Kumar, Bhavani Shankara Bagepally, Manickam Ponnaiah, Tarun Bhatnagar, Manoj V Murhekar, Seroprevalence of IgG antibodies against SARS-CoV-2 in India, March 2020 to August 2021: a systematic review and meta-analysis, *International Journal of Infectious Diseases*, Volume 116, 2022, Pages 59-67.
243. Pradhan T, Kumar V, Surya H E, Krishna R, John S, Jissa VT, Anjana S, Chandramohan K, Nair SA. STIL Endows Oncogenic and Stem-Like Attributes to Colorectal Cancer Plausibly by Shh and Wnt Signaling. *Front Oncol.* 2021 Aug 12;11:581671.
244. Jibin K, Victor M, Saranya G, Santhakumar H, Murali V, Maiti KK, Jayasree RS. Nanohybrids of Magnetically Intercalated Optical Metamaterials for Magnetic Resonance/Raman Imaging and In Situ Chemodynamic/Photothermal Therapy. *ACS Appl Bio Mater.* 2021 Jul 19;4(7):5742-5752.
245. Prasad K, George A, Ravi NS, Mohankumar KM. CRISPR/Cas based gene editing: marking a new era in medical science. *Mol Biol Rep.* 2021 May;48(5):4879-4895. doi: 10.1007/s11033-021-06479-7.
246. Kurien SS, David RS, Chellappan AK, Varma RP, Pillai PR, Yadev I. Clinical Profile and Determinants of Mortality in Patients With COVID-19: A Retrospective Analytical Cross-Sectional Study in a Tertiary Care Center in South India. *Cureus.* 2022 Mar 12;14(3):e23103.
247. Vijayan B, Ramanathan M, Rangamani S, Joe W, Gopinathan S, Mishra US. Treatment and rehabilitation of stroke patients in India: A gendered analysis based on repeated cross-sectional national sample surveys on health, 2014 and 2019. *Health Care Women Int.* 2021 Nov;42(11):1237-1254.
248. Kumar B, Agstam S, Vijay J, Batta A. Long term safety and efficacy of the Yukon Choice Flex sirolimus-eluting coronary stent-a real-world data from India. *Indian Heart J.* 2021 Nov-Dec;73(6):733-736.
249. Gangadharan N, Venkatachalapathi A, Jebaraj B, Zachariah SM, Devasahayam S, Saravana Kumar G, Subramani S. Electrical modelling of tissue experiments confirms precise locations of resistance and compliance in systemic arterial tree-they are mutually exclusive. *Clin Exp Pharmacol Physiol.* 2022 Feb;49(2):242-253.
250. Scaria L, Soman B, George B, Ahamed Z, Hariharan S, Jeemon P. Determinants of very low birth weight in India: The National Family Health Survey - 4. *Wellcome Open Res.* 2022 May 17;7:20.
251. Rahul A, Saini P, Valampampil MJ, Singh G, Suresh MM, Prajitha KC, Jose MS, Nair ANKK, Ananth M, Sreekanth KB, Sujatha C, Kumar NP, Indu PS, Anish TS. Epidemiological and clinical characterization of dengue virus serotypes during 2017-2019 in southern Kerala, India. *Trans R Soc Trop Med Hyg.* 2022 Feb 10:trac001.
252. Balakrishnan B, Payanam U, Laurent A, Wassef M, Jayakrishnan A. Efficacy evaluation of an in situ forming tissue adhesive hydrogel as sealant for lung and vascular injury. *Biomed Mater.* 2021 May 11;16(4).
253. Madhusudhan KS, Jineesh V, Keshava SN. Indian College of Radiology and Imaging Evidence-Based Guidelines for Percutaneous Image-Guided Biliary Procedures. *Indian J Radiol Imaging.* 2021 Apr;31(2):421-440.



254. Zujum ZT, Valampampil MJ, Rajagopal MR, Rahul A, Siju NS, Prajitha KC. Efficacy of 2% lignocaine medicated pad for pain alleviation during rabies immunoglobulin administration: A randomized controlled trial. *Indian J Public Health*. 2021 Oct-Dec;65(4):356-361.
255. Dain CP, Ganapathi S, Geevar Z, Harikrishnan S, Ammu JV, Chacko M. The traditional and modifiable risk factors of coronary artery disease - a community-based cross-sectional study among 2 populations. *Medicine (Baltimore)*. 2021 Oct 1;100(39):e27350.
256. Paplikar A, Alladi S, Varghese F, Mekala S, Arshad F, Sharma M, Saroja AO, Divyaraj G, Dutt A, Ellajosyula R, Ghosh A, Iyer GK, Sunitha J, Kandukuri R, Kaul S, Khan AB, Mathew R, Menon R, Nandi R, Narayanan J, Nehra A, Padma MV, Pauranik A, Ramakrishnan S, Sarath L, Shah U, Tripathi M, Sylaja PN, Varma RP, Verma M, Vishwanath Y; ICMR-NCTB Consortium. Bilingualism and Its Implications for Neuropsychological Evaluation. *Arch Clin Neuropsychol*. 2021 Mar 27;acab012.
257. Joseph S, Panniyammakal J, Abdullakutty J, S S, Vaikathuseril L J, Joseph J, Mattummal S, Punnose E, Unni G, Natesan S, Sivadasanpillai H. The Cardiology Society of India-Kerala Acute Heart Failure Registry: poor adherence to guideline-directed medical therapy. *Eur Heart J*. 2021.
258. Quadros S, Garg S, Ranjan R, Vijayasarithi G, Mamun MA. Fear of COVID 19 Infection Across Different Cohorts: A Scoping Review. *Front Psychiatry*. 2021 Sep 7;12:708430.(287)
259. Saheera S, Potnuri AG, Guha A, Palaniyandi SS, Thandavarayan RA. Histamine 2 receptors in cardiovascular biology: A friend for the heart. *Drug Discov Today*. 2022 Jan;27(1):234-245.
260. Menon J, Numpeli M, Kunjan SP, Karimbuvayilil BV, Sreedevi A, Panniyammakal J, Suseela RP, Thachathodiyil R, Banerjee A. A Sustainable Community-Based Model of Noncommunicable Disease Risk Factor Surveillance (Shraddha-Jagrithi Project): Protocol for a Cohort Study. *JMIR Res Protoc*. 2021 Oct 22;10(10):e27299.
261. Venketasubramanian N, Pandian J, Sylaja PN, Bhatia R, Yoon BW, Tan KS. Asia Pacific Stroke Conference 2021: Stroke Care in Challenging Times. *Cerebrovasc Dis*. 2021;50 Suppl 1:III-VI.
262. Kishore A, James P, Popa T, Thejaus A, Rajeswari P, Sarma G, Krishnan S, Meunier S. Plastic responsiveness of motor cortex to paired associative stimulation depends on cerebellar input. *Clin Neurophysiol*. 2021 Oct;132(10):2493-2502.
263. Ramanathan M, Tiwari RK, Mohan SP, Shankar DP, Bagadia RK, Varma PRH, Fernandez FB, Babu SS. Utility of Chitra-HASi Granules in Cystic Defects of the Maxillofacial Region: A Pilot Study. *J Pharm Bioallied Sci*. 2021 Jun;13(Suppl 1):S772-S777.
264. Abraham SV, Melit RJ, Krishnan SV, George T, Kunhahamed MO, Kassiyap CK, Bhoi S, Sinha TP. Indigenously Developed Ultrasound Phantom Model versus a Commercially Available Training Model: Randomized Double-blinded Study to Assess Its Utility to Teach Ultrasound Guided Vascular Access in a Controlled Setting. *J Med Ultrasound*. 2022 Mar 23;30(1):11-19.
265. Namboodiri N, Bhargava K, Padmanabhan D, Selvaraj R, Pandurangi U, Arora V, Chaturvedi V, Nabar A, Udyavar A, Yadave RD, Lokhandwala Y. Consensus statement on cardiac electrophysiology practices during the coronavirus disease 2019 (COVID-19) pandemic: From the Indian Heart Rhythm Society. *Indian Pacing Electrophysiol J*. 2021 Sep-Oct;21(5):281-290.
266. Singh Bhalla G, Grover N, Singh G, Kumar M, Bhatt P, Singh Sarao M, Mishra D. Prevalence of non tuberculous mycobacterial infection



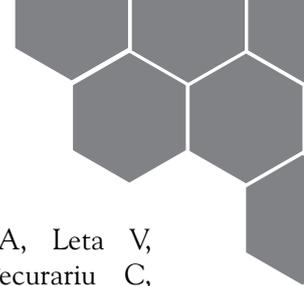


- in surgical site infections and their antibiotic susceptibility profile. *Med J Armed Forces India*. 2021 Jul;77(3):343-348.
267. Samandi G, Gupta V, Mohan N, McHugh P, Berkland C, Detamore M, Lohfeld S. Polymer-coated microparticle scaffolds engineered for potential use in musculoskeletal tissue regeneration. *Biomed Mater*. 2021 May 24;16(4).
268. Vinny PW, Takkar A, Lal V, Padma MV, Sylaja PN, Narasimhan L, Dwivedi SN, Nair PP, Iype T, Gupta A, Vishnu VY. Mobile application as a complementary tool for differential diagnosis in Neuro-ophthalmology: A multicenter cross-sectional study. *Indian J Ophthalmol*. 2021 Jun;69(6):1491-1497.
269. Titus AS, Venugopal H, Ushakumary MG, Wang M, Cowling RT, Lakatta EG, Kailasam S. Discoidin Domain Receptor 2 Regulates AT1R Expression in Angiotensin II-Stimulated Cardiac Fibroblasts via Fibronectin-Dependent Integrin-1 Signaling. *Int J Mol Sci*. 2021 Aug 28;22(17):9343.
270. Narayanan N, Kim JH, Santhakumar H, Joseph MM, Karunakaran V, Shamjith S, Saranya G, Sujai PT, Jayasree RS, Barman I, Maiti KK. Nanotheranostic Probe Built on Methylene Blue Loaded Cucurbituril [8] and Gold Nanorod: Targeted Phototherapy in Combination with SERS Imaging on Breast Cancer Cells. *J Phys Chem B*. 2021 Dec 16;125(49):13415-13424.
271. Malhotra N, Koshy T, Bhatia P, Datta R, Jain D, Koppal R. The changing face of postgraduate anaesthesia teaching curriculum: Need of the hour! *Indian J Anaesth*. 2022 Jan;66(1):15-19. doi: 10.4103/ija.ija\_1116\_21.
272. Gnanaraj JP, Princy SA, Sliwa-Hahnle K, Sathyendra S, Jeyabalan N, Sethumadhavan R, G S, Sumathi N, S V, P P, Murali V, B S, T G, P M, Jeemon P, Elavarasi E, R R, S V, K K; TNPHDR investigators. Tamil Nadu Pregnancy and Heart Disease Registry (TNPHDR): design and methodology. *BMC Pregnancy Childbirth*. 2022 Jan 29;22(1):80.
273. Sivakumar K, Sagar P, Qureshi S, Promphan W, Sasidharan B, Awasthy N, Kappanayil M, Suresh PV, Koneti NR. Outcomes of Venus P-valve for dysfunctional right ventricular outflow tracts from Indian Venus P-valve database. *Ann Pediatr Cardiol*. 2021 Jul-Sep;14(3):281-292.
274. Steinbrenner M, Duncan JS, Dickson J, Rathore C, Wächter B, Aygun N, Menon RN, Radhakrishnan A, Holtkamp M, Ilyas-Feldmann M. Utility of 18F-fluorodeoxyglucose positron emission tomography in presurgical evaluation of patients with epilepsy: A multicenter study. *Epilepsia*. 2022 May;63(5):1238-1252.
275. Kulkarni S, Mishra G, Maru H, Parchure D, Gupta D, Bajaj AK, Sindhwani SP, Chaphekar A, Shah R, Férec C, Madkaikar M, Fichou Y. Molecular characterization of rare D-/D- variants in individuals of Indian origin. *Blood Transfus*. 2022 Jan;20(1):59-65.
276. Thanopoulos BVD, Soendergaard L, Ngugen HL, Marasini M, Giannopoulos A, Bompotis GC, Thonghong T, Krishnamoorthy KM, Placid S, Deleanou D, Toutouzas KP. International experience with the use of Cocoon septal occluder for closure of atrial septal defects. *Hellenic J Cardiol*. 2021 May-Jun;62(3):206-211.
277. Devarakonda BV, Goel A, Singh S, Kumar Sreevastava D, Vadapalli K, Mohan Reddy M. Efficacy of evidence-based institutional protocol for prevention of postoperative nausea and vomiting: A prospective observational study. *Med J Armed Forces India*. 2022 Jan;78(1):36-41.
278. Luginbühl J, Kouno T, Nakano R, Chater TE, Sivaraman DM, Kishima M, Roudnický F, Carninci P, Plessy C, Shin JW. Decoding Neuronal Diversification by Multiplexed Single-cell RNA-Seq. *Stem Cell Reports*. 2021 Apr 13;16(4):810-824.



279. Yavagal DR, Saini V, Inoa V, Gardener HE, Martins SO, Fakey M, Ortega S, Mansour O, Leung T, Al-Mufti F, Jadhav AP, Potter-Vig J, Mairal A, Zhongrong M, Sylaja PN, Demchuk AM; MT2020 Global Executive Committee. International Survey of Mechanical Thrombectomy Stroke Systems of Care During COVID-19 Pandemic. *J Stroke Cerebrovasc Dis.* 2021 Aug;30(8):105806. doi: 10.1016/j.jstrokecerebrovasdis.2021.
280. Ravi NS, Wienert B, Wyman SK, Bell HW, George A, Mahalingam G, Vu JT, Prasad K, Bandlamudi BP, Devaraju N, Rajendiran V, Syedbasha N, Pai AA, Nakamura Y, Kurita R, Narayanasamy M, Balasubramanian P, Thangavel S, Marepally S, Velayudhan SR, Srivastava A, DeWitt MA, Crossley M, Corn JE, Mohankumar KM. Identification of novel HPFH-like mutations by CRISPR base editing that elevate the expression of fetal hemoglobin. *Elife.* 2022 Feb 11;11:e65421.
281. Kondal D, Jeemon P, Manimunda S, Narayanan G, Purty AJ, Negi PC, Ladhani SS, Sanghvi J, Singh K, Deshpande A, Sobti N, Toteja GS, Prabhakaran D; DISHA study investigators †. Structured Lifestyle Modification Interventions Involving Frontline Health Workers for Population-Level Blood Pressure Reduction: Results of a Cluster Randomized Controlled Trial in India (DISHA Study). *J Am Heart Assoc.* 2022 Mar 15;11(6):e023526.
282. Cao Y, Huynh Q, Kapoor N, Jeemon P, Mello GT, Oldenburg B, Thankappan KR, Sathish T. Associations between Dietary Patterns and Cardiometabolic Risk Factors-A Longitudinal Analysis among High-Risk Individuals for Diabetes in Kerala, India. *Nutrients.* 2022 Feb 4;14(3):662.
283. Mini GK, Sathish T, Sarma PS, Thankappan KR. Effectiveness of a School-Based Educational Intervention to Improve Hypertension Control Among Schoolteachers: A Cluster-Randomized Controlled Trial. *J Am Heart Assoc.* 2022 Jan 18;11(2):e023145.
284. Verma M, Tripathi M, Nehra A, Paplikar A, Varghese F, Alladi S, Narayanan J, Dhaliwal RS, Sharma M, Saroja AO, Arshad F, Divyaraj G, Ghosh A, Manae TS, Mekala S, Menon RN, Hooda R, Iyer GK, Sunitha J, Kandukuri R, Kaul S, Khan AB, Mathew R, Nandi R, Padma MV, Pauranik A, Ramakrishnan S, Sarath L, Shah U, Sylaja PN, Varma RP, Vishwanath Y. Validation of ICMR Neurocognitive Toolbox for Dementia in the Linguistically Diverse Context of India. *Front Neurol.* 2021 Oct 18;12:661269.
285. Jones SP, Baqai K, Clegg A, Georgiou R, Harris C, Holland EJ, Kalkonde Y, Lightbody CE, Maulik PK, Srivastava PM, Pandian JD, Kulsum P, Sylaja PN, Watkins CL, Hackett ML. Stroke in India: A systematic review of the incidence, prevalence, and case fatality. *Int J Stroke.* 2022 Feb;17(2):132-140.
286. Kumar A, Chauhan G, Sharma S, Dabla S, Sylaja PN, Chaudhary N, Gupta S, Agrawal CS, Anand KS, Srivastava AK, Vibha D, Sagar R, Raj R, Maheshwari A, Vivekanandhan S, Kaul B, Raghavan S, Gorthi SP, Mohania D, Kaushik S, Yadav RK, Hazarika A, Sharma P, Prasad K. Association of SUMOylation Pathway Genes With Stroke in a Genome-Wide Association Study in India. *Neurology.* 2021 Jul 27;97(4):e345-e356.
287. India State-Level Disease Burden Initiative Neurological Disorders Collaborators. The burden of neurological disorders across the states of India: the Global Burden of Disease Study 1990-2019. *Lancet Glob Health.* 2021 Aug;9(8):e1129-e1144.
288. Bhatia R, Padma Srivastava MV, Sylaja PN, Komakula S, Upadhyay A, Pardasani V, Iype T, Parthasarathy R, Reddy R, Kushwaha S, Roy J, Satish P, Trikha A, Wig N, Dhar L, Vibha D, Vishnu VY, Pandit AK, Gupta A, Elavarasi A, Agarwal A, Gupta V, Singh RK, Oza H, Halani H, Ramachandran D, George GB, Panicker P, Suresh MK, Kumaravelu S, Khurana D, Rajendran SP, Pamidimukkala V, Gupta S,





- Pandian JD, Chowdhury D, Rai NK, Sharma A, Nambiar VK. Clinical Features and Outcome of Stroke with COVID-19. COVID-19 Stroke Study Group (CSSG), India. *Ann Indian Acad Neurol.* 2021 Sep-Oct;24(5):668-685.
289. Bhatia R, Sylaja PN, Srivastava MVP, Komakula S, Iype T, Parthasarathy R, Khurana D, Pardasani V, Pamidimukkala V, Kumaravelu S, Pandian J, Kushwaha S, Chowdhury D, Gupta S, Rajendran SP, Reddy R, Roy J, Sharma A, Nambiar V, Rai NK, Upadhyay AD, Parkipandla S, Singh MB, Vibha D, Vishnu VY, Rajan R, Gupta A, Pandit AK, Agarwal A, Gaikwad SB, Garg A, Joseph L, Sreedharan SE, Reddy S, Sreela K, Ramachandran D, George GB, Panicker P, Suresh MK, Gupta V, Ray S, Suri V, Ahuja C, Kajal K, Lal V, Singh RK, Oza H, Halani H, Sanivarapu S, Sahonta R, Duggal A, Dixit P, Kulkarni GB, Taallapalli AVR, Parmar M, Chalasani V, Kashyap M, Misra B, Pachipala S, Yogeesh PM, Salunkhe M, Gupta P; COVID-19 Stroke Study Group (CSSG) India. Clinical profile and outcome of non-COVID strokes during pandemic and the pre pandemic period: COVID-Stroke Study Group (CSSG) India. *J Neurol Sci.* 2021 Sep 15;428:117583.
290. Krishnan A, Mathur P, Kulothungan V, Salve HR, Leburu S, Amarchand R, Nongkynrih B, Chaturvedi HK, Ganeshkumar P, K S VU, Laxmaiah A, Boruah M, Kumar S, Patro BK, Raghav PR, Rajkumar P, Sarma PS, Sharma R, Tambe M, Arlappa N, Mahanta TG, Bhuyan PJ, Joshi RP, Pakhare AP, Galhotra A, Kumar D, Behera BK, Topno RK, Gupta MK, Rustagi N, Trivedi AV, Thankappan KR, Gupta S, Garg S, Shelke SC; ICMR-NNMS investigator group; Co-investigators; Collaborators. Preparedness of primary and secondary health facilities in India to address major noncommunicable diseases: results of a National Noncommunicable Disease Monitoring Survey (NNMS). *BMC Health Serv Res.* 2021 Jul 31;21(1):757.
291. van Wamelen DJ, Sauerbier A, Leta V, Rodriguez-Blazquez C, Falup-Pecurariu C, Rodriguez-Violante M, Rizos A, Tsuboi Y, Metta V, Bhidayasiri R, Bhattacharya K, Borgohain R, Prashanth LK, Rosales R, Lewis S, Fung V, Behari M, Goyal V, Kishore A, Lloret SP, Martinez-Martin P, Chaudhuri KR. Cross-sectional analysis of the Parkinson's disease Non-motor International Longitudinal Study baseline non-motor characteristics, geographical distribution and impact on quality of life. *Sci Rep.* 2021 May 5;11(1):9611.
292. Garg D, Dhamija RK, Choudhary A, Shree R, Kumar S, Samal P, Pathak A, Vijaya P, Sireesha Y, Nair SS, Sharma S, Desai S, Sinha HP, Agarwal A, Upadhyay A, Padma Srivastava MV, Bhatia R, Pandit AK, Singh RK, Reyaz A, Yogeesh PM, Salunkhe M, Lal V, Modi M, Singh G, Singla M, Panda S, Gopalakrishnan M, Puri I, Sharma S, Kumar B, Kushwaha PK, Chovatiya H, Ferreira T, Bhoi SK, Bhartiya M, Kaul S, Patil A, Mathukumalli NL, Nagappa M, Sharma PP, Basheer A, Ramachandran D, Balaram N, Sebastian J, Vishnu VY; GBS consortium. Impact of the COVID-19 Pandemic on the Frequency, Clinical Spectrum and Outcomes of Pediatric Guillain-Barré Syndrome in India: A Multicentric Ambispective Cohort Study. *Ann Indian Acad Neurol.* 2022 Jan-Feb;25(1):60-67.
293. Karabegovi I, Portilla-Fernandez E, Li Y, Ma J, Maas SCE, Sun D, Hu EA, Kühnel B, Zhang Y, Ambatipudi S, Fiorito G, Huang J, Castillo-Fernandez JE, Wiggins KL, de Klein N, Grioni S, Swenson BR, Polidoro S, Treur JL, Cuenin C, Tsai PC, Costeira R, Chajes V, Braun K, Verweij N, Kretschmer A, Franke L, van Meurs JBJ, Uitterlinden AG, de Knecht RJ, Ikram MA, Dehghan A, Peters A, Schöttker B, Gharib SA, Sotoodehnia N, Bell JT, Elliott P, Vineis P, Relton C, Herceg Z, Brenner H, Waldenberger M, Rebholz CM, Voortman T, Pan Q, Fornage M, Levy D, Kayser M, Ghanbari M. Epigenome-wide association meta-analysis of DNA methylation with coffee and tea consumption. *Nat Commun.* 2021 May 14;12(1):2830.



294. Riddell MA, Mini GK, Joshi R, Thrift AG, Guggilla RK, Evans RG, Thankappan KR, Chalmers K, Chow CK, Mahal AS, Kalyanram K, Kartik K, Suresh O, Thomas N, Maulik PK, Srikanth VK, Arabshahi S, Varma RP, D'Esposito F, Oldenburg B. ASHA-Led Community-Based Groups to Support Control of Hypertension in Rural India Are Feasible and Potentially Scalable. *Front Med (Lausanne)*. 2021 Nov 22;8:771822.
295. Rosenthal VD, Duszynska W, Ider BE, Gurskis V, Al-Ruzzieh MA, Myatra SN, Gupta D, Belkebir S, Upadhyay N, Zand F, Todi SK, Kharbanda M, Nair PK, Mishra S, Chaparro G, Mehta Y, Zala D, Janc J, Aguirre-Avalos G, Aguilar-De-Morós D, Hernandez-Chena BE, Gün E, Oztoprak-Cuvalci N, Yildizdas D, Abdelhalim MM, Ozturk-Deniz SS, Gan CS, Hung NV, Joudi H, Omar AA, Gikas A, El-Kholy AA, Barkat A, Koirala A, Cerero-Gudiño A, Bouziri A, Gomez-Nieto K, Fisher D, Medeiros EA, Salgado-Yepez E, Horhat F, Agha HMM, Vimercati JC, Villanueva V, Jayatilleke K, Nguyet LTT, Raka L, Miranda-Novales MG, Petrov MM, Apisarntharak A, Tayyab N, Elahi N, Mejia N, Morfin-Otero R, Al-Khawaja S, Anguseva T, Gupta U, Belskii VA, Mat WRW, Chapeta-Parada EG, Guanche-Garcell H, Barahona-Guzmán N, Mathew A, Raja K, Pattnaik SK, Pandya N, Poojary AA, Chawla R, Mahfouz T, Kanj SS, Mioljevic V, Hlinkova S, Mrazova M, Al-Abdely HM, Guclu E, Ozgultekin A, Baytas V, Tekin R, Yalçın AN, Erben N. International Nosocomial Infection Control Consortium (INICC) report, data summary of 45 countries for 2013-2018, Adult and Pediatric Units, Device-associated Module. *Am J Infect Control*. 2021 Oct;49(10):1267-1274.
296. Nguyen TN, Qureshi MM, Klein P, Yamagami H, Abdalkader M, Mikulik R, Sathya A, Mansour OY, Czlonkowska A, Lo H, Field TS, Charidimou A, Banerjee S, Yaghi S, Siegler JE, Sedova P, Kwan J, de Sousa DA, Demeestere J, Inoa V, Omran SS, Zhang L, Michel P, Strambo D, Marto JP, Nogueira RG; SVIN COVID-19 Global COVID Stroke Registry, Kristoffersen ES, Tsivgoulis G, Lereis VP, Ma A, Enzinger C, Gattringer T, Rahman A, Bonnet T, Ligot N, De Raedt S, Lemmens R, Vanacker P, Vandervorst F, Conforto AB, Hidalgo RCT, Mora Cuervo DL, de Oliveira Neves L, Lameirinhas da Silva I, Martins RT, Rebello LC, Santiago IB, Sakelarova T, Kalpachki R, Alexiev F, Cora EA, Kelly ME, Peeling L, Pikula A, Chen HS, Chen Y, Yang S, Roje Bedekovic M, abal M, Tenora D, Fibrich P, Dušek P, Hlavá ová H, Hrabanovska E, Jurák L, Kadl íková J, Karpowicz I, Kle ka L, Ková M, Neumann J, Paloušková H, Reiser M, Rohan V, Šim nek L, Skoda O, Škor a M, Šrámek M, Drenck N, Sobh K, Lesaine E, Sabben C, Reiner P, Rouanet F, Strbian D, Boskamp S, Mbroh J, Nagel S, Rosenkranz M, Poli S, Thomalla G, Karapanayiotides T, Koutroulou I, Kargiotis O, Palaiodimou L, Barrientos Guerra JD, Huded V, Nagendra S, Prajapati C, Sylaja PN, Sani AF, Ghoreishi A, Farhoudi M, Sadeghi Hokmabadi E, Hashemilar M, Sabetay SI, Rahal F, Acampa M, Adami A, Longoni M, Ornello R, Renieri L, Romoli M, Sacco S, Salmaggi A, Sangalli D, Zini A, Sakai K, Fukuda H, Fujita K, Imamura H, Kosuke M, Sakaguchi M, Sonoda K, Matsumaru Y, Ohara N, Shindo S, Takenobu Y, Yoshimoto T, Toyoda K, Uwatoko T, Sakai N, Yamamoto N, Yamamoto R, Yazawa Y, Sugiura Y, Baek JH, Lee SB, Seo KD, Sohn SI, Lee JS, Arsovska AA, Chieh CY, Wan Zaidi WA, Wan Yahya WNN, Gongora-Rivera F, Martinez-Marino M, Infante-Valenzuela A, Dippel D, van Dam-Nolen DHK, Wu TY, Punter M, Adebayo TT, Bello AH, Sunmonu TA, Wahab KW, Sundseth A, Al Hashmi AM, Ahmad S, Rashid U, Rodriguez-Kadota L, Vences MÁ, Yalung PM, Dy JSH, Brola W, D bic A, Dorobek M, Karlinski MA, Labuz-Roszak BM, Lasek-Bal A, Sienkiewicz-Jarosz H, Staszewski J, Sobolewski P, Wi cek M, Zielinska-Turek J, Araújo AP, Rocha M, Castro P, Ferreira P, Nunes AP, Fonseca L, Pinho E Melo T, Rodrigues M, Silva ML, Ciopleias B, Dimitriade A, Falup-Pecurariu C, Hamid MA, Venketasubramanian





- N, Krastev G, Haring J, Ayo-Martin O, Hernandez-Fernandez F, Blasco J, Rodríguez-Vázquez A, Cruz-Culebras A, Moniche F, Montaner J, Perez-Sanchez S, García Sánchez MJ, Guillán Rodríguez M, Bernava G, Bolognese M, Carrera E, Churojana A, Aykac O, Özdemir AÖ, Bajrami A, Senadim S, Hussain SI, John S, Krishnan K, Lenthall R, Asif KS, Below K, Biller J, Chen M, Chebl A, Colasurdo M, Czap A, de Havenon AH, Dharmadhikari S, Eskey CJ, Farooqui M, Feske SK, Goyal N, Grimmert KB, Guzik AK, Haussen DC, Hovingh M, Jillela D, Kan PT, Khatri R, Khoury NN, Kiley NL, Kolikonda MK, Lara S, Li G, Linfante I, Loochtan AI, Lopez CD, Lycan S, Male SS, Nahab F, Maali L, Masoud HE, Min J, Orgeta-Gutierrez S, Mohamed GA, Mohammaden M, Nalleballe K, Radaideh Y, Ramakrishnan P, Rayo-Taranto B, Rojas-Soto DM, Ruland S, Simpkins AN, Sheth SA, Starosciak AK, Tarlov NE, Taylor RA, Voetsch B, Zhang L, Duong HQ, Dao VP, Le HV, Pham TN, Ton MD, Tran AD, Zaidat OO, Machi P, Dirren E, Rodríguez Fernández C, Escartín López J, Fernández Ferro JC, Mohammadzadeh N, Suryadevara NC, de la Cruz Fernández B, Bessa F, Jancar N, Brady M, Scozzari D. Global Impact of the COVID-19 Pandemic on Cerebral Venous Thrombosis and Mortality. *J Stroke*. 2022 May;24(2):256-265. doi: 10.5853/jos.2022.00752.
297. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. *Lancet*. 2021 Sep 11;398(10304):957-980. doi: 10.1016/S0140-6736(21)01330-1.
298. GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurol*. 2021 Oct;20(10):795-820.
299. Nogueira RG, Qureshi MM, Abdalkader M, Martins SO, Yamagami H, Qiu Z, Mansour OY, Sathya A, Czlonkowska A, Tsivgoulis G, Aguiar de Sousa D, Demeestere J, Mikulik R, Vanacker P, Siegler JE, Körv J, Biller J, Liang CW, Sangha NS, Zha AM, Czap AL, Holmstedt CA, Turan TN, Ntaios G, Malhotra K, Tayal A, Loochtan A, Ranta A, Mistry EA, Alexandrov AW, Huang DY, Yaghi S, Raz E, Sheth SA, Mohammaden MH, Frankel M, Bila Lamou EG, Aref HM, Elbassiouny A, Hassan F, Menecie T, Mustafa W, Shokri HM, Roushdy T, Sarfo FS, Alabi TO, Arabambi B, Nwazor EO, Sunmonu TA, Wahab K, Yaria J, Mohammed HH, Adebayo PB, Riahi AD, Sassi SB, Gwaunza L, Ngwende GW, Sahakyan D, Rahman A, Ai Z, Bai F, Duan Z, Hao Y, Huang W, Li G, Li W, Liu G, Luo J, Shang X, Sui Y, Tian L, Wen H, Wu B, Yan Y, Yuan Z, Zhang H, Zhang J, Zhao W, Zi W, Leung TW, Chugh C, Huded V, Menon B, Pandian JD, Sylaja PN, Usman FS, Farhoudi M, Hokmabadi ES, Horev A, Reznik A, Sivan Hoffmann R, Ohara N, Sakai N, Watanabe D, Yamamoto R, Dojjiri R, Tokuda N, Yamada T, Terasaki T, Yazawa Y, Uwatoko T, Dembo T, Shimizu H, Sugiura Y, Miyashita F, Fukuda H, Miyake K, Shimbo J, Sugimura Y, Yagita Y, Takenobu Y, Matsumaru Y, Yamada S, Kono R, Kanamaru T, Yamazaki H, Sakaguchi M, Todo K, Yamamoto N, Sonoda K, Yoshida T, Hashimoto H, Nakahara I, Kondybayeva A, Faizullina K, Kamenova S, Zhanuzakov M, Baek JH, Hwang Y, Lee JS, Lee SB, Moon J, Park H, Seo JH, Seo KD, Sohn SI, Young CJ, Ahdab R, Wan Zaidi WA, Aziz ZA, Basri HB, Chung LW, Ibrahim AB, Ibrahim KA, Looi I, Tan WY, Yahya NW, Groppa S, Leahu P, Al Hashmi AM, Imam YZ, Akhtar N, Pineda-Franks MC, Co CO, Kandyba D, Alhazzani A, Al-Jehani H, Tham CH, Mamauag MJ, Venketasubramanian N, Chen CH, Tang SC, Churojana A, Akil E, Aykaç Ö, Ozdemir AO, Giray S, Hussain SI, John S, Le Vu H, Tran AD, Nguyen HH, Nhu Pham T, Nguyen TH, Nguyen TQ, Gattringer T, Enzinger C, Killer-Oberpfalzer M, Bellante F, De Blauwe S, Vanhooren G, De Raedt S,



- Dusart A, Lemmens R, Ligot N, Pierre Rutgers M, Yperzeele L, Alexiev F, Sakelarova T, Bedekovi MR, Budincevic H, Cindric I, Hucika Z, Ozretic D, Saric MS, Pfeifer F, Karpowic I, Cernik D, Sramek M, Skoda M, Hlavacova H, Klecka L, Koutny M, Vaclavik D, Skoda O, Fiksa J, Hanelova K, Nevsimalova M, Rezek R, Prochazka P, Krejstova G, Neumann J, Vachova M, Brzezanski H, Hlinovsky D, Tenora D, Jura R, Jurák L, Novak J, Novak A, Topinka Z, Fibrich P, Sobolova H, Volny O, Krarup Christensen H, Drenck N, Klingenberg Iversen H, Simonsen CZ, Truelsen TC, Wienecke T, Vibo R, Gross-Paju K, Toomsoo T, Antsov K, Caparros F, Cordonnier C, Dan M, Faucheux JM, Mechtouff L, Eker O, Lesaine E, Ondze B, Peres R, Pico F, Piotin M, Pop R, Rouanet F, Gubeladze T, Khinikadze M, Lobjanidze N, Tsiskaridze A, Nagel S, Ringleb PA, Rosenkranz M, Schmidt H, Sedghi A, Siepmann T, Szabo K, Thomalla G, Palaiodimou L, Sagris D, Kargiotis O, Klivenyi P, Szapary L, Tarkanyi G, Adami A, Bandini F, Calabresi P, Frisullo G, Renieri L, Sangalli D, Pirson A, Uyttenboogaart M, van den Wijngaard I, Kristoffersen ES, Brola W, Fudala M, Horoch-Lyszczarek E, Karlinski M, Kazmierski R, Kram P, Rogoziewicz M, Kaczorowski R, Luchowski P, Sienkiewicz-Jaros H, Sobolewski P, Fryze W, Wisniewska A, Wiszniewska M, Ferreira P, Ferreira P, Fonseca L, Marto JP, Pinho E Melo T, Nunes AP, Rodrigues M, Tedim Cruz V, Falup-Pecurariu C, Krastev G, Mako M, de Leciñana MA, Arenillas JF, Ayo-Martin O, Cruz Culebras A, Tejedor ED, Montaner J, Pérez-Sánchez S, Tola Arribas MA, Rodriguez Vasquez A, Mayza M, Bernava G, Brehm A, Machi P, Fischer U, Gralla J, Michel PL, Psychogios MN, Strambo D, Banerjee S, Krishnan K, Kwan J, Butt A, Catanese L, Demchuk AM, Field T, Haynes J, Hill MD, Khosravani H, Mackey A, Pikula A, Saposnik G, Scott CA, Shoamanesh A, Shuaib A, Yip S, Barboza MA, Barrientos JD, Portillo Rivera LI, Gongora-Rivera F, Novarro-Escudero N, Blanco A, Abraham M, Alsbrook D, Altschul D, Alvarado-Ortiz AJ, Bach I, Badruddin A, Barazangi N, Brereton C, Castonguay A, Chaturvedi S, Chaudry SA, Choe H, Choi JH, Dharmadhikari S, Desai K, Devlin TG, Doss VT, Edgell R, Etherton M, Farooqui M, Frei D, Gandhi D, Grigoryan M, Gupta R, Hassan AE, Helenius J, Kaliaev A, Kaushal R, Khandelwal P, Khawaja AM, Khoury NN, Kim BS, Kleindorfer DO, Koefman F, Lee VH, Leung LY, Linares G, Linfante I, Lutsep HL, Macdougall L, Male S, Malik AM, Masoud H, McDermott M, Mehta BP, Min J, Mittal M, Morris JG, Multani SS, Nahab F, Nalleballe K, Nguyen CB, Novakovic-White R, Ortega-Gutierrez S, Rahangdale RH, Ramakrishnan P, Romero JR, Rost N, Rothstein A, Ruland S, Shah R, Sharma M, Silver B, Simmons M, Singh A, Starosciak AK, Strasser SL, Szeder V, Teleb M, Tsai JP, Voetsch B, Balaguera O, Pujol Lereis VA, Luraschi A, Almeida MS, Cardoso FB, Conforto A, De Deus Silva L, Varrone Giacomini L, Oliveira Lima F, Longo AL, Magalhães PSC, Martins RT, Mont'alverne F, Mora Cuervo DL, Costa Rebello L, Valler L, Zetola VF, Lavados PM, Navia V, Olavarria VV, Almeida Toro JM, Amaya PFR, Bayona H, Corredor A, Rivera Ordonez CE, Mantilla Barbosa DK, Lara O, Patiño MR, Diaz Escobar LF, Dejesus Melgarejo Fariña DE, Cardozo Villamayor A, Zelaya Zarza AJ, Barrientos Iman DM, Rodriguez Kadota L, Campbell B, Hankey GJ, Hair C, Kleinig T, Ma A, Tomazini Martins R, Sahathevan R, Thijs V, Salazar D, Yuan-Hao Wu T, Haussen DC, Liebeskind D, Yavagal DR, Jovin TG, Zaidat OO, Nguyen TN; SVIN COVID-19 Global Stroke Registry; SVIN COVID-19 Global Stroke Registry. Global Impact of COVID-19 on Stroke Care and IV Thrombolysis. *Neurology*. 2021 Jun 8;96(23):e2824-e2838.
300. GBD 2019 Chewing Tobacco Collaborators. Spatial, temporal, and demographic patterns in prevalence of chewing tobacco use in 204 countries and territories, 1990-2019: a systematic analysis from the Global Burden of Disease Study 2019. *Lancet Public Health*. 2021 Jul;6(7):e482-e499. doi: 10.1016/S2468-





- 2667(21)00065-7. Epub 2021 May 28. Erratum in: *Lancet Public Health*. 2021 Jul;6(7):e449.
301. GBD 2019 Tobacco Collaborators. Spatial, temporal, and demographic patterns in prevalence of smoking tobacco use and attributable disease burden in 204 countries and territories, 1990-2019: a systematic analysis from the Global Burden of Disease Study 2019. *Lancet*. 2021 Jun 19;397(10292):2337-2360.
302. Menon D, Nair SS, Thomas B, Krishna Kumar K, Nair M. Clinico-radiological correlation and surgical outcome of idiopathic spinal cord herniation: A single centre retrospective case series. *J Spinal Cord Med*. 2021 May;44(3):437-441.
303. Seshachala BB, Jose M, Lathikakumari AM, Murali S, Kumar AS, Thomas SV. Valproate usage in pregnancy: An audit from the Kerala Registry of Epilepsy and Pregnancy. *Epilepsia*. 2021 May;62(5):1141-1147.
304. Sasikumar D. COVID-19 and pediatric cardiac care in India: Time to take stock. *Ann Pediatr Cardiol*. 2021 Oct-Dec;14(4):566-567.
305. Mani A, Harikrishnan S, Valaparambil AK. A curious case of stent fracture and left ventricular pseudoaneurysm - A rare association in the background of cardiac tuberculosis. *Trop Doct*. 2021 Oct;51(4):594-595.
306. Ramachandran H, Girdhar S, Sreedharan SE, Enakshy Rajan J, Kannath SK, Vinoda Thulaseedharan J, Sukumaran S, Sylaja PN. Does thrombus imaging characteristics predict the degree of recanalisation after endovascular thrombectomy in acute ischaemic stroke? *J Stroke Cerebrovasc Dis*. 2022 Jul 5;31(9):106621.
307. Jose J, Keni RR, Hassan H, Menon R, Sukumaran S, Cherian A, Radhakrishnan A. Predictors of outcome in super refractory status epilepticus. *Epilepsy Behav*. 2021 May;118:107929.
308. Mani A, S H, G S, Valaparambil AK. Conduction abnormalities post alcohol septal ablation for hypertrophic cardiomyopathy - A single center experience. *Indian Heart J*. 2021 Nov-Dec;73(6):743-745.
309. GBD 2019 Adolescent Mortality Collaborators. Global, regional, and national mortality among young people aged 10-24 years, 1950-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2021 Oct 30;398(10311):1593-1618.
310. Varghese BT. Head and neck surgical oncology training in the current era of molecular oncology. *Oral Oncol*. 2022 Jan;124:105474.
311. Mani A, Dubey MK, Ojha V. Hypertrophic cardiomyopathy with associated ventricular non-compaction-double whammy. *Indian J Thorac Cardiovasc Surg*. 2022 May;38(3):350-352.
312. Ramanathan M, Thomas SC. Infertility - an unfinished reproductive rights agenda in India. *Indian J Med Ethics*. 2021 Oct-Dec;VI(4):267-269.
313. Harikrishnan S, Mani A, G S, M A, Menon J, G R, Kumar RK, Koshy AG, Attacheril TV, George R, Punnose E, Ashraf SM, Sr A, Cholakkal M, Jeemon P, Joseph S, Govindan U, Joseph J, Eapen K, Sreedharan M, Kumar A, Venugopal K. Pulmonary Hypertension Registry of Kerala, India (PRO-KERALA): One-year outcomes. *Indian Heart J*. 2022 Jan-Feb;74(1):34-39.
314. Das D, Nair KKM, Namboodiri N, Valaparambil A. Tricuspid annular PVCS: Radiofrequency ablation by subtricuspid retrograde catheter approach. *Indian Pacing Electrophysiol J*. 2021 Nov-Dec;21(6):412-415.
315. Jacob JE, Chandrasekharan S, Nair GK, Cherian A, Iype T. Effect of combining features generated through non-linear analysis and wavelet transform of EEG signals for the diagnosis of encephalopathy. *Neurosci Lett*. 2021 Nov 20;765:136269.



316. Joseph T, Sreejith S, Joseph X, Sangeetha V P, Prajitha N, Vandana U, Jayaprakas C A, Mohanan P V. Effect of cyanide ions (CN-) extracted from cassava (*Manihotesculenta* Crantz) on Alveolar Epithelial Cells (A549 cells). *Toxicology*. 2021 Dec;464:153019.
317. Blackburn CMR, Schilke RM, Vozenilek AE, Chandran S, Bamgbose TT, Finck BN, Woolard MD. Myeloid-associated lipin-1 transcriptional co-regulatory activity is atheroprotective. *Atherosclerosis*. 2021 Aug;330:76-84.
318. Narula N, Wong ECL, Dehghan M, Mente A, Rangarajan S, Lanas F, Lopez-Jaramillo P, Rohatgi P, Lakshmi PVM, Varma RP, Orlandini A, Avezum A, Wielgosz A, Poirier P, Almadi MA, Altuntas Y, Ng KK, Chifamba J, Yeates K, Puoane T, Khatib R, Yusuf R, Boström KB, Zatonska K, Iqbal R, Weida L, Yibing Z, Sidong L, Dans A, Yusufali A, Mohammadifard N, Marshall JK, Moayyedi P, Reinisch W, Yusuf S. Association of ultra-processed food intake with risk of inflammatory bowel disease: prospective cohort study. *BMJ*. 2021 Jul 14;374:n1554.



# BOOK CHAPTERS

1. Ameer JM, Pai RR, Komeri R, Vinod D, Anil Kumar PR\*, Kasoju N\*. Combinatorial approaches in electrospinning, electrospaying and 3D printing for biomedical applications. In *Biomedical Applications of Electrospinning and Electrospaying* edited by Kasoju N, Ye H, Elsevier Inc. Pg. 355-373, 2021.
2. Anju MS, Raj DK, Madathil BJ, Kasoju N, Anil Kumar PR. Intelligent biomaterials for biomedical applications: concepts, state-of-the-art and future prospects. In *Biomaterials in Tissue Engineering and Regenerative Medicine* edited by Bhaskar B, Rao PS, Kasoju N, Nagarjuna V, Raju BR, Springer Nature Group, Pg. 535-560, 2021.
3. Anupama SJ, Athira RK, Lakshmi TS, Velayudhan S, Bhatt A, Anil Kumar PR, Kasoju N. 3D Bioprinting in tissue engineering and regenerative medicine: from basic concepts to emerging trends. In *Biomaterials in Tissue Engineering and Regenerative Medicine* edited by Bhaskar B, Rao PS, Kasoju N, Nagarjuna V, Raju BR, Springer Nature Group, Pg. 561-580, 2021.
4. Arathi A, Akhil V, Mohanan PV (2021) Application of biosurfactants in the disruption of cell biomass. In book: *Microbially-Derived Biosurfactants for Improving Sustainability in Industry*. Edited by Inamuddin, Charles OA, Abdullah MA. Elsevier publications, USA, pages 317-326.
5. Arsha jyothirmayi VA, Gulia KK (2022). Neurotoxicity Assays. *Biomedical Product and Material Evaluation: Standard and Ethics*. Chapter 26, pages 703-723. Elsevier Publication. Edited by Dr PV Mohanan. DOI: <https://doi.org/10.1016/B978-0-12-823966-7.00021-9>.
6. Arun Gopalakrishnan, Harikrishnan KN. "Pulmonary and systemic venous anomalies". In *IAP Specialty Series in Pediatric Cardiology 3rd edition*, Jaypee Brothers. 2022; 328 – 343. ISBN: 9789390595143
7. Arun Gopalakrishnan. "Diagnostic cardiac catheterization and angiography". In *IAP Specialty Series in Pediatric Cardiology 3rd edition*, Jaypee Brothers. 2022; 123 – 134. ISBN: 9789390595143
8. Arun Gopalakrishnan. "Evaluation and diagnostic work up of Pediatric heart failure". *Manual of Heart Failure Management*. Chapter 72 Jaypee Brothers. 2021; 375-378. ISBN: 9789390595488.
9. Arun Gopalakrishnan. "Mitral regurgitation and heart failure". *Manual of Heart Failure Management*. Chapter 44 Jaypee Brothers. 2021; 206 – 212. ISBN: 9789390595488.
10. Arun Gopalakrishnan. *Multisystem Inflammatory Syndrome in Children (MIS-C) and Heart Failure*. *Heart Failure Rewind*. Newsletter. Volume 1, Issue 2 Mar – May 2021. Pages 25 – 30.
11. Arun Gopalakrishnan. *Pediatric heart failure vs Adult heart failure*. What is different? *Heart Failure Rewind*. Newsletter. Volume 1, Issue 1 Jan – Mar 2021.
12. Asha Kishore, Divya K P, Genetics of Parkinson's disease, Book Chapter , *Parkinson's disease and Movement disorders*, Second edition, Chapter 5, Editor : Kalyan Bhattacharya 2021.
13. Asish Vijayaraghavan, Patel Khushboo Subhash, Divya KP, Syam Krishnan. Tremor disorders In: *Ranganathan L N (Editor). Reviews in Neurology 2020. Movement Disorders: Indian Perspective (Published in 2021)*, Wolters Kluwer (India) Pvt. Ltd., New Delhi, 2021. Page 94-105. ISBN: 978-93-90612-88-8. ISSN: 0971-5924.



14. Athira RK, Kripamol R, Anju MS, Maya B, Pai RR, Ajit S, Aswathy MR, Anil Kumar PR, Kasoju N. Alternatives to animal testing: concepts, state of art and regulations. In *Biomedical Product and Materials Evaluation: Standards and Ethics* edited by Dr. P.V. Mohanan, Elsevier, Pg. 501-529, 2022..
15. Bejoy Thomas edited the Pediatric Neuroradiology subsection of the Neuroradiology volume of the IRIA textbook of Radiology by the Indian Radiology Imaging and imaging association.
16. Bernadeth K Madathil Anil Kumar PR, Thomas V and Shiny Velayudhan (2021). Nanomaterial-Based Bio Scaffolds for Enhanced Biomedical Applications. In: Pal K. (eds) *Bio-manufactured Nanomaterials*. Springer, Cham. [https://doi.org/10.1007/978-3-030-67223-2\\_7](https://doi.org/10.1007/978-3-030-67223-2_7).
17. Bhaskar B, Rao PS, Kasoju N, Nagarjuna V, Raju BR. *Biomaterials in Tissue Engineering and Regenerative Medicine - Edition 1*, Springer Nature Group 2021 (ISBN 9789811600012, Apr 2021).
18. Deepa S Kumar. The Blue baby- what a pediatrician should know. IAP Trivandrum e-magazine
19. Deepa Sasikumar. "Pediatric Heart Failure-clinical features and outcomes". *Manual of heart failure management*. Harikrishnan S. JAYPEE BROTHERS MEDICAL PUBLISHERS. 2021. Chapter 71.
20. Dinoop KP: Sundaram S., Ponnambath D.K., Nair S.S. (2022) Microbiota-Gut-Brain Axis in Neurological Disorders. In: Thomas S. (eds) *Human Microbiome*. Springer, Singapore. [https://doi.org/10.1007/978-981-16-7672-7\\_7](https://doi.org/10.1007/978-981-16-7672-7_7).
21. Eva C. Das, Manoj Komath, P.R. Anil Kumar, Chapter 21 - Dental tissue engineering, Editor(s): Chandra P. Sharma, Thomas Chandy, Vinoy Thomas, Finosh G. Thankam, *Tissue Engineering*, Academic Press, 2022, Pages 493-529, ISBN 9780128240649, <https://doi.org/10.1016/B978-0-12-824064-9.00021-6>.
22. Gayathry G, Manoj Komath, Shiny Velayudhan, Chapter 2 - Biomaterials for medical products, Editor(s): P.V. Mohanan, In *Woodhead Publishing Series in Biomaterials, Biomedical Product and Materials Evaluation*, Woodhead Publishing, 2022, Pages 25-62, ISBN 9780128239667, <https://doi.org/10.1016/B978-0-12-823966-7.00012-8>.
23. Gulia KK, BS Aswathy, Kumar VM (2021). Developmental aspects of sleep. Chapter 10, pages 115-122. *Pediatric Sleep Medicine*, Edited by David Gozal and Leila Kheirandish-Gozal. Published by © Springer Nature Switzerland AG 2021, ISBN 978-3-030-65573-0 ISBN 978-3-030-65574-7 (eBook).
24. Harikrishnan KN. "Etiology of Pediatric Heart Failure". *Manual of Heart Failure Management*. Chapter 70 Jaypee Brothers. 2021;375-378. ISBN: 9789390595488.
25. Jayadevan ER edited the Interventional Neuroradiology subsection of the Neuroradiology volume of the IRIA textbook of Radiology by the Indian Radiology Imaging and imaging association.
26. Joseph, L., Ramesh, P, Remya, N.S. et al. Significance of Metrological Tools in an ISO 17025 Accredited Quality System for a Biological Evaluation Facility. *MAPAN* (2022). <https://doi.org/10.1007/s12647-021-00517-2>.
27. Kasoju N, Ye H, Cui Z, Ramakrishna S. Electrospinning and electrospaying in biomedical engineering: retrospect and prospects. In *Biomedical Applications of Electrospinning and Electrospaying* edited by Kasoju N, Ye H, Elsevier Inc. Pg. 375-393, 2021.
28. Kasoju N, Ye H. *Biomedical Applications of Electrospinning and Electrospaying - Edition 1*, Elsevier Inc. 2021 (ISBN 9780128224762, May 2021).





29. Kavita Raja. Enterococcal Infections: Recent Nomenclature and emerging trends. Submitted in Book entitled “Streptococcal infections” by INTECH Open.
30. Kesavadas C edited the Adult Neuroradiology subsection of the Neuroradiology volume of the IRIA textbook of Radiology by the Indian Radiology Imaging and imaging association.
31. Kesavapisharady K, Krishnan S. Role of lesioning procedures in the Deep Brain Stimulation era. In: Paniker D et al. (Editors). Progress in Clinical Neurosciences Volume, First Edition. Thieme Medical and Scientific Publishers, Mumbai, 2022. Page 135-138. ISBN 978-93-90553-94-5.
32. Krishnakumar. Chapter “Role of lesioning procedures in the DBS era” in Progress in clinical neurosciences - Panikar et al., Progress in Clinical Neurosciences Volume 34, First Edition (ISBN978-93-90553-94-5)
33. Krishnamoorthy KM, Deepa S Kumar. “Approach to cyanotic congenital heart disease”. IAE Textbook of Echocardiography.2020. Chapter 34.
34. Krishnan S. Autoimmune Movement Disorders. In: Ranganathan L N, Krishnan M, Iyer RS (Editors). Monograph Immune Mediated Neurological Disorders, 1st Edition, Jaypee Brothers Publishers, New Delhi, 2022. Page 67-75. ISBN: 9789352704514.
35. Kurup, H., Aregullin, O., Vettukattil, J. “Paravalvular leak closure”. In Textbook of Interventions in Adult Congenital Heart Disease. A case-based approach. Vaikom.S.Mahadevan. Springer Nature. ISBN-13: 978-3030854072, 2023.
36. Lionel KR, Hrishi AP, Ajayan N. Craniosynostosis and Anesthetic Concerns. In: Fundamentals of Pediatric Neuroanesthesia. Springer, Singapore; 2021. p. 289–303.
37. Lizymol PP. Effects of Thermal Cycling on Surface Hardness, Diametral Tensile Strength and Porosity of an Organically Modified Ceramic (ORMOCER)-Based Visible Light Cure Dental Restorative Resin, Lizymol PP. Chapter 15, In book: Advanced Studies in Experimental and Clinical Medicine, Modern Trends and Latest Approaches, CRC Press DOI: 10.1201/9781003057451-17.
38. Manikandan S., Nair P. (2021) Anesthesia for Minimally Invasive Neurosurgical Procedures in Children. In: Rath G.P (eds) Fundamentals of Pediatric Neuroanesthesia. Springer, Singapore. [https://doi.org/10.1007/978-981-16-3376-8\\_20](https://doi.org/10.1007/978-981-16-3376-8_20) .
39. Manikandan Sethuraman, Prakash Nair. Anesthesia for minimally invasive neurosurgical procedures in children. In: Fundamentals of Pediatric Neuroanesthesia. Springer, Singapore; 2021 p 321-341.
40. Manju Saraswathy, Venkateshwaran Krishnaswami, Deepu Damodharan Ragini, Biomaterials for Hard Tissue Engineering: Concepts, Methods, and Applications. Book title: Biomaterials in Tissue Engineering and Regenerative Medicine, From Basic Concepts to State-of-the-Art Approaches. Springer Nature Singapore Pte Ltd. 2021. DOI: <https://doi.org/10.1007/978-981-16-0002-9>.
41. Muthusamy S, Velayudhan S, and Anil Kumar PR (2021). Hydrogel Systems for Tissue Engineering, Chapter 10 In: Drug Delivery, Nanomedicine and Tissue Engineering: Guide to Strengthen Healthcare System, Ed: Rajakumari R, Hanna J. Maria, Nandakumar Kalarikkal and Sabu Thomas, Apple Academic Press, Taylor and Francis Group, Florida, USA .
42. Nair SS, Sundaram S, Nair M. Immunotherapy. In: Ranganathan LN, Krishnan M, Iyer RS eds. Immune mediated neurological disorders. Jaypee Brothers Medical Publishers. 2022.



43. Vinodkumar V, Amrutha C & Nagesh D S “Overview of Medical Device Development” in the book “Biomedical Product and Materials Evaluation, Standards and Ethics”, Woodhead Publishing Series in Biomaterials, Elsevier, 2022 1st Edition ISBN: 978-0-12-823966-7 (print), ISBN: 978-0-12-824173-8 (online)
44. Rajalekshmy, G.P, Rekha, M.R. Trends in Bioactive Biomaterials in Tissue Engineering and Regenerative Medicine. In: Bhaskar, B., Sreenivasa Rao, P, Kasoju, N., Nagarjuna, V., Baadhe, R.R. (eds) Biomaterials in Tissue Engineering and Regenerative Medicine. Springer, Singapore, 2021. [https://doi.org/10.1007/978-981-16-0002-9\\_8](https://doi.org/10.1007/978-981-16-0002-9_8).
45. Rekha M.R., Gum-based micro- and nano-biomaterials in gene delivery in Micro- and Nanoengineered Gum-Based Biomaterials for Drug Delivery and Biomedical Applications. Editors Sougata Jana, Subrata Jana, eBook ISBN: 9780323909877, Paperback ISBN: 9780323909860, Elsevier, 2022. <https://doi.org/10.1016/C2020-0-02507-7>.
46. Remya K, Kasoju N, Anil Kumar PR. In vitro cytotoxicity and cytocompatibility assays for biomaterial testing under regulatory platform. In Biomedical Product and Materials Evaluation: Standards and Ethics edited by Dr. P.V. Mohanan, Elsevier, Pg. 329-353, 2022..
47. Roopesh R. Pai, J.AnupamaSekar, ShilpaAjit, Shiny Velayudhan, NareshKasoju, Anil Kumar PR., Chapter 5 - Three-dimensional bioprinting of tissues and organs, Editor(s): P.V. Mohanan, In Woodhead Publishing Series in Biomaterials, Biomedical Product and Materials Evaluation, Woodhead Publishing, 2022, Pages 135-150, ISBN 9780128239667, <https://doi.org/10.1016/B978-0-12-823966-7.00018-9>.
48. Sundaram S, Ponnambath DK, Nair SS. Microbiota-Gut-Brain Axis in Neurological Disorders. In. Human Microbiome. 2022. 147-167. Springer, Singapore.
49. Sylaja PN, Soumya Sundaram. Clinical overview of Primary central nervous system vasculitis - management - India Point of Care 2021 by Elsevier.
50. Varma PRH, Fernandez FB. “Bioceramics in tissue engineering: retrospect and prospects” Bhaskar B, Sreenivasa Rao P, Kasoju N, Nagarjuna V, Baadhe RR, editors. Biomaterials in Tissue Engineering and Regenerative Medicine: From Basic Concepts to State of the Art Approaches [Internet]. Singapore: Springer; 2021 [cited 2022 Mar 23]. p. 61–87. Available from: <https://doi.org/10.1007/978-981-16-0002-9>.



## EXTERNALLY-FUNDED RESEARCH PROJECTS (ONGOING)

### Hospital Wing

Title of the Project	Principal Investigator	Funding Agency	Total Outlay (Rs in Lakhs)	Duration
ISCHEMIA: International Study of Comparative Health Effectiveness with Medical and Invasive Approaches	Dr Ajit Kumar V K	National Institutes of Health, USA & New York University School of Medicine	23.82	5 years
Tichval-2 Pilot Study TTK Chitra Titanium Heart Valve (Model –Tc2) Clinical Pilot Study	Dr Vivek Pillai	TTK Health Care	102.00	5 years
Prospective single arm, multi-center, observational registry to further validate safety and efficacy of Ultimaster DES system in unselected patients representing everyday clinical practice	Dr Bijulal S	Terumo India Ltd.	11.74	1.5 years
Novel technique of developing trans-catheter heart valve from human homograft for percutaneous pulmonary valve replacement	Dr Bijulal S	Biotechnology Industry Research Assistance Council (BIRAC)	28.00	1 year
Contemporary outcomes in cardiac channelopathies guided by genotype-based management	Dr Narayanan Namboodiri K K	ICMR	15.73	5 years
Centre for Advanced Research and Excellence in Heart Failure - overall management of the Project	Dr Harikrishnan S	ICMR	77.45	5 years



Centre for Advanced Research and Excellence in Heart Failure - Biobank	Dr Harikrishnan S	ICMR	59.90	5 years
Centre for Advanced Research and Excellence in Heart Failure - NGS Genetics	Dr Harikrishnan S	ICMR	40.88	5 years
Centre for Advanced Research and Excellence in Heart Failure - National HF Database	Dr Harikrishnan S	ICMR	7.12	5 years
Centre for Advanced Research and Excellence in Heart Failure - Economic Impact	Dr Harikrishnan S	ICMR	19.02	5 years
Centre for Advanced Research and Excellence in Heart Failure - Quality of Life	Dr Harikrishnan S	ICMR	60.29	5 years
Centre for Advanced Research and Excellence in Heart Failure - NT proBNP Point-of-Care device development	Dr Harikrishnan S	ICMR	68.10	5 years
Centre for Advanced Research and Excellence in Heart Failure - Structured Physical Training	Dr Harikrishnan S	ICMR	56.19	5 years
Trivandrum Heart Failure Cohort	Dr Harikrishnan S	ICMR	21.72	5 years
National Heart Failure Registry	Dr Harikrishnan S	ICMR	149.17	3 years
Congenital heart disease registry for newborns in Trivandrum	Dr Deepa S Kumar	ICMR	12.34	2 years
Prospective study of patients undergoing micro neurosurgical procedures through a midline inter-hemispheric transcalsal approach	Dr Mathew Abraham	Chitra Alumni Educational and Research Foundation	8.76	3 years



Predictors of visual outcome and recurrence following surgical resection of medial sphenoid wing meningiomas	Dr Mathew Abraham	Chitra Alumni Educational and Research Foundation	4.00	3 years
Retrospective study of the surgical outcome of anterior petrosectomy approach for posterior fossa and Meckels cave lesions over a period of 6 years from 2014 to 2019	Dr Mathew Abraham	Brain Lab Pvt. Ltd.	1.68	1 year
Real time assessment of shift of ICA during extended endoscopic skullbase surgery using intraoperative doppler and the role of tumour consistency in causing ICA displacement	Dr Prakash Nair	SERB	18.64	3 years
Development of HPC tools for CFD-based patient specific management of Cerebral Aneurysms	Dr B Jayanand Sudhir	National Supercomputing Mission (NSM)	25.74	2 years
Computational Fluid Dynamics based tools to the aid of clinical decision making in the management of intracranial aneurysms	Dr B Jayanand Sudhir	SERB	48.70	3 years
A resting state fMRI and Task-based fMRI	Dr Kesavadas C	G E Technology Centre	09.00	3 years
Virtual reality-based solution for effective neuroanatomy teaching	Dr Kesavadas C	SERB	106.52	3 years
An automated lung ultrasound workflow for continuous monitoring and diagnostic assistance	Dr Kesavadas C	SERB	5.94	2 years
Development of portable low-cost disposable defibrillator for cardiac arrest management	Dr Manikandan S	DST	12.95	2 years



General Anesthesia vs Sedation -Cognitive decline in elderly - A randomized controlled trial in patients with chronic subdural hematoma (GAS-CDE)	Dr Smita V	DST	26.42	3 years
Comprehensive and novel model for health care in geriatric pain conditions in India	Dr Subin Sukesan	Kusuma Trust, U K	£ 41000	5 years
Establishment of the India Stroke Clinical Trial Network (INSTRuCT)	Dr Sylaja P N	ICMR	66.75	4 years
Ayurvedic treatment in the rehabilitation of ischemic stroke patients in India: A Randomized Controlled Trial (RESTORE)	Dr Sylaja P N	ICMR	124.70	3 years
Improvement of secondary prevention in stroke survivors by a primary health care approach	Dr Sylaja P N	ICMR	7.27	3 years
HTA of National Stroke Care Registry Programme: Development of hospital based stroke registries in different regions of India	Dr Sylaja P N	ICMR	8.34	5 years
Improvis-ation (Improving stroke care in India – Advancing the INSTRuCT Operations and Network)	Dr Sylaja P N	NIHR, UK	24.05	1 year
A Comprehensive framework for treatment of impairment of upper extremity due to stroke by computational modelling and virtual reality	Dr Sylaja P N	MHRD & TCS under UAY scheme	45.00	2 years



Early versus Late initiation of direct oral Anticoagulants in post-ischaemic stroke patients with atrial fibrillation (ELAN): An international, multicentre, randomised-controlled, two-arm, assessor-blinded trial	Dr Sylaja P N	Insel Gruppe AG University Hospital of Bern Switzerland	12.44	1 year
Medication adherence and management of risk factors for secondary prevention of stroke using smart phone-based application: A feasibility study	Dr Sylaja P N	World Stroke Organization, Switzerland	14.70	1 year
Quantitative EEG and multi-model neuro imaging biomarkers of memory dysfunction in epilepsy	Dr Ramshekhar Menon	DST	66.42	3.5 years
Incidence, prevalence, risk analysis of dementia and basic research thereof	Dr Ramshekhar Menon	DBT through NBRC	36.42	3 years
Genetics of complex pediatric epilepsy syndromes: Electro-clinico imaging based genotype-phenotype correlations in an Indian cohort	Dr Ramshekhar Menon	ICMR	99.30	3 years
Exploring the human gut microbiome and metabolome in health and Parkinson's disease- a window to the gut microbiota brain axis alterations in Parkinson's disease	Dr Syam K	ICMR	16.72	3 years
Spiral Dx: Tremor diagnosis and quantification using artificial intelligence	Dr Syam K	DBT	25.33	5 years
Clinical Registry of Movement Disorders	Dr Syam K	Movement Disorders Society of India	15.00	10 years



Enhancement of Research and Clinical resources of Movement Disorder Program under the Comprehensive Care Centre for Movement Disorder, SCTIMST	Dr Syam K	Dr T S Ravikumar Foundation, USA	16.77	5 years
Encoding of interhemispheric interactions in mirror dystonia: A window to the physiology of dystonia	Dr Divya K P	Dystonia Medical Foundation, USA	US \$ 36000	4 years
Deciphering the genetic architecture of Parkinson's disease in Indian population	Dr Divya K P	Michael J Fox Foundation, USA	US \$ 299922 (US \$ 46992 to SCTIMST)	2 years
Genetic architecture of Parkinson's disease in India	Dr Divya K P	Michael J Fox Foundation, USA	375.00	3 years
Comprehensive Care Centre for Neurodevelopmental Disorders	Dr Soumya Sundaram	Federal Bank Hormis Memorial Foundation	219.00	5 years
Emotional Face Recognition: Understanding the underlying neural connectivity in high functioning adolescents with autism	Dr Soumya Sundaram	DST	16.98	2 years
Indian Multiple Sclerosis and Allied Demyelinating Disorders Registry and Research Network	Dr Sruthi S. Nair	ICMR	7.57	3 years
Can cardiovascular patients with obstructive sleep apnea have adverse perioperative outcomes - A prospective study	Dr Sapna Erat Sreedharan	Resmed Foundation	3.80	2 years
Prevalence of atrial cardiopathy in cryptogenic strokes in comparison with strokes of known etiology - A prospective study	Dr Sapna Erat Sreedharan	ICMR	3.51	3 years



Dynamic modelling of $\alpha$ -synucleinopathy pathology using hiPSC-derived cerebral organoids for biomarkers and drug screening application	Dr Divya M S	National Centre for Biological Sciences	37.80	2 years
DNA methylation profiling of gangliogliomas and dysembryoplastic neuroepithelial tumors	Dr Rajalakshmi P	SERB	50.38	3 years
Role of connexins in cardiac fibroblast phenotypic transformation and extra cellular matrix synthesis in cardiac diseases	Dr Neethu Mohan	ICMR	28.31	3 years
Regulation of progenitor cell function in heart by angiotensin	Dr Neethu Mohan	ICMR	19.73	3 years
Resting state functional magnetic resonance imaging and its cognitive correlates in patients with intracranial dural arteriovenous fistulas before and after interventional therapy	Dr Bejoy Thomas	DST	22.68	3 years
Transcriptional and translational regulation of periostin and its interaction with DDR2 in cardiac fibrosis	Ms Sruthi Radhakrishnan	DST	19.44	3 years
A prospective cohort study on cerebrospinal fluid (CSF) diversion catheter related infections in a tertiary referral neurosurgical care center	Dr Dinoop K P	ICMR	20.43	2 years
A randomized, multicentric, double-blind, placebo-controlled clinical trial of Nardostachys jatamansi and Withania somnifera formulation (SDA-217) as add-on therapy in patients of chronic insomnia	Dr Ashalatha Radhakrishnan	ICMR	38.91	3 years



Development of an artificial intelligence- based system for comprehensive cerebral arterial stroke imaging and prognostication	Dr Santhosh K	DBT	18.26	2 years
Effect and outcome determinants of right ventricular function in post-operative Tetralogy of Fallot: A retrospective descriptive study	Dr Baiju S Dharan	ICMR	21.36	3 years
Identification and characterization of ubiquitin and SUMO modified exosomal proteins from Parkinson's disease patients' blood	Dr Madhusoodanan U K	ICMR	9.32	3 years
Prognostic value of circulating microRNAs in heart failure	Dr Sanjay G	ICMR	22.39	2 years
Randomized placebo-controlled trial of digoxin in patients with rheumatic heart disease	Dr Sanjay G	ICMR	2.76	4 years
Non-invasive measurement and monitoring of pulmonary congestion	Mr Shaj Upendran	DST (through NIT Calicut)	37.27	2 years
Development of device for non-invasive continuous measurement of jugular venous saturation	Mr Manoj G S	DST	17.89	2 years
Molecular mechanisms of stress-induced NLRP3 activation and neuroinflammation by macrophages in presence of amyloid-beta in Alzheimer's disease	Dr Sreenivas G	ICMR	11.98	3 years



Comparing mitochondrial function and dynamics in atrial tissue of patients undergoing cardiopulmonary bypass surgery and aortic valve repair	Dr Sreenivas G	SERB	37.63	3 Years
Study of the effect of donor characteristics and component processing methods on formation of microparticles in stored blood using flowcytometric approach	Dr R Amita	SERB	20.56	3 years

## Biomedical Technology Wing

Title of the Project	Principal Investigator	Funding Agency	Total Outlay (Rs in Lakhs)	Duration
Defining the mechanobiology that leads to heterogeneity in muscle stem cells and its implication in regeneration	Dr Praveen K S	SERB (Ramanujan Fellow)	32.00	5 years
Bioengineered construct with cardiac mesenchymal cells for myocardial repair	Dr Senthilkumar Muthuswamy	DBT (Ramalingaswamy Fellow)	88.00	5 years
Blood-brain barrier permeable nanocarriers for diagnosis and therapy of neurodegenerative diseases	Dr Jayasree R S	DBT	94.98	3 years
Designing of 3D-printed cell-free biphasic matrices loaded with an admixture of biomolecules for enhanced progenitor cells recruitment and improved osteochondral regeneration	Dr Amrita Natarajan	ICMR (Fellowship)	3.51	3 years



Development of 'Human on-a-chip' device technology - A paradigm shift in biological evaluation and disease model	Dr P V Mohanan	DST	311.83	3 years
Extending benefits of biomedical science and technology to SC & ST communities through all level participatory engagement - ST components	Dr Roy Joseph	DST	301.43	3 years
Extending benefits of biomedical science and technology to SC&ST communities through all level participatory engagement - SC components	Dr Roy Joseph	DST	311.43	3 years
Development of P modified glass-ionomer cement to improve mechanical properties	Dr Manju S	SERB	24.14	2 years
Efficacy evaluation of 3D bioprinted liver constructs established from niche-specific bioink and stem cell- derived hepatocyte-like cells	Dr Anilkumar P R	SERB	47.41	3 years
Design and development of a micro dialysis set-up for cerebral applications	Dr Chhavi Gupta	DST	47.91	2.5 years
Gender Advancement for Transforming Institution (GATI)	Dr Jayasree R S	DST	7.99	1.5 years
Development of plasticizer-free acrylic denture soft liners using nanogel additives	Dr Manju S	DBT	59.5	3 years



Development of pedicle screw-based dynamic stabilization systems for degenerative diseases of lumbosacral spine	Mr Arvind Kumar Prajapathi	DST	43.03	3 years
Bio-inspired total foot pressure off-loading device for diabetic foot ulcer management in geriatric population	Mr Subhash N N	DST	33.83	3 years

## Achutha Menon Centre For Health Science Studies

Title of the Project	Principal Investigator	Funding Agency	Total Outlay (Rs in Lakhs)	Duration
Resource Centre/HUB for conducting "Health Technology Assessment"	Dr Biju Soman	Department of Health Research, Government of India	81.57	5 years
National Environmental Health Profile	Dr Manju R Nair	Ministry of Environment, Forest and Climate change	52.67	3 years
Mobile Telemedicine Project for Waynad	Dr Biju Soman	DST	564.00	3 years
A family-based randomized controlled trial of cardiovascular risk reduction in individuals with family history of premature coronary heart disease in India	Dr Jeemon P	Wellcome Trust DBT India Alliance	226.67	5 years
The long-term effect of peer-led lifestyle intervention program on diabetes progression and cardiovascular risk: The Kerala Diabetes Prevention Program	Dr Jeemon P	National Health and Medical Research Council, Australia	144.00	3 years



Worksite-based lifestyle program for reducing diabetes and cardiovascular risk in India (India-Works)	Dr Jeemon P	Madras Diabetes Research Foundation/ Emory University	64.43	3 years
Team-based collaborative care model, facilitated by a mHealth enabled and trained nurse, for management of heart failure in India (TIME-HF)",	Dr Jeemon P	Wellcome Trust- DBT India Alliance	469.82	5 years
Scale up of an adapted Kerala Diabetes Prevention Program to improve control of hypertension and diabetes among people living in the states of Kerala and Tamil Nadu	Dr Jeemon P	National Health and Medical Research Council, Australia	AUD 324,723	3 years and 8 months
Social, economic and health impact of industrial pollution in Dindigul district, Tamil Nadu	Dr Srinivasan K	Indian Council of Social Science Research	15.00	2 years
Delineating the role of DNA methylation in insulin resistance driven breast cancer development and progression	Dr Srikant A	DBT	42.50	5 years
HPSR Fellowship India	Dr Rakhal Gaitonde	Forum for Health Systems Design and Transformation (HSTP)	5.83	5 years



## INSTITUTE-FUNDED TDF PROJECTS (ONGOING)

Title of the Project	Principal Investigator	Total Outlay (Rs in Lakhs)	Duration
Design and development of a new kind of current steering electrodes with feedback for deep brain stimulator application	Mr Jithin Krishnan	5.00	2 years
Development of a cost-effective device for the isolation of autologous platelet- rich plasma for various therapeutic purposes	Dr Renjith P Nair	5.00	1 year
Reconstruction geometry optimization and methodology development using computational fluid dynamics evaluation for patient-specific vascular model acquired by MRI scanning	Mr Subhash S Nair	4.99	1 year
A suction-retractor device for aortic valve replacement in adult cardiac surgery	Dr Bineesh	4.5	3 years
Optimization of complete blood count hematology controls for use as internal quality controls in hematology analysers	Dr Anughya Bhatt	5.30	1 year
Alginate dialdehyde-gelatin as a post-surgical adhesion prevention material in thoracic surgery - A proof-of-concept study in swine models	Dr Sachin Shenoy	6.58	2 years
Indigenous bone graft expander for masquetel-induced membrane technique	Dr Lizymol P P	4.5	2 years
Developing decellularized porcine pericardium with enhanced strength for pediatric cardiovascular application	Dr Uma Shankar	7.5	3 years
Development of mucoadhesive bandages for the treatment of desquamative gingivitis	Dr Manju	5.10	2 years
Functional near infrared spectroscopy- based brain-computer interface	Dr Sujesh Sreedharan	4.83	1 year
Augmentation of Central Analytical Facility with tests on personal protective equipment for medical use	Dr Renjith S	3.00	1 year
Pre-validation of <i>in vitro</i> hepatotoxicity test of drugs using 3D bioprinted liver construct	Dr Anilkumar P R	5.50	2 years



Development of a semi-automatic angiography system for facilitating coronary angiography and angioplasty	Mr Sarath S Nair	5.00	2 years
Home –based post-Covid physiotherapy assistance system	Mr Praveen James	0.60	1year
Development of device for continuous non-invasive percutaneous capillary glucose measurement in children	Vishal V P	4.75	2 years
Development and evaluation of air-borne infection control system for health care facilities	Mr Shaj Upendran	4.90	2 years

## INSTITUTE-FUNDED TRC PROJECTS (ONGOING)

Title of the Project	Principal Investigator	Total Outlay (Rs in Lakhs)	Duration
Development of a spinal cord stimulator for pain management	Mr Jithin Krishnan	78.48	3 years
Development of rapid diagnostic kit for sepsis (procalitonin-based) and <i>Chlamydia trachomatis</i>	Dr Manoj G	40.61	2 years

## INSTITUTE-FUNDED PROJECTS (ONGOING)

Title of the Project	Principal Investigator	Funding	Total Outlay (Rs. in Lakhs)	Duration
Understanding disease clustering (Multi-morbidity) in the tribal population of Kerala	Dr Jeemon P	ST Grant-SCTIMST	165.00	2 years
Documenting cause of death among tribal population through automated verbal autopsy using Information and Communication Technology (ICT)	Dr Jissa V T	ST Grant-SCTIMST	71.10	3 years



## COMPLETED PROJECTS

### Hospital Wing & Achutha Menon Centre For Health Science Studies

Title of the Project	Principal Investigator	Funding Agency	Total Outlay (Rs in Lakhs)	Duration
Baseline surveillance of major risk factors of NCD in Kerala (KIRAN)	Dr Sankara Sarma	Government of Kerala	258.00	2 years
Quantitative estimation of regional brain iron deposition- a potential biomarker for Parkinson`s disease and other neurodegenerative conditions causing atypical Parkinsonism	Dr Syam K	DBT	18.73	3 years
Improving Stroke Care in India (IMPROVISE)	Dr Sylaja P N	NIHR, UK	£ 48382	4 years
Structural and functional imaging correlates of cognitive dysfunction in relapsing remitting multiple sclerosis	Dr Sruthi S Nair	DST	32.15	3 years
Effect of combined visual-auditory-sensory stimulation using a structured protocol in hemineglect following right hemispheric ischemic stroke: A randomized controlled trial	Dr Sajith S	Centre for Disability Studies	4.00	1.5 years
Molecular, clinicoradiologic and pathological characterization of oligodendrogliomas with CIC and FUBP1 mutations	Dr Deepti A N	SERB	24.69	3 years
An obligate role for Discoidin Domain Receptor 2 in cell cycle progression and apoptosis resistance in cardiac fibroblasts	Dr Neethu Mohan	DBT	39.87	3 years
Three dimensional printing in congenital heart disease	Dr Kapilamoorthy	SERB	38.12	3 years



Effectiveness of drugs control and regulating mechanism of the Drugs Control Department in Kerala State	Dr Ravi Prasad Varma	Planning Board, Government of Kerala	8.98	2 years
Availability, distribution and utilization of health care facilities in Kerala	Dr Manju R Nair	Planning Board, Government of Kerala	9.00	2 years

## Biomedical Technology Wing

Title of the Project	Principal Investigator	Funding Agency	Total Outlay (Rs in Lakhs)	Duration
Programme support on translational research on biomaterials	Dr H K Varma, Dr Manoj Komath, Dr A Sabareeswaran	DBT	47.05	5 years
Differentiation of mesenchymal stem cells into chondrocytes by sustained delivery of miRNAs using chitosan hydrogel	Dr Prabha D Nair	SERB	76.97	3 years
MUSTER - Musculoskeletal stem cells targeting	Dr Prabha D Nair	DBT	209.96	4 years
MUSTER - Musculoskeletal stem cells targeting	Dr Harikrishna Varma	DBT	96.00	4 years
Design and fabrication of a head phantom for dosimetric evaluation of radiotherapy treatment plan	Dr Roy Joseph	KSCSTE and RCC Trivandrum	29.34	3 years
Magneto-optic sensor for cardiac biomarker detection	Dr R S Jayasree	DST	7.46	2 years
Stem cell-derived exosome therapy for clinical management of lung damage in critically-ill corona viral pneumonia patients	Dr Naresh Kasoju	SERB	19.14	1 year
Antimicrobial peptide-loaded multifunctional 3D collagen scaffold for vascularized bone tissue regeneration	Dr P V Mohanan	DST	5.04	2 years
An easy and rapid detection platform for viral diseases from saliva: COVID-19 and beyond	Dr Jayasree R S	SERB	16.54	1 year



## Institute-Funded TDF Projects (Completed)

Title of the Project	Principal Investigator	Total Outlay (Rs in Lakhs)	Duration
Development of a dural substitute with mucoadhesive and antibacterial properties	Dr P Ramesh	9.99	2 years
Ceramic tile forms and tile support matrix-standardization and design considerations	Dr Francis Fernandez	6.50	1 year
Cavity conformable surgical space stent retractor(SSSR): design and proof- of- concept	Dr George C Vilanilam	5.00	1.5 years
Automated External Defibrillator (AED)	Ms Neethu	5.00	1.5 years
Design of novel polyaxial pedicle screws for thoracolumbar stabilization	Mr Aravind Kumar Prajapathi	4.86	2 years
Multi-layered wrap-knitted polyester in strengthening valve annulus after valve repair	Varghese T Panicker	6.76	2 years
Role of resting state functional magnetic resonance imaging in patients with intracranial dural arteriovenous fistula	Dr Bejoy Thomas	1.90	2 years
Assessment of carotid plaque vulnerability using 3T MRI and correlation with carotid endarterectomy	Dr Anoop.A	0.75	2 years
Role of intravoxel incoherent motion imaging (IVIM) in post transarterial chemoembolisation (TACE) response evaluation of hepatocellular carcinoma (HCC)	Dr Jineesh	0.96	2 years
The role of biomarkers in predicting the risk of hemorrhagic transformation in acute ischemic stroke	Dr Sapna Erat Sreedhran	5.00	2 years
Development of Real Time RT-PCR assay for detection of SARS-CoV2	Dr Jyothi E K	2.75	1 year



## Institute-funded TRC Projects (Completed)

Title of the Project	Principal Investigator	Total Outlay (Rupees in Lakhs)	Duration
Chitra Acrylosorb Respiratory Secretion Solidification System	Dr Manju S	4.30	2 months
Smart Assistive Breathing Device	Sarath S Nair	2.00	2 months
Digital Sanitization Systems	Sarath S Nair	2.00	2 months
Isolation Pods	Sarath G	2.00	2 months
Emergency Response Isolation Systems	Subhash N N	2.00	2 months
Ventilator Sharing Kit	Vinodkumar V	2.00	2 months
Examination Booth with UV disinfection system as barrier between patient and doctor	Ramesh Babu V	2.00	2 months
Disinfection Gateway for entry points at offices, hospitals, apartments, etc	Jithin Krishnan	2.00	2 months
Antibody against ASPIKE protein to prevent COVID-19	Dr Anugya Bhatt	3.00	6 months
Rapid detection kit for IgG/IgM antibody	Dr Manoj G	4.00	6 months
Nylon Flocked Swabs (Nasopharyngeal and Oropharyngeal) for COVID-19 testing	Dr Lynda Velutheril Thomas	6.00	6 months
Oropharyngeal Sample Collection Kit	Dr Anugya Bhatt	6.00	6 months
Developing a point-of-care testing protocol based on RT-LAMP for fast detection of SARS-CoV-2	Dr Anoop Kumar T	20.00	6 months
Development of a cost-effective Ventilator	Nagesh D S	26.4	18 months



## Institute-funded Projects (Completed)

Title of the Project	Principal Investigator	Funding	Total Outlay (Rs in Lakhs)	Duration
Regulation of progenitor cell function in heart by Angiotensin II	Dr Neethu Mohan	Seed Funding- SCTIMST	5.00	2 years
Intraoperative quantification of left ventricular volumes and ejection fraction by real-time three dimensional transesophageal echocardiography: Comparison with cardiac magnetic resonance imaging	Dr M S Saravana Babu	Seed Funding - SCTIMST	3.75	2 years
Identification and characterization of neuronal derived circulating exosomal miRNA and protein cargoes in Parkinson`s disease patients	Dr Madhusoodanan U K	Seed Funding - SCTIMST	4.85	2 years
AGE modification of basement membrane: Implications in neurodegenerative disease	Dr Cibir	Seed Funding - SCTIMST	5.00	2 years



# STATUTORY COMMITTEES

## INSTITUTE BODY

### **Dr V K Saraswat (President)**

Member-NITI Aayog  
New Delhi

### **Shri Umesh G Jadhav**

Hon'ble Member of Parliament (Lok Sabha)

### **Dr Shashi Tharoor**

Hon'ble Member of Parliament (Lok Sabha)

### **Hon'ble Member of Parliament (Rajya Sabha) (to be elected)**

### **Secretary to Government of India**

Department of Science & Technology  
Technology Bhavan, New Mehrauli Road  
New Delhi

### **Dr Sunil Kumar**

Director General of Health Services  
Ministry of Health & Family Welfare  
Government of India, Nirman Bhavan  
Maulana Azad Road, New Delhi

### **Smt Annie G Mathew**

Joint Secretary (Pers.)  
Department of Expenditure, Ministry of Finance  
Government of India, New Delhi

### **Ms Ishita Roy**

Joint Secretary (Higher Education)  
Ministry of Human Resource Development  
Government of India  
Shastri Bhawan, New Delhi

### **Dr Ali Manikfan Abdullage**

Senior Regional Director  
Regional Office of Health & Family Welfare  
Meads Lane, Cantonment, Thiruvananthapuram

### **Shri Rajan N Khobragade**

Principal Secretary, Health & Family Welfare &  
Ayush  
Department of Health & Family Welfare  
Government of Kerala

### **Dr K P Sudheer**

Executive Vice-President  
Kerala State Council for Science, Technology &  
Environment  
Sasthra Bhavan, Thiruvananthapuram

### **Prof V P Mahadevan Pillai**

Vice-Chancellor  
University of Kerala  
Thiruvananthapuram

### **Dr Tapas K Kundu**

Director  
Central Drug Research Institute  
Lucknow

### **Dr Chitra Mandal**

CSIR-Indian Institute of Chemical Biology  
Raja S C Mullick Road  
Kolkata

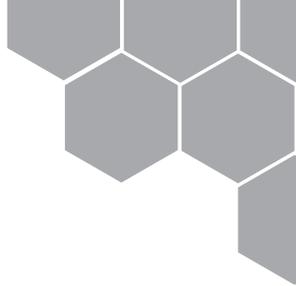
### **Shri T P Senkumar**

Ex-DGP Kerala  
Pradeeksha, Anand Lane  
PTP Nagar, Vattiyookavu PO  
Thiruvananthapuram

### **Prof Gagandeep Kang**

Executive Director  
Translational Health Science & Technology Institute  
NCR Biotech Science Cluster  
Faridabad





**Prof B Ravi**  
Department of Mechanical Engineering  
IIT Bombay  
Mumbai

**Dr B N Gangadhar**  
Director  
NIMHANS  
Bengaluru

**Prof Shally Awasthi**  
King George's Medical University  
Lucknow

**Prof Goutam Ganguly**  
Bangur Institute of Neurosciences  
Kolkata

**Prof Ajit Kumar V K (Member Secretary)**  
Director  
SCTIMST

**Dr Harikrishna Varma P R**  
Head, Biomedical Technology Wing  
SCTIMST

## GOVERNING BODY

**Dr V K Saraswat (President)**  
Member-NITI Aayog  
New Delhi

**Secretary to Government of India**  
Department of Science & Technology  
Technology Bhavan, New Mehrauli Road  
New Delhi

**Dr Sunil Kumar**  
Director General of Health Services  
Ministry of Health & Family Welfare  
Government of India, Nirman Bhavan  
Maulana Azad Road, New Delhi

**Financial Advisor**  
Department of Science & Technology

**Dr K P Sudheer**  
Executive Vice-President  
Kerala State Council for Science, Technology &  
Environment  
Sasthra Bhavan, Thiruvananthapuram

**Shri T P Senkumar**  
Ex-DGP Kerala  
Pradeeksha, Anand Lane  
PTP Nagar, Vattiyookavu PO  
Thiruvananthapuram

**Prof Goutam Ganguly**  
Bangur Institute of Neurosciences  
Kolkata

**Prof Ajit Kumar V K (Member Secretary)**  
Director  
SCTIMST

**Dr Harikrishna Varma P R**  
Head, Biomedical Technology Wing  
SCTIMST

**Dr Sankara Sarma**  
Professor (Senior Grade), Achutha Menon Centre  
for Health Science Studies  
SCTIMST

## ACADEMIC COMMITTEE

**Prof Ajit Kumar V K (Chairman)**  
Director  
SCTIMST

**Prof Kesavadas C**  
Dean, Academic Affairs  
SCTIMST

**Dr Harikrishna Varma P R**  
Head, Biomedical Technology Wing  
SCTIMST

**Dr Thomas Koshy**  
Professor (Senior Grade)  
Department of Anaesthesiology  
SCTIMST



**Dr Kavita Raja**

Professor (Senior Grade) & Head, Department of Microbiology  
SCTIMST

**Dr Maya Nandakumar**

Scientist G & Head, Department of Applied Biology  
Biomedical Technology Wing, SCTIMST

**Shri Ramesh Babu V**

Engineer G, Department of Medical Devices  
Engineering  
Biomedical Technology Wing, SCTIMST

**Prof Biju Soman**

Achutha Menon Centre for Health Science Studies  
SCTIMST

**Prof K Srinivasan**

Achutha Menon Centre for Health Science Studies  
SCTIMST

**Prof Sanjay Zodpey**

Vice-President, Public Health Foundation of India &  
Director, Indian Institute of Public Health-Delhi

**Prof M Madhusudanan**

Head, Department of Neurology  
Pushpagiri Medical College, Thiruvalla

**Prof R Krishna Kumar**

Department of Engineering Design  
IIT Madras

**Dr Kuruvilla Joseph**

Senior Professor & Dean  
Department of Chemistry  
Indian Institute of Space Science and Technology  
Thiruvananthapuram

**Prof Anil Peethambaran**

Head, Department of Neurosurgery  
Government Medical College  
Thiruvananthapuram

**Prof Naresh Bhatnagar**

Department of Mechanical Engineering  
IIT Delhi

**FINANCE COMMITTEE****Prof Ajit Kumar V K (Chairman)**

Director  
SCTIMST

**Secretary to Government of India**

Department of Science & Technology  
Technology Bhavan, New Mehrauli Road  
New Delhi

**Financial Advisor**

Department of Science & Technology

**Prof V P Mahadevan Pillai**

Vice-Chancellor  
University of Kerala  
Thiruvananthapuram

**Financial Advisor (Ex-officio Convener)**

SCTIMST

**RESEARCH COUNCIL****Prof P Balram (Chairman)**

Former Director, IISc  
Molecular Biophysics Unit  
Indian Institute of Science  
Bengaluru

**Prof Ajit Kumar V K**

Director  
SCTIMST

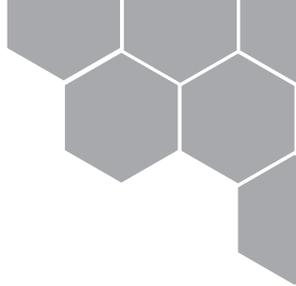
**Prof M S Ananth**

Former Director, IIT Madras  
Emeritus Research Fellow, Department of Chemical  
Engineering  
CSIR - National Chemical Laboratory  
IIT Madras

**Prof G K Ananthasuresh**

Centre for Biosystems Science & Engineering  
Department of Mechanical Engineering  
Indian Institute of Science  
Bengaluru





**Shri Anil Kumar Anand**  
Director Technical  
Microtrol Sterilisation Services Pvt. Ltd.  
Mumbai

**Shri Sasi P M**  
Director  
International Centre for Free and Open Source  
Software (ICFOSS)  
Thiruvananthapuram

**Dr Balasubramanian Gopalan**  
Former CSO & Executive Director, Orchid Research  
Laboratories Limited Scientific Advisor, Projects  
on Drug Discovery, Synthetic Chemistry & Process  
Research and in Crop Protection Chemicals  
CSIR - Indian Institute of Chemical Technology  
Hyderabad

**Shri V Sashi Kumar**  
Managing Director, Phoenix Medical Systems (P)  
Ltd.  
DP 42, SIDCO Industrial Estate  
Chennai

**Prof Vikram Jayaram**  
Chair, Division of Mechanical Sciences  
Department of Materials Engineering  
Indian Institute of Science  
Bengaluru

**Shri A V Ramani**  
Group Advisor (R&D)  
TTK Group of Companies  
Bengaluru

**Dr Soma Guhathakurtha**  
Director  
SynkroMax Biotech Pvt. Ltd.  
Chennai

**Dr Jyotsna Dhawan**  
Chief Scientist  
Centre for Cellular & Molecular Biology  
Hyderabad

**Dr C N Ramchand**  
Chief Executive Officer  
Saksin Lifesciences Pvt. Ltd.  
Chennai

**Dr K P Mohan Kumar**  
Director  
Inter University Centre for Biomedical Research &  
Super Specialty Hospital  
MG University Campus, Kottayam

**Dr Manohar V Badiger**  
Senior Principal Scientist  
Polymer Science and Engineering Division  
CSIR - National Chemical Laboratory  
Dr Homi Bhabha Road, Pune

**Shri Ajay Pitre**  
Managing Partner  
Pitre Business Ventures LLP  
Pune

**Shri Nandakumar S**  
Chief Executive Officer  
Perfint Healthcare Pvt. Ltd.  
Chennai

## INSTITUTIONAL ETHICS COMMITTEE

**Prof C C Kartha (Chairman)**  
Former Professor of Eminence, Molecular Medicine  
& Disease Biology, RGCB  
7B, SFS Golfinks Apartments, Kowdiar  
Thiruvananthapuram

**Prof Kala Kesavan P**  
Head, Department of Pharmacology  
Government Medical College, Thiruvananthapuram

**Prof Pradeep S**  
Head, Department of Pharmacology  
Dr Somervell Memorial CSI Medical College and  
Hospital  
Karakonam PO, Thiruvananthapuram



**Smt Sathi Nair**

Retd. Chief Secretary  
'Samtripthi' Devapalan Nagar  
Peroorkada, Thiruvananthapuram

**Shri N Anand**

Advocate, High Court of Kerala  
II Floor, Papali Enclave, Providence Road  
Ernakulam

**Dr Rejnish Kumar**

Additional Professor  
Regional Cancer Centre  
Thiruvananthapuram

**Prof Christina George**

Head, Department of Psychiatry  
Dr Somervell Memorial CSI Medical College and  
Hospital  
Karakonam PO, Thiruvananthapuram

**Dr P Manickam**

Scientist E, ICMR-National Institute of  
Epidemiology (NIE)  
R 127, 31'd Avenue, TNHB, Ayapakkam  
Chennai

**Smt Priya Kaimal**

Advocate, High Court of Kerala  
C/8, V B Crest, St Martin Road  
Palarivattom, Ernakulam

**Dr Harikrishna Varma P R**

Head, Biomedical Technology Wing  
SCTIMST

**Prof Narayanan Namboodiri K K**

Department of Cardiology  
SCTIMST

**Prof Manikandan S**

Department of Anaesthesiology  
SCTIMST

**Prof Ashalatha R**

Department of Neurology  
SCTIMST

**Prof Biju Soman**

Achutha Menon Centre for Health Science Studies  
SCTIMST

**Prof Achuth Sankar S Nair (Alternate Member)**

Department of Computational Biology &  
Bioinformatics  
University of Kerala

**Dr Srinivas G (Member Secretary)**

Scientist G & Head  
Department of Biochemistry  
SCTIMST

**INSTITUTIONAL ANIMAL ETHICS  
COMMITTEE****Dr Anilkumar T V (Chairperson)**

Scientist G (Senior Grade)  
Division of Experimental Pathology  
Biomedical Technology Wing  
SCTIMST

**Dr P V Mohanan**

Scientist G  
Division of Toxicology  
Biomedical Technology Wing  
SCTIMST

**Dr P R Umashankar**

Scientist G  
Division of In Vivo Models and Testing  
Biomedical Technology Wing  
SCTIMST

**Dr V S Harikrishnan (Member Secretary)**

Scientist E  
Division of Laboratory Animal Science  
Biomedical Technology Wing  
SCTIMST

**Dr K R Chandramohan Nair - CPCSEA, Main  
Nominee****Dr Madhavrao - Link Nominee**

**Dr Murali Krishna P - Scientist from outside the Institute**

**Dr Guruvayoorappan C, Socially-Aware Nominee**

## **INSTITUTIONAL COMMITTEE FOR STEM CELL RESEARCH**

**Prof Chandrabhas Narayana (Chairman)**

Director, Rajiv Gandhi Centre for Biotechnology  
Thycaud PO, Poojappura  
Thiruvananthapuram

**Prof Geetha N (Vice-Chairperson)**

Head, Medical Oncology  
Regional Cancer Centre  
Thiruvananthapuram

**Prof Shaji R V**

Department of Hematology  
CMC Vellore  
Tamil Nadu

**Dr Pradeep Kumar G**

Scientist G, Reproductive Biology  
Rajiv Gandhi Centre for Biotechnology  
Thiruvananthapuram

**Dr C Nirmala**

Head (Rtd) Department. of Obstetrics and  
Gynaecology, MCH  
C-VI-L, Millanium Apartment  
Thiruvananthapuram

**Dr Manoj Unni**

Clinical Associate Professor  
Clinical Hematology, Fellowship in Stem Cell  
Transplant  
Amrita Cardio-Oncology Clinic  
AIMS, Kochi

**Smt Sathi Nair**

Retd. Chief Secretary  
'Samtripthi' Devapalan Nagar  
Peroorkada, Thiruvananthapuram

**Dr K R S Krishnan**

Technology Management Adviser & Chairman  
Advisory Committee, NABL (India) & Formerly,  
Adviser Engineering & Technology (DST)  
Director (Technical & Operations) HLL Lifecare  
Ltd. 4-B, Cloud Nine Apartments, Law College  
Junction  
Thiruvananthapuram

**Dr P Manickam**

Scientist E, ICMR-National Institute of  
Epidemiology (NIE)  
R 127, 31'd Avenue, TNHB, Ayapakkam  
Chennai

**Dr Annie John**

ICMR Emeritus Professor  
Department of Biochemistry  
University of Kerala  
Thiruvananthapuram

**Shri Nemom V Sanjeev**

Advocate & Notary  
Nemom Chamber  
Vanchiyoor PO  
Thiruvananthapuram

**Dr Aneesh V Pillai**

Assistant Professor, School of Legal Studies  
Cochin University of Science and Technology  
(CUSAT), Kochi

**Dr Neethu Mohan (Member Secretary)**

Scientist D  
Division of Cellular and Molecular Cardiology  
SCTIMST

**Ms Sreepriya C S (Co-ordinator)**

Executive Secretary to the Director-cum-Ethics  
Committee Co-ordinator  
SCTIMST



## INSTITUTIONAL BIOSAFETY COMMITTEE

### **Shri C V Muraleedharan (Chairman)**

Scientist G & Associate Head  
Biomedical Technology Wing  
SCTIMST

### **Prof Kavita Raja (Biosafety Officer)**

Head, Department of Microbiology  
SCTIMST

### **Dr K Madhavan Nampoothiri (DBT Nominee)**

Principal Scientist (Biotechnology) &  
Head, Microbial Processes and Technology  
National Institute of Interdisciplinary Science and  
Technology (NIIST)  
Thiruvananthapuram

### **Dr Abdul Jaleel**

Scientist E-II, Proteomics Core Facility  
Rajiv Gandhi Centre for Biotechnology  
Thiruvananthapuram

### **Dr P Ramesh**

Scientist G, Division of Polymeric Medical Devices  
Biomedical Technology Wing  
SCTIMST

### **Dr Sathyabhama**

Scientist G  
Department of Transfusion Medicine  
SCTIMST

### **Dr Srinivas G**

Scientist G & Head  
Department of Biochemistry  
SCTIMST

### **Dr Anugya Bhatt**

Scientist F, Thrombosis Research Unit  
Biomedical Technology Wing  
SCTIMST

### **Dr A Maya Nandkumar (Member Secretary)**

Scientist G & Head, Department of Applied Biology  
Biomedical Technology Wing  
SCTIMST

## TECHNOLOGY DEVELOPMENT COMMITTEE

### **Prof Ajit Kumar V K (Chairman)**

Director  
SCTIMST

### **Dr Harikrishna Varma P R**

Head, Biomedical Technology Wing  
SCTIMST

### **Dr Roy Joseph**

Scientist G & Head, Department of Medical Devices  
Engineering  
Biomedical Technology Wing  
SCTIMST

### **Prof Harikrishnan S**

Department of Cardiology  
SCTIMST

### **Prof Bejoy Thomas**

Department of Imaging Sciences and Interventional  
Radiology  
SCTIMST

### **Dr Chitra Mandal**

CSIR-Indian Institute of Chemical Biology  
Raja S C Mullick Road  
Kolkata

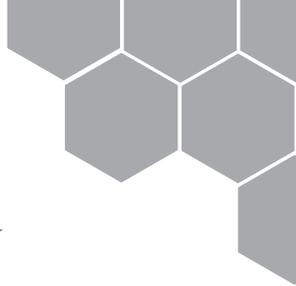
### **Dr Raghu Krishnapuram**

Distinguished Member of Technical Staff  
Robert Bosch Centre for Cyber-Physical Systems  
Indian Institute of Science  
Bengaluru

### **Prof Jayesh Bellare**

Department of Chemical Engineering  
IIT Bombay





**Prof R Krishna Kumar**  
Head, Paediatric Cardiology  
AIMS, Kochi

**Shri V Sashi Kumar**  
Managing Director, Phoenix Medical Systems (P)  
Ltd.  
DP 42, SIDCO Industrial Estate  
Chennai

## BUILDING COMMITTEE

**Prof Ajit Kumar V K (Chairman)**  
Director  
SCTIMST

**Dr Harikrishna Varma P R**  
Head, Biomedical Technology Wing  
SCTIMST

**Financial Advisor (Ex-officio Convener)**  
SCTIMST

**Dr K P Sudheer**  
Executive Vice-President  
Kerala State Council for Science, Technology &  
Environment  
Sasthra Bhavan, Thiruvananthapuram

**Shri S J Vijaya Das**  
Chief Project Examiner  
Kerala Infrastructure Fund Board

## SENIOR STAFF SELECTION COMMITTEE

**Director (Chairman - Ex-Officio)**  
Head, Biomedical Technology Wing  
Nominee of the Secretary, DST  
An expert from outside the Institute nominated by  
the President  
Scientist nominated by the President from among the  
members of the Institute  
Senior academic staff of the Institute not below the  
rank of Professor/Scientist G/Engineer G

## JUNIOR STAFF SELECTION COMMITTEE

**Medical Superintendent**  
Head, Biomedical Technology Wing  
A Representative of the Academic Wing of the  
Institute nominated by the Director  
Three Members nominated by the President

## SPECIAL RESERVATION CELL

**Sri Kiran K V**  
Assistant Accounts Officer  
F&A Division, SCTIMST

**Sri Renu Remesan**  
Nursing Officer - B  
SCTIMST

**Sri Vinod D**  
Technical Assistant (Lab) - B  
SCTIMST

**Smt Preethamol P**  
Nursing Officer - C  
SCTIMST

**Sri Aji K**  
Physiotherapist - B  
SCTIMST

## INTERNAL COMPLAINTS COMMITTEE

**Dr Kavita Raja (Chairperson)**  
Professor (Senior Grade) & Head  
Department of Microbiology  
SCTIMST

**Dr Bismi Gopalakrishnan**  
Department of Law  
University of Kerala

**Dr Jayasree R S**  
Scientist F, Division of Biophotonics and Imaging  
Biomedical Technology Wing  
SCTIMST



**Dr Jayadevan E R**  
Additional Professor  
Department of Imaging Sciences and Interventional  
Radiology  
SCTIMST

**Prof Sanjay G**  
Department of Cardiology  
SCTIMST

**Dr Sapna Erat Sreedharan**  
Additional Professor  
Department of Neurology  
SCTIMST

**Dr Jissa V T**  
Scientist C, Achutha Menon Centre for Health  
Science Studies  
SCTIMST

**Nursing Superintendent**  
SCTIMST

## **PUBLIC GRIEVANCE COMMITTEE**

**Dr Harikrishna Varma P R (Chairman)**  
Head, Biomedical Technology Wing  
SCTIMST

**Prof Thomas Koshy**  
Department of Anaesthesiology  
SCTIMST

**Dr Maya Nandakumar**  
Scientist G & Head, Department of Applied Biology  
Biomedical Technology Wing, SCTIMST

**Prof Debasish Gupta**  
Head, Department of Transfusion Medicine  
SCTIMST

**Dr Jeemon P**  
Associate Professor, Achutha Menon Centre for  
Health Science Studies, SCTIMST

**Shri Vipin C G**  
Chief Accounts Officer  
SCTIMST

**Smt Sudha T**  
Librarian-cum-Information Officer  
SCTIMST

**Nursing Superintendent**  
SCTIMST

**Smt Rosamma Manuel**  
Junior Scientific Officer (MSW)  
SCTIMST

**Administrative Officer Grade I**  
Hospital Wing, SCTIMST

## **EMPLOYEES GRIEVANCE COMMITTEE**

*Hospital Wing & Achutha Menon Centre for Health  
Science Studies*

**Prof K K Narayanan Namboodiri (Chairman)**  
Department of Cardiology  
SCTIMST

**Prof Srinivasan K**  
Achutha Menon Centre for Health Science Studies  
SCTIMST

**Dr Jayadevan E R**  
Additional Professor  
Department of Imaging Sciences and Interventional  
Radiology  
SCTIMST

**Dr Prakash Nair**  
Associate Professor  
Department of Neurosurgery  
SCTIMST

**Nursing Superintendent (ex officio)**





**Smt Sudha T**  
 Librarian-cum-Information Officer  
 SCTIMST

**Shri Binu Thomas**  
 Senior Scientific Assistant  
 Department of Anaesthesiology  
 SCTIMST

**Shri Shibu Raj R (Convenor)**  
 Assistant Administrative Officer (P&A Division)  
 SCTIMST

**Dr Satheesh Nair M (External Member)**  
 Clinical Psychologist  
 Department of Health Services  
 Government of Kerala

**Biomedical Technology Wing**

**Dr Manoj Komath (Chairman)**  
 Scientist G & Head, Department of Biomaterial  
 Science and Technology  
 SCTIMST

**Shri Vinodkumar V**  
 Engineer F, Division of Extracorporeal Devices  
 SCTIMST

**Dr Jayasree R S**  
 Scientist F, Division of Biophotonics and Imaging  
 Biomedical Technology Wing  
 SCTIMST

**Shri Sajithlal M K**  
 Engineer E, Network Service Cell  
 SCTIMST

**Smt Sandhya C G**  
 Engineer E, Technology Business Division  
 SCTIMST

**Shri Arumugham V**  
 Senior Scientific Assistant (Instruments)  
 Calibration Cell, Biomedical Technology Wing  
 SCTIMST

**Administrative Officer (Convenor, ex officio)**  
 Biomedical Technology Wing, SCTIMST

**Dr Satheesh Nair M (External Member)**  
 Clinical Psychologist  
 Department of Health Services  
 Government of Kerala

**INTERNAL COMPLAINTS  
 COMMITTEE ON SEXUAL  
 HARASSMENT OF WOMEN IN  
 THE WORKPLACE (PREVENTION,  
 PROHIBITION AND REDRESSAL)**

The Annual Report of the Internal Complaints Committee, SCTIMST, fulfils the requirements of Section 21(1) of the Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013.

1. Number of complaints of sexual harassment received during the year: 1
2. Number of complaints disposed of during the year: 1
3. Number of cases pending for more than 90 days: Nil
4. Number of Workshops or Awareness Programmes against sexual harassment carried out: 1

An Awareness Programme (online) on commemoration of Prevention of Sexual Harassment Act 2013 (PoSH Act 2013) was organized by the ICC on 9 December 2021. Dr Bismi Gopalakrishnan, Advocate and Professor, Department of Law, University of Kerala delivered a talk on the theme: "Prevention of Sexual Harassment at the Workplace (PoSH Act 2013) Legal & Human Right Considerations". Poster competitions on the following topics were organized:

- Gender Advancement for Transforming Institutions (GATI) - ensuring gender equality is a Human fight, not a Woman's fight
- Safe workplace- an Institute's pride



## PROGRESS ON IMPLEMENTATION OF INTEGRITY PACT AT SCTIMST AS PER CENTRAL VIGILANCE COMMISSION REQUIREMENT

In the year 2007, the Central Vigilance Commission (CVC) vide office order dated 04-12-2007 recommended implementation of a concept called “Integrity Pact”(IP) in respect of all major procurements. The IP essentially envisages an agreement between the prospective vendors/bidders and the buyer committing the persons/officials of both the parties not to exercise any corrupt influence on any aspect of the contract. The Integrity Pact, in respect of a particular contract shall be operative from the date IP is signed by both the parties till the final completion of the contract.

The Governing Body of SCTIMST vide its resolution No.V.37 dated 03-03-2018 recommended to incorporate Integrity Pact for procurements/contracts above a threshold value of Rupees One Crore. The IP is to be implemented through Independent External Monitors (IEMs) appointed by the organization. IEMs would review independently and objectively whether and to what extent parties have complied with their obligations under the pact. The main role and responsibility of IEM is to resolve issues raised by a potential bidder regarding any aspect of the tender which allegedly restricts competition or indicates bias towards some bidders.

Accordingly, SCTIMST had appointed Shri Sanjeev Behari, IRS(Retd) and Shri Sharda Prasad, IPS(Retd) both from Noida as Independent External Monitors for implementation of Integrity Pact at SCTIMST vide our letter of appointment dated 31-01-2019 for a period of three years. Both the IEMs were appointed as per the recommendation from CVC from their empanelled list.

SCTIMST had incorporated Integrity Pact in open tenders with an estimated value of more than Rs 1 Crore floated by SCTIMST during the financial year 2021-22.

During the year 2021-22, the following were some of the agenda points discussed during the online review meetings with IEMs:

1. Generally understand the working of the institute, its requirements, standards followed and existing rules and procedures followed in the Tender process.
2. Discussed/Reviewed the information on Tenders awarded by the institute during the financial year.
3. Reviewed the compliance by the institute and modifications in the system of the institute
4. Reviewed post-tender instructions as issued by CVC and its compliance.
5. Reviewed the status on implementation of E-procurement.
6. Discussion with Vigilance Officer of the institute regarding compliance with various requirements of CVC and submission of reports to CVC periodically.
7. Gave suggestions/improvements to be made in the procurement system in line with CVC guidelines from time to time.
8. Conducted a session on “Integrity in Governance and Preventive Vigilance” to the staff of the institute as part of Vigilance Awareness Week.
9. Examined the purchase process integrity of major Tenders.



## RESERVATION AND OTHER WELFARE MEASURES FOR SCHEDULED CASTES/ SCHEDULED TRIBES/ OTHER BACKWARD CLASSES/ ECONOMICALLY WEAKER SECTIONS AND PERSONS WITH DISABILITIES

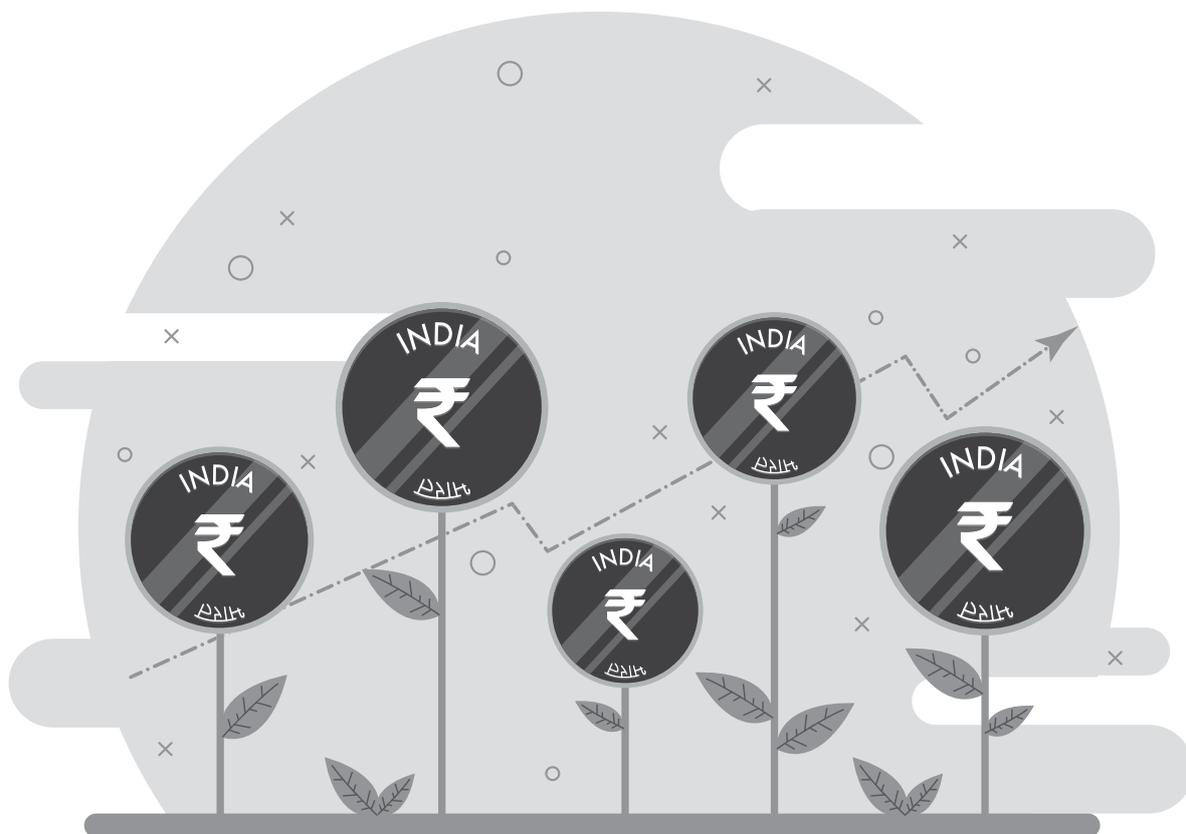
SCTIMST has been following, in letter and spirit, the Presidential directives and other guidelines related to reservation/concession for Scheduled Castes/Scheduled Tribes/Other Backward Classes/Economically Weaker Sections issued by the Government of India from time to time. An adequate monitoring mechanism was put in place in the Institute for sustained and effective compliance with the Reservation Policy. Rosters were maintained as per the directives and are regularly inspected by the Liaison Officer to ensure compliance. A Special Reservation Cell for SC/ST employees was functioning with five members, including an Officer. In order to monitor the implementation of reservation of students admitted to various academic programs, a Student Reservation and Equal Opportunity Cell was also functioning. This Cell will address the grievances of candidates/students who belong to reservation categories on reservation related matters and ensure measures to prevent any caste based discrimination in the Institute. It will also monitor and implement various scholarship (International/National/State/Others) opportunities to students belong to reservation categories.

The following were the major welfare measures implemented by the Institute for the benefit of Scheduled Castes/Scheduled Tribes/Other Backward Classes/Economically Weaker Sections and Persons with Disabilities:

1. Nominated: Liaison Officer for SC/ST/PWD, Liaison Officer for OBC, Liaison Officer for EWS and Liaison Officer for Ex-service Men.
2. Constitution of a 5-member Special Reservation Cell including one Officer-In-Charge.
3. Implemented reservation in all temporary and project appointments above 45 days.
4. Implemented reservation in Group A academic posts, laid down in the Central Educational Institutions (Reservation in Teachers' Cadre) Act, 2019 (10 of 2019) through regulation amendment vide Government of India Gazette notification.
5. Providing Fellowship for SC/ST students.
6. Free treatment for Scheduled Tribe patients utilizing the ST funds received from the Government of Kerala. Till date, Rs 115 Lakh was received from Government of Kerala under this scheme and a sum of Rs 104.59 Lakh was utilized as on 31-03-2022 for treatment of 1685 patients in Inpatient and Outpatient services in the Hospital.
7. Institute provided Telemedicine Facility to the tribal population of Wayanad under the Mobile Telemedicine Project. The programme is funded by DST and executed in collaboration with the State Health Department of Kerala and the Centre for Development of Advanced Computing (C-DAC), Trivandrum. This project uses innovative approaches to harness an existing sophisticated technology (Telemedicine) to improve access to secondary healthcare services in remote areas (a pressing public health need). Two mobile Telemedicine Units with a dedicated medical team (one MBBS doctor, one BSc Nurse, and a driver-cum-technician) were available for this Clinical project. The mobile units visited the peripheral health centres on a fixed day and used the telemedicine facility to connect with the specialists. This facility has proven convenient, especially for the tribal people, who are reluctant to seek care from far off hospitals.
8. Two more tribal study projects from ST Grant of the Institute were ongoing at AMCHSS: (1) Documenting cause of death among tribal population through automated verbal autopsy using Information and Communication Technology (ICT) and (2) Understanding disease clustering (Multi-morbidity) in the tribal population of Kerala.







# STATEMENT OF ACCOUNTS 2021-22

**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM**

**BALANCE SHEET AS AT 31<sup>st</sup> March 2022**

CORPUS/CAPITAL FUND AND LIABILITIES		2021-22	2020-21
		Rs.	Rs.
CAPITAL FUND	1	5701708648	4826556824
RESERVES & SURPLUS	2	252139924	244829294
EARMARKED ENDOWMENT FUNDS	3	863069350	877774200
SECURED LOANS & BORROWINGS, UNSECURED LOANS & BORROWINGS, DEFERRED CREDIT LIABILITIES	4,5,6	0	0
CURRENT LIABILITIES & PROVISIONS	7	742515118	537015338
<b>TOTAL</b>		<b>7559433040</b>	<b>6486175657</b>
<b>ASSETS</b>			
FIXED ASSETS	8	2136918128	1751259011
INVESTMENTS FROM EARMARKED ENDOWMENT FUNDS	9	482316616	640508212
INVESTMENTS-OTHERS	10	252139924	244829294
CURRENT ASSETS , LOANS, ADVANCES ETC	11	4688058372	3849579139
MISCELLANEOUS EXPENDITURE (TO THE EXTENT NOT WRITTEN OFF)			
<b>TOTAL</b>		<b>7559433040</b>	<b>6486175657</b>
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES & NOTES ON ACCOUNT	25		

Sd/-  
Financial Adviser

Sd/-  
Director



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM**

**INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR 2021-22**

INCOME	Schedule	2021-22	2020-21
		Total Rs.	Total Rs.
Income from Sales / Services	12	1000355264	754916044
Grants Received from Govt of India(Salary & General)	13	3100100000	2650000000
Fees/Subscription	14	15724489	16486501
Income from Investments } Withdrawal from ERF }	15	14586937 0	18611077 0
Income from Royalty, Publication etc	16	4981543	7261992
Interest earned	17	31211419	35543373
Other Income	18	29272578	15803341
	Total	4196232230	3498622328
<b>EXPENDITURE</b>			
Establishment Expenses	20	2106300355	2148546839
Other Administrative Expenses	21	1016484341	772665657
Bank Charges	23	1915089	84447
Depreciation - Current Year		82077870	127482684
		3206777655	3048779627
Balance being Excess Expenditure over Income (-)/Excess income over expenditure(+)		989454575	449842701
Add: Transfer to Special Reserve Account		4292268	6785866
<b>BALANCE BEING DEFICIT CARRIED TO CAPITAL FUND</b>		<b>985162307</b>	<b>443056835</b>

Sd/-  
Financial Adviser

Sd/-  
Director



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM  
SCHEDULES**

SCHEDULE 1 - CORPUS/CAPITAL FUND		2021-22	2020-21
	PARTICULARS	[Rs.]	[Rs.]
	Balance as at the beginning of the year	7998550154	7037740954
	Less Depreciation up to the end of the previous year	3171993330	3044510646
	Net balance at the beginning of the year	4826556824	3993230308
	Add: Plan Grants received from Government of India for creation of Capital Assets	250000000	450000000
	Add: Grants received under CSR scheme	0	1290000
	Less: Unutilized Grant-in-Aid ST-General	250000000	0
	Deduct: Balance of net expenditure transferred from the Income and Expenditure Account Or add excess of income over expenditure	985162307	443056835
	Less: Value of Assets Written off during the year	110010482	61020319
	Deduct Transfer to BMT/Add Transfer from CHO	0	0
	<b>BALANCE AS AT THE YEAR-END</b>	<b>5701708648</b>	<b>4826556824</b>
<b>SCHEDULE 2-RESERVES AND SURPLUS:</b>			
	1. Capital Reserve:		
	As per last Account	--	--
	Addition during the year	--	--
	Less: Deduction during the year	--	--
	3. Special Reserves:		
	As per last Account	244829294	242526805
	Addition during the year (Current year transfer- Increase in provision)	7310630	2302489
	Less: Deductions during the year	0	0
	4. General Reserve:		
	As per last Account	--	--
	Addition during the year	--	--
	Less: Deductions during the year	--	--
	<b>TOTAL</b>	<b>252139924</b>	<b>244829294</b>

Sd/-  
Financial Adviser

Sd/-  
Director



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM**

SCHEDULE 3-EARMARKED/ENDOWMENT FUNDS		2021-22	2020-21
	a) Opening balance of the funds	877774201	853496857
	b) Additions to the funds:		
	i. Donations/grants	986630121	878884537
	ii. Income from Investments made on account of funds		
	iii. Other additions (Specify nature)	0	0
	<b>TOTAL (a+b)</b>	<b>1864404322</b>	<b>1732381394</b>
	c) Utilisation / Expenditure towards objective of funds		
	i. Capital Expenditure		
	- Fixed Assets	104412630	52084738
	- Others	0	0
	<b>Total (Detailed Schedule Attached)</b>	<b>104412630</b>	<b>52084738</b>
	ii. Revenue Expenditure		
	- Salaries, Wages and allowances etc.	74448052	66911520
	- Rent & Consumables etc.,	130565965	157582261
	- Other Administrative expenses	691908325	578028674
	<b>Total</b>	<b>896922342</b>	<b>802522455</b>
	<b>TOTAL (c)</b>		
	<b>NET BALANCE AS AT THE YEAR-END (a+b+c)</b>	<b>863069350</b>	<b>877774200</b>

Sd/-  
Financial Adviser

Sd/-  
Director



SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL

SCHEDULE 3-EARMARKED/ENDOWMENT FUNDS - AS ON 31.03.2022

PROJ #	NAME OF GRANTEE/ PRINCIPAL INVESTIGATOR	FUND-WISE BREAK UP			TOTAL	FIXED ASSETS	
		OPENING BALANCE	ADDITIONS TO FUND				
			GRANTS	OTHER RECEIPTS			
	HOSPITAL PROJECTS		ADDITIONS TO FUND				
5000	PROJ-MISCELLANEOUS	4274485.26	2309322.00	3022357.00	9606164.26	0.00	
5040	DEVELOPING EXPERIMENTAL THERAUPEUTICALS	586177.58	0.00	0.00	586177.58	0.00	
5055	ROCKFELLER FOUNDATION,USA	686120.00	0.00	0.00	686120.00	0.00	
5078	PROJECT GRANT/DR MALA RAMANATHAN	5810.00	0.00	0.00	5810.00	0.00	
5094	KERALA STATE AIDS CONTROL SOCIETY	599376.90	164100.00	0.00	763476.90	0.00	
5100	AMC/MAC ARTHUR FOUND TION/ 02-70546	46315.05	0.00	0.00	46315.05	0.00	
5108	EVAL.SUB-TYPES DEMENTIA/DR.MATHURA	15800.50	0.00	0.00	15800.50	0.00	
5119	STAKE HOLDER-PERCEPT/ INST.REV BO	104492.73	0.00	0.00	104492.73	0.00	
5133	WHO FELLOWSHIP TRAINING CBICD	215059.00	0.00	0.00	215059.00	0.00	
5139	A 24 WEEK, MULTICENTER/ DR. MATHURANATH	2602046.78	0.00	0.00	2602046.78	0.00	



# SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

Amount Rs.

UTILIZATION						TOTAL EXPENDITURE	NET BALANCE
CAPITAL EXPENDITURE		REVENUE EXPENDITURE					
OTHERS	TOTAL	SALARIES/WAGES	RENT/CONSUMABLES	OTHER ADMN EXP	TOTAL		
		UTILIZATION					
0.00	0.00	0.00	0.00	447621.98	447621.98	447621.98	9158542.28
0.00	0.00	0.00	4350.00	1106.00	5456.00	5456.00	580721.58
0.00	0.00	0.00	0.00	0.00	0.00	0.00	686120.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5810.00
0.00	0.00	0.00	0.00	112697.00	112697.00	112697.00	650779.90
0.00	0.00	0.00	0.00	0.00	0.00	0.00	46315.05
0.00	0.00	0.00	0.00	0.00	0.00	0.00	15800.50
0.00	0.00	0.00	0.00	0.00	0.00	0.00	104492.73
0.00	0.00	0.00	0.00	0.00	0.00	0.00	215059.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2602046.78



5140	HARVARD SCHOOL OF PUBLIC HEALTH	91794.32	0.00	0.00	91794.32	0.00
5142	BANKING FOR BETTER HEALTH-MEDISAVE	153911.36	0.00	0.00	153911.36	0.00
5146	DEVELOPMENT OF SPEC-TROSCOPIC PROTOCOL	11026.00	0.00	0.00	11026.00	0.00
5150	PROTOCOL 6002-INT 001	112096.60	0.00	0.00	112096.60	0.00
5153	DEV REF. MANUAL FOR PRIMARY	155802.00	0.00	0.00	155802.00	0.00
5159	NCD RISK FACTOR SURVEILLANCE	71123.00	0.00	0.00	71123.00	0.00
5174	CHANGES IN SLEEP WAKEFULNESS-Dr.Mohanku.	49317.00	0.00	0.00	49317.00	0.00
5175	SURGICAL TRIAL IN LOBAR INTRACEREBRAL	39125.27	0.00	0.00	39125.27	0.00
5180	COMMUNITY BASED INTR-VEN-CV DIS	18308.00	0.00	0.00	18308.00	0.00
5184	COMP HEALTH CARE PROJECT ST	2448774.00	0.00	0.00	2448774.00	0.00
5190	PREVALENCE OF TYPE II DIABETES IN RURAL	42210.00	0.00	0.00	42210.00	0.00
5192	TO PROVIDE INFRASTRUCTURE TO AMCHSS	145022.50	0.00	0.00	145022.50	0.00
5193	SAFE MOTHERHOOD PROGRAMME	71796.00	0.00	0.00	71796.00	0.00
5201	OPEN LABEL TRIAL IN PARKINSON	1672244.50	0.00	0.00	1672244.50	0.00
5203	STUDY IN MRI - ISIR	26183.00	0.00	0.00	26183.00	0.00
5209	MANAGEMENT - CORONARY EVENT	164611.00	0.00	0.00	164611.00	0.00
5213	CREATION OF AMC FUND	18778194.92	0.00	915691.00	19693885.92	0.00
5226	ISOLATION, CHARACTERIZATION OF GLIOMAS	265709.00	0.00	0.00	265709.00	0.00



0.00	0.00	0.00	0.00	0.00	0.00	0.00	91794.32
0.00	0.00	0.00	0.00	0.00	0.00	0.00	153911.36
0.00	0.00	0.00	0.00	0.00	0.00	0.00	11026.00
0.00	0.00	0.00	0.00	60000.00	60000.00	60000.00	52096.60
0.00	0.00	0.00	0.00	0.00	0.00	0.00	155802.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	71123.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	49317.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	39125.27
0.00	0.00	0.00	0.00	0.00	0.00	0.00	18308.00
0.00	0.00	0.00	0.00	1408401.00	1408401.00	1408401.00	1040373.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	42210.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	145022.50
0.00	0.00	0.00	0.00	0.00	0.00	0.00	71796.00
0.00	0.00	403200.00	6500.00	14655.00	424355.00	424355.00	1247889.50
0.00	0.00	0.00	0.00	0.00	0.00	0.00	26183.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	164611.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	19693885.92
0.00	0.00	0.00	0.00	0.00	0.00	0.00	265709.00



5227	MONOTHERAPY/ ACTIVE CONTROL	173369.86	0.00	0.00	173369.86	0.00
5234	IMPROVING LOCALIZATION IN LESION NEGATIVE	-2860415.00	0.00	0.00	-2860415.00	0.00
5237	KERALA DIABETES PREVENTION PROGRAM(K-DPP	26957.47	0.00	0.00	26957.47	0.00
5238	IMPROVING LOCALIZATION IN LESION NEGA...	4884.00	0.00	0.00	4884.00	0.00
5245	IMPROVING LOCALIZATION IN LESION N..	184938.00	0.00	0.00	184938.00	0.00
5246	COMPREHENSIVE HEART FAILURE	100000.00	0.00	0.00	100000.00	0.00
5247	A PHASE 3, 12-WEEK, DOUBLE BLIND, PLA...	1817731.85	0.00	0.00	1817731.85	0.00
5248	A PHASE 3, DOUBLE BLIND, PLACEBO AND A..	1668927.73	0.00	0.00	1668927.73	0.00
5267	EVALUATION STUDY OF THE ASHA	190689.00	0.00	0.00	190689.00	0.00
5275	ENCODING OF INTERHEMISPHERIC -	852989.00	0.00	0.00	852989.00	0.00
5277	VASCULAR CONGNITIVE IMPAIRMENT	39340.00	0.00	0.00	39340.00	0.00
5279	FAMILY LED REHABILITATION AFTER STROKE..	25860.00	0.00	0.00	25860.00	0.00
5284	INTERNATIONAL STUDY FOR COMPARATIVE	40399.00	7716.00	0.00	48115.00	0.00
5289	MITOCHONDRIAL METABOLISM...	2232.00	0.00	0.00	2232.00	0.00
5292	A RESTING STATE FMRI & TASK ..	2282.00	0.00	0.00	2282.00	0.00
5294	MTP/EC SERVICES OF WOMEN	227053.00	0.00	0.00	227053.00	0.00
5296	ELECTROENCEPHALOGRAPHY WORKSHOP	25230.00	0.00	0.00	25230.00	0.00



0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	173369.86
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2860415.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26957.47
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4884.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	184938.00
0.00	0.00	0.00	0.00	100000.00	100000.00	100000.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1817731.85
0.00	0.00	0.00	609615.75	0.00	609615.75	609615.75	1059311.98	1059311.98
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	190689.00
0.00	0.00	252432.00	0.00	0.00	252432.00	252432.00	600557.00	600557.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39340.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25860.00
0.00	0.00	0.00	0.00	6728.00	6728.00	6728.00	41387.00	41387.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2232.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2282.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	227053.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25230.00



5297	THE HUMAN BRAIN MAPPING PROJ..	2962.00	0.00	0.00	2962.00	0.00
5300	ANALYSING FUNCTIONAL NETWORKS	603761.00	0.00	0.00	603761.00	0.00
5301	IN VITRO BETA AMYLOID UPTAKE	37214.35	0.00	0.00	37214.35	0.00
5302	/DISABILITY STUDIES IN EPILEPSY	45407.00	0.00	0.00	45407.00	0.00
5305	A FAMILY BASED RANDOMIZED	3123070.64	0.00	57571.00	3180641.64	0.00
5307	A RESTING FMRI	275752.00	0.00	0.00	275752.00	0.00
5308	EPILEPSY CARE THROUGH SCHOOLS	261924.29	0.00	0.00	261924.29	0.00
5310	KERALA DIABETES PREVENTION	1075067.25	0.00	0.00	1075067.25	0.00
5313	EQUIPMENT FOR HEART FAILURE	1914426.35	0.00	36691.00	1951117.35	0.00
5314	NON COMMUNICABLE DISEASES	1090168.55	0.00	0.00	1090168.55	0.00
5315	PROSPECTIV SINGLE ARM MUL	897459.85	0.00	0.00	897459.85	0.00
5317	MERES1 TRIAL A PROSPECTIVE	64965.00	0.00	0.00	64965.00	0.00
5319	ENCORE	40532.00	0.00	0.00	40532.00	0.00
5323	CHITRA DHWANI	35500.00	0.00	0.00	35500.00	0.00
5325	DECIPHERING THE GENERIC	2349220.00	0.00	0.00	2349220.00	0.00
5326	NEURO DEVELOPMENTAL DISORDERS	5695362.91	1892000.00	235597.00	7822959.91	1808289.28
5327	MOVEMENT DISORDER	1453340.00	0.00	0.00	1453340.00	0.00
5329	E-DELIVERY FOR HEALTH CARE	7409368.88	0.00	0.00	7409368.88	0.00
5332	HYPOXIA AND MINERALISATION	641.00	0.00	0.00	641.00	0.00



0.00	0.00	0.00	0.00	0.00	0.00	0.00	2962.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	603761.00
0.00	0.00	0.00	27318.00	7181.00	34499.00	34499.00	2715.35
0.00	0.00	0.00	0.00	45407.00	45407.00	45407.00	0.00
0.00	0.00	350000.00	31395.00	2799246.64	3180641.64	3180641.64	0.00
0.00	0.00	0.00	0.00	18667.00	18667.00	18667.00	257085.00
0.00	0.00	0.00	0.00	261924.29	261924.29	261924.29	0.00
0.00	0.00	255500.00	0.00	67220.00	322720.00	322720.00	752347.25
0.00	0.00	0.00	0.00	1387341.00	1387341.00	1387341.00	563776.35
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1090168.55
0.00	0.00	0.00	37940.00	65758.00	103698.00	103698.00	793761.85
0.00	0.00	0.00	0.00	0.00	0.00	0.00	64965.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	40532.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	35500.00
0.00	0.00	0.00	1168300.00	7021.00	1175321.00	1175321.00	1173899.00
0.00	1808289.28	928819.00	0.00	647843.72	1576662.72	3384952.00	4438007.91
0.00	0.00	222989.00	0.00	1200.00	224189.00	224189.00	1229151.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	7409368.88
0.00	0.00	0.00	0.00	0.00	0.00	0.00	641.00



5333	ELEKTROENCEPHALOGRAPHIC	95612.00	0.00	0.00	95612.00	0.00	
5336	ESTABLISHMENT OF THE INDIAN STROKE CLINICAL TRIAL NETWORK (IN-STRUCT)	568421.00	1240661.00	0.00	1809082.00	0.00	
5337	SECONDARY PREVENTION BY STROKE	909591.00	0.00	0.00	909591.00	0.00	
5339	ANTI EPILEPTIC DRUGS	20950.00	0.00	0.00	20950.00	0.00	
5341	SLEEP APNEA	333751.75	0.00	0.00	333751.75	0.00	
5342	TRIVANDRUM HEART FAILURE	339367.00	388825.00	0.00	728192.00	0.00	
5343	BRAIN IRON DEPOSITION	90448.26	0.00	0.00	90448.26	0.00	
5344	IMPROVEMENT OF SECONDARY	14014.00	0.00	0.00	14014.00	0.00	
5345	MOBILE TELEMEDICINE PROJECT	28604378.98	0.00	43250.00	28647628.98	0.00	
5348	PROSPECTIVE STUDY OF PATIENTS	190759.00	264000.00	0.00	454759.00	0.00	
5349	FRACTIONAL FLOW REVERSE	60710.00	0.00	0.00	60710.00	38441.00	
5350	ICMR-THSTI FORMS	106715.00	0.00	0.00	106715.00	0.00	
5354	WORKSITE BASED LIFESTYLE	2743542.00	0.00	9677.00	2753219.00	0.00	
5355	REGIONAL TRC FOR HEALTH ASSESSMENT	2652715.00	2722906.00	0.00	5375621.00	0.00	
5356	AROGYAM NETWORK (KIRAN)	14809819.00	0.00	0.00	14809819.00	0.00	
6055	MOVEMENT DISORDER SURGERY	0.00			0.00	0.00	



0.00	0.00	0.00	0.00	95612.00	95612.00	95612.00	0.00
0.00	0.00	1089440.00	0.00	104176.00	1193616.00	1193616.00	615466.00
0.00	0.00	0.00	26950.00	34121.00	61071.00	61071.00	848520.00
0.00	0.00	0.00	0.00	20950.00	20950.00	20950.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	333751.75
0.00	0.00	372000.00	0.00	68461.00	440461.00	440461.00	287731.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	90448.26
0.00	0.00	0.00	0.00	0.00	0.00	0.00	14014.00
0.00	0.00	2643195.00	0.00	1196703.00	3839898.00	3839898.00	24807730.98
0.00	0.00	355871.00	0.00	24000.00	379871.00	379871.00	74888.00
0.00	38441.00	0.00	0.00	0.00	0.00	38441.00	22269.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	106715.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2753219.00
0.00	0.00	2636743.00	0.00	59080.00	2695823.00	2695823.00	2679798.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	14809819.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



5357	MOLECULAR, CLINICORADIOLOGIC AND PATHOLOGICAL CHARACTERIZATION OF OLIGODENDROGLIOMAS WITH CIC AND FUBP1 MUTATIONS (EMR/2016/005832)	527717.12	0.00	0.00	527717.12	0.00
5358	AN OBLIGATE ROLE FOR DISCOIDIN DOMAIN RECEPTOR 2 IN CELL CYCLE PROGRESSION AND APOPTOSIS RESISTANCE IN CARDIAC FIBROBLASTS	135192.48	1368616.00	12718.00	1516526.48	0.00
5359	THREE DIMENSIONAL PRINTING IN CONGENITAL HEART DISEASE	447246.60	0.00	0.00	447246.60	0.00
5361	IMPROVING STROKE CARE IN INDIA (IMPROVISE)	2364464.56	271193.00	0.00	2635657.56	0.00
5363	NATIONAL HEART FAILURE REGISTRY	5842145.92	0.00	0.00	5842145.92	92999.55
5365	NATIONAL ENVIRONMENTAL HEALTH PROFILE	1021052.39	0.00	0.00	1021052.39	0.00
5368	VIRTUAL REALITY-BASED SOLUTION FOR EFFECTIVE NEUROANATOMY TEACHING	7169427.00	0.00	0.00	7169427.00	0.00
5369	WORKSHOP ON BRAIN CONNECTIVITY ANALYSIS AND CONFERENCE ON BRAIN COMPUTER INTERFACE	135539.00	0.00	0.00	135539.00	0.00
5370	TRANSCRIPTIONAL AND TRANSLATIONAL REGULATION OF PERIOSTIN AND ITS INTERACTION WITH DDR2 IN CARDIAC FIBROSIS	78277.46	550000.00	0.00	628277.46	0.00



0.00	0.00	0.00	439452.00	0.00	439452.00	439452.00	88265.12
0.00	0.00	7736.00	0.00	858055.00	865791.00	865791.00	650735.48
0.00	0.00	0.00	86775.00	360471.60	447246.60	447246.60	0.00
0.00	0.00	476767.00	69984.00	142585.00	689336.00	689336.00	1946321.56
0.00	92999.55	830847.00	0.00	495029.00	1325876.00	1418875.55	4423270.37
0.00	0.00	372000.00	0.00	11538.00	383538.00	383538.00	637514.39
0.00	0.00	0.00	1064602.00	579.00	1065181.00	1065181.00	6104246.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	135539.00
0.00	0.00	292320.00	2000.00	58000.00	352320.00	352320.00	275957.46



5371	GENERAL ANESTHESIA VS SEDATION-COGNITIVE DECLINE IN ELDERLY – A RANDOMIZED CONTROLLED TRIAL IN PATIENTS WITH CHRONIC SUBDURAL HEMATOMA (GAS-CDE)	660204.48	0.00	0.00	660204.48	0.00
5373	ARCHITECTURE OF PARKINSON'S	11217094.57	0.00	0.00	11217094.57	0
5374	RISK ANALYSIS OF DEMENTIA	1789071.50	0.00	0.00	1789071.50	55702.00
5375	CARE IN HEART FAILURE	1329511.00	2702789.00	0.00	4032300.00	0.00
5376	CARE IN HEART FAILURE	1418155.01	1482368.00	0.00	2900523.01	633975.00
5377	CARE IN HEART FAILURE	2516008.68	3676650.00	0.00	6192658.68	14112.80
5378	CARE IN HEART FAILURE	489448.00	177250.00	0.00	666698.00	0.00
5379	CARE IN HEART FAILURE	1623342.00	760000.00	0.00	2383342.00	0.00
5380	CARE IN HEART FAILURE	1048180.00	0.00	0.00	1048180.00	0.00
5381	CARE IN HEART FAILURE0	3121588.00	401208.00	0.00	3522796.00	60100.00
5382	CARE IN HEART FAILURE	0.00	1937879.00	0.00	1937879.00	0.00
5383	VISUAL-AUDITORY	44947.00	0.00	0.00	44947.00	0.00
5384	MAHATARI JATAN YOJANA	400000.00	0.00	0.00	400000.00	0.00
5385	QUANTITATIVE EEG AND MULTI-MO	954748.10	1200000.00	0.00	2154748.10	0.00
5386	COMPREHENSIVE AND NOVEL MODEL	1253000.00	0.00	0.00	1253000.00	0.00
5387	INDUSTRIAL POLLUTION	28329.00	450000.00	0.00	478329.00	49474.95
5388	EFFICIENT PORTABLE STAND	197471.00	0.00	2835.00	200306.00	0.00
5389	PEDIATRIC EPILEPSY SYNDROME	5123743.25	0.00	0.00	5123743.25	0.00
5390	HUMAN GUT MICROBIOME	6882.00	1095864.00	0.00	1102746.00	0.00
5391	DISPOSABLE DEFIBRILLATOR	477972.00	0.00	0.00	477972.00	0.00



0.00	0.00	141625.00	0.00	903.00	142528.00	142528.00	517676.48
0.00	0.00	1094636.00	72975.00	8327000.00	9494611.00	9494611.00	1722483.57
0.00	55702.00	1071240.00	16710.00	10912.00	1098862.00	1154564.00	634507.50
0.00	0.00	2118576.00	19057.00	122168.00	2259801.00	2259801.00	1772499.00
0.00	633975.00	444774.00	376157.77	62093.00	883024.77	1516999.77	1383523.24
0.00	14112.80	0.00	2346203.20	52859.00	2399062.20	2413175.00	3779483.68
0.00	0.00	0.00	0.00	40610.00	40610.00	40610.00	626088.00
0.00	0.00	0.00	0.00	920.00	920.00	920.00	2382422.00
0.00	0.00	0.00	0.00	8142.00	8142.00	8142.00	1040038.00
0.00	60100.00	1361032.00	105950.00	154213.00	1621195.00	1681295.00	1841501.00
0.00	0.00	0.00	0.00	1937879.00	1937879.00	1937879.00	0.00
0.00	0.00	0.00	0.00	8401.00	8401.00	8401.00	36546.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	400000.00
0.00	0.00	804523.00	110240.00	31568.00	946331.00	946331.00	1208417.10
0.00	0.00	127130.00	0.00	0.00	127130.00	127130.00	1125870.00
0.00	49474.95	114508.00	14851.25	9267.00	138626.25	188101.20	290227.80
0.00	0.00	0.00	0.00	2835.00	2835.00	2835.00	197471.00
0.00	0.00	1141440.00	3512023.00	286594.00	4940057.00	4940057.00	183686.25
0.00	0.00	175667.00	0.00	75793.00	251460.00	251460.00	851286.00
0.00	0.00	289691.00	16100.00	74755.00	380546.00	380546.00	97426.00



5392	DNA METHYLATION IN INSULIN	1372255.90	0.00	0.00	1372255.90	0.00
5393	LIFESTYLE INTERVENTION	4053001.60	9454265.00	0.00	13507266.60	0.00
5394	SKULLBASE SURGERY	112068.00	350000.00	8339.00	470407.00	0.00
5395	ROLE OF CONNEXINS	828204.19	1394462.00	0.00	2222666.19	43604.40
5396	ATRIAL CARDIOPATHY	47500.00	50000.00	0.00	97500.00	0.00
5397	SYNUCLEINOPATHY PATHOLOGY	652372.93	1856092.00	0.00	2508464.93	0.00
5398	INTERVENTIONAL THERAPY	302051.24	600000.00	0.00	902051.24	0.00
5399	STROKE CARE REGISTRY	165256.00	334744.00	0.00	500000.00	0.00
5400	VISUAL OUTCOME RECURRENT	99333.00	0.00	0.00	99333.00	0.00
5401	PREVENTION IN STROKE	0.00	400000.00	0.00	400000.00	0.00
5402	CRANIOVERTEBRAL ANOMALIES	462000.00	0.00	0.00	462000.00	0.00
5403	VIRTUAL AIRWAY ASSESSMENT	5001.00	0.00	0.00	5001.00	0.00
5404	EMOTIONAL FACE RECOGNITION	459374.00	0.00	0.00	459374.00	0.00
5405	DNA METHYLATION PROFILING	1667561.00	0.00	0.00	1667561.00	497329.00
5406	MANPOWER FOR COVID 19 TESTING UNDER NHM	0.00	3310940.00	0.00	3310940.00	0.00
5407	LUNG ULTRASOUND WORKFLOW	550000.00	0.00	0.00	550000.00	500000.00
5408	DRUGS CONTROL	179691.00	0.00	0.00	179691.00	0.00
5410	CEREBROSPINAL FLUID	1092486.00	814864.00	0.00	1907350.00	153563.00
5411	SYSTEM THINKING APPROACH	0.00	6776188.00	0.00	6776188.00	0.00
5412	CARDIAC CHANNELOPATHIES	1573971.00	0.00	0.00	1573971.00	71505.00
5413	CHRONIC INSOMNIA	1201360.00	0.00	0.00	1201360.00	118520.50



0.00	0.00	58710.00	143202.68	0.00	201912.68	201912.68	1170343.22
0.00	0.00	1668832.00	0.00	927817.00	2596649.00	2596649.00	10910617.60
0.00	0.00	216000.00	194920.00	2529.00	413449.00	413449.00	56958.00
0.00	43604.40	359284.00	424880.55	42409.00	826573.55	870177.95	1352488.24
0.00	0.00	0.00	0.00	0.00	0.00	0.00	97500.00
0.00	0.00	302760	831195	0.00	1133955.00	1133955.00	1374509.93
0.00	0.00	431520.00	49860.00	69255.00	550635.00	550635.00	351416.24
0.00	0.00	332258.00	0.00	34586.00	366844.00	366844.00	133156.00
0.00	0.00	43314.00	0.00	0.00	43314.00	43314.00	56019.00
0.00	0.00	213936.00	0.00	70630.00	284566.00	284566.00	115434.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	462000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5001.00
0.00	0.00	348000	4380	2222.00	354602.00	354602.00	104772.00
0.00	497329.00	431520.00	271495.32	5250.00	708265.32	1205594.32	461966.68
0.00	0.00	3310940.00	0.00	0.00	3310940.00	3310940.00	0.00
0.00	500000.00	0.00	0.00	9900.00	9900.00	509900.00	40100.00
0.00	0.00	0.00	0.00	3476.00	3476.00	3476.00	176215.00
0.00	153563.00	343000.00	541885.41	5297.00	890182.41	1043745.41	863604.59
0.00	0.00	85714.00	0.00	3460.81	89174.81	89174.81	6687013.19
0.00	71505.00	745486	304909	43097.00	1093492.00	1164997.00	408974.00
0.00	118520.50	613713.00	0.00	6991.50	620704.50	739225.00	462135.00



5414	AVAILABILITY, DISTRIBUTION AND	636709.00	180000.00	0.00	816709.00	0.00
5415	ARTERIAL STROKE IMAGING	1373000.00	0.00	0.00	1373000.00	944762.00
5416	IMPROVIS-ATION (IMPROVING ST	1360076.00	273654.00	0.00	1633730.00	65900.00
5417	REGULATION OF PROGENITOR CE	1917000.00	0.00	0.00	1917000.00	0.00
5418	NOVEL TECHNIQUE OF DEVELOPING	0.00	840000.00	0.00	840000.00	0.00
5419	HPSR FELLOWSHIP INDIA	540000.00	0.00	0.00	540000.00	0.00
5420	TTK CHITRA	2000000.00	0.00	0.00	2000000.00	52200.00
5421	OUTCOME DETERMINANTS OF TOF	2136100.00	0.00	0.00	2136100.00	0.00
5422	ATRIAL CARDIOPATHY	351230.00	0.00	0.00	351230.00	0.00
5423	CHARACTERIZATION OF UBIQUITIN	932966.00	0.00	0.00	932966.00	0.00
5424	HPC TOOLS	0.00	787200.00	0.00	787200.00	0.00
5425	HEART DISEASE REGISTRY	0.00	1234500.00	0.00	1234500.00	0.00
5426	EDOXABAN FOR	0.00	58272.00	0.00	58272.00	0.00
5427	PROGNOSTIC VALUE OF CIRCULATING MICRORNAS IN HEART FAILURE	2239467.00	0.00	0.00	2239467.00	0.00
5428	EXCOA-CVT	0.00	64011.00	0.00	64011.00	0.00
5429	TREATMENT OF IMPAIRMENT	0.00	2000000.00	0.00	2000000.00	69500.00
5430	JUGULAR VENOUS SATURATION	0.00	1063890.00	0.00	1063890.00	260397.00
5431	NLRP3 ACTIVATION	0.00	1198867.00	0.00	1198867.00	0.00
5432	CLINICAL TRIAL (STROKE)	0.00	1244005.00	0.00	1244005.00	0.00
5433	MANAGEMENT OF HEART FAILURE	0.00	4516559.00	0.00	4516559.00	0.00



0.00	0.00	0.00	0.00	327350.00	327350.00	327350.00	489359.00
0.00	944762.00	259067.00	0.00	6693.00	265760.00	1210522.00	162478.00
0.00	65900.00	684000.00	0.00	49931.00	733931.00	799831.00	833899.00
0.00	0.00	320000.00	372214.00	5744.00	697958.00	697958.00	1219042.00
0.00	0.00	346840.00	425000.00	0.00	771840.00	771840.00	68160.00
0.00	0.00	215484.00	0.00	0.00	215484.00	215484.00	324516.00
0.00	52200.00	570000.00	102690.00	11550.00	684240.00	736440.00	1263560.00
0.00	0.00	239067.00	169400.00	65522.00	473989.00	473989.00	1662111.00
0.00	0.00	143420.00	8930.00	12065.00	164415.00	164415.00	186815.00
0.00	0.00	319000.00	276169.00	26446.00	621615.00	621615.00	311351.00
0.00	0.00	248446.00	0.00	100000.00	348446.00	348446.00	438754.00
0.00	0.00	493952.00	0.00	57880.00	551832.00	551832.00	682668.00
0.00	0.00	0.00	0.00	1291.00	1291.00	1291.00	56981.00
0.00	0.00	490680.00	607417.00	3772.00	1101869.00	1101869.00	1137598.00
0.00	0.00	0.00	0.00	1302.00	1302.00	1302.00	62709.00
0.00	69500.00	326038.00	27200.00	269372.00	622610.00	692110.00	1307890.00
0.00	260397.00	201833.00	0.00	105371.00	307204.00	567601.00	496289.00
0.00	0.00	265330.00	0.00	49594.00	314924.00	314924.00	883943.00
0.00	0.00	280645.00	0.00	152282.00	432927.00	432927.00	811078.00
0.00	0.00	0.00	0.00	61002.00	61002.00	61002.00	4455557.00



5434	SPIRAL DX: TREMOR DIAGNOSIS	0.00	525000.00	0.00	525000.00	67000.00
5435	MULTIPLE SCLEROSIS	0.00	757216.00	0.00	757216.00	0.00
5436	FLUID DYNAMICS BASED TOOLS	0.00	3008230.00	0.00	3008230.00	1050500.00
5437	NON INVASIVE MEASUREMENT	0.00	823954.00	0.00	823954.00	0.00
5438	AZADI KA AMRIT	0.00	0.00	48101.00	48101.00	0.00
5439	MOVEMENT DISORDERS (MDSI)	0.00	1500000.00	0.00	1500000.00	0.00
5440	RANDOMIZED- PLACEBO CONTROLLED	0.00	276658.00	0.00	276658.00	0.00
5441	SCALEUP OF AN ADAPTED KERALA	0.00	3399850.00	0.00	3399850.00	0.00
5442	A PROSPECTIVE, MULTI-CENTRIC	0.00	158483.00	0.00	158483.00	0.00
5443	RETROSPECTIVE STUDY OF THE	0.00	168000.00	0.00	168000.00	0.00
5444	STROKE-SMART PHONE APPLICATION	0.00	1479000.00	0.00	1479000.00	0.00
5445	REGISTRY ISCHEMIC STROKE	0.00	9000.00	0.00	9000.00	0.00
5446	MITOCHONDRIAL FUNCTION	0.00	1327600.00	0.00	1327600.00	0.00
5447	A V S IYER FUND	0.00	500000.00	0.00	500000.00	0.00
5448	DONOR CHARACTERISTICS	0.00	692000.00	0.00	692000.00	0.00
5449	STROKE CLINICAL TRIAL NETWORK	0.00	3627217.00	0.00	3627217.00	0.00
5450	TRANSFORMING COVID-19 DATA	0.00	1313596	0.00	1313596.00	0.00
5451	ALGINATE DIALDEHYDE	0.00	1471000	0.00	1471000.00	0.00
6077	TECHNICAL ADVISORY COMMITTEE	0.00	280576.00	0.00	280576.00	0.00



0.00	67000.00	57806.00	0.00	26470.00	84276.00	151276.00	373724.00
0.00	0.00	102880.00	0.00	17316.00	120196.00	120196.00	637020.00
0.00	1050500.00	69020.00	0.00	273474.00	342494	1392994.00	1615236.00
0.00	0.00	0.00	0.00	66728.00	66728.00	66728.00	757226.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	48101.00
0.00	0.00	0.00	0.00	30000.00	30000.00	30000.00	1470000.00
0.00	0.00	0.00	0.00	8058.00	8058.00	8058.00	268600.00
0.00	0.00	0.00	0.00	2602.00	2602.00	2602.00	3397248.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	158483.00
0.00	0.00	8806.00	0.00	0.00	8806.00	8806.00	159194.00
0.00	0.00	26960.00	0.00	85454.00	112414.00	112414.00	1366586.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	9000.00
0.00	0.00	0.00	0.00	98073.00	98073.00	98073.00	1229527.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	500000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	692000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3627217.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1313596.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1471000.00
0.00	0.00	280576.00	0.00	0.00	280576.00	280576.00	0.00



6080	COMPREHENSIVE PAIN CLINIC	0.00	16500.00	0.00	16500.00	0.00
6111	REGULATION OF PROGENITOR CELL	0.00	80602.00	0.00	80602.00	0.00
6113	EXOSOMAL MIRNA	0.00	244065.00	0.00	244065.00	0.00
6114	AGE MODIFICATION	0.00	429448.00	0.00	429448.00	0.00
6117	UNDERSTANDING DISEASE CLUST	0.00	97433.00	0.00	97433.00	0.00
6118	AUTOMATED VERBAL AUTOPSY	0.00	837354.00	0.00	837354.00	0.00
6119	CLINICAL SCORING SYSTEMS	0.00	94448.00	0.00	94448.00	0.00
6120	GENETIC PATTERN	0.00	231340.00	0.00	231340.00	0.00
6121	REAL TIME RT-PCR ASSAY	0.00	224018.00	0.00	224018.00	0.00
6122	AIR-BORNE INFECTION	0.00	329545.00	0.00	329545.00	0.00
6123	PLATELET RICH FIBRIN	0.00	113448.00	0.00	113448.00	0.00
7101	ADVANCE TO P I	0.00	0.00	364940.00	364940.00	0.00
	1291305723.66	197218975.22	89873908.00	4757767.00	291850650.22	6647875.48

	OTHER PROJECTS				0	
1014	NEW PENSION SCHEME	8325586		269997623.1	278323209	
1301	EMPLOYEES PENSION FUND	325814783	344000000	16310273	686125056	
1075	PATIENT WELFARE FUND	12206274		2413817	14620091	
					0	
1078	DR. RICHARD A CASH & DR K MOHANDAS AWARD	319962		84331	404293	
1080	STAFF BENEVOLENT FUND	8833386.25		3459513	12292899	
1099	CSR GRANT - REVENUE	7689525			7689525	
	TOTAL ( B )	363189516	344000000	292265557	999455073	0



0.00	0.00	0.00	0.00	16500.00	16500.00	16500.00	0.00
0.00	0.00	0.00	80602.00	0.00	80602.00	80602.00	0.00
0.00	0.00	0.00	244065.00	0.00	244065.00	244065.00	0.00
0.00	0.00	0.00	429448.00	0.00	429448.00	429448.00	0.00
0.00	0.00	92143.00	0.00	5290.00	97433.00	97433.00	0.00
0.00	0.00	724575.00	0.00	112779.00	837354.00	837354.00	0.00
0.00	0.00	0.00	94448.00	0.00	94448.00	94448.00	0.00
0.00	0.00	0.00	231340.00	0.00	231340.00	231340.00	0.00
0.00	0.00	0.00	220018.00	4000.00	224018.00	224018.00	0.00
0.00	0.00	216000.00	105915.00	7630.00	329545.00	329545.00	0.00
0.00	0.00	0.00	113448.00	0.00	113448.00	113448.00	0.00
0.00	0.00	0.00	0.00	364940.00	364940.00	364940.00	0.00
0.00	6647875.48	37703042.00	16540902.93	27235154.54	81479099.47	88126974.95	203723675.27

0	0	0	0	275254682	275254682	275254682	3068527
	0			346142788	346142788	346142788	339982268
	0			183064.05	183064	183064	14437027
	0					0	0
	0				0	0	404293
	0			2337055	2337055	2337055	9955844
	0				0	0	7689525
0	0	0	0	623917589	623917589	623917589	375537484



OTHER PROJECTS							
1014	NEW PENSION SCHEME	8325586		269997623.1	278323209		
1301	EMPLOYEES PENSION FUND	325814783	344000000	16310273	686125056		
1075	PATIENT WELFARE FUND	12206274		2413817	14620091		
					0		
1078	DR. RICHARD A CASH & DR K MOHANDS AWARD	319962		84331	404293		
1080	STAFF BENEVOLENT FUND	8833386.25		3459513	12292899		
1099	CSR GRANT - REVENUE	7689525			7689525		
1096	PEDIATRIC WELFARE FUND	0			0		
1099	CSR GRANT - REVENUE	9259704		3210000	12469704		
	<b>TOTAL ( B )</b>	<b>363189516</b>	<b>344000000</b>	<b>292265557</b>	<b>999455073</b>	<b>0</b>	

BMT PROJECTS							
PROJ #	NAME OF GRANTEE/ PRINCIPAL INVESTIGATOR	FUND-WISE BREAK UP				TOTAL	FIXED ASSETS
		OPENING BALANCE	ADDITIONS TO FUND				
			GRANTS	OTHER RECEIPTS			
5000	PROJECT SUSPENSE	2180386.49	0.00	75654086.23	77834472.72	0.00	
5057	DYNAMIC ORTHOPAEDIC PVT LTD, HYDROXY	6787.55	0.00	0.00	6787.55	0.00	
5089	DETEC & TREAT OF CANCER BY LASER	3959.00	0.00	0.00	3959.00	0.00	
7000	MISCELLENEOUS PROJECT	30944.09	0.00	0.00	30944.09	0.00	
7001	PRO;SAHAJANAND VAS-CU;DR.AURTHUR	78108.75	0.00	0.00	78108.75	0.00	
7002	Dr.TOMS LABORATORY, Dr. K.KRISHNAN	13876.00	0.00	0.00	13876.00	0.00	



0	0	0	0	275254682	275254682	275254682	3068527
	0			346142788	346142788	346142788	339982268
	0			183064.05	183064	183064	14437027
	0					0	0
	0				0	0	404293
	0			2337055	2337055	2337055	9955844
	0				0	0	7689525
	0				0	0	0
	0			4780179	4780179	4780179	7689525
0	0	0	0	623917589	623917589	623917589	375537484

UTILIZATION								
CAPITAL EXPENDITURE		REVENUE EXPENDITURE						
OTHERS	TOTAL	SALARIES/WAGES	RENT/CONSUMABLES	OTHER ADMN EXP	TOTAL	TOTAL EXPENDITURE	NET BALANCE	
0.00	0.00	0.00	73342795.25	0.00	73342795.25	73342795.25	4491677.47	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	6787.55	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3959.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	30944.09	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	78108.75	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	13876.00	



7003	PROJ:D.S.T. DR.PV. MO-HANAN	2537.40	0.00	0.00	2537.40	0.00
7004	PROJ:ATMRF:DR LISSY KRISHNAN	551.25	0.00	0.00	551.25	0.00
7005	PROJECT:DYNAMIC ORTHO-PAEDICS	13656.00	0.00	0.00	13656.00	0.00
7006	PROJ: D.S.T. D.S.NAGESH	181074.00	0.00	0.00	181074.00	0.00





0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2537.40
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	551.25
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13656.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	181074.00



7009	CHITOSAN BASED WOUND DRESSING	4761.75	0.00	0.00	4761.75	0.00
7011	DST-FAB: CLINICALLY/ SIG:SHAPE OF HEVA	213826.00	0.00	0.00	213826.00	0.00
7014	AUROLAB,ARAVIND EYE HOSPITAL	13674.00	0.00	0.00	13674.00	0.00
7015	TTK.HEALTHCARE.DEVELOPMENT OF VALV	39424.00	0.00	0.00	39424.00	0.00
7016	INDO-GERMAN COMMITTEE MEETING-DST	5407.00	0.00	0.00	5407.00	0.00
7017	HINDUSTAN LATEX.EVALU: BLOOD BAG	108073.53	75110.00	0.00	183183.53	0.00
7018	ALL INDIA COUNCIL FOR TECHNI:EDU:SH	761562	104723.00	0	866285.00	0.00
7019	DST.NIRANJAN	69847.00	0.00	0.00	69847.00	0.00
7020	IFCPAR-DR.JAYAKRISHNAN	188.00	0.00	0.00	188.00	0.00
7022	DST-LBFDPSBC-DR.SHARMA	79385.00	0.00	0.00	79385.00	0.00
7023	DEV: HYDRO-CEPHALUS-HINDUSTAN LATEX	45510.00	0.00	0.00	45510.00	0.00
7026	DEV.HEART VALVE-DST. MURALEE	2522.00	0.00	0.00	2522.00	0.00
7029	DONERG/LIFE SCIENCE BOARD	6876.00	0.00	0.00	6876.00	0.00
7031	DBT/DR P V MOHAN/DEV INVITROPYRO	79064.00	0.00	0.00	79064.00	0.00
7032	DST. DR. ANNINE/BONE REGENERATION	29166.00	0.00	0.00	29166.00	0.00
7033	BIOFUNCTIONAL EVALUATION DR. UMASANKER	72581.00	0.00	0.00	72581.00	0.00
7034	DST. DR. NIRMALA RACHEL	14664.00	0.00	0.00	14664.00	0.00
7035	DST-H.K.VARMA	95433.00	0.00	0.00	95433.00	0.00
7037	INVIVO EVALUATION/ STED/ DR. LISSY	6205.00	0.00	0.00	6205.00	0.00



0.00	0.00	0.00	0.00	0.00	0.00	0.00	4761.75
0.00	0.00	0.00	0.00	0.00	0.00	0.00	213826.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	13674.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	39424.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5407.00
0.00	0.00	0	101515	0.00	101515.00	101515.00	81668.53
0.00	0.00	0.00	8000.00	0.00	8000.00	8000.00	858285.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	69847.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	188.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	79385.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	45510.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2522.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	6876.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	79064.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	29166.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	72581.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	14664.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	95433.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	6205.00



7039	JNC/ASR/DR. MOHANAN/ STUDY OF ACCUTE.....	44684.00	0.00	0.00	44684.00	0.00
7040	BIOMED/ C.V. MURALEED- HARAN	44000.00	0.00	0.00	44000.00	0.00
7041	CSIR-GRANT-ASHA S MATHEW,PHD STUDENT	55973.00	0.00	0.00	55973.00	0.00
7042	CSIR-GRANT-BERNADETTE K. MADATHIL,PHD	25870.00	0.00	0.00	25870.00	0.00
7043	CSIR-GRANT-SAILA- JA.G.S.SRF	9067.00	0.00	0.00	9067.00	0.00
7044	LISI NO TRIAL TRIAL ME- RIND	21672.65	0.00	0.00	21672.65	0.00
7045	NIRMALA RACHEL, CSIR	14063.00	0.00	0.00	14063.00	0.00
7047	U.G.C. GRANT- RESEARCH FELLOW	300935.00	0.00	0.00	300935.00	0.00
7048	CSIR GRANT- JOSENA JOSEPH	47473.00	0.00	0.00	47473.00	0.00
7049	CSIR GRANT - MARY VAR- GHESE	35837.00	0.00	0.00	35837.00	0.00
7050	INTEREST-PROJECT AC- COUNT	11892489.22	0.00	2628951	14521440.22	0.00
7051	CSIR GRANT - MANITHA B NAIR	12062.00	0.00	0.00	12062.00	0.00
7053	DR.SREENIVASAN/DEVEL. OF TEMPRES.CO-OPLY	22619.00	0.00	0.00	22619.00	0.00
7054	DST-DR.ANOOP-DIFF:EX- PR:RAT BRAIN.....	44434.00	0.00	0.00	44434.00	0.00
7055	CSIR-NMITLI SCHEME-C.V.MURALEED- HARAN	756552.00	0.00	0.00	756552.00	0.00
7057	DST - PROJECT.DR.JAYA- BALAN	14471.00	0.00	0.00	14471.00	0.00
7060	ICMR PROJECT/ SUDHA- KAR MUTHALEE	124392.00	0.00	0.00	124392.00	0.00



0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44684.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55973.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25870.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9067.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21672.65
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14063.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	300935.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47473.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35837.00
0.00	0.00	0.00	498933.98	0	498933.98	498933.98	498933.98	14022506.24
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12062.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22619.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44434.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	756552.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14471.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	124392.00



7062	DR. LIZY-SAHAJA:EVA "STENT"INVITRO.....	101675.00	0.00	0.00	101675.00	0.00
7065	DR.T.V.KUMARI,DBT.BIO- GENE	38659.00	0.00	0.00	38659.00	0.00
7069	VSSC - PROJECT. D.S. NAGESH	153302.00	0.00	0.00	153302.00	0.00
7071	STEC-PROJECT: DR.MAYA NANDKUMAR	375.00	0.00	0.00	375.00	0.00
7072	SAHAJANAND MED.TECH. C.V.MURALIDHARAN	76292.00	0.00	0.00	76292.00	0.00
7074	STUDY PROJECT: CLRI- DR.MOHAN	289303.00	0.00	0.00	289303.00	0.00
7075	STUDY PROJECT - BIOSYNC SCI	11935.00	0.00	0.00	11935.00	0.00
7076	ARROW INTERNATIONAL : DR.UMASHANKAR	399773.00	0.00	0.00	399773.00	0.00
7080	DBT-DR.MAYA- TISSUE ENGINEERING HYBRID	10518.00	0.00	0.00	10518.00	0.00
7081	USV LTD. MUMBAI - DR.MOHAN	88349.00	0.00	0.00	88349.00	0.00
7082	INDO-US JOINT PROJECT	878.00	0.00	0.00	878.00	0.00
7083	ARROW HAEMO DIALYSIS	30882.00	0.00	0.00	30882.00	0.00
7085	DR.R.V.THAMPAN - CSIR	26381.00	0.00	0.00	26381.00	0.00
7087	CSIR - KALADHAR - BST	39103.00	0.00	0.00	39103.00	0.00
7092	PROJ/7092/SEA FOOD	1993.00	0.00	0.00	1993.00	0.00
7093	PROJ/7093/CSIR GRANT- LPA	50562.00	0.00	0.00	50562.00	0.00
7095	PROJ/7095/CSIR GRANT-VI- OLA.B.MORRIS	22072.00	0.00	0.00	22072.00	0.00
7097	PROJ/7097/ACCELERATED AGEING	88999.27	0.00	111365.00	200364.27	0.00
7099	PROJ/7099/BCL	7011.00	0.00	0.00	7011.00	0.00
7100	PROJ/7100/ITR PRO- GRAMME	4079.00	0.00	0.00	4079.00	0.00





0.00	0.00	0.00	0.00	0.00	0.00	0.00	101675.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	38659.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	153302.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	375.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	76292.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	289303.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	11935.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	399773.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	10518.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	88349.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	878.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	30882.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	26381.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	39103.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1993.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	50562.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	22072.00
0.00	0.00	0.00	28280.00	0.00	28280.00	28280.00	172084.27
0.00	0.00	0.00	0.00	0.00	0.00	0.00	7011.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	4079.00



7101	PROJ/7101/CSIR/SONIA.T.A	2650.00	0.00	0.00	2650.00	0.00
7103	PROJ/7103/CSIR/VIDYARAJ	5682.00	0.00	0.00	5682.00	0.00
7105	PROJ/7105/CSIR/ARJUN NAMBOODIRI	26821.00	0.00	0.00	26821.00	0.00
7107	PROJ/7107/CSIR/NEENA & 2 FELLOWS	34082.00	0.00	0.00	34082.00	0.00
7108	PROJ/7108/CSIR/FRAN-CIS.B.FERNANDEZ	2154.00	0.00	0.00	2154.00	0.00
7110	PROJ/7110/CSIR/DEEPA.R	10919.00	0.00	0.00	10919.00	0.00
7111	PROJ/7111/CSIR/SHEEJA LIZA EASO	6353.00	0.00	0.00	6353.00	0.00
7200	JOINT PROGRAME/M.TECH	464180	0.00	0.00	464180.00	0.00
7210	PROJ/7210/CSIR/SOMA DEY	1641.00	0.00	0.00	1641.00	0.00
7220	COST OF ANIMAL FEED	3445465	0.00	1434901.00	4880366.00	94500.00
7230	PROJ/7230/CSIR/MANJU.S	12421.00	0.00	0.00	12421.00	0.00
7250	PROJ/7250/CSIR/ KIRAN.S.NAIR	15281.00	0.00	0.00	15281.00	0.00
7260	PROJ/7260/STOX083Y09/ DR.PV.MOHANAN	149985.00	0.00	0.00	149985.00	0.00
7290	PROJ/7290/CSIR/RAKHI.A	19584.00	0.00	0.00	19584.00	0.00
7330	Y.M.THASNEEM - UGC GRANT	7195.00	0.00	0.00	7195.00	0.00
7370	VALIDATION OF ETO STERILSATION SYSTEM-	234186	0.00	336364	570550.00	329967.00
7375	ICMR PROJECT- Ms. Renu Ramesh	32250.00	0.00	0.00	32250.00	0.00
7385	CSIR GRANT - CAROLINE DIANA SHERLY	1321.73	0.00	0.00	1321.73	0.00
7390	TOXICITY STUDY OF MATEI-RIALS Dr. P V Mohanan	2042765	0.00	3207400.00	5250165.00	0.00



0.00	0.00	0.00	0.00	0.00	0.00	0.00	2650.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5682.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	26821.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	34082.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2154.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	10919.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	6353.00
0.00	0.00	0.00	0	0.00	0.00	0.00	464180.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1641.00
0.00	94500.00	0.00	337174.00	0.00	337174.00	431674.00	4448692.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	12421.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	15281.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	149985.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	19584.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	7195.00
0.00	329967.00	54000.00	23750.00	0.00	77750.00	407717.00	162833.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	32250.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1321.73
0.00	0.00	518400.00	531469.00	0	1049869.00	1049869.00	4200296.00



7395	RAISING ANTIBODIES IN RABITS - DR V S HARIKRISH	1195599.13	0.00	645000	1840599.13	106186.00
7400	CSIR GRANT :SHAIJU S NAZEER	3333.00	0.00	0.00	3333.00	0.00
7402	PROOF OF CONCEPT STUDY - DR UMA SHANKAR	100747.00	0.00	0.00	100747.00	0.00
7403	ICMR GRANT - PARVATHY R S	22455	0	0.00	22455.00	0.00
7404	BIOFUNCTIONAL AND HIS- TILO - DR UMA SHANKAR	761369.00	0.00	0.00	761369.00	0.00
7405	IN VITRO EVALUATION OF CELL- DR T V KUMAR	253158.58	0.00	331018.00	584176.58	0.00
7406	CSIR GRANT - R ARATHI	6135.00	0.00	0.00	6135.00	0.00
7407	TRSF MESENCHYMAL STEM CELL	1686.00	0.00	0.00	1686.00	0.00
7409	SRUTHI PHD STUDENT UGC	9292.00	0.00	0.00	9292.00	0.00
7411	DEV POLY ADHESIVE & POTT	206140.00	0.00	0.00	206140.00	0.00
7412	REMYA K CSIR FELLOW	19900.00	0.00	0.00	19900.00	0.00
7413	"PROJ/7413/ANTIMICRO- BIAL ACTIVITY"	89585.75	0.00	0.00	89585.75	0.00
7414	"PROJ/7414/EFFECT OF NANOGRAPHENE MOUSE.."	34620.00	0.00	0.00	34620.00	0.00
7415	"PROJ/7415/AXONAL GUIDANCE"	18450.00	0.00	0.00	18450.00	0.00
7416	"PROJ/7416/PULMONARY FIBROSIS"	31023	455393	0.00	486416.00	0.00
7417	"PROJ/7417/INVITRO & INVIVO EVALUATION"	33965	507200	0.00	541165.00	0.00
7419	PROJ/7419/DETERMINA- TION OF TOXICITY	52516.00	0.00	0.00	52516.00	0.00



0.00	106186.00	0.00	146043	0.00	146043.00	252229.00	1588370.13
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3333.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	100747.00
0.00	0.00	0	0.00	0.00	0.00	0.00	22455.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	761369.00
0.00	0.00	0.00	294449	0.00	294449.00	294449.00	289727.58
0.00	0.00	0.00	0.00	0.00	0.00	0.00	6135.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1686.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	9292.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	206140.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	19900.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	89585.75
0.00	0.00	0.00	0.00	0.00	0.00	0.00	34620.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	18450.00
0.00	0.00	435393	0.00	0.00	435393.00	435393.00	51023.00
0.00	0.00	188301.00	0.00	0.00	188301.00	188301.00	352864.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	52516.00



7422	PROJ/7422/HISTOPATHOLOGICAL EVALUATION	1066951.07	0.00	1688747	2755698.07	0.00
7423	PROJ/7423/TRACKING CARDIAC STEM	63872	0.00	0.00	63872.00	0.00
7424	PROJ/7424/SYNAPTIC PROTEOME	15494.00	0.00	0.00	15494.00	0.00
7425	PROJ/7425/BIOENGINEERED SKIN GRAFT FOR...	10736	0.00	0.00	10736.00	0.00
7426	PROJ/7426/POLYMERIC MICRO NEEDLES	37370.46	0	144600.00	181970.46	0.00
7427	PROJ/7427/ANIONIC POLYSACCHARIDE BASED .	3003.05	0.00	0	3003.05	0.00
7428	PROJ/7428/BACTERIAL RESISTANCE	42712	0	0.00	42712.00	0.00
7429	PROJ/7429/BIORESORBABLE POLYMER MESH	101326.00	0.00	0.00	101326.00	0.00
7430	PROJ/7430/TEST OF CRANIAL FIXATION	201070	0.00	0.00	201070.00	0.00
7431	PROJ/7431/SHELL NACRE	600.00	507200	0.00	507800.00	0.00
7432	PROJ/7432/CSIR CONTINGENCY GRANT	18530.00	0	0.00	18530.00	0.00
7433	PROJ/7433/CSIR CONTINGENCY GRANT	20000.00	0	0.00	20000.00	0.00
7434	PROJ/7434/CSIR CONTINGENCY GRANT	766.00	0	0.00	766.00	0.00
7435	PROJ/7435/CSIR CONTINGENCY GRANT	15203.00	0.0	0.00	15203.00	0.00
7436	PROJ/7436/CSIR CONTINGENCY GRANT	101.00	0	0.00	101.00	0.00
7437	PROJ/7437/CSIR CONTINGENCY GRANT	16767.00	0	0.00	16767.00	0.00
7438	PROJ/7438/SCTAC2010 DRUG FORMULATION	131297.58	0	0.00	131297.58	0.00
7439	CSIR CONT.GRANT/MEDHASURENDRANATH	18871	0	0.00	18871.00	0.00



0.00	0.00	0.00	344206	0.00	344206.00	344206.00	2411492.07
0.00	0.00	0.00	0	0.00	0.00	0.00	63872.00
0.00	0.00	0.00	15223.00	0.00	15223.00	15223.00	271.00
0.00	0.00	0.00	10045.00	0.00	10045.00	10045.00	691.00
0.00	0.00	0.00	0	21000.00	21000.00	21000.00	160970.46
0.00	0.00	0.00	0	0.00	0.00	0.00	3003.05
0.00	0.00	0	12420.00	0.00	12420.00	12420.00	30292.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	101326.00
0.00	0.00	0.00	0.00	0	0.00	0.00	201070.00
0.00	0.00	487200.00	16379	0.00	503579.00	503579.00	4221.00
0.00	0.00	0.00	7100	0.00	7100.00	7100.00	11430.00
0.00	0.00	0.00	15839	0.00	15839.00	15839.00	4161.00
0.00	0.00	0.00	0	0.00	0.00	0.00	766.00
0.00	0.00	0.00	3937	0.00	3937.00	3937.00	11266.00
0.00	0.00	0.00	0	0.00	0.00	0.00	101.00
0.00	0.00	0.00	3000	0.00	3000.00	3000.00	13767.00
0.00	0.00	0.00	1624	0.00	1624.00	1624.00	129673.58
0.00	0.00	0.00	17873	0.00	17873.00	17873.00	998.00



7440	CSIR CONT.GRNAT/MANJULA P M	18356	0	0.00	18356.00	0.00	
7441	PROJ/7441/THERMORE-SPONSIVE POLYMERIC	49410.00	0	66000.00	115410.00	0.00	
7442	PROJ/7442/RAPID PROTOTYPING FACILITY	50000.00	0	569000.00	619000.00	0.00	
7443	PROJ/7443/MATRIX GEL(CHOLEGEL)	31074.00	84533	0.00	115607.00	0.00	
7444	PROJ/7444/DIABETIC FOOT ULCER	88394.00	111150	0.00	199544.00	0.00	
7445	PROJ/7445/RIGID KNEE BRACE	102485.00	310500	0.00	412985.00	0.00	
7446	PROJ/7446/FAST RESORBING CERAMIC	16667.00	674240	0.00	690907.00	0.00	
7447	PROJ/7447/BIOMINERAL BASED SELF-SETTING	141535.00	1230462	0.00	1371997.00	0.00	
7448	PROJ/7448/STRUCTURAL PERFORMANCE ASSES..	129400.00	0	27377.00	156777.00	0.00	
7449	"PROJ/7449/SHORT COIR FIBER"	0.00	44880.00	0.00	44880.00	0.00	
7450	"PROJ/7450/HYBRID COATINGS"	0.00	79221.00	0.00	79221.00	0.00	
7451	"PROJ/7451/EFFECTS OF BACOPA MONNIERI ..."	0.00	338795.00	0.00	338795.00	48300.00	
7452	"PROJ/7452/ANTI-MICROBIAL ACTIVITY"	0.00	178100	0.00	178100.00	0.00	
7454	PROJ/7454/NANOSENSITIZERS	0.00	451520	0.00	451520.00	0.00	
7455	PROJ/7455/RAPID DIAGNOSTIC KIT	0.00	0	50000.00	50000.00	0.00	
7456	"PROJ/7456/EVALUATION STUDIES OF DTRT"	0.00	0	700000.00	700000.00	0.00	
8004	PROJ/8004/PROGRAM SUPPORT & TISSUE	-278345.00	0.00	0.00	-278345.00	0.00	



0.00	0.00	0.00	0	0.00	0.00	0.00	18356.00
0.00	0.00	0.00	0	0.00	0.00	0.00	115410.00
0.00	0.00	72090.00	404101	0.00	476191.00	476191.00	142809.00
0.00	0.00	81200.00	17230	0.00	98430.00	98430.00	17177.00
0.00	0.00	93600.00	36000	0.00	129600.00	129600.00	69944.00
0.00	0.00	360000.00	0	12500.00	372500.00	372500.00	40485.00
0.00	0.00	654240.00	16667	0.00	670907.00	670907.00	20000.00
0.00	0.00	1177415.00	14355	0.00	1191770.00	1191770.00	180227.00
0.00	0.00	0.00	91473	0.00	91473.00	91473.00	65304.00
0.00	0.00	0.00	11760	0.00	11760.00	11760.00	33120.00
0.00	0.00	0.00	67047		67047.00	67047.00	12174.00
0.00	48300.00	144310.00	44313	0.00	188623.00	236923.00	101872.00
0.00	0.00	0.00	43726	0.00	43726.00	43726.00	134374.00
0.00	0.00	215760.00	0	0.00	215760.00	215760.00	235760.00
0.00	0.00	0.00	1966	0.00	1966.00	1966.00	48034.00
0.00	0.00	0.00	0	0.00	0.00	0.00	700000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	-278345.00



8005	PROJ/8005/PROGRAM SUPPORT & TISSUE	-98722.00	0.00	0.00	-98722.00	0.00
8006	PROJ/8006/BIOCONJUGATION NANO MAT.	139019.00	0.00	0.00	139019.00	0.00
8008	PROJ/8008/CSIR GRANT-PADMAJA.PNAMBI	12990.00	0.00	0.00	12990.00	0.00
8009	PROJ/8009/DBT/DR.T.V.ANILKUMAR/DE...TISSUE	-310641.00	0.00	0.00	-310641.00	0.00
8011	PROJ/8011/NANOFRONT/DR.NIRANJAN/INTRAMAS	139900.00	0.00	0.00	139900.00	0.00
8012	PROJ/8012/VSSC/DR.NIRANJAN/DESIGN STUDIES	2148623.00	0.00	0.00	2148623.00	0.00
8015	PROJ/8015/DR.ANOOPKUMAR/PROGRAMME...	12581.00	0.00	0.00	12581.00	0.00
8020	PROJ/8020/CSIR/DR.LISSY KRISHNAN	19974.36	0.00	0.00	19974.36	0.00
8021	PROJ/8021/ANGIOGENESIS EXP/DR.UMASHANKAR	79036.00	0.00	0.00	79036.00	0.00
8023	PROJ/8023/KSCSTE/DR.H.K.VARMA	76545.00	0.00	0.00	76545.00	0.00
8024	PROJ/8024/IIT/DR.PR.ANILKUMAR	2935.00	0.00	0.00	2935.00	0.00
8026	PROJ/8026/	3339.00	0.00	0.00	3339.00	0.00
8027	PROJ/8027/DR.PV.MOHANAN	79732.00	0.00	0.00	79732.00	0.00
8028	PROJ/8028/DR.DIKSHA PAINULY	22332.00	0.00	0.00	22332.00	0.00
8031	PROJ/8031	-309053.00	0.00	0.00	-309053.00	0.00
8032	PROJ/8032/O.S.N.NAIR	128471.00	0.00	0.00	128471.00	0.00
8034	PROJ/8034/FLURO PASSI... DR.ROY JOSEPH	679576.1	0.00	0.00	679576.10	0.00
8035	PROJ/EVALN OF SEWING RING-DR.UMASHANKAR	18801.00	0.00	0.00	18801.00	0.00
8038	PROJ/DEV OF MISSION PROGRAM - DR.GSB	1182223.00	0.00	0.00	1182223.00	0.00





0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-98722.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	139019.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12990.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-310641.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	139900.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2148623.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12581.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19974.36
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	79036.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76545.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2935.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3339.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	79732.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22332.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-309053.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128471.00
0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	679576.10
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18801.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1182223.00



8040	PROJ/SYNTHESIS OF OX-IDE-DR.H.K.VARMA	1475.00	0.00	0.00	1475.00	0.00
8046	PROJ/DIFF. OF ADULT PRO - DR.ASHA.S.MATHEW	739755.00	0.00	0.00	739755.00	0.00
8049	PROJ/NEW VISION BIO-MAT-DR.C.P.SHARMA	13271.00	0.00	0.00	13271.00	0.00
8054	PROJ/MUSCULOSKELETAL STEM CELL/DR.PDNAIR	0.21	0.00	0.00	0.21	0.00
8055	MUSCULOSKELETAL STEM CELLS/DR.H.K.VARMA	3.00	0.00	0.00	3.00	0.00
8059	PROJ/CELL SHEET EN-GG-DR.PR.ANILKUMAR	108000.00	0.00	0.00	108000.00	0.00
8062	PROJ/ACCELERATED ARE-ING./MR.C.V.MURALI	213728.00	0.00	0.00	213728.00	0.00
8064	NONVIRAL GENE DELIVERY VECTORS- DR.REKHA	33801.00	0.00	0.00	33801.00	0.00
8066	TO INVESTIGATE THE EF-FECTS OF/ DR.GULIA	0.55	0.00	0.00	0.55	0.00
8068	INSPIRE RESEARCH PROJ-ECT -DR.BINDU.PNAI R	3957.00	0.00	0.00	3957.00	0.00
8069	PROJ/8069/STUDIES BIO-DEGRADABLE	1425.00	0.00	0.00	1425.00	0.00
8070	PROJ/8070/PINSPIRE FAC-ULTY AWARD-DR.SHIV	472880.65	0.00	0.00	472880.65	0.00
8071	PROJ/8071/REGEN .OF INTERVERTEBRAL DISC	5840.00	0.00	0.00	5840.00	0.00
8072	PROJ/8072/NANO CALCIUM PHOSPHATE	15412.10	0.00	0.00	15412.10	0.00
8074	PRODUCTION OF NOVEL NANO INDO-UK DR.CPS	303180.00	0.00	0.00	303180.00	0.00
8077	HOME BASED VITAL SIGNS - DR.NIRANJAN.D.	204509.75	0.00	0.00	204509.75	0.00
8079	DOSE RANGING STUDY FOR DES / DR.SABAREES	731710.00	0.00	0.00	731710.00	0.00



0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1475.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	739755.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13271.00
0.00	0.00	0.00	0.21	0.00	0.21	0.21	0.21	0.00
0.00	0.00	0.00	3.00	0.00	3.00	3.00	3.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	213728.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33801.00
0.00	0.00	0.00	0.55	0.00	0.55	0.55	0.55	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3957.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1425.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	472880.65
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5840.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15412.10
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	303180.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	204509.75
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	731710.00



8082	ASSESSMENT OF CERAM- ICCONSTRUCTS - FRANC	37118.00	0.00	0.00	37118.00	0.00
8083	IN VITRO OSTEOARTHRI- TIC-DR.NEETHUMOHAN	8294.82	0.00	0.00	8294.82	0.00
8085	PROJ/8085/ELECTRO- CHEMICALLY ASSISTED	40.00	0.00	0.00	40.00	0.00
8086	PROJ/8086/GOLD NA- NORODS FOR THERAPY	18626.77	0.00	0.00	18626.77	0.00
8087	PROJ/8087/CONTROLLED DELIVERY	26580.86	0.00	0.00	26580.86	0.00
8088	PROJ/8088/CANCER TIS- SUE ENGINEERING A 3D	98.00	0.00	0.00	98.00	0.00
8090	INSPIRE FELLOW PHD KEERTHI S JRF	3446	409760	0.00	413206.00	0.00
8094	ALTERNATE	902.02	0.00	0.00	902.02	0.00
8095	DEV RAPID UTI DR. MAYA - DST	8173.15	0.00	0.00	8173.15	0.00
8097	MULTIFUNCN - DBT SUNITHA PREM	223322.22	0.00	0.00	223322.22	0.00
8098	HOW ACTIN FILAMENT STRUCTUDR RENU MOH	1129.00	0.00	0.00	1129.00	0.00
8102	"ENGINEERING BIOMIMET- IC.... NICHE TARA.S"	54224.75	0.00	0.00	54224.75	0.00
8106	PROJ/8106/MECHANISM OF ANGIOGENESIS	12150	0	0.00	12150.00	0.00
8107	"PROJ/8107/DEFINING MECHANO -BIOLOGY TO HETEROGE- NEITY IN MUSCLE STEM -BIOLOGY"	1233368.52	2000000	0.00	3233368.52	0.00
8108	"PROJ/8108/Development Of A Dental Restorative Ma- terial Based On Inorganic Hybrid Resin OF A DENTAL RES..."	44556.45	0.00	0.00	44556.45	0.00



0.00	0.00	0.00	0.00	0.00	0.00	0.00	37118.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	8294.82
0.00	0.00	0.00	40.00	0.00	40.00	40.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	18626.77
0.00	0.00	0.00	0.00	0.00	0.00	0.00	26580.86
0.00	0.00	0.00	98.00	0.00	98.00	98.00	0.00
0.00	0.00	0	0.00	0.00	0.00	0.00	413206.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	902.02
0.00	0.00	0.00	0.00	0.00	0.00	0.00	8173.15
0.00	0.00	0.00	0	0.00	0.00	0.00	223322.22
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1129.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	54224.75
0.00	0.00	0.00	12150	0.00	12150.00	12150.00	0.00
0.00	0.00	1495834.00	488119.00	100000.00	2083953.00	2083953.00	1149415.52
0.00	0.00	0.00	0.00	0.00	0.00	0.00	44556.45



8110	"PROJ/8110/TO ALLEVIATE COGNITIVE DEFECTS"	0.06	0.00	0.00	0.06	0.00
8113	"PROJ/8113/TREATMENT OF BONE DEFECTS"	139800.00	0.00	0.00	139800.00	0.00
8114	"PROJ/8114/NANO PARTICLES WITH CELLS"	103633.17	182395	0.00	286028.17	0.00
8115	PROJ/8115/TECHNOLOGY RESEARCH CENTRE	94034310.41	0.00	28599273.46	122633583.87	61834939.00
8116	"PROJ/8116/Program support of Translational research on Bio materials for orthopaedics and Dental applications SUPPORT ON TRAN..."	273907.71	0	39379.00	313286.71	0.00
8117	"PROJ/8117/Gold Nanorod Based Targeted nanoprobe for cancer theranostics: Diagnosis by surface Enhanced Raman Scattering (SERS) and Fluorescence imaging and therapy by PDT and PPT BASED TARGETED"	10371.19	0	0.00	10371.19	0.00
8118	PROJ/8118/The role of NMDA & dopamine receptors in spinal pain pathways	0.25	0.00	0.00	0.25	0
8119	PROJ/8119/DEVELOPMENT OF BIOMIMETIC STRONTIUM INCORPORATED NANOSTRUCTURED CERAMIC COATINGS ON CP-TITANIUM FOR ORTHOPAEDIC	0.49	1129702.00	0.00	1129702.49	
8122	PROJ/8122/DEV. OF CENTRIFUGAL BLOOD PUMP	1256920.36	0.00	0.00	1256920.36	0.00
8123	PROJ/8123/DEV.OF LEFT VENTRICULAR DEVICE	1869985.04	0.00	0.00	1869985.04	23848.00
8124	PROJ/8124/DEV. OF AORTIC STENT GRAFT	6484999.36	0.00	0.00	6484999.36	425250.00



0.00	0.00	0.00	0.06		0.06	0.06	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	139800.00
0.00	0.00	182394.00	75901.00	0.00	258295.00	258295.00	27733.17
0.00	61834939.00	1920031.30	3102647.00	19587244.0	24609922.30	86444861.30	36188722.57
0.00	0.00	0.00	20640.00	0.00	20640.00	20640.00	292646.71
0.00	0.00	0.00	0.00	0.00	0.00	0.00	10371.19
0.00	0.00	0.00	0.25	0.00	0.25	0.25	0.00
0.00	0.00		1094057.49	35645.00	1129702.49	1129702.49	0.00
0.00	0.00	0.00	0.00	1256920.36	1256920.36	1256920.36	0.00
0.00	23848.00	153090.00	34650.00	1658397.04	1846137.04	1869985.04	0.00
0.00	425250.00	700502.00	2258379.00	0.00	2958881.00	3384131.00	3100868.36



8125	PROJ/8125/DEV. OF DEEP BRAIN STIMULATOR	3067721.99	0.00	0.00	3067721.99	898517.00
8126	PROJ/8126/CARDIOVERTER DEFIBRILLATOR	11603675.44	1000000.00	0.00	12603675.44	3798273.00
8127	PROJ/8127/DEVELOPMENT OF LEUKODEPLETION	422521.86	0.00	0.00	422521.86	0.00
8128	PROJ/8128/DEPT.OFANNU-LOPLASTY./MITRALVALVE-CORRECTION	4396001.80	0.00	0.00	4396001.80	0.00
8129	PROJ/8129/DEVPT.OF BIO-PROSTHETICHEART VALVE	1623600.32	3275000.00	0.00	4898600.32	0.00
8130	"PROJ/8130/INTER VERTEBRAL SPACER"	352216.74	0.00	0.00	352216.74	0.00
8131	PROJ/8131/BIOACTIVE MATERIAL PLATFORM	288896.56	0.00	0.00	288896.56	0.00
8132	PROJ/8132/DEV. INTRA-CRANIAL ELECTRODES	231641.20	0.00	0.00	231641.20	0.00
8133	PROJ/8133/OPTICAL PE-RIPHERAL NERVE	501648.81	0.00	0.00	501648.81	0.00
8134	PROJ/8134/HYDROCEPHA-LUS SHUNT	6429437.00	325000.00	0.00	6754437.00	663584.00
8135	PROJ/8135/STANDARDIZA-TION OF ALBUMIN	1707733.80	0.00	0.00	1707733.80	738098.00
8136	PROJ/8136/DEVELOPMENT OF NOVEL WOUND HEAL-ING MATRIX COMPOSED OF HUMAN-FIBRIN	194536.73	0.00	0.00	194536.73	0.00
8137	PROJ/8137/3D PRNTNG OF SKIN TISSUE CONSTRUCTS FOR IN-VIRTO TESTING&AP-PLICATIONS	3221530.91	0.00	0.00	3221530.91	47256.00
8138	PROJ/8138/DEVLPMT OF PLATFORM TECLGY IM-PLATABLE MICRO INFUSION RECHRGING SYSTEM	2766394.72	0.00	0.00	2766394.72	1008866.00



0.00	898517.00	387127.00	54865.00	0.00	441992.00	1340509.00	1727212.99
0.00	3798273.00	929311.00	466763.50	0.00	1396074.50	5194347.50	7409327.94
0.00	0.00	0.00	0.00	422521.86	422521.86	422521.86	0.00
0.00	0.00	217800.00	100000.00	0.00	317800.00	317800.00	4078201.80
0.00	0.00	1349753.00	72509.55	0.00	1422262.55	1422262.55	3476337.77
0.00	0.00	0.00	0.00	352216.74	352216.74	352216.74	0.00
0.00	0.00	0.00	0.00	288896.56	288896.56	288896.56	0.00
0.00	0.00	0.00	0.00	231641.20	231641.20	231641.20	0.00
0.00	0.00	0.00	0.00	501648.81	501648.81	501648.81	0.00
0.00	663584.00	460844.00	139972.00	0.00	600816.00	1264400.00	5490037.00
0.00	738098.00	0.00	229912.00	0.00	229912.00	968010.00	739723.80
0.00	0.00	0.00	0.00	194536.73	194536.73	194536.73	0.00
0.00	47256.00	45213.00	2324953.23	0.00	2370166.23	2417422.23	804108.68
0.00	1008866.00	602581.00	81440.00	0.00	684021.00	1692887.00	1073507.72



8139	PROJ/8139/PARYLENE COATING FOR IMPLANT-ABLE MEDICAL DEVICES& DELIVERY SYSTEM	760025.88	0.00	0.00	760025.88	0.00
8140	PROJ/8140/REPAIR OF CARTILAGE INJURY	279957.32	0.00	0.00	279957.32	0.00
8141	PROJ/8141/3D PRINTING OF LIVER TISSUE	2830572.89	0.00	0.00	2830572.89	0.00
8142	PROJ/8142/DEVELOPMENT OF ASSAY PLATFORM	251683.03	0.00	0.00	251683.03	0.00
8143	PROJ/8143/POLYMERIC WOUND	353263.30	0.00	0.00	353263.30	0.00
8144	PROJ/8144/WOUND HEALING MATRIX	387455.34	0.00	0.00	387455.34	0.00
8145	PROJ/8145/LINT FREE ABSORBENT DRESSING	993854.09	0.00	0.00	993854.09	0.00
8146	PROJ/8146/POINT OF CARE DETECTION	3379780.75	0.00	0.00	3379780.75	897838.00
8147	PROJ/8147/POINT OF CARE DIAGNOSIS	961315.05	0.00	0.00	961315.05	0.00
8148	PROJ/8148/ALGINATE SCAFFOLD	726149.84	0.00	0.00	726149.84	0.00
8149	PROJ/8149/EVALUATION OF PLGC	92400.19	0.00	0.00	92400.19	0.00
8150	PROJ/8150/DEV. OF OCCLUSION DEVICE	1854965.74	861874.00	0.00	2716839.74	574666.00
8151	PROJ/8151/DEV.EMBOLIZATION DEVICE	423865.93	0.00	0.00	423865.93	0.00
8152	PROJ/8152/DEVELOPMENT OF TITANIUM NITRATE COATED CORONARY STENT	2745770.65	0.00	0.00	2745770.65	291795.00
8153	PROJ/8153/CHARACTERISATION OF BACILLUS SPECIES-(MRSA)	2276505.52	0.00	0.00	2276505.52	0.00



0.00	0.00	113845.00	89308.00	0.00	203153.00	203153.00	556872.88
0.00	0.00	0.00	0.00	279957.32	279957.32	279957.32	0.00
0.00	0.00	0.00	0.00	2830572.89	2830572.89	2830572.89	0.00
0.00	0.00	0.00	0.00	251683.03	251683.03	251683.03	0.00
0.00	0.00	0.00	0.00	353263.30	353263.30	353263.30	0.00
0.00	0.00	0.00	0.00	387455.34	387455.34	387455.34	0.00
0.00	0.00	0.00	0.00	993854.09	993854.09	993854.09	0.00
0.00	897838.00	463353.00	871215.00	0.00	1334568.00	2232406.00	1147374.75
0.00	0.00	0.00	83025.00	0.00	83025.00	83025.00	878290.05
0.00	0.00	0.00	86010.75	0.00	86010.75	86010.75	640139.09
0.00	0.00	0.00	0.00	92400.19	92400.19	92400.19	0.00
0.00	574666.00	443447.00	1342799.00	0.00	1786246.00	2360912.00	355927.74
0.00	0.00	0.00	1991.00	421874.93	423865.93	423865.93	0.00
0.00	291795.00	434757.00	204539.00	0.00	639296.00	931091.00	1814679.65
0.00	0.00	0.00	0.00	2276505.52	2276505.52	2276505.52	0.00



8154	PROJ/8154/DEPT.OF BIOMATERIAL SCIENCE & TECHNOLOGY	849611.12	0.00	0.00	849611.12	0.00
8155	PROJ/8155/DEVPT.OF FLOW DIVERTERTREATMENT OF ANEURYSMS	2572312.24	0.00	0.00	2572312.24	14220.00
8156	PROJ/8156/RADIOPAQUE POLYMERIC MICRO-SPHERES OF EMBOLIZATION THERAPY	601673.12	0.00	0.00	601673.12	0.00
8157	PROJ/8157/DEVLPMNT OF PLRS&HIGH STAKE DECISION MKNG FROM CONCEPT PDT	501940.00	180000.00	0.00	681940.00	85040.00
8158	PROJ/8158/PRIMER TECHNOLOGY TNFR TECHNICAL, MKT, FINICIAL, CL, REGULURTY INPUTS	0.00	165000.00	0.00	165000.00	0.00
8159	PROJ/8159/ITI INFRA-STRUCTURE UPGRADTION PLAN	1594152.32	0.00	0.00	1594152.32	502969.00
8160	PROJ/8160/TOXICOLOGICAL EVALUATION	5325514.20	340000.00	0.00	5665514.20	9660.00
8161	PROJ/8161/LARGE ANIMAL EVALUATION	7245805.85	120000.00	0.00	7365805.85	54765.00
8162	PROJ/8162/BLOOD COMPATIBILITY	418836.60	155000.00	0.00	573836.60	31637.00
8163	PROJ/8163/CYTOCOMPATIBILITY	612649.99	266800.00	0.00	879449.99	0.00
8164	PROJ/8164/HISTOPATHOLOGICAL EVALUATION	659235.52	208000.00	0.00	867235.52	0.00
8165	PROJ/8165/MICROBIOLOGICAL EVALUATION	148322.34	85000.00	0.00	233322.34	0.00
8166	PROJ/8166/ANALYTICAL CHARACTERISATION	1006776.64	65000.00	0.00	1071776.64	108300.00





0.00	0.00	0.00	0.00	849611.12	849611.12	849611.12	0.00
0.00	14220.00	579296.00	164995.00	0.00	744291.00	758511.00	1813801.24
0.00	0.00	0.00	0.00	601673.12	601673.12	601673.12	0.00
0.00	85040.00	249355.00	0.00	0.00	249355.00	334395.00	347545.00
0.00	0.00	151315.70	0.00	0.00	151315.70	151315.70	13684.30
0.00	502969.00	0.00	280783.00	810400.32	1091183.32	1594152.32	0.00
0.00	9660.00	561432.00	3897385.30	0.00	4458817.30	4468477.30	1197036.90
0.00	54765.00	224360.00	804002.80	0.00	1028362.80	1083127.80	6282678.05
0.00	31637.00	250941.00	119040.00	0.00	369981.00	401618.00	172218.60
0.00	0.00	0.00	165644.79	0.00	165644.79	165644.79	713805.20
0.00	0.00	0.00	515583.00	0.00	515583.00	515583.00	351652.52
0.00	0.00	142202.00	0.00	0.00	142202.00	142202.00	91120.34
0.00	108300.00	40320.00	47299.04	0.00	87619.04	195919.04	875857.60



8167	PROJ/8167/DESIGN & PRO-TOTYPING	469705.64	782000.00	0.00	1251705.64	0.00
8168	PROJ/8168/DEVPT OF EQPT FOR PCKG VALIDATION	1891629.32	0.00	0.00	1891629.32	0.00
8169	PROJ/8169/PREPARATION STD FOR BIOLOGICAL EVALUATION	1871010.20	0.00	0.00	1871010.20	0.00
8171	PROJ/8171/ENTERIC COATING & MICRO INCAPSULATION OF ANTIBODIES	4938.4	0.00	11470.00	16408.40	0.00
8173	PROJ/8173/BLOOD DRAIN AREA TARGETED NANO CONSTRUCTS FOR DIAGNOSIS OF BRAIN DISEASES & DELIVERY OF THERAPUETICS INTO THE BRAIN	3463.23	0.00	0.00	3463.23	0.00
8174	PROJ/8174/SCAFFOLDS BASED ON SELF-ASSEMBLING PEPTIDE DENDRIMERS AND RESORBABLE CALCIUM PHOSPHATES FOR ENDODONTIC TISSUE REGENERATION	0.14	0.00	0.00	0.14	0.00
8175	PROJ/8175/MUSTER- MUSCULOSKELETAL STEM CELL TARGETING	1171125.74	4683805.00	58096	5913026.74	0.00
8176	PROJ/8176MUSTER- MUSCULOSKELETAL STEM CELL TARGETING	645128.18	0.00	0.00	645128.18	0.00
8178	PROJ/8178/PRECLINICAL EVALUATION & COMMERCIALISATION ANTI SNAKE VENOM (IGY)	55086.9	0.00	0.00	55086.90	0.00





0.00	0.00	805714.00	208474.04	0.00	1014188.04	1014188.04	237517.60
0.00	0.00	0.00	0.00	1891629.32	1891629.32	1891629.32	0.00
0.00	0.00	0.00	0.00	1871010.20	1871010.20	1871010.20	0.00
0.00	0.00	0.00	7602	0.00	7602.00	7602.00	8806.40
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3463.23
0.00	0.00	0.00	0.14	0.00	0.14	0.14	0.00
0.00	0.00	1397447.00	2859008.00	0.00	4256455.00	4256455.00	1656571.74
0.00	0.00	0.00	0.00	0.00	0.00	0.00	645128.18
0.00	0.00	0	0.00	0.00	0.00	0.00	55086.90



8179	PROJ/8179/DEVELOPMENT OF NOVEL PROTOTYPE MECHANICAL PLOT RETRIEVER FOR TREATMENT OF ACUTE CEREBRAL ISCHEMIC STROKE	378380.75	0.00	0.00	378380.75	0.00
8180	PROJ/8180/TO MODEL THE EFFECT OF MUTATION OF HCN CHANNELS IN NEURONAL EXITABILITY AND IMPACT OF GABABR ON GIRK AND HCN MUTATION USING NEURON	43768	0	0	43768.00	0.00
8181	PROJ/8181/DEVELOPMENT OF INDIGENOUS VOICE PROTHESIS FOR REHABILITATION of laryngectomies	0.43	0	0.00	0.43	0.00
8182	PROJ/8182/A TISSUE ENGINEERED SKIN SUBSTITUTE WITH LOCALISED HAIR FOLLICLE STEM CELLS FOR HAIR FOLLICLES AND SEBACEOUS GLAND REGENERATION	62075.04	0.00	3927	66002.04	0.00
8183	PROJ/8183/BIO ENGINEERED CONSTRUCT WITH CARDIAC MESENCHYMAL CELLS FOR MYOCARDIAL REPAIR	88036.55	1851115	2376.98	1941528.53	0.00
8184	PROJ/8184/FABRICATION OF A HEAD PHANTOM FOR DOSIMETRIC EVALUATION OF RADIOTHERAPY TREATMENT PLANS	79961.68	66570.00	1104.00	147635.68	0.00
8185	PROJ/8185/BLOOD BRAIN BARRIER PERMEABLE NANOCARRIERS FOR DIAGNOSIS7THERAPY OF NEURO GENERATIVE DISEASES	3044779.45	1924881.00	245217.00	5214877.45	2847599.00





0.00	0.00	44709.00	52237.00	0.00	96946.00	96946.00	281434.75
0.00	0.00	0.00	0.00	0	0.00	0.00	43768.00
0.00	0.00	0.00	0.43	0	0.43	0.43	0.00
0.00	0.00	0.00	33927	0	33927.00	33927.00	32075.04
0.00	0.00	1422000.00	501120.00	0.00	1923120.00	1923120.00	18408.53
0.00	0.00	0.00	147635.68	0.00	147635.68	147635.68	0.00
41986.00	2889585.00	0.00	366964.18	0.00	366964.18	3256549.18	1958328.27



8186	PROJ/8186/3D PRINTED CELL FREE BIPHASIC MATRICES LOADED WITH AN ADMIXTURE OF BIOMOLECULES FOR ENHANCED PROGENITOR CELL	26898	422667	0.00	449565.00	0.00
8187	PROJ/8187/DEVELOPMENT OF HUMAN-ON-A-CHIP DEVICE TECHNOLOGY	3405960.31	2500000.00	530887.00	6436847.31	2022866
8188	PROJ/8188/EXPERT ADVISORY GROUP	300114.00	0.00	0.00	300114.00	0.00
8189	PROJ/8189/CARE IN heart failure NT pro BNP POC DEVICE	2257282.25	1937879	0.00	4195161.25	0
8190	PROJ/8190/MAGNETO-optic sensor for cardiac biomarker detection.	169219.67	0	0.00	169219.67	0
8191	PROJ-8191:INDO-JAPAN-ANTI -MICROBIAL peptide(II37) loaded multi-functional	252000.00	0	5454.00	257454.00	0
8192	PROJ/8192/EXTENDING BENEFITS OF BIOMEDICAL SCIENCE &TECH TO ST COMPONENTS	9447473.57	10000000.00	85027.00	19532500.57	4051421.00
8193	PROJ/8193/EXTENDING BENEFITS OF BIOMEDICAL SCIENCE &TECH TO SC COMPONENTS	8546328.00	5000000.00	76917.00	13623245.00	4057840.00
8194	PROJ/8194/STEM CELL DERIVED EXOSOMETHERAPY FOR CLINICAL MGT OF LUNG DAMAGEIN CRITICALLY ILL CORONA VIRAL PNEUMONIA PATIENTS	1508471.87	0.00	27155.00	1535626.87	85998.00
8195	"PRO/8195/AN EASY 7RAPID DETECTTION PLATFORM FOR VIRAL DISEASES FROM SALIVA"	1109006.56	0.00	0.00	1109006.56	0.00





0.00	0.00	406000	6490.00	0.00	412490.00	412490.00	37075.00
0.00	2022866.00	807701.00	1088166.93	0.00	1895867.93	3918733.93	2518113.38
0.00	0.00	0.00	0.00	0.00	0.00	0.00	300114.00
0.00	0.00	403560.00	194071.00	0.00	597631.00	597631.00	3597530.25
0.00	0.00	0.00	0	0.00	0.00	0.00	169219.67
0.00	0.00	0.00	50000	5454.00	55454.00	55454.00	202000.00
0.00	4051421.00	3900033.00	1685730.06	85027.00	5670790.06	9722211.06	9810289.51
0.00	4057840.00	4455683.00	965467.19	76917.00	5498067.19	9555907.19	4067337.81
0.00	85998.00	128206.00	1126529.05	0.00	1254735.05	1340733.05	194893.82
0.00	0.00	319607.00	286102.82	0.00	605709.82	605709.82	503296.74



8196	"PROJ/8196/DEVPT OF MODIFIED GLASS IONOMER CEMERT TO IMPROVE MECHANICAL PROPERTIES"	1470766.00	0.00	17846.00	1488612.00	549418.00	
8197	"PROJ/8197/PURDUE UNIVERSITY OVERSEASES VISITING DOCTORAL FELLOWSHIP"	584000.00	704400.00	0.00	1288400.00	0.00	
8198	"PROJ/8198/EFFICACY EVALUATION OF 3D BIOPRINTED LIVER CONSTRUCTS ESTABLISHED FROM NICHE SPECIFIC BIOINIK&STEMCELL DERIVED HEPATOCYTE LIKE CELL"	1624720.00	0.00	232000.00	1856720.00	414750.00	
8199	PROJ/8199/DESIGN AND DEVPT OF A MICRO DIALYSIS SET-UP FOR CEREBRAL APPLICATIONS	2592050.00	0.00	0.00	2592050.00	573194.00	
8200	"PROJ/8200/GENDER ADVANCEMENT FOR TRANSFORMING INSTITUTIONS"	0.00	200000.00	0.00	200000.00	0.00	
8201	"PROJ/8201/DEVPT OF PLASTICIZER FREE ACRYLIC DENTURE SOFT LINERS USING NANOGELADDITIVES"	0.00	2631520.00	0.00	2631520.00	1000000.00	
8202	"PROJ/8202/DEVPT OF PEDICLE SCREW BASED DYNAMIC STABILIZATION SYSTEMS FOR DEGENERATIVES DISEASES OF LUMBOSACRAL SPINE"	0.00	1080920.00	0.00	1080920.00	0.00	





0.00	549418.00	347806.00	353016.00	0.00	700822.00	1250240.00	238372.00
0.00	0.00	1288400.00	0.00	0.00	1288400.00	1288400.00	0.00
0.00	414750.00	156077.00	1080280.00	0.00	1236357.00	1651107.00	205613.00
0.00	573194.00	426319.00	348815.00	0.00	775134.00	1348328.00	1243722.00
0.00	0.00	115867.00	26579.00	18000.00	160446.00	160446.00	39554.00
0.00	1000000.00	170247.00	470567.00	0.00	640814.00	1640814.00	990706.00
0.00	0.00	0.00	0.00	93720.00	93720.00	93720.00	987200.00



8205	"PROJ/8205/NATIONAL TRANSLATIONAL RE-SEARCH FACILITY FOR BIOMATERIAL&DEVICE&INVITRO DIAGNOSTICS"	0.00	84795200.00	0.00	84795200.00	0.00
8220	PROJ/8220/SPINAL FIXATION SYSTEM FOR THORACOLUMBAR STABLIZATION	11326581.80	0.00	0.00	11326581.80	6930740.00
8221	PROJ/8221/DEVELOPMENT OF HIGH-STRENGTH TI-6Al- +4V CASTINGS FOR ORTHOPAEDIC IMPLANTS	4812868.57	0.00	0.00	4812868.57	364819.00
8222	PROJ/8222/BIOCERAMIC CAGES WITH AXIALLY ALIGNED PORES AS A SUBSTITUTE FOR TRICORTICAL BONE GRAFT	409109.77	0.00	0.00	409109.77	0.00
8223	PROJ/8223/CORNEAL EPITHELIAL CELL SHEET ENGINEERING:STANDARDIZATION & PRE-CLINICAL EVALUATION	3744835.73	0.00	0.00	3744835.73	470800.00
8224	PROJ/8224/Chitra Acrylosorb fluid and Technology"	132529.49	0.00	0.00	132529.49	0.00
8225	PROJ/8225/Smart Assistive breathing device"	8715.80	0.00	0.00	8715.80	0.00
8226	PROJ/8226/Digital Sanitization Systems"	22660.91	0.00	0.00	22660.91	0.00
8227	PROJ/8227/Isolation Pods"	61272.00	0.00	0.00	61272.00	0.00
8228	PROJ/8228/Emergency Response Isolation Sysyems"	20420.98	0.00	0.00	20420.98	0.00
8229	PROJ/8229/Ventilator Sharing Kit"	39559.90	0.00	0.00	39559.90	0.00
8230	PROJ/8230/Examination booth with UV disfection system as barrier b/w patient and doctor"	200000.00	0.00	0.00	200000.00	0.00



	0.00	0.00	0.00	0.00	0.00	0.00	84795200.00
0.00	6930740.00	599261.00	695701.38	0.00	1294962.38	8225702.38	3100879.42
0.00	364819.00	241348.00	734349.00	0.00	975697.00	1340516.00	3472352.57
0.00	0.00	5120.00	209587.00	0.00	214707.00	214707.00	194402.77
0.00	470800.00	347960.00	41944.00	0.00	389904.00	860704.00	2884131.73
0.00	0.00	0.00	0.00	132529.49	132529.49	132529.49	0.00
0.00	0.00	0.00	0.00	8715.80	8715.80	8715.80	0.00
0.00	0.00	0.00	0.00	22660.91	22660.91	22660.91	0.00
0.00	0.00	0.00	0.00	61272.00	61272.00	61272.00	0.00
0.00	0.00	0.00	0.00	20420.98	20420.98	20420.98	0.00
0.00	0.00	0.00	0.00	39559.90	39559.90	39559.90	0.00
0.00	0.00	0.00	133140.00	66860.00	200000.00	200000.00	0.00



8231	PROJ/8231/Disinfection gateway for entry points of offices,hospitals,apartments,etc	152380.00	0.00	0.00	152380.00	0.00
8232	PROJ/8232/SPINAL CORD STIMULATOR	19327748.00	0.00	0.00	19327748.00	1597430.00
8233	PROJ/8233/RAPID DIAGNOSTIC KITS	10409614.26	0.00	0.00	10409614.26	101420.00
8234	PROJ/8234/Antibody against ASPIKE protein to Prevent COVID 19"	300000.00	0.00	0.00	300000.00	0.00
8235	PROJ/8235/Rapid detection Kit for IgG/IgM Antibody"	142882.16	0.00	0.00	142882.16	0.00
8236	PROJ/8236/Nylon Flocked Swabs (Nasopharyngeal and Oropharyngeal) for COVID 19 testing"	600000.00	0.00	0.00	600000.00	0.00
8237	PROJ/8237/Oropharyngeal Sample Collection Kit"	274567.90	0.00	0.00	274567.90	0.00
8238	PROJ/8238/Developing a point of care testing protocol based on RT-LAMP for fast detection of SARS-CoV-2"	79554.84	0.00	0.00	79554.84	0.00
8239	PROJ/8239/Development of a cost effective Ventilator"	2275164.07	0.00	0.00	2275164.07	0.00
		317365709.02	134502515.00	117530938.67	569399162.69	97656769.00

	INTERNAL PROJECTS					
6221	PROJ/6221/CIRCULATING TUMOR CELLS	0.00	0.00	72798.55	72798.55	0.00
6223	PROJ/6223/DEVELOPMENT OF A DURAL SUB.	0.00	0.00	156927	156927.00	66000.00
6232	PROJ/6232/STEERING ELECTRODES	0.00	0.00	226250	226250.00	0.00



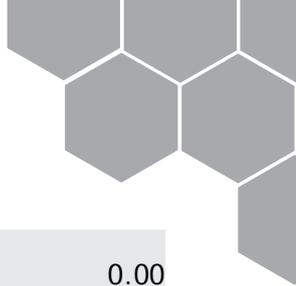
0.00	0.00	0.00	0.00	152380.00	152380.00	152380.00	0.00
0.00	1597430.00	653004.00	548750.00	0.00	1201754.00	2799184.00	16528564.00
0.00	101420.00	273216.00	294443.86	0.00	567659.86	669079.86	9740534.40
0.00	0.00	0.00		300000.00	300000.00	300000.00	0.00
0.00	0.00	0.00	0.00	142882.16	142882.16	142882.16	0.00
0.00	0.00	0.00		600000.00	600000.00	600000.00	0.00
0.00	0.00	0.00	0.00	274567.90	274567.90	274567.90	0.00
0.00	0.00	0.00	0.00	79554.84	79554.84	79554.84	0.00
0.00	0.00	259683.00	1324543.00	0.00	1584226.00	1584226.00	690938.07
41986.00	97698755.00	35555981.00	111580655.51	40755580.97	187892217.48	285590972.48	283808190.21

0.00	0.00	0.00	72798.55	0.00	72798.55	72798.55	0.00
0.00	66000.00	0.00	90927.00	0.00	90927.00	156927.00	0.00
0.00	0.00	0.00	226250.00	0.00	226250.00	226250.00	0.00



6233	PROJ/6233/EXTERNAL DEFIBRILLATOR	0.00	0.00	243771	243771.00	0.00	
6234	DSGNOF NOVEL POLY. PED. SCREW/A.PRAJAPATH	0.00	0.00	267273	267273.00	0.00	
6235	PROJ/6235/PLATELET RICH PLASMA	0.00	0.00	247699	247699.00	0.00	
6236	PROJ/6236/VASCULAR MODEL	0.00	0.00	254285	254285.00	0.00	
6237	PROJ/6237/SUCTION-RETRACTOR DEVICE	0.00	0.00	238362	238362.00	0.00	
6238	PROJ/6238/COMPLETE BLOOD COUNT	0.00	0.00	102220	102220.00	0.00	
6239	PROJ/6239/ALGINATE DIALDEHYDE	0.00	0.00	500871	500871.00	0.00	
6240	PROJ/6240/BONE GRAFT EXPANDER	0.00	0.00	107300	107300.00	0.00	
6241	PROJ/6241/PORCINE PERICARDIUM	0.00	0.00	278574	278574.00	0.00	
6242	PROJ/6242/MUCOADHESIVE BANDAGES	0.00	0.00	137147	137147.00	0.00	
6243	PROJ/6243/RS.5.10 LAKHS	0.00	0.00	245759	245759.00	0.00	
6244	PROJ/6244/AUGMENTAT. ANALYTICAL FACILITY	0.00	0.00	169988	169988.00	0.00	
6245	PROJ/6245/CERAMIC TILE FORMS	0.00	0.00	307214	307214.00	0.00	
6247	PROJ/6247/PRE-VALIDATION OF IN VITRO ...	0.00	0.00	86174	86174.00	0.00	
6248	proj/6248/development of a device	0.00	0.00	34245	34245.00	0.00	
6250	PROJ/6250/DEVELOPMENT OF A DEVICE.....	0.00	0.00	22578	22578.00	0.00	
		0.00	0.00	3699435.55	3699435.55	66000.00	
	Total (C)	317365709	134502515	121230374	573098598	97722769	
	GRAND TOTAL (A+B+C)	877774201	568376423	418253698	1864404322	104370644	





0.00	0.00	195426.00	48345.00	0.00	243771.00	243771.00	0.00
0.00	0.00	162000.00	105273.00	0.00	267273.00	267273.00	0.00
0.00	0.00	135023.00	112676.00	0.00	247699.00	247699.00	0.00
0.00	0.00	239325.00	14960.00	0.00	254285.00	254285.00	0.00
0.00	0.00	147484.00	90878.00	0.00	238362.00	238362.00	0.00
0.00	0.00	0.00	102220.00	0.00	102220.00	102220.00	0.00
0.00	0.00	76738.00	424133.00	0.00	500871.00	500871.00	0.00
0.00	0.00	0.00	107300.00	0.00	107300.00	107300.00	0.00
0.00	0.00	0.00	278574.00	0.00	278574.00	278574.00	0.00
0.00	0.00	0.00	137147.00	0.00	137147.00	137147.00	0.00
0.00	0.00	233033.00	12726.00	0.00	245759.00	245759.00	0.00
0.00	0.00	0.00	169988.00	0.00	169988.00	169988.00	0.00
0.00	0.00	0.00	307214.00	0.00	307214.00	307214.00	0.00
0.00	0.00	0.00	86174.00	0.00	86174.00	86174.00	0.00
0.00	0.00	0.00	34245.00	0.00	34245.00	34245.00	0.00
0.00	0.00	0.00	22578.00	0.00	22578.00	22578.00	0.00
0.00	66000.00	1189029.00	2444406.55	0.00	3633435.55	3699435.55	0.00
41986	97764755	36745010	114025062	40755581	191525653	289290408	283808190
41986	104412630	74448052	130565965	691908325	896922342	1001334972	863069350



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM**

<b>SCHEDULE 4-SECURED LOANS AND BORROWINGS:</b>		<b>2021-2022</b>	<b>2020-2021</b>
	1. Central Government	--	--
	2. State Government (Specify)	--	--
	3. Financial Institutions	--	--
	a) Term Loans	--	--
	b) Interest accrued and due	--	--
	4. Banks:	--	--
	a) Term Loans-Interest accrued and due	--	--
	b) Other Loans(specify)- Interest accrued and due-Over draft	--	--
	5. Other Institutions and Agencies	--	--
	6. Debentures and Bonds	--	--
	7. Others(Specify)	--	--
	Against OD facility- cheques issued	--	--
	<b>TOTAL</b>		
<b>SCHEDULE 5-UNSECURED LOANS AND BORROWINGS</b>		<b>2021-2022</b>	<b>2020-2021</b>
	1. Central Government	--	--
	2. State Government (Specify)	--	--
	3. Financial Institutions	--	--
	4. Banks:	--	--
	a) Term Loans	--	--
	b) Other Loans(specify)	--	--
	5. Other Institutions and Agencies	--	--
	6. Debentures and Bonds	--	--
	7. Fixed Deposits	--	--
	8. Others(Specify)	--	--
	<b>TOTAL</b>		
<b>SCHEDULE 6-DEFERRED CREDIT LIABILITIES:</b>		<b>2021-2022</b>	<b>2020-2021</b>
	a) Acceptances secured by hypothecation of capital equipment and other assets	--	--
	b) Others		
	<b>TOTAL</b>	--	--

Sd/-  
Financial Adviser

Sd/-  
Director



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM**

SCHEDULE 7-CURRENT LIABILITIES AND PROVISIONS		2021-2022	2020-2021
<b>A. CURRENT LIABILITIES</b>			
1. Acceptances			
2. Sundry Creditors:			
a) For Goods		195201488	262113510
b) Others		0	0
3. Advances Received		84190898	74082106
4. Interest accrued but not due on:		0	0
a) Secured Loans / borrowings		0	0
b) Unsecured Loans / borrowings		0	0
5. Statutory Liabilities:		0	0
a) Overdue			
b) Others		6938924	4403980
6. Other current Liabilities		452019441	189201375
<b>TOTAL(A)</b>		<b>738350752</b>	<b>529800970</b>
<b>B. PROVISIONS</b>			
1. For Taxation		0	0
2. Gratuity		0	0
3. Accumulated Leave Encashment		0	0
4. Trade Warranties/Claims		0	0
5. Others(Specify)   Audit fee		400000	431640
Emergency Reserve Fund contribution		0	0
Technology Development Fund contribution		3764366	6782728
<b>TOTAL(B)</b>		<b>4164366</b>	<b>7214368</b>
<b>TOTAL(A+B)</b>		<b>742515118</b>	<b>537015338</b>

Sd/-  
Financial Adviser

Sd/-  
Director



## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL

### SCHEDULE 8- FIXED ASSETS

PARTICULARS	GROSS BLOCK		
	Cost/valuation as at the beginning of the year (01.04.2021)	Additions during the year 2021-22	Deductions during the year 2021-22
<b>A. FIXED ASSETS:</b>			
<b>1. LAND:</b>			
a) Freehold	16894606	0	0
b) Leasehold			
<b>2. BUILDINGS:</b>			
a) On Freehold Land *	47627608	0	0
b) On Leasehold Land			
c) Ownership Flats/Premises			
d) Superstructures on Land not belonging to the entity	477182357	0	
<b>3. A) PLANT MACHINERY &amp; EQUIPMENT</b>	3221554824	142696375	108811913
B) Equipment - From Non Monetary grants	2	0	0
<b>4. VEHICLES</b>	8546800	0	
<b>5. FURNITURE, FIXTURES</b>	93566223	726043	176077
<b>6. OFFICE EQUIPMENT</b>	1236622	0	0
<b>7. COMPUTER/ PERIPHERALS</b>	9108546	0	0
<b>8. ELECTRIC INSTALLATIONS</b>	173068457	0	0
<b>9. LIBRARY BOOKS</b>	228045128	19059597	0
<b>10. TUBEWELLS &amp; W.SUPPLY</b>	301965	0	
<b>11. OTHER FIXED ASSETS</b>			
A) OXYGEN CYLNDRS/GAS PLANT INST	2190203	821521	
B) KITCHEN/CANTEEN EQUIPMENTS	3766780	345402	399
C) PAINTINGS	450216	0	
D) SURGICAL EQUIPMENTS	2169478	0	1022094
<b>Total for the year ( Total -A)</b>	4285709814	163648937	110010482
<b>Total for the previous year</b>	4273563598	73166535.13	61020319
<b>Capitla Work in Progress (B)</b>	637542529	414098542	0
<b>Total for the year (A+B)</b>	4923252343	577747479	110010482
* Depreciation for item2(a) has been provided along with depreciation on 2(d)			

Sd/-  
Financial Adviser

Sd/-  
Director



# SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

DEPRECIATION					NET BLOCK	
Cost/valuation at the year end (31.03.2022)	Depreciation as at the beginning of the year (01.04.2021)	Depreciation on items written off	During the year 2021-22	Total up to the year end (31.03.2022)	As at the end of current year end (31.03.2022)	As at the previous year end (31.03.2021)
16894606	0	0	0	0	16894606	16894606
47627608	0		0	0		
477182357	354584432	0	17022553	371606985	153202979	170225533
3255439286	2401611407	98991145	43931708	2445543117	809896169	819943417
2	1	0	0	1	1	1
8546800	7523051		153562	7676613	870187	1023749
94116190	56652934	143870	3616843	60269777	33846413	36913289
1236622	1097270		13935	1111206	125416	139352
9108546	8812936	0	118244	8931180	177366	295610
173068457	118091567	0	5497689	123589256	49479201	54976891
247104725	216887907	0	12086727	228974634	18130091	11157221
301965	241210		6076	247286	54679	60755
3011724	1966587		418055	2384642	627082	223616
4111782	1974304	307	213471	2187775	1924007	1792476
450216	415886		3433	419319	30896	34329
1147384	2133838	1016393	-1004417	1129421	17963	35640
4339348268	3171993332	100151715	82077879	3254071213	1085277056	1113716484
4285709814	3044510647	54551113	127482684	3171993332	1113716482	1229052952
1051641071	0	0	0	0	1051641071	637542529
5390989339	3171993332	100151715	82077879	3254071213	2136918127	1751259011

Sd/-  
Financial Adviser

Sd/-  
Director



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM**

<b>SCHEDULE 9 - INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS</b>		<b>2021-2022</b>	<b>2020-2021</b>
	1. In Government Securities	47081032	47081032
	2. Other approved Securities	5685391	5685391
	3. Shares	0	0
	4. Debentures and Bonds	0	0
	5. Subsidiaries and Joint Ventures	0	0
	6. Others (to be specified)	0	0
	Pension & staff funds	159720544	146898446
	Project funds	269829648	440843343
	<b>TOTAL</b>	<b>482316615</b>	<b>640508212</b>
<b>SCHEDULE 10-INVESTMENTS-OTHERS</b>		<b>2021-2022</b>	<b>2020-2021</b>
	1. In Government Securities	--	--
	2. Other approved Securities	--	--
	3. Shares	--	--
	4. Debentures and Bonds	--	--
	5. Subsidiaries and Joint Ventures	--	--
	6. Others (to be specified) Sinking Fund Investments	150000000	150000000
	Technology Fund	102139924	94829294
	<b>6. Others (to be specified)</b>	--	--
	<b>TOTAL</b>	<b>252139924</b>	<b>244829294</b>
<b>SCHEDULE 11-CURRENT ASSETS, LOANS, ADVANCES ETC</b>		<b>2021-2022</b>	<b>2020-2021</b>
	<b>A. CURRENT ASSETS</b>		
	1. Inventories:		
	a) Stores and Spares	0	0
	b) Instruments & Loose Tools	0	0
	c) Stock-in trade		
	Store items	122651633	157635940
	Stamps	0	0
	Medicine	5519	18258
	Medicine	15714258	16026116
	2. Sundry Debtors:	0	0
	a) Debts Outstanding for a period exceeding six months	30262021	30262021
	b) Others	254242084	296194991
	2.1 Income tax deducted at source	3634222	13995361



3. Cash balances in hand(including cheques/ drafts and imprest)	3002296	1738986
4. Bank Balances:	0	0
a) With Scheduled Banks:	0	0
-On Current Account	2227630	2228279
-On Deposit Accounts(L.C. margin & Commitment deposit)	3236795718	1060257459
-On Savings Accounts	422041427	1276174791
b) With non-Scheduled Banks:	0	0
-On Current Account	0	0
-On Deposit Accounts	0	0
-On Savings Accounts	0	0
<b>5. Post-Office-Savings Accounts</b>	0	0
<b>TOTAL(A)</b>	<b>4090576808</b>	<b>2854532202</b>
<b>B.LOANS, ADVANCES AND OTHER ASSETS</b>		
1. Loans:		
a) Staff	14256281	13104498
b) Other Entities engaged in activities/ objectives similar to that of the Entity	0	0
c) Other(specify)	0	0
2. Advances and other amounts recoverable in cash or in kind or for value to be received:	0	0
a) On Capital Account	348682198	746694076
b) Prepayments	0	0
c) Others	12785128	13965374
3. Income Accrued:	0	0
a) On Investments from Earmarked/ endowment Funds	15429623	16029103
b) On Investments-Others	0	0
c) On Loans and Advances	0	0
d) Others (Royalty)	1614087	539639
(includes income due unrealised)	0	0
4. Claims Receivable	0	0
From Govt of India on Grant in aid (7th CPC arrears)	204714247	204714247
<b>TOTAL(B)</b>	<b>597481564</b>	<b>995046937</b>
<b>TOTAL(A+B)</b>	<b>4688058372</b>	<b>3849579139</b>
Savings bank account includes Rs.15/- (GL code No.2410-Synd Bank vikas certificate)		



SCHEDULE 12- INCOME FROM SALES/SERVICES		2021-2022	2020-2021
1. Income from Sales			
a) Sale of Finished Goods		0	0
b) Sale of Raw Material		0	0
c) Sale of Scraps		0	0
2. Income from Services			
a) Labour and processing charges		0	0
b) Professional/Consultancy Services		0	0
c) Agency Commission and Brokerage		0	0
d) Maintenance Services		0	0
e) Others (Specify)		0	0
From Hospital Services-Gross Income		992774803	748070638
		0	0
From Projects		3959513	2114081
Testing & Facility charges received		3620948	4731325
<b>TOTAL</b>		<b>1000355264</b>	<b>754916044</b>
SCHEDULE 13- GRANTS/SUBSIDIES		2021-2022	2020-2021
(Irrevocable Grants & Subsidies Received)			
1. Central Government (Salary & General)		3100100000	2650000000
2. State Government(s)		0	0
3. Government Agencies		0	0
4. Institution/Welfare Bodies		0	0
5. International Organisations		0	0
6. Others(Specify)		0	0
<b>TOTAL</b>		<b>3100100000</b>	<b>2650000000</b>
SCHEDULE 14-FEES/SUBSCRIPTIONS		2021-2022	2020-2021
1. Entrance Fees		1005560	2366480
2. Annual Fees/ Subscriptions		12423119	12235384
3. Seminar/Program Fees		0	0
4. Consultancy Fees		0	0
5. Examination Fees and others		2295810	1884637
<b>TOTAL</b>		<b>15724489</b>	<b>16486501</b>
SCHEDULE 15- INCOME FROM INVESTMENTS		2021-2022	2020-2021
(Income on Invest.from Earmarked/Endowment Funds transferred to Funds)			
1) Interest			
a) On Govt. Securities		0	0



	b) Other Bonds/Debentures	0	0
	2) Dividends:		
	a) On Shares	0	0
	b) On Mutual Fund Securities	0	0
	3) Rents	0	0
	4) Others(Special Reserve Funds)1. Interest on Sinking Fund	14350069	17718455
	2. Withdrawal from Sinking Fund	0	0
	3. Interest on Technology Fund	236869	892622
	<b>TOTAL</b>	<b>14586937</b>	<b>18611077</b>
<b>SCHEDULE 16- INCOME FROM ROYALTY,PUBLICATION ETC</b>		<b>2021-2022</b>	<b>2020-2021</b>
	1) Income from Royalty	4981543	7261992
	2) Income from Publications	0	0
	3)Others(Specify)	0	0
	<b>TOTAL</b>	<b>4981543</b>	<b>7261992</b>
<b>SCHEDULE 17- INTEREST EARNED</b>		<b>2021-2022</b>	<b>2020-2021</b>
	1) On Term Deposit		
	a) With Scheduled Banks	20651939	23961199
	b) With non-scheduled banks	0	0
	c) With Institutions	0	0
	d) Others	0	0
	2) On Savings Account	0	0
	a) With Scheduled Banks	10054301	10562890
	b) With non-scheduled banks	0	0
	c) Post Office Savings Account	0	0
	d) Others(accrued)	0	0
	3) On Loans	0	0
	a) Employees/Staff	505179	1019284
	b) Others	0	0
	4) Interest on Debtors and other Receivables	0	0
	<b>TOTAL</b>	<b>31211419</b>	<b>35543373</b>
<b>SCHEDULE 18- OTHER INCOME</b>		<b>2021-2022</b>	<b>2020-2021</b>
	1. Profit on Sale/disposal of Assets:		
	a) Owned assets	0	0
	b) Assets acquired out of grants, or received free of cost	0	0



	c) WIP written back from Repairs and Maintenance	0	0
	2. Rent	2198135	2075578
	3. Fees for Miscellaneous Services	0	0
	4. Miscellaneous Income Rent	328281	10000
	grant CPC	Other Income (including receivable from DST for 7th	19056315
			13717762
	Prior period income	7689847	0
	<b>TOTAL</b>	<b>29272578</b>	<b>15803341</b>
<b>SCHEDULE 20-ESTABLISHMENT EXPENSES</b>		<b>2021-2022</b>	<b>2020-2021</b>
	a) Salaries and Wages	1359170744	1343690940
	b) Allowances and Bonus	19974402	16190251
	c) Contribution to Provident Fund	0	0
	d) Contribution to other fund(specify)	0	0
	e) Staff Welfare Expenses	14243025	31708736
	f) Expenses on Employee's Retirement and Terminal Benefits	525694728	502272517
	g) Others(Specify) PG Training & Accademic payments	187217456	254684395
	<b>TOTAL</b>	<b>2106300355</b>	<b>2148546839</b>
<b>SCHEDULES 21- ADMINISTRATIVE EXPENSES</b>		<b>2021-2022</b>	<b>2020-2021</b>
	a) Purchases	744098540	545354083
	b) Concession to Poor patients/Labour and processing expenses	79945413	49163155
	c) Cartage and Carriage Inwards	358601	238682
	d) Electricity and power	56932664	55607991
	e) Water charges	6039172	4619677
	f) Insurance	5031522	2781590
	g) Repairs and maintenance	30450588	50699507
	h) Excise duty	0	0
	i) Rent ,Rates and Taxes	0	208032
	j) Vehicles Running and Maintenance	643296	711260
	k) Postage, Telephone and Communication Charges	4789743	3918309
	l) Printing and Stationary	20453	44526
	m) Travelling and Conveyence Expenses	642829	451050
	n) Expenses on Seminar/Workshop	183673	240807
	o) Subscription Expenses	0	0
	p) Expenses on Fees	0	0
	q) Auditors Renumeration	784069	931715
	r) Hospitality Expenses	0	0
	s) Professional Charges	0	0
	t) Provision for Bad and Doubtful Debts/Advances	0	0



	u) Irrecoverable Balances Written-off	0	0
	v) Packing Charges	0	0
	w) Freight and Forwarding Expenses	0	0
	x) Prior period expenses	46761773	22692477
	y) Distribution Expenses	0	0
	z) Advertisement and Publicity	2969159	1036277
	z1) Others(specify)	36832847	33966519
	<b>TOTAL</b>	<b>1016484341</b>	<b>772665657</b>
<b>SCHEDULE 23-INTEREST</b>		<b>2021-2022</b>	<b>2020-2021</b>
	a) On Fixed Loans		
	b) Bank Charges)	1915089	84447
	c) Others(specify)	0	0
	<b>TOTAL</b>	<b>1915089</b>	<b>84447</b>

Sd/-  
Chief Financial Adviser

Sd/-  
Director



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM  
SCHEDULES FORMING PART OF ACCOUNTS AS AT 31-03-2022**

**SCHEDULE 24- SIGNIFICANT ACCOUNTING POLICIES**

**1. ACCOUNTING CONVENTION**

Financial Statements are prepared on the basis of historical cost convention and on accrual method of accounting except in the accounts not directly connected with the functioning of the Institute including Staff Benevolent Fund, Pension, etc.

**2. INVENTORY VALUATION**

Stores and spares including machinery spares are valued at cost.

**3. INVESTMENTS**

Investments including long term investments are carried at cost.

**4. FIXED ASSETS**

Fixed assets are stated at cost of acquisition inclusive of inward freight, duties and taxes incidental and direct expenses related to acquisition. Non monetary assets acquired free of cost are recorded at a nominal value ie. Re.1 (Rupee One).

**5. DEPRECIATION**

Depreciation is provided on reducing balance method at the rates specified by the Income Tax Act 1961. In respect of additions to fixed assets during the year depreciation is provided for full year. In case of condemnation of an asset, depreciation for the current year has not been provided and the accumulated depreciation for the previous years has been duly adjusted from the depreciation of the current year.

**6. GOVERNMENT GRANTS/SUBSIDIES**

Government Grant from Plan fund-Capital is treated as additions to Capital fund of Institute. Grants in respect of specific fixed assets acquired are shown as deduction from the cost of the related asset. Government Grants/subsidies are accounted on Grant release order basis, except grant in aid receivable for meeting arrears on account of 7th CPC.

**7. FOREIGN CURRENCY TRANSACTIONS**

Transactions denominated in foreign currency are accounted at exchange rate prevailing at the date of transactions.

**8. RETIREMENT BENEFITS**

Gratuity: From the year 2006, (with the implementation 6th Pay Commission report), the gratuity payments are treated as Institute expenses and accounted on actual payment basis.

Leave Salary: Leave encashment eligible at the time of retirement/reliving is treated as Institute expenses and accounted on actual payment basis.

Pension: From the year 2006, (with the implementation 6th Pay Commission report) 12% of the salary is transferred to the Pension Fund.

New Pension Scheme: In the case of employees who joined on or after 01.01.2004, 10% of the salary is deducted as employees subscription and equal contribution is being made by the Institute. The funds are remitted to NPS Trust Account maintained by GOI and subscription details forwarded to NSDL/CRA every month.

**9. PROVIDENT FUND**

Assets and Liabilities of General Provident Fund account were separated from Balance sheet of Institute and shown as separate statement. Interest is provided on the accumulations as per the rates prescribed by Central Government from time to time.

**10. EMERGENCY RESERVE FUND**

An amount equal to 7.50 percent of receipts from patient is to be transferred to a Fund for meeting unexpected requirements for Fixed assets subject to a maximum of Rs.50 Crore. It was decided to reduce the limit of ERF to Rs.15 crore and to utilize the remaining funds and the guideline of recouping these funds do not apply till further decision.

**11. TECHNOLOGY DEVELOPMENT FUND**

Receipts against technology developed by the Institute are transferred to the above fund and interest earned is utilized for meeting additional expenses on Improvement of technologies already developed.

Sd/-  
Financial Adviser

Sd/-  
Director



# SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

## SCHEDULE 25-CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS

### 1. CONTINGENT LIABILITIES

	Rs. In lakhs	
	2021-22	2020-21
Claims against the Institute not acknowledged as debts	NIL	NIL
Bank Guarantee given by Institute	45.96	45.96
Letters of credit opened on behalf of Institute	19.81	503.99
In respect of claims from parties for non- execution of orders	NIL	NIL

#### Service Tax :

“ The office of the Commissioner of Central Excise and Customs vide order no: C.No.IV/16/152/2014 ST ADJ. Dated 08.06.2015 confirm demand of Service tax Rs.4.72 Lakhs under section 73(2) of the Finance Act 1994, being service tax short paid under the category “Technical Inspection and certification service” during the period 1.4.2009-31.03.2012 . Further impose a penalty of Rs 2.36 lakhs towards penalty under section 78 and Rs.0.05 lakhs for contravention of section 70 of the Act. In order to file appeal against the order, the institute paid Rs.0.35 lakhs towards deposit (i e 7.5% of demand confirmed).” During the year 2018-19, Institute received Order-In-Appeal dated 19.09.2018 issued by Commissioner (Appeals) rejecting the appeal filed by the Institute. Institute filed appeal before CESTAT, Bangalore against the above and remitted Rs.0.44 lakh as deposit under section 35F of CE Act.

Name of the Statute	Nature of Dues	Amount in Rs. in lakhs	Period to which the amount relates	Forum where dispute is pending.
Service Tax	Service tax and penalty	4.72	01/04/2009 to 31/03/2012	CESTAT, Bangalore.

### 2. UNEXPIRED CAPITAL COMMITMENTS

Rs. in lakh

	2021-22	2020-21
Estimated value of orders remaining to be executed on Capital Account	8006.11	6641.46
Construction of New Hospital block (NHB)& Hospital Equipments & Facilities for NHB	6309.85	3175.15
Completion of Combination Devices Block	2291.18	7539.87

*Ministry of Health and Family Welfare approved the construction of a new Hospital Block in the Institute at a cost of Rs.230 crore. The project is funded Jointly by Ministry of Health and Family Welfare - MoHFW (Rs.120crore) and Department of Science & Technology - DST (Rs.110 crore). Institute received Rs.110 crore from DST; out of which Rs. 70 crore was paid as advance to CPWD. CPWD received another Rs.31 crore directly from MoHFW.*

*Administrative approval and expenditure sanction was accorded for the completion of Combinational Devices Block (Originally called as Biology Block) at BMT wing vide BMT letter dated 21.05.2018. The work is being executed through CPWD.*

Lease obligation for rentals for Plant & Machinery	NIL	NIL
--	-----	-----

### 3. CURRENT ASSETS, LOANS & ADVANCES

The aggregate amount shown in the Balance sheet for the Current assets, Loans and Advances, have the value, which is realisable in the ordinary course of business.

### 4. PROVISIONS

Provision for Income tax not made since there is no taxable income for Institute under Income tax Act 1961, during the year.

### 5. FOREIGN CURRENCY TRANSACTIONS:

Rs. in lakh



	2021-22	2020-21
5.1 Value of Imports Capital Goods (284.55+99.88) Stores Spare & Consumables (4.84+ 22.35)	368.51	683.46
5.2 Expenditure in foreign currency Travel Expenses	NIL	NIL
5.3 Earnings: Value of Exports	NIL	NIL

6. Current year Income, net of expenditure, under Institute Ethics Committee has been treated as income of the Institute amounting to Rs.24.47 lakh (previous year Rs.5.16 lakh).
7. Claim for Audit fees by C&AG amounting to Rs.NIL has been paid during the year. Provision for Audit fees has been made for current year amounting to Rs.0.83 lakh.
8. Accrued Interest on Investment amounting Rs.154.30 lakh (previous year Rs. 160.29 lakh) has been provided in the current year accounts.
9. As pointed out by C&AG, unutilized portion of Grant in Aid(ST General) is shown as current liability.
10. In order to release the pension dues as per the CCS pension rules, an additional amount of Rs.3120.25 lakh has been expended over and above the sanctioned 12% Institute contribution (amounting to Rs.319.75 lakh) to the Pension Fund.
11. Institute has done the actuarial valuation to ascertain the liability on account of Gratuity, Pension and Leave Encashment in respect of serving employees through an Actuary. As per their valuation report the liability is as follows :

Present value of the past service gratuity (CCS)	Rs. 2004.06 lakh
Present value of the past service gratuity (NPS)	Rs. 2539.59 lakh
Present value of the pensionary liability for serving employees	Rs. 19250.00 lakh
Present value of the pensionary liability for Existing pensioners	Rs. 40000.00 lakh

Sd/-  
Financial Adviser

Present value of the past service leave encashment	Rs. 4056.60 lakh
--	------------------

12. (a) Value of assets acquired from externally funded projects during the last three years has been identified as detailed below:-

FY 2019-20	Rs. 1165.23 lakh
FY 2020-21	Rs. 518.19 lakh
FY 2021-22	Rs. 1043.04 lakh

Since the cost of acquisition of these assets is nil, no depreciation has been charged on these assets.

(b) Value of non monetary assets acquired by the Institute is shown at nominal value of Re.1.

### 13. Technology Development Fund

An amount of Rs.73.10 lakh (previous year Rs. 23.02 lakh) was transferred to Technology Development Fund. During the year Rs.42.38 lakh has been spent from Technology Development Fund.(Previous year Rs.43.19 lakh)

### 14. Funding of In house Projects to set off negative balance.

Administrative expenses include an amount of Rs.14.90 lakh (Previous year Rs.2.73 lakh) transferred to nullify the negative balances in the In house projects accounts.

15. Grant received during the last quarter of the financial year for creation of capital assets amounting to Rs. 25 crore, remained unutilized was refunded to DST as directed. An amount of Rs.15.75 lakh was also repaid as interest on the unutilized grant.

16. Corresponding figures for previous years have been regrouped, wherever necessary.

Schedules 1 to 25 annexed, form an integral part of the Balance Sheet as at 31-03-2022, and Income & Expenditure Account for the year ended on that date.

Sd/-  
Director



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM**

**SCHEDULE TO RECEIPTS & PAYMENTS ACCOUNTS FOR THE PERIOD FROM 01.04.2021 to 31.03.2022**

RECEIPTS		2021-22	2020-21	Payments		2021-2022	2020-2021
		Rs.	Rs.			Rs.	Rs.
I	Opening Balances			I	Expenses		
a)	Cash In Hand	1738986	776457				
b)	Bank Balances			a)	Establishment expenses	2660647855	2428086547
	i) In Current Account	1	1	b)	Administrative Expenses		
	ii) In deposit Account				For Purchases	14797955	14122975
	iii) Savings Account *	1276174806	114275271		Other expenses	75096108	78384926
				II	Payments made against funds for various		
II	Grant Received				Projects		
	From Government of India				As Per schedule	178217550	150676284
	Under Object head - Creation of Capital assets	250000000	450000000				
	Under Object Head - Salary/General scheme	3100100000	2650000000	III	Investments & Deposits made		
					a) Out of Earmarked funds		
					b) Out of own funds		
III	Receipts against Earmarked Funds					115047883	141412711
				IV	Expenditure on Fixed Assets & Capital work		



	a) Earmarked funds	297949560	379812120		-in- progress		
	b)Own funds						
					a) Purchase of Fixed Assets	21705406	30466712
IV	Interest Received				b) Capital work-in progress		
	a) On Bank deposits	31729132	29015906	V	Refund of Loans		
	b) Loans Advances etc	16180	496104				
	c) On NCMMR funds	0	0				
V	Receipts from services			VI	Finance Charges(Bank charges)	967608	84364
	Receipts from Patient services	941240897	843413318				
	Other receipts including Royalty	35421942	39272619	VII	Other Payments		
					To Funds/Deposit-refunds	3245751432	1297787987
VI	Other receipts			VIII	Closing Balance		
	Grant received for Projects	192592225	89784909		a) Cash in hand	3002296	1738986
	Refund of Deposits(LC Margin)				b) Bank Balances		
	Other receipts	612539435	822089594		l) In current Account	1	1
					iii) Savings Account *	424269070	1276174806
	Total	6739503165	5418936300		Total	6739503164	5418936300

Sd/-  
Financial Adviser

Sd/-  
Director



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM  
Provident Fund Account For The Year Ended 31-03-2022**

Particulars	2021-22 [Rupees]	2020-21 [Rupees]
<b>LIABILITIES</b>		
MEMBERS BALANCE	75921148	125801425
MEMBERS CREDITS [ for march]	3359183	3643773
BALANCE DUE TO MEMBERS NOT IN SERVICE		
Under EPF scheme	7696198	7696198
„GPF,,	532055	532055
PENSION FUND DUES	0	0
RESERVES&SURPLUS-INTEREST	250783722	232099697
<b>TOTAL</b>	<b>338292306</b>	<b>369773148</b>
<b>ASSETS</b>		
INVESTMENT AT COST	321105898	350253428
DUES TO PF ACCOUNT		
FROM INSTITUTE	3359183	3643773
FROM PF COMMISSIONER	0	0
INTEREST ACCRUED NOT DUE	6830344	5088040
BALANCE WITH BANKS		
SBT -GPF A/C	6996882	10787907
<b>TOTAL</b>	<b>338292306</b>	<b>369773148</b>

Sd/-  
Financial Adviser

Sd/-  
Director



## Seperate Audit Report of the Controller & Auditor General of India on the Accounts of Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram for the year ended 31 March 2022.

1. We have audited the Balance Sheet of Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram AS AT 31 March 2022, the Income Expenditure Account and the Receipts & Payment Account for the year ended on that date under Section 19 (2) of the Controller & Auditor General's (Duties, Power & Conditions of Service) Act, 1971 read with section 18 (2) of the SCTIMST Act, 1980. These financial statements include the accounts of Bio-Medical Technology (BMT) wing of the SCTIMST. These financial statements are the responsibility of the SCTIMST's management. Our responsibility is to express an opinion on these financial statements based on our audit.
2. This Draft Seperate Audit Report contains the comments of this office on the accounting treatment only with regard to classification, conformity with the best accounting practices, accounting standards and disclosure norms etc. Audit observations on financial transactions with regard to compliance with the Law, Rules & Regulations (Propriety and Regularity) and efficiency-cum-performance aspects etc., if any, are reported through Inspection Reports/CAG's audit reports seperately.
3. We have conducted our audit in accordance with auditing standards generally accepted in India. These standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatements. An audit includes examining, on a test basis, evidences supporting the amounts and disclosure in the financial statements. An audit also includes assessing the accounting principle used and significant estimate made by management, as well as evaluating the overall presentation of financial statement. We believe that our audit provides a reasonable basis for our opinion.
4. Based on our audit, we report that:
  - i. We have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our audit.
  - ii. The Balance Sheet, Income & Expenditure Account and Receipt & Payment Account dealt with by this report have been drawn up in the format approved by the Government of India, Ministry of finance.
  - iii. In our opinion, proper books of accounts and other relevant records have been maintained by the SCTIMST as required under Section 18 (1) of SCTIMST Act, 1980 in so far as it appears from our examination of such books subject to observations made hereunder.
  - iv. Based on our audit, we further report that:
    - (A) **Balance Sheet**
      - A1. **Understatement of current liabilities and provisions (schedule-7) of ₹74.25 crore (Checklist item)**

As per Peragraph 8 of schedule-24 Significant Accounting Policies of the Annual Accounts for the year 2021-22, the retirement benefits are being accounted for on actual payment basis by SCTIMST. However, the institute has done the actuarial valuation for the year 2021-22 and the liability towards gratuity, pension and accumulated leave encashment were ₹45.44 crore, ₹592.50 crore, ₹40.57 crore respectively.



Against the liability of ₹678.51 crore as on 31 March 2022, SCTIMST has created Pension Fund amounting to ₹34 crore only. This has resulted in understatement of Schedule-7: Current Liabilities and Provisions by ₹644.51 crore and understatement of establishment expenses.

#### **A2. Understatement of Current liabilities and provisions (Schedule-7) of ₹74.25 crore (Checklist item)**

As per Rule 230 (7) of GFR, 2017 when recurring Grants-in-aid are sanctioned to the same Institution or Organisation, the unspent balance of the previous Grant should be taken into account in sanctioning the subsequent Grants/releases. To assist the grant sanctioning authority, the un-spent portion of money received from Ministry/Departments of the Government of India is required to be shown under 'Schedule 7- Current Liabilities and Provisions' so that the un-spent grant is either refunded in full at its request or adjusted against the subsequent releases. the un-spent grant includes advances on capital accounts.

- (i) audit scrutiny of the grant release orders and fund utilisation certificate of SCTIMST revealed that under 'Grants for creation of Capital Assets' the unspent balance at the end of the year (March 2022) was ₹73.64 crore. Out of this, an amount of ₹25 crore was shown under 'Schedule 7-Current Liabilities and provisions' balance un-spent grant of ₹48.64 crore was not shown under the head instead was shown under 'Schedule-1: Capital Fund'. thus, current liability of the Institute was understand and Capital Fund overstated by ₹48.64 crore.
- (ii) The advances on capital accounts for the year ending March 2022 is ₹34.87 crore. The amount was included under 'Schedule-1: Capital Fund' instead of 'schedule-7 current Liabilities and Provisions'. thus, Current liability of the institute was understated, and capital Fund overstated by ₹34.87 crore.

As per Unifrom format of Accounts prescribed for Central Autonomous Bodies, material amounts included under the Sub Heads 'Other Liabilities' should be seperately shown indicating the nature of transaction. the unspent capital is a material transaction hence may be shoed as a distinct sub-Head under 'Current Liabilities and Provisions'.

#### **A3. Current Assets (Schedule-11) ₹468.81 crore**

- (i) As per the Uniform Format of Accounts prescribed for Central Autonomous Bodies, the investments from earmarked funds in Government Securities, Shares, Debentures, Bonds etc. are to be accounted under 'Schedule-9- Investments from Earmarked Funds'. The fixed/term deposits in Scheduled/ Non-Scheduled banks are to be accounted under 'Schedule-11-Currents Assets'. Audit scrutiny, however, revealed that the institute accounted ₹42.95 crore deposited in bank account under 'Schedule-9- Investments from Earmarked funds' instead of 'Schedule-11 - Current Assets'. Thus, current Assets account is understated and investment account is overstated by ₹42.95 crore.
- (ii) Similarly, as per the Uniform Format of Accounts prescribed for Central Autonomous Bodies, the investments other than from earmarked funds in Government Securities, Shares, Debentures, Bonds etc. are to be accounted under 'Schedule-10- Investments-Others'. The fixed/ term deposits in Scheduled/Non-Scheduled banks are to be accounted under 'Schedule-11-Current Assets'. Audit scrutiny, however, revealed that SCTIMST accounted ₹25.21 crore deposited in bank account under 'Schedule-10 - Investments- Others' Instead of 'Schedule-11- Current Assets'. Thus, Current Assets accounts is understated and 'Investment-others account is overstatedby ₹25.21 crore.



## **(B) Income and Expenditure Account**

### **B1. Understatement of Depreciation account of ₹8.21 crore**

According to Uniform format of Accounts prescribed for Central Autonomous Bodies, the Depreciation Block of Schedule 8 has; Opening Balance at the Beginning of the year plus Additions during the year Minus deductions during the year to arrive at the total depreciation up to the year end.

Audit scrutiny of the Schedule 8 of the annual account for the year 2021-22 however revealed that under Depreciation Block the additions during the year 2021-22 was reported as ₹8.21crore (after making adjustment on account of depreciation on deductions/write off during the year 2021-22) instead of ₹18.22 crore. The depreciatiojn on account of deductions/write off during the year of ₹10.01 crore is to be shown as addition under Schedule-1 Capital Fund.

Thus, the Depreciation Account of Income and Expenditure Account is understated by ₹10.01 crore (₹18.22 crore minus ₹8.21 crore) and capital Fund account of Schedule-1 overstated by the same amount.

### **B2 Understatement of ‘Repairs and Maintenance (GL Code 3605 of Schedule 21 Administrative Expenses of ₹3.04 crore’**

According to Uniform format of accounts prescribed for the Central Autonomous Bodies, the CABs shall maintain their Accounts in Accrual Basis. The repairs and Maintenance Charges for the year shall be worked out on Accrual Basis and charged to Expenses Account Audit scrutiny of the vouchers revealed that in Voucher Nos. 8963 and 8964 dated 28 March 2022 the annual repairs and maintenance charges of the equipment amounting<sup>1</sup> to ₹32.12

lakh (₹20.07 lakh and ₹12.05 lakh) were booked under the Head ‘Other Liabilities (Gl code 2317)’ against previous year instead of ‘Repairs and Maintenance Account (GL Code 3605)’ for the Current year 2021-22.

Thus, the Repairs and Maintenance Account is overstatement of current Liabilities Account understated by ₹32.12 lakh.

## **(C) General**

### **C1 Grant-in-aid**

The grant release orders and fund utilisation certificate of SCTIMST revealed that the institute received an amount of ₹335.01 crore from DST during the financial year 2021-22. Out of which grants-in-aid towards Salary received from DST was ₹170 crore and Grant-in-aid towards General purpose received was ₹140.01 crore and the entire amount was spent. grant-in-aid for ‘Creation of Capital Assets’ was with an opening balance of ₹74.60 crore and an amount of ₹25 crore grants was received during the financial year 2021-22, an amount of ₹25.96 crore was spent during the financial year and un-spent balance at the end of the year was ₹73.64 crore.

### **C2 Assets procured out of sponsored agencies not reported in Accounts**

As per rule 233(ii) of GFR 2017, on completion of the projects or schemes, if the assets are allowed to be retained by the sponsoring institute/organization, the implementing agency should include the assets at book value in their own accounts.

As per Paragraph 12 of Schedule-25 Contingent Liabilities and Notes on accounts for the year ended March 2022, the value of assets acquired from on-going external projects for the last three years were reported. the value of Assets from<sup>2</sup> April 2014 to March 2022 was ₹53.68 crore. However, the value of assets procured towards



the completed projects was not worked out and the consent of the sponsoring agencies not obtained to include the value of these assets in the institute accounts. Similar observations were made in the SAR of the previous year however SCTIMST did not include the assets in its accounts after obtaining the consent of the sponsoring agencies.

- 1 ₹1205000 (₹2401000 X 6 Months/12 Months) vide voucher No. 8964 dated 28/3/22 ₹200692 (₹4100000 X ₹8.32 Months/12 Months) vide voucher No. 8963 dated 28/3/22
- 2 Year 2014-16 ₹132.07 lakh, Year 2016-17 ₹718.52 lakh, Year 2017-18 ₹850.68 lakh, Year 2018-19 ₹940.31 lakh, Year 2019-20 ₹1165.23 lakh, Year 2020-21 ₹518.19 lakh, Year 2021-22 ₹1043.04 lakh.

#### (D) Management Letter

Deficiencies which have not been included in the Draft Separate Audit Report have been brought to the notice of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram through a Draft letter

Date: 27-09-2022  
Place: New Delhi

issued separately for remedial/corrective action.

- i) Subject to our observations in the preceding paragraphs, we report that the Balance Sheet, Income & Expenditure account and Receipts & Payment Account dealt with by this report are in agreement with the books of accounts.
- ii) In our opinion and to the best of our information and according to the explanations given to us, the said financial statements read together with the Accounting Policies and Notes on Accounts, subject to the significant matters stated above and other matters mentioned in **Annexure** to this Audit Report give a true and fair view in conformity with accounting principles generally accepted in India.
  - a. In so far as it relates to the Balance Sheet of the state of affairs of the Sree Chithra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram as at 31 march 2022; and
  - b. In so far as it relates to Income & Expenditure Account for the year ended on that date.

For and on behalf of C&AG of India

Director General of Audit  
Environment and Scientific Departments



**Reply to Separate Audit Report of the Comptroller & Auditor General of India on the Accounts of Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram for the year ended 31 March 2022.**

Audit Para Number	Observation	Reply of the Institute
<p>A Balance Sheet A1. Understatement of Current liabilities and provisions (Schedule-7) of ₹74.25 crores (Checklist item)</p>	<p>As per Paragraph 8 of Schedule-24 Significant Accounting Policies of the Annual Accounts for the year 2021-22, the retirement benefits are being accounted for on an actual payment basis by SCTIMST. However, the institute has done the actuarial valuation for the year 2021-22 and the liability towards gratuity, pension and accumulated leave encashment were ₹45.44 crore, ₹592.50 crore and ₹40.57 crore respectively. Against the liability of ₹678.51 crore as on 31 March 2022 SCTIMST has created Pension Fund amounting to ₹34 crore only. This has resulted in understatement of Schedule-7: Current Liabilities and Provisions by ₹644.51 crore and understatement of establishment expenses.</p>	<p>The liability in respect of Gratuity, Pension and Leave Encashment is disclosed in para 11 of Schedule No. 25 under notes on accounts. Detailed fund requirement for the proposal based on the actuarial valuation and report submitted by the LIC of India for the creation of Pension fund has been forwarded to DST. It is understood that DST has taken up the matter with DoE for approval &amp; budget allocation. In the recently convened Finance Committee held on 17/6/2022, DST representatives mentioned that the proposal is under the consideration of the DoE, and MoF. Based on the decision of GB held on 22/6/2022, a follow-up letter in this regard has also been forwarded to the DST.</p>
<p>A2. Understatement of Current liabilities and provisions (Schedule-7) of ₹74.25 crore (Checklist item)</p>	<p>As per Rule 230 (7) of GFR, 2017 when recurring Grants-in-aid are sanctioned to the same Institution or Organisation, the unspent balance of the previous Grant should be taken into account in sanctioning the subsequent Grants/ releases. To assist the grant sanctioning authority, the un-spent portion of money received from Ministry/ Departments of the Government of India is required to be shown under 'Schedule 7-Current Liabilities and Provisions' so that the un-spent grant is either refunded in full at its request or adjusted against the subsequent releases. The unspent grant includes advances on capital accounts.</p>	<p>(i) Audit may kindly note as per GFR 230(7) of GFR 2017, the recurring Grants-in-aid received during the year 2021-22 were fully utilized and the non-recurring Grants-in Aid which remained unutilized during the year was duly disclosed (₹25 crore) under 'Schedule 7 - Current Liabilities and Provisions' as payable to Govt. of India and also mentioned the fact in detail under 'Schedule 25-Notes forming part of Accounts. Hence there is no understatement of Current Liability during the year.</p>



	<p>(i) Audit scrutiny of the grant release orders and fund utilisation certificate of SCTIMST revealed that under 'Grants for creation of Capital Assets' the unspent balance at the end of the year (March 2022) was ₹73.64 crore. Out of this, an amount of ₹25 crore was shown under 'Schedule 7-Current Liabilities and Provisions' balance un-spent grant of ₹48.64 crore was not shown under the head instead was shown under 'Schedule-1: Capital Fund'. Thus, Current liability of the institute was understated, and Capital Fund overstated by ₹48.64 crore.</p> <p>(ii) The advances on capital accounts for the year ending March 2022 is ₹34.87 crore. The amount was included under 'Schedule-1: Capital Fund' instead of 'Schedule-7 Current Liabilities and Provisions'. Thus, Current liability of the institute was understated, and Capital Fund overstated by ₹34.87 crore.</p> <p>As per Uniform format of Accounts material amounts included under the Sub Heads 'Other Liabilities' should be separately shown indicating the nature of transaction. The unspent capital grant is a material transaction hence may be shown as a distinct sub Head under 'Current Liabilities and Provisions'.</p>	<p>The unutilized amount shown in the Utilization certificate submitted to DST includes the amount received (during 2018-19) for the PMSSY project Construction of New Hospital Building for which advances are released to the executing agency viz. CPWD against the demand raised by them. All relevant records were submitted to audit. It may also be noted that there is no addition to Capital Fund- Schedule 1 during the current year under audit.</p> <p>(ii) Advances on the capital account for the year ending March 2022 amounting to ₹34.87 is correctly disclosed in <i>Schedule 11 - "Current Assets Loans and Advances" B.2.(a) Advances and other amounts recoverable in cash or kind or for value to be received: -On Capital Account'</i>. There is no addition to Schedule 1 during the year towards advances on the capital account. Hence there is neither understatement of current liability nor overstatement of the capital fund. It is expected that the construction will be completed during the last quarter of 2022-23 (March 2023) and the full amount will be utilized upon which this will be capitalised.</p>
<p>A3. Current Asset (Schedule 11) ₹468.81 crore</p>	<p>(i) As per the Uniform Format of Accounts prescribed for central autonomous bodies, the investments from earmarked funds in Government Securities, Shares, Debentures, Bonds etc. are to be accounted under 'Schedule-9 - Investments from Earmarked Funds'. The fixed/ term deposits in Scheduled/ Non-Scheduled banks are to be accounted under 'Schedule-11 - Current Assets'.</p>	<p>(i) It may please be noted that the investment of funds in term deposits which are available for the general use of the Institute at short notice is shown in the Current asset Schedule -11 whereas, the investment of earmarked/ endowment funds (Pension Fund, Project fund etc. ₹42.95 Crore) are shown in Schedule-9 Investment of Earmarked and Endowment funds-under the subhead "Others".</p>



Audit scrutiny, however, revealed that the institute accounted ₹42.95 crore deposited in bank account under 'Schedule-9 - Investments instead of Schedule-11 - Current Assets'. Thus Current Assets account is understated and the Investment account is overstated by ₹42.95 crore.

(ii) Similarly as per the Uniform Format of Accounts prescribed for central autonomous bodies, the investments other than from earmarked funds in Government Securities, Shares, Debentures, Bonds etc. are to be accounted under 'Schedule-10 - Investments- Others'. The fixed/term deposits in Scheduled/Non-Scheduled banks are to be accounted under 'Schedule-11 - Current Assets'. Audit scrutiny, however, revealed that SCTIMST accounted ₹25.21 crore deposited in a bank account under Schedule-10 - Investments-Others instead of Schedule-11 - Current Assets'. Thus Current Assets account is understated and the 'Investment-Others' account is overstated by ₹25.21 crore.

This has been the accounting procedure consistently followed at the Institute over the years. Earmarked/endowment funds cannot form part of the current assets of the Institute as it is not for the general use of the Institute and hence classifying them in Schedule 11 - Current Asset may give a wrong picture of the working capital of the Institute. As such, there is neither an understatement of Current assets nor an overstatement of Investment from Earmarked Funds.

(ii) Investments for the general use at the Institute are shown in the Current asset, Schedule-11 whereas the investment of specific funds such as Emergency Reserve Fund and Technology Development funds are booked under **Schedule-10, Investment Others** (₹25.21 crore). This has been the accounting procedure consistently followed at the Institute over the years. These investments cannot form part of the current asset of the Institute as these are investments of reserve funds. As these investments are not for general use at the Institute and hence classifying them in Schedule-11, Current Asset may give a wrong picture of the working capital of the Institute. Thus, there is neither an understatement of Current assets nor an overstatement of Investment -Others.



<p>B Income and Expenditure Account</p> <p>B1. Understatement of Depreciation account of ₹8.21 crore</p>	<p>According to the Uniform format of Accounts, the Depreciation Block of Schedule 8 has; an Opening Balance at the beginning of the year plus Additions during the year Minus deductions during the year to arrive at the total up to the year-end. Audit scrutiny of Schedule 8 of the Annual Account for the year 2021-22 however revealed that under Depreciation Block the additions during the year 2021-22 was reported as ₹8.21 crore (after making adjustment on account of depreciation on deductions/ write off during the year 2021-22) instead of ₹18.22 core. The depreciation on account of deductions/write-off during the year of ₹10.01 crore is also to be shown as an addition under Schedule -1 Capital Fund. Thus, the Depreciation Account of Income and Expenditure Account is understated by ₹10.01 crore (₹18.22 crore minus ₹8.21 crore) and the Capital Fund Account of Schedule 1 is understated by the same amount.</p>	<p>The audit may kindly note that the depreciation policy followed by the Institute has been clearly disclosed in the Notes forming part of Accounts (Schedule 24). It says: -</p> <p><b>5. DEPRECIATION</b></p> <p>Depreciation is provided on the reducing balance method at the rates specified by the Income Tax Act 1961. In respect of additions to fixed assets during the year, depreciation is provided for the full year. In the case of the condemnation of an asset, depreciation for the current year has not been provided and <b>the accumulated depreciation of the previous years has been duly adjusted from the depreciation of the current year.</b></p> <p>As such, the depreciation for the year is calculated as the net of current year depreciation minus depreciation on condemnation. Hence there is no understatement of depreciation during the year 2021-22.</p>
<p>B2. Understatement of Repairs and Maintenance (GL cod 3605) of Schedule 21 Administrative expenses of ₹3.04 crore</p>	<p>According to the common format of accounts prescribed for the Central Autonomous Bodies, the CABs shall maintain their accounts on Accrual Basis. The Repairs and Maintenance Charges for the year shall be worked out on accrual basis and charged to Expenses Account</p>	<p>The audit may please note that an amount of ₹32.12 lakh booked under the head 'prior period expenses' belongs to the previous year and hence was not charged to the current years 'Repair maintenance'. This was duly mentioned during the last year's audit based on which the observation was dropped (A M No. 16 dt. 9.11.2021).</p>



	<p>Audit scrutiny of the vouchers revealed that in Voucher Nos. 8903 and 8904 dated 28 March 2022 the annual repairs and maintenance charges of the equipment amounting to ₹32.12 lakh were booked under the Head 'Other Liabilities (GL Code 2317)' against the previous year instead of 'Repairs and Maintenance Account (GL Code 3605)' for the Current year 2021-22.</p> <p>Thus, the Repairs and Maintenance Account is understated and the Current Liabilities is understated by ₹32.12 lakh.</p>	
<p>C. GENERAL C1. Grant-in-aid</p>	<p>The grant release orders and fund utilisation certificate of SCTIMST revealed that the institute received an amount of ₹335.01 crore from DST during the financial year 2021-22. Out of which Grants-in-aid towards Salary received from DST was ₹170 crore and Grant-in-aid towards General purpose received was ₹140.01 crore and the entire amount was spent. Grant-in-aid for 'Creation of Capital Assets' was with an opening balance of ₹74.60 crore and an amount of ₹25 crore grants was received during the financial year 2021-22, an amount of ₹25.96 crore was spent during the financial year and un-spent balance at the end of the year was ₹73.64 crore.</p>	<p>Confirmed</p>
<p>C2. Assets procured out of sponsored agencies not reported in Accounts (Checklist item)</p>	<p>As per Rule 233(ii) of GFR 2017, on completion of the projects or schemes, if the assets are allowed to be retained by the sponsoring institute/ organization, the implementing agency should include the assets at book value in their accounts.</p>	<p>Institute disclosed the value of assets acquired out of external projects in the Notes to the Accounts (para 12 (a)). These assets were acquired mainly out of funds received from GoI projects (DBT, DST for the TRC &amp;Meity etc.) and these projects are ongoing.</p>





	<p>As per Paragraph 12 of Schedule-25 for the year ended March 2022, the value of assets acquired from ongoing external projects for the last three years was reported. The value of Assets from April 2014 to March 2022 was ₹53.68 crore. However, the value of assets procured for the completed projects was not worked out and the consent of the sponsoring agencies not was obtained to include the value of these assets in the institute accounts. Similar observations were made in the SAR of the previous year however SCTIMST did not include the assets in its accounts after obtaining the consent of the sponsoring agencies.</p>	<p>Since the projects funded by external agencies are ongoing and the final report is yet to be forwarded to the respective funding agency. The value of these assets will be included in the accounts (Schedule- 8) in the future after the due closure of projects.</p> <p>Based on the audit observation of the previous year, Institute has started the practice of obtaining consent letters from the concerned funding agencies through project investigators as required in Rule 233 of GFR, 2017. But consent is yet to be received. On receiving consent from the funding agencies, assets will be included in the Institute's books of accounts.</p>
D. Management Letter	<p>Deficiencies which have not been included in the Separate Audit Report have been brought to the notice of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram through a Draft management letter issued separately for remedial/corrective action.</p>	<p>The observations mentioned in the Management letter have been noted for future guidance as well as for remedial/corrective action</p>







**SCTIMST**  
[www.sctimst.ac.in](http://www.sctimst.ac.in)