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Sree Chitra Tirunal Institute for  
Medical Sciences & Technology  
Trivandrum-695 011-KERALA



**ANNUAL REPORT**  
1987 - 1988

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# Annual Report

## 1987 - '88

Sree Chitra Tirunal Institute for  
Medical Sciences and Technology, Trivandrum, 695011  
Kerala, India.

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*Cover:* Hydrogel beads laced together  
by cells in culture (SME x 75).

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## OVERVIEW

The Institute witnessed continued development and new directions of growth during 1987-'88.

The claim of the Institute to public affection and esteem had always rested on the ability and readiness of its hospital to serve the weaker sections of society who could ill afford the high cost of specialist care elsewhere. In spite of mounting wage bills and rising prices of goods, the Institute continued to validate the claim and even manage to support a modest increase in patient services during the year.

On the pattern of the previous year's report the breakup of expenditure under total, recurring and hospital wing is shown in Fig. 1 which reflect the concern of the Institute for monitoring the 'teeth to tail' ratio in expenditure as it often tends to become unfavourable for patient services in the public sector. As indicated in the figures, the percentage allocation for patient services was 37 during the year, portents notwithstanding. In the context of ever increasing demand for services from poor patients, liberal service conditions for employees,

DISTRIBUTION OF TOTAL EXPENDITURE

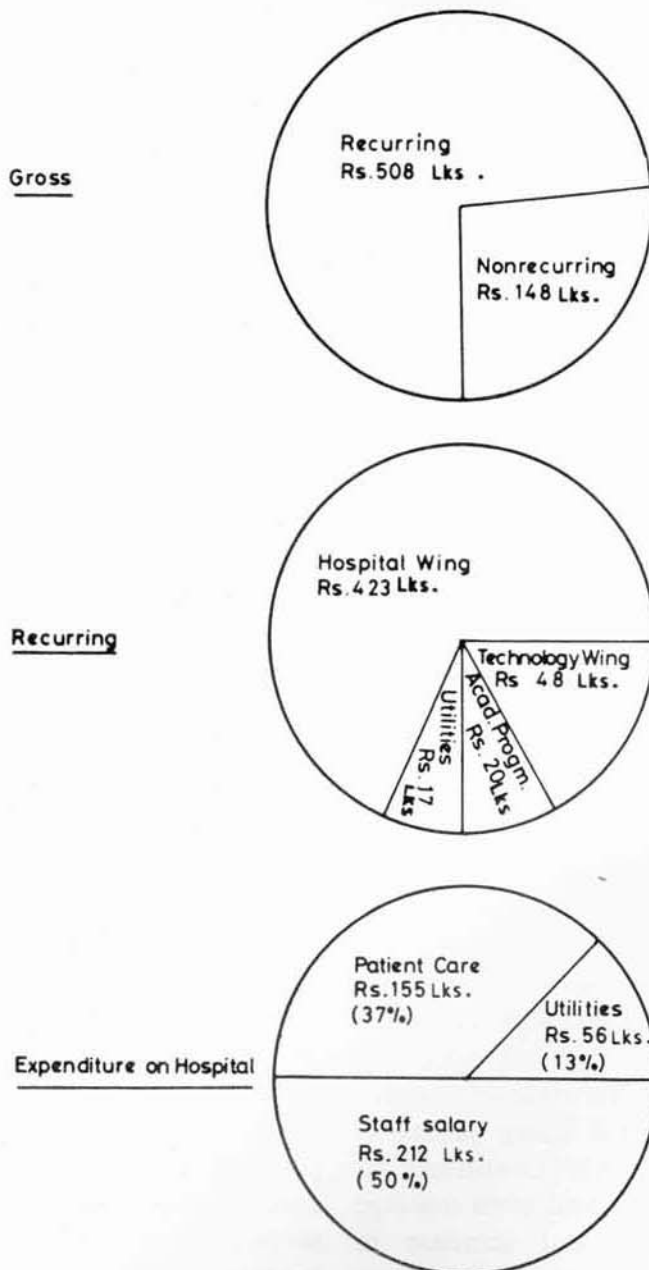


Fig. 1

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rising cost of utilities and relatively fixed annual grants, the demonstration of high standards of patient care as enjoined in the Act is, and will always remain, the foremost challenge of the Institute. Among the medical institutes in the country, Sree Chitra Tirunal Institute has been successful in meeting this challenge, however imperfectly, by allocating a substantial percentage of its recurring expenditure as a matter of deliberate policy for patient care items and avoiding, among other things, the practice of issuing lists of hospital disposables to indigent patients for procurement. Thanks to this policy, continual and selective updating of equipment as well as the introduction of new modalities of treatment ranging from simple urobags to complex embolotherapy could be introduced in the hospital without detriment to the volume and quality of services to poor patients. It would not be wrong to claim that this has been the guiding principle of the Institute in the management and performance audit of its hospital.

The growing emphasis on efficiency in technology transfer characterised the policy of the Biomedical Technology Wing which recognised that R&D effort deserves support only to

the extent its products are used by patients and the industry. A new mechanism for technology transfer and efforts to attract industrial sponsorship for R&D projects were indicative of the changing approach of the Institute towards technology transfer. The survey carried out by the Institute during 1985 had estimated the demand for medical devices in the country to be Rs. 350 crores which was expected to reach Rs. 1000 crores by 2000 AD. The sheer size of the demand and its impingement on the day to day needs of hospitals made it obligatory for the Institute to generate technologies which would support the growth of an Indian devices industry before the turn of the century. The attempt to stimulate interest in biomaterials and devices among Indian universities through the Indo-UK Symposium was part of the strategy to broad base the technological effort in the new field.

The serious consideration being given to the possibility of offering a Masters level programme in medical technology marked a new direction in educational programmes and a conscious effort to introduce integrated programmes of training in technology and medicine. In the fullness of time the products of this

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training could be expected to propagate a joint culture as they would be equally at home in medical sciences and technology and out of place nowhere. It would not be wrong to claim that the enduring contribution

of the Institute among its many activities will be the advancement of medicine through the development of a joint culture and the creation of new medical tools from science and technology.

## SURVEY OF MAJOR PROGRAMMES

### i. HOSPITAL SERVICES

*Medical Superintendent:*

Dr. (Maj.) K. A. Hameed, MBBS

*Administrative Medical Officer:*

Dr. D. Hariprasad, MBBS, MD.

#### Outpatient & Inpatient Services

The upward trend in patient services continued during 1987-'88 as shown in Figs. 2-6.

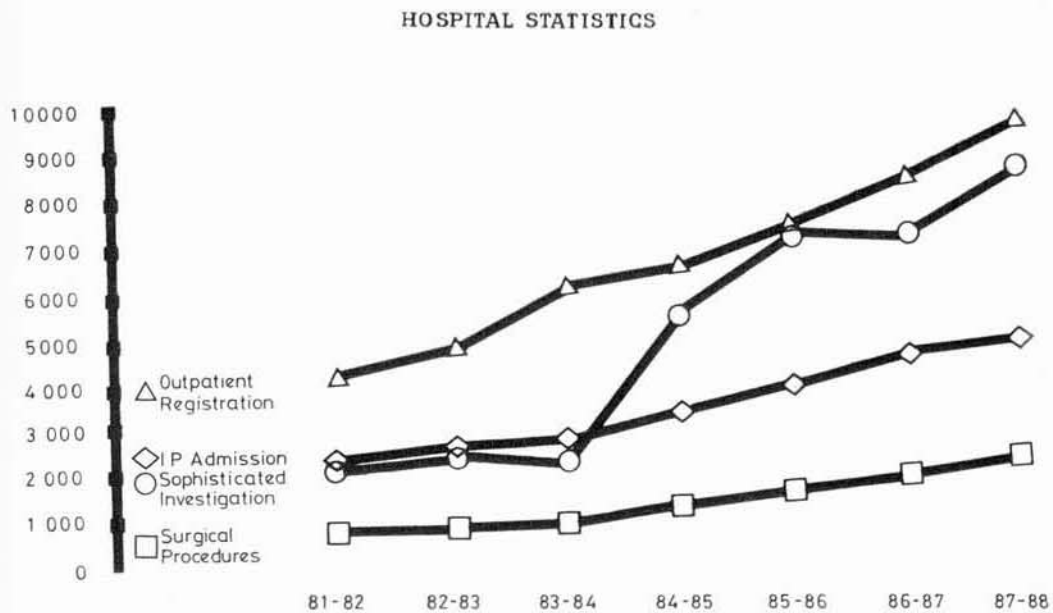


Fig. 2



As anticipated in the previous year's report, the uninterrupted growth in patient services produced bottlenecks which were maximally felt in the outpatient clinics. Whereas the present capacity for receiving new patients in cardiology and neurology was limited to fifty per day, it was not unusual for a hundred to reach the hospital to the great disappointment of patients and the distress of the hospital staff. In an effort to tackle this problem over 400 letters were sent to referring institutions

and notifications issued in the newspapers, prior to the introduction of an appointment system for new patients for elective visits to the hospital. Even though the appointment system had worked satisfactorily for followup visits its extension to new patients had been viewed with scepticism if not concern lest it should lead to virtual curtailment of patient services. In the event, the new policy for the registration of new patients was welcomed by the patients and doctors

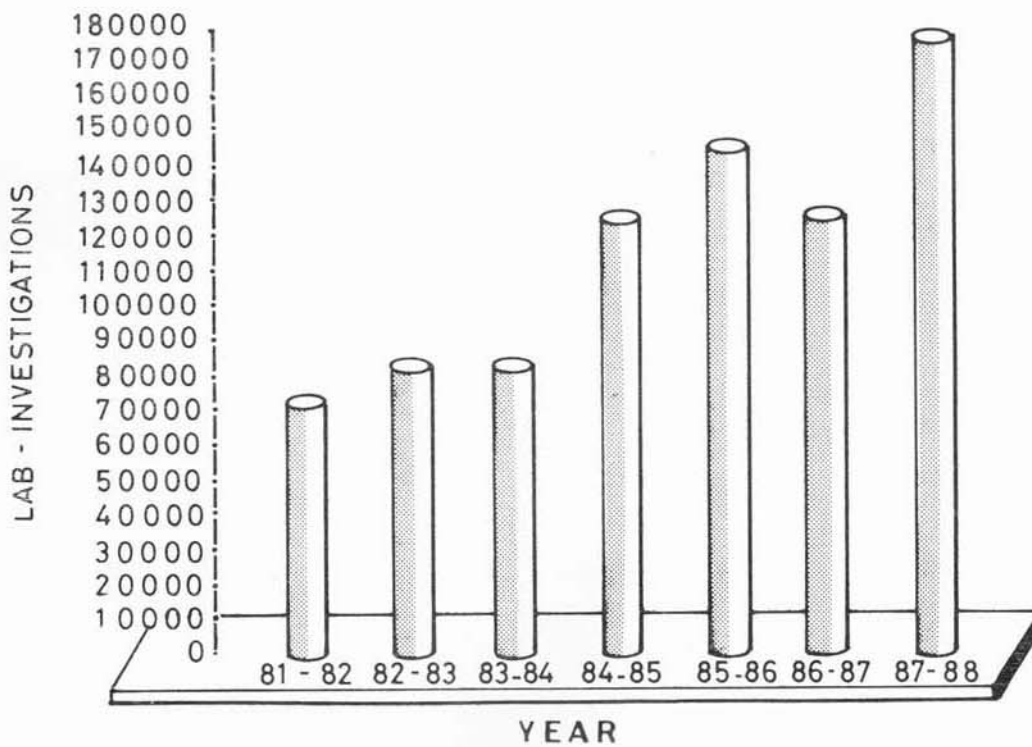


Fig. 3

alike as the patients could come to the hospital under the new dispensation with the certainty of being seen and investigated by consultants the same day. The structural modifications in the outpatient clinic areas and the commissioning of the central clinical laboratory also contributed to the success of the outpatient services.

In the inpatient sector, the coronary care unit was expanded from six beds to eight and one of the previous cardiac operating room suites was

extensively modified to receive the new and upto date cardiac catheterisation equipment including DSA which was on order. Laundry space and equipment were also augmented to meet extra demand.

Brig. S. Gopalakrishnan M.C. (Retd.) who had served the Institute as Medical Superintendent in its formative years visited the hospital as a consultant for a three month period when he prepared a draft manual for hospital services and carried out a review of the existing hospital rates. His

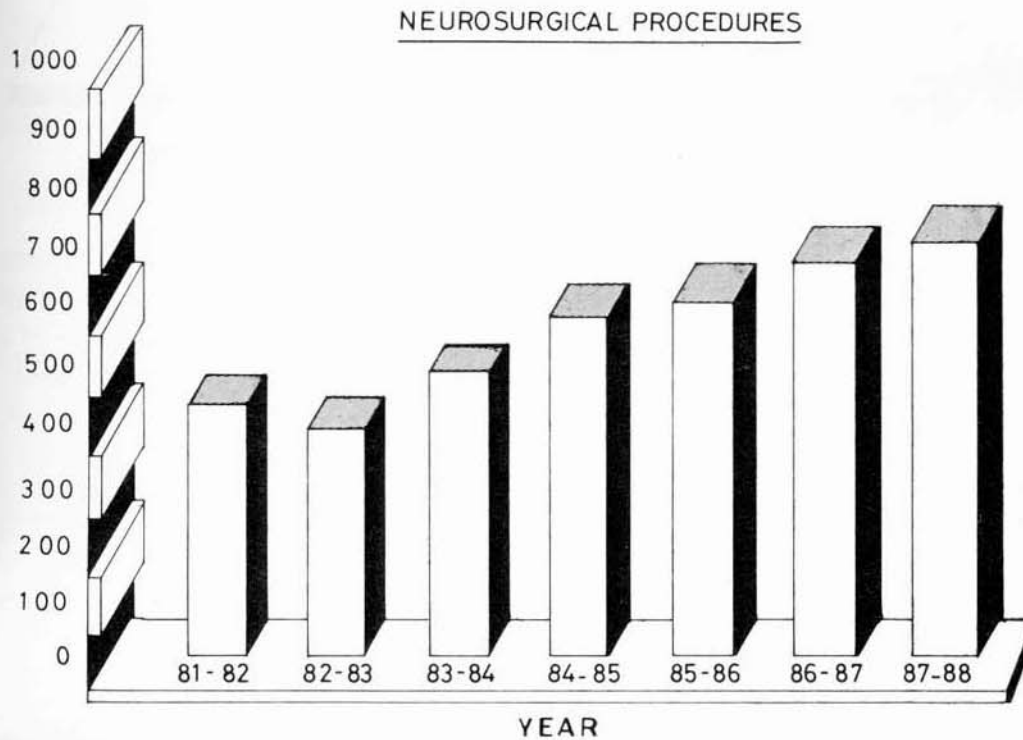


Fig. 4

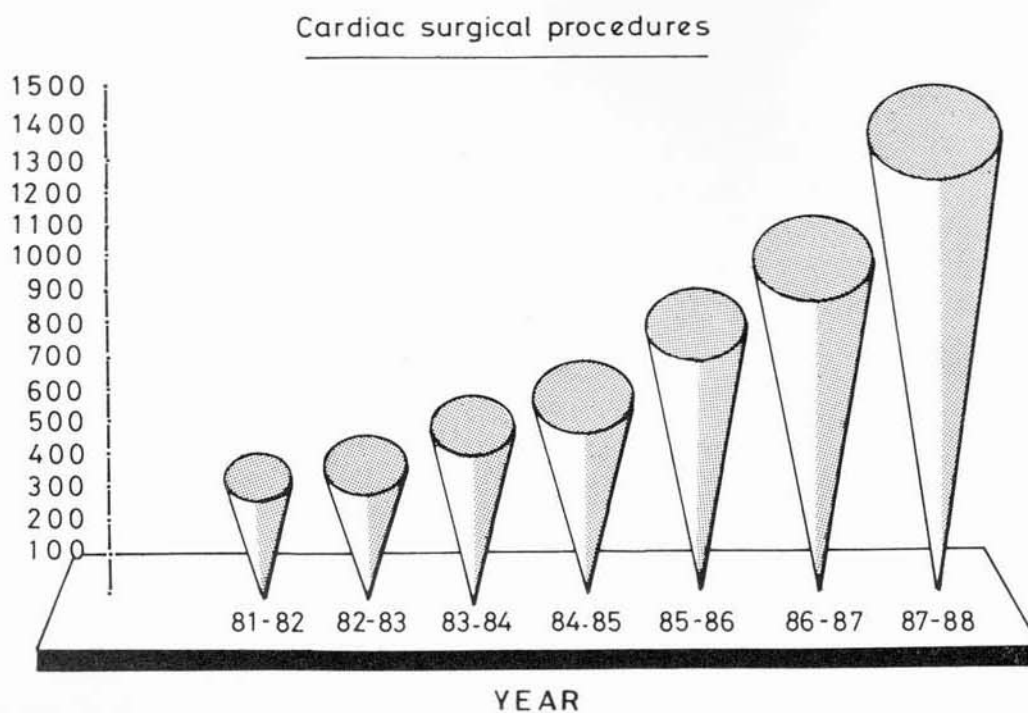


Fig. 5

suggestions were also helpful in bringing about changes which streamlined patient care practices.

Lt. Gen. Kapur, Director-General, Armed Forces Medical Services visited the hospital and showed interest in the various medical devices being developed in the Institute.

#### **Royal Donation**

The Royal Family of Travancore whose munificence had laid the foundations of the Institute showed

their continued interest in its growth by making a generous donation of Rs. 2.75 lakhs for the purchase of a new ambulance for the hospital.

#### **Medical Records**

Patient data base became regularly operational and the inserting of microfiche jacket work was completed during the year. The Medical Records Section continued to serve not only patient services but also academic work and research by

making patient charts and information available for the use of investigators.

Mr. Krishnamurthia Pillai took charge as Senior Medical Records Officer.

### Nursing Services

The major new development in nursing services was the introduction of the postbasic certificate course in cardiovascular and thoracic nursing with Mrs. PP Saramma as Instructor. With five students in the first

batch, the course had a good start with full involvement of the nursing and academic staff in its day to day operation.

Apart from regular inservice educational activities, the nursing staff organised an annual conference which became the fifth in the series. Forty-four delegates from sixteen institutions attended the conference which had 'management of patients with congenital heart disease' and 'brain tumours' as the twin themes. Nurses as well as members of the

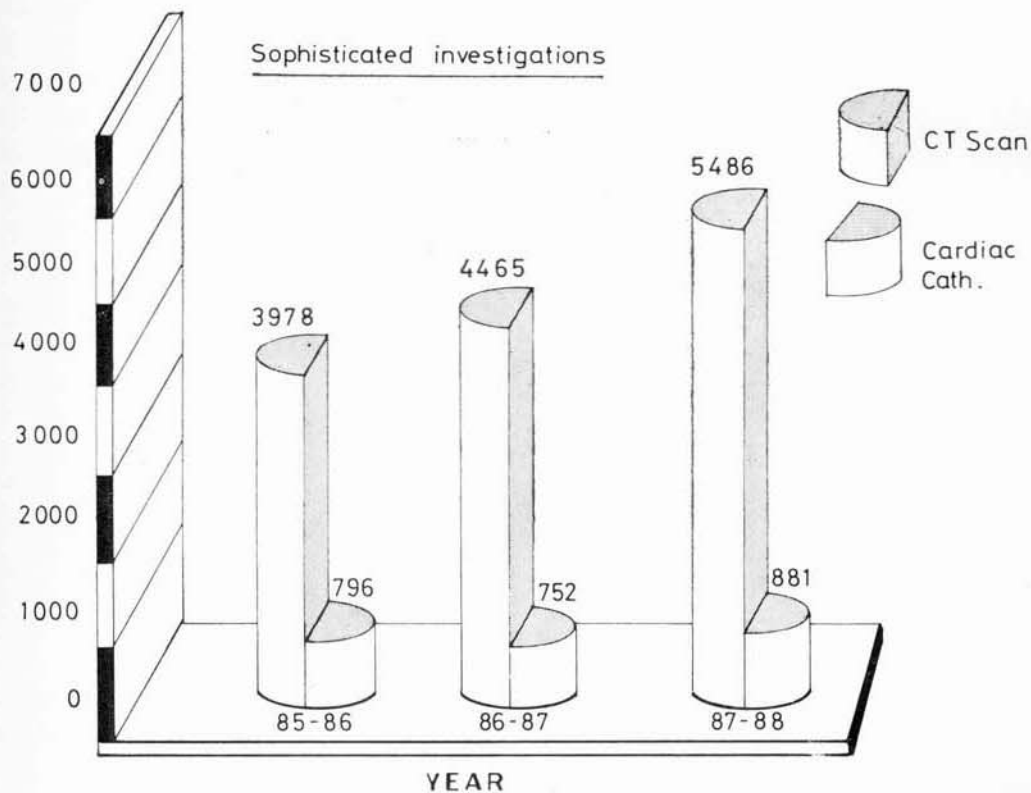


Fig. 6

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academic staff took active part in the teaching programme which featured audiovisual techniques including video presentations.

Two staff nurses from the Medical College, Alleppey received training in the coronary care unit for four months and B. Sc. nursing students from Nursing Colleges in Trivandrum and Kottayam visited the hospital for two week periods as part of advanced medical surgical nursing course. A Master's degree student from RAK College of Nursing, New Delhi spent a month in the Institute for summer field experience.

Three members of the nursing staff presented papers at the Joint Annual Conference of the Association of Thoracic and Cardiovascular surgeons and the Cardiological Society of India in Bangalore and three nurses took part in the Neuro Nurses Satellite Conference held in Hyderabad. Ms Celine Joseph won the rolling trophy for the best scientific paper and Ms Accamma Abraham received the third prize for paper presentation.

Miss Saramma Abraham, Nursing Superintendent retired from service on 31-3-1988.

### **Clinical Engineering**

Preventive and breakdown maintenance of diverse equipment continued

to be the major activity of the clinical engineering group who were also involved in the installation of new items of equipment. These included CUSA, Nd-Yag laser, electron microscope and various types of ventilators. A solid state cautery was developed as a development project.

Mr. R. Mohandas and Mr. Korath Varghese were elected as Senior Member and Member respectively of the Institute of Electrical and Electronic Engineers of USA. Mr. Korath Varghese and Mr. Madhusudanan Pillai were also elected Members of the Institution of Engineers of India. Mr. Korath Varghese received training in the maintenance of electron microscope at the Hitachi factory in Japan. Mr. Korath Varghese and Mr. Madhusudhanan Pillai passed the examination for Diploma in Computer applications with first class and distinction respectively.

Trainees from the Engineering College, Trivandrum as well as graduates and diploma holders in engineering were accepted for short term training in clinical engineering.

Mr. Mohandas served as an examiner for engineering examinations of the Kerala and Calicut Universities.

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**ii. BIOMEDICAL  
TECHNOLOGY WING**

*Head:* Shri A. V. Ramani, B.Sc.  
(Chem. Tech.)

In making an overall estimate of the Biomedical Technology Wing, its programmes in scientific research, devices development and technology transfer need to be reviewed. The exhaustive studies on biosurface phenomena and the novel approach to platelet aggregation are two examples of the kind of basic investigations in progress which could uncover new ground and offer possibilities for application. Not surprisingly both these studies came to attract scientific attention in the country and abroad. Other investigations of a basic nature included studies on the physico-chemical effects of sterilisation on polymers and those of biological environment on carbon-carbon composites.

The variflo oxygenator model was redesigned in a record period of one year in view of the estimated high cost of its production. The new model which is under trial at the time of this report is free from the manufacturing problems of the earlier model and suitable for large scale production. The other major device,

a tilting disc valvular prosthesis, also overcame earlier setbacks and came closer to the point of clinical trial which had been twice postponed.

Regardless of whether the technology belonged to that of blood bag, disposable oxygenator or valvular prosthesis, experience over the years had emphasised the major drawbacks in the Institute's procedures for the transfer of technology. Apart from total dependence on Governmental agencies for developmental funds, the existing procedure provided no scope for continual interaction with industry during the development of a device and presented formidable difficulties in its ultimate linkage with the manufacturing process. This problem which was by no means unique to the Institute had been the subject of repeated discussions in various administrative committees who had favoured a policy of closer interaction with industry. Apart from providing developmental funds, industrially sponsored projects also ensured concurrent monitoring of the R&D effort and assured transfer of the technology for commercial production. The importance attached by the Institute to technology transfer could be seen from the emer-

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gence of a new committee under the chairmanship of Prof. S. Ramaseshan for streamlining its procedures.

As a broadbased programme in biomaterials research is a sine qua non for the development of a medical devices industry in the country, the Institute took the initiative in organising an Indo-UK symposium on biomaterials on the occasion of Raman Centenary with the financial support of the University Grants Commission, Department of Science

& Technology and the British Council. Attended by delegates from several Indian Universities, the symposium featured presentations by eminent scientists from the U.K. and India and served to stimulate serious interest in biomaterials research among several participants. A brief report of the proceedings of the symposium is given in Annexure. The complete proceedings are being published by the Indian Academy of Sciences.

### iii. EDUCATIONAL PROGRAMMES

*Registrar:* Shri V. Narasimhan,  
M. Sc., MIMS

From their inception, the formal training programmes of the Institute had confined themselves to medical disciplines. Whereas the post-doctoral courses of training covered Anaesthesia, Cardiology, Cardiovascular and Thoracic Surgery, Neurology, Neurosurgery, and Radiology, the Ph. D. Programme offered additional opportunities for investigative work in biochemistry, biomaterials science and technology, biomedical engineering, microbiology and pathology. A new addition to the educational programmes was the postbasic course in cardiovascular nursing which opened during 1987-88 with five nurses. A 10 month course, it was designed to meet the demand for specialised training among nurses and for skilled personnel among hospitals. Apart from Mrs. P. P. Saramma, Instructor in Nursing, guest nursing faculty and members of the academic and nursing staff contributed to the teaching programme in nursing.

Mindful of the mandate to promote integrated programmes of training,

the Institute initiated a feasibility study for introducing a master's level course in medical technology which could draw freely from its resources in engineering and medical sciences and blaze a new trail in the field of technological education in the country. A staff committee consisting of Dr. C. P. Sharma, Dr. P. V. Vedanarayanan, Dr. M. Jamaluddin, Shri S. N. Pal and Shri. H. Vijayakumar prepared a draft document for the course which was to be further examined by the following committee of experts

1. Prof. S. Ramaseshan, Bangalore—Chairman
2. Dr. M. D. Deshpande, Bangalore
3. Dr. S. C. Gupta, VSSC, Trivandrum
4. Sri. V. Krishnamurthy, Madras
5. Dr. R. A. Mashelkar, Pune
6. Dr. M. D. Nair, Madras
7. Dr. B. Sankaran, New Delhi.

The syllabus and other details of the proposed course were to receive the consideration of the Academic Committee and Governing Body of the Institute with a view to the possible introduction of the course during 1988-'89.

The national response to various academic courses remained impressive and the statewise break up of the



applications confirmed the nationwide acceptance of the educational programmes (Table 1). The Table-2 gives the details of the Programme-wise demand and the number selected and joined.

**Table-1**

<i>State/Union Territories</i>	<i>Number applied</i>
Andhra Pradesh	36
Assam	1
Bihar	14
Delhi	5
Gujarat	15
Haryana	3
Himachal Pradesh	1
Jammu & Kashmir	2
Karnataka	16
Kerala	45
Madhya Pradesh	27
Maharashtra	16
Orissa	7
Punjab	1
Rajasthan	14
Tamil Nadu	21
Uttar Pradesh	15
West Bengal	14

To meet the demand for professional training at the post D.M./M.Ch. level, the Institute approved the creation of two Postdoctoral fellowships as an experimental measure. It was felt that this scheme would fill an existing gap in training between the acquisition of D.M./M.Ch. and the achievement of junior consultant status.

*Postgraduate Examinations*

Except for one failure each in the DM Cardiology and M. Ch. Cardiovascular and thoracic surgery all candidates were declared successful in the 1987 examination. They are listed in Table-3.

All candidates registered for post-doctoral certificate course completed their training satisfactorily in December 1987. The details are given in Table-4.

*Ph. D. Programme:*

Mr. Thomas Chandy, an internal candidate, registered for Ph.D. in biomaterials science and technology in June 1984 under Dr. Chandra P. Sharma, Head, Division of bio-surface technology submitted his thesis on "Fibrinogen-Polymer interaction-influence of plasma components" and defended it successfully in March 1988.

**Table-2**

<i>Course</i>	<i>No. of applicants</i>	<i>No. selected and joined</i>
DM Cardiology	87	2
DM Neurology	32	2
M.Ch. Cardiovascular and thoracic surgery	48	2+1 *
M.Ch. Neurosurgery		
3 year	21	2
5 year	25	nil
Postdoctoral certificate course in Anaesthesia	26	4
Postdoctoral certificate course in Radiology	14	2

\* Sponsored by Government of West Bengal

**Table-3**

<i>Name of candidate</i>	<i>Degree</i>	<i>Speciality</i>
Dr. M. Srinivasan Dr. Shailender Singh	DM	Cardiology
Dr. Suresh G Rao Dr. Jitheshkumar Tharachand Tolia	M.Ch.	Cardiovascular and Thoracic Surgery
Dr. K. S. Sunil Kumar Dr. P.H. Abdul Majeed	DM	Neurology
Dr. Anirudha Kumar Purohit Dr. K. N. Krishna Dr. Ajay Kumar Gehlot	M.Ch.	Neurosurgery

The list of candidates working on sponsored projects registered for Ph. D. during the year is given in Table-5.

Following a review of the existing

doctoral projects it was decided to suspend the registration of internal candidates under the external teacher scheme until the progress of the present registrants could be evaluated further.

**Table-4**

<i>Name of the candidate</i>	<i>Speciality</i>
Dr. Rupa Sreedhar Dr. Madhavi V. Purohit Dr. Raman Chadha	Cardiovascular and Neurosurgical Anaesthesia
Dr. R. V. Phadke Dr. NLN Murthy	Cardiovascular and Neuroradiology

**Table-5**

<i>Name</i>	<i>Thesis Area</i>	<i>Guide</i>
Ms. Yasmin Marikkar	Biochemical studies on cell surface glycoproteins of glial cells in developing brain	Prof. Debkumar Basu, Neurochemistry
Mr. Bobby Zachariah	Physico chemical studies on cell surface glycojugates of neurons from developing brain	Prof. Debkumar Basu, Neurochemistry

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### **Library**

The Biomedical technology wing library continued with the compilation and storage of bibliographies in computer diskettes and made a beginning in the computerisation of the catalogue. The library arranged a lecture-cum-demonstration to a group of visitors consisting of faculty and students from the department of Library and Information Science of the University of Kerala on the "Introduction of computers in Library Management".

### **Training facilities for staff from other institutions**

As in the previous years the Institute received staff members and students from several institutions for short term training in various departments and disciplines the details of which are contained in the departmental reports.

### **Continuing Medical Education Programme**

The faculty under the direction of Dr. P. K. Mohan, Head Neurology Department, organised two continuing education programmes for general practitioners in the region, one in

September 1987 on "Infections of the heart and brain" and another in March 1978 on "Congenital heart diseases; and Brain tumours".

### **Nursing Education**

The annual activity of organising a 2-day conference for the benefit of nurses in the region by the nursing staff of the Institute took place on 13 & 14 November 1987. The themes were "Management of patient with congenital heart disease with special emphasis on cyanotic heart disease; myasthenia gravis and pituitary tumours". The conference evoked excellent response from the nursing community.

### **General**

Sri Narasimhan was elected to the Membership of International Institute of Management Sciences, Calcutta and was admitted to the Trivandrum Management Association as a member. He presented two papers on 'Faculty - Administration Interface' and 'University Administration as a profession' in the Annual Conference of Association of University Administrators (India) held in September 1987 at Nagpur.

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## SPECIAL SCHEMES OF RESEARCH

### i. Centre for Advanced Research in Cardiomyopathy (Sponsored by the Indian Council of Medical Research)

Prof. M. S. Valiathan	Head of the Centre
Dr. C. C. Kartha, MD.	Asst. Prof. of Pathology
Dr. Renuka Nair, Ph.D.	Lecturer
Dr. K. Shivakumar, Ph.D.	Senior Research Officer
Dr. Prabha Nini Gupta, MD.	Research Officer
Dr. John T Eapen, Ph.D.	Research Associate

The research activities of the Centre during 1987-88 centered around the hypothesis that a combination of magnesium deficiency and excess of one element of monazite sand may synergistically act to produce cellular injury and form a basis for the pathogenesis of endomyocardial fibrosis in the tropics. Analysis of human cardiac tissues revealed that tissues from patients with endomyocardial fibrosis contain significantly higher amounts of cerium. The significance and role of the excess of thorium and cerium were therefore investigated. Experiments done in rats indicated, that after repeated administration of small doses of thorium intraperitoneally, tissues levels of thorium in rats maintained

on a magnesium deficient diet were higher than those in rats which were given normal diet.

This observation led to studies on the ionic interactions at the cellular level. Using radioactive isotope techniques, amino acid uptake was studied in explant cultures from human fetal hearts grown in culture media with different concentrations of magnesium and thorium. Preliminary results suggested an inverse relationship between the concentration of magnesium in the culture medium and the magnitude of the stimulatory effect of thorium on amino acid uptake by cardiac explants.

During these studies, the necessity of isolated cardiac myocytes became

obvious and techniques were standardised for the isolation of cardiomyocytes. Ventricles from hearts of 8-10 week old human tissues were dissociated by enzyme digestion. The yield of myocardial cells could be increased by the use of collagenase and by altering the concentration of trypsin. Spontaneously beating myocardial cells were obtained within 24 hours of inoculation. Cells multiplied and formed synchronously beating monolayers by the third day. Myofibrillar striations of myocardial cells were clearly visible in a proportion of the cells and the cells remained viable for two weeks.

Standardisation of techniques for dissociation and separation of cells also helped the initiation of studies on cell adhesion to biomaterials. Development of surfaces which would support derivatizable cell growth would serve the twin purposes of providing better cell yields as well as deeper insights into the complex cellular characteristics such as selective adhesion, growth, motility and differentiation. A hydrogel derived from polymethyl methacrylic acid, developed at the Biomedical Technology Wing, was assessed for its ability to support cell growth. The hydrogel in the form of microspheres was found to support

the growth of human skin fibroblasts, human fetal heart and lung cells. C14 amino acid uptake and incorporation into proteins, when studied using fibroblasts grown on hydrogel surface, were found to be comparable to those in fibroblasts grown on commercially available tissue culture flask. It was felt that the ability of these microspheres to support cell growth could be further improved by derivatizing the surface with biomolecules which promote cell adhesion and also by the employment of suspension cultures.

In parallel with the studies in animals and tissue culture, a study was also initiated in plants to estimate their ability to concentrate monazite elements in the presence of magnesium deficiency. Cultures of *coleus Parvi florus* (a tuber plant) were set up in Murashige and Skoog medium for the study.

Studies on platelet aggregation in patients with endomyocardial fibrosis were continued. Results so far indicate a significantly diminished aggregation rate with collagen and adrenalin in the patients. Aggregation rate with ADP was not significantly different when compared to controls. An immunological assay for Protein C, a natural anticoagulant, was also being carried



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out as part of the coagulation work-up in patients with EMF.

With the installation of an electron-microscope which was gifted by the Government of Kerala, ultrastructural studies in biopsy tissues from patients with EMF were extended with particular emphasis on the study of endothelial cells of the heart and the intramyocardial microvasculature.

Dr. C. C. Kartha, Dr. Renuka Nair, Dr. Shivakumar and Dr. Nini Gupta participated in the International

Symposium on heart research at Chandigarh in February 1988 and presented scientific papers.

Dr. Shivakumar presented a paper at the Indo-UK symposium on biomaterials held at the Institute.

The Scientific Advisory Committee of the ICMR consisting of Prof. Usha Luthra, Prof. Vaidya and Prof. Chapekar visited the Centre. The other distinguished visitors were Dr. KKG Menon, Prof. A. S. Paintal and Prof. Carl G Becker.

## ii. Medical and Surgical applications of Lasers

(Sponsored by the Department of Science & Technology)

Principal investigators: Dr. M. S. Valiathan

Dr. D. D. Bhawalkar,  
Centre for Advanced Technology,  
Department of Atomic Energy, Indore

Co-investigators: Dr. K. Ravimandalam  
Dr. Arthur Vijayan Lal SCTI  
Dr. K. S. Neelakandan  
Dr. Meera Mohanty  
Dr. V. R. K. Rao  
Dr. V. K. Chatterji BARC  
Dr. TPS Nathan  
Dr. L. M. Kukhreja

Duration: 3 years

The project which commenced in 1986 envisaged the development of Nd-Yag laser source and an appropriate delivery system for angioplasty which would initially be applied to vessels larger than 5 mm in diameter. Whereas the laser source was to be developed by the Bhabha Atomic Energy Centre, the delivery system was to be designed & developed in collaboration with Dr. R. Hridayanath of Defence Research & Development Organisation, Dera-dun by the Institute which was also responsible for carrying out basic studies on the vascular effects of laser energy and ultimately, for conducting clinical trials.

During the year, Nd-Yag laser equipment from Cooper Sonics and a portable image intensifier were installed and experimental studies begun on the effects of varying parameters of laser applications such as power, power density and total energy delivered on cadaveric arteries and vascular prosthesis. Work was also initiated in collaborating institutions for the development of the laser source and an appropriate delivery system.

Sri T. Ramachandran and a technical assistant were appointed as members of the project staff.

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## DEPARTMENTAL REPORTS

### HOSPITAL WING

#### Department of Anaesthesiology

Dr. K. Mohandas, MD	Professor
Dr. V. Padmanabhan, MD	Associate Professor
Dr. R. C. Rathod, MD	Associate Professor
Dr. Mrs. A. Rout, MD	Assistant Professor
Dr. H. D. Waiker, MD	Assistant Professor
Dr. J. M. Shahani, MD	Assistant Professor
Dr. D. K. Saxena, MD	Assistant Professor
Dr. Madhavi Purohit, MD	Lecturer
Dr. Roopa Sreedhar, MD	Lecturer
Dr. P. Bhattacharya, MD	Candidate for Postdoctoral Certificate Course
Dr. S. Prakash, MD	do.
Dr. A. Vaidya, MD	do.
Dr. Mantha Srinivas, MD	do.

Apart from giving general anaesthesia for 1150 cardiothoracic and 656 neurosurgical operations, anaesthetic support was also provided for nearly hundred diagnostic and interventional procedures by the Department of Anaesthesia. The overall charge of the five intensive care units was also assumed by the Department in accordance with the recommendation of the Wadia Committee.

The new equipment added during the year included four ventilators and two coagulation monitors.

Dr. (Mrs.) A. Rout presented a paper on 'Role of lignocaine anaesthesia in neurosurgery' at the 7th Asian Association Congress of Neurological Surgery at Brisbane. Dr. Mohandas gave scientific lectures at Kasturba Medical College,

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Manipal, Madurai Medical College, Madurai and Cardiothoracic Centre of the Armed Forces Medical College, Pune. Dr. Surendra Singh, Lecturer in Anaesthesia, Benaras Hindu University and Wg. Cdr. Joseph of the Defence Services completed one year of training in anaesthesia. Postdoctoral students

in Anaesthesia from the Medical Colleges of Trivandrum & Kottayam continued to attend the Department for short periods of training.

Dr. (Mrs.) P. Chari of the Department of Anaesthesiology, PGI, Chandigarh visited the Department and gave lectures.

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### Division of Biochemistry

Dr. K. Subramonia Iyer, Ph.D.	Associate Professor
Mrs. Santha A. George, M.Sc.	Scientist
Dr. N. Jayakumari, Ph.D.	Lecturer
Mr. B. Sasikumar, M.Sc.	Scientific Assistant

The newly reorganised central clinical laboratory provided effective round-the-clock service in clinical chemistry and clinical pathology. The number of tests carried out by the central laboratory during the year crossed 1.5 lakhs which was 30% higher than the previous year. Installation of the new blood gas analyser (ABL 300 from Radiometer) in the satellite laboratory on the cardiac operating room floor greatly improved service efficiency.

The normal lipid levels are known to vary among populations. On the basis of a preliminary survey, the normal range of high density lipoprotein cholesterol (HDL-C) for the local population was established. The ratio of total cholesterol to HDL-C needs to be below 5 for normal subjects (irrespective of their

total cholesterol) and any increase in this value is considered to be a warning signal. The normal level was studied as the first step in investigating the lipid profile of patients with coronary artery disease.

Dr. Jayakumari received a grant for two years from the Department of Science & Technology for her project entitled "membrane lipid peroxidation in human atherosclerosis: A study of risk associated by products and apolipoproteins".

The new equipment added to the Division included Flame photometer FLM3 from Radiometer, Microfuge 11 from Beckman, and Blood gas analyser ABL 300 from Radiometer.

Mr. B. Sasikumar was promoted to the post of Scientific Assistant.

### Division of Blood Transfusion Services

Dr. P. A. Jayaprakash, MBBS, DIBT	Chief Blood Transfusion Officer (resigned with effect from 20-12-87)
Dr. Jaisy Mathai, MBBS, DCP	Junior Blood Transfusion Officer
Dr. P. V. Sulochana, MBBS	Junior Blood Transfusion Officer

The following table lists the activities of the department during 1987-88.

**Table-6**

1. Blood donation	5701
2. Whole blood transfusion	4211
3. Component transfusion	716
4. Compatibility tests—	
saline	7602
Albumin	7602
AHG	2281
5. Blood grouping	14103
6. HBs Ag Screening	6434
7. Syphilis RPR test	2892
8. Therapeutic plasma- pheresis	10

As part of these activities, a function was organised in September 1987 when the motivators and donors were honoured with mementos. The Institute co-sponsored a one-day seminar on blood transfusion organised by the NSS in the University campus where Drs. Jaisy Mathai and Sulochana spoke on the scientific and psychological aspects of blood transfusion. The Institute also took an active part in organising the meeting of the Hemophiliac Society and World Federation of Hemophilia in the Medical College, Trivandrum. The Division responded to the demand for blood components from neighbouring institutions for emergency needs.

As in previous years, the Division continued to take active interest in donor motivation programmes in association with voluntary groups.

The laboratories of the Division provided support to Dr. Mira Mohanty's project for the preparation and standardisation of stable hemoglobin

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solution. The clinical evaluation of the Penpol single bags was completed satisfactorily and the evaluation of double bag system initiated. During the year blood collection was carried out entirely in PVC bags.

Two nurses from the Directorate of Health Services and one blood trans-

fusion assistant from the GG Hospital, Trivandrum attended the Division for training in blood banking techniques for one month. The important visitors included Dr. Ambika Nanu of AIIMS and Dr. Arunabha Chattopadhyaya, Secretary of the West Bengal Blood donors forum.

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### Department of Cardiology

Dr. K. G. Balakrishnan, MD, DM, FACC, MNAMS	Professor
Dr. C. G. Venkitachalam, MD, DM	Associate Professor
Dr. R. Subramaniam, MD, DM	Assistant Professor
Dr. Thomas Titus, MD, DM, MNAMS	Assistant Professor
Dr. Jagmohan Tharakan, MD, DM	Lecturer
Dr. P. K. Goel, MD, DM	Lecturer
Dr. M. V. Joseph Joy, MD, DM	Lecturer
Dr. Nageswara Rao, MD	Candidate for DM
Dr. Asha Rajan, MD	do.
Dr. K. K. Haridas, MD	do.
Dr. Tiny Nair, MD	do.
Dr. Y. R. Yellury, MD	do.
Dr. K. Raghu, MD	do.

In spite of the ceiling of 25 new patients which had been fixed for the daily cardiac clinic, new registrations in Cardiology increased from 4323 in 1986-87 to 5390 in 1987-88. Investigating procedures like treadmill test, echocardiograph and cardiac catheterisation showed a proportionate increase. Given the functioning of special clinics and the insistence of appointment system for the visits of patients the number for repeat visits however showed a decline from 8928 to 6528 for 1987-'88.

Interventional procedures like balloon septostomy and balloon valvuloplasty became a regular feature with good results during the year. Clinical studies which were in progress included Doppler estimation of left to right shunts, viral studies in acute-rheumatic carditis and myocarditis of unknown cause, natural history of aortoarteritis, Doppler evaluation of diastolic LV functions in coronary artery disease, hypertrophic cardiomyopathy and endomyocardial fibrosis.



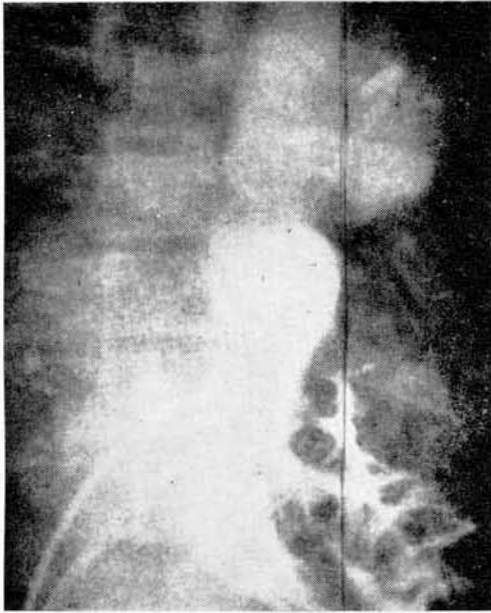


Fig. 7

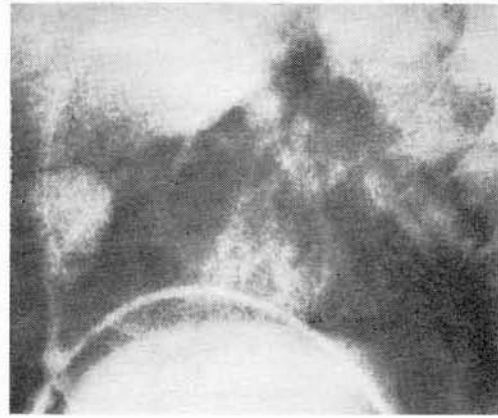


Fig. 8

Figs. 7 & 8 Right Ventricular angiogram in antero-posterior and lateral views—shows thickening and doming of the pulmonary valve, severe post-stenotic dilatation of main pulmonary artery.

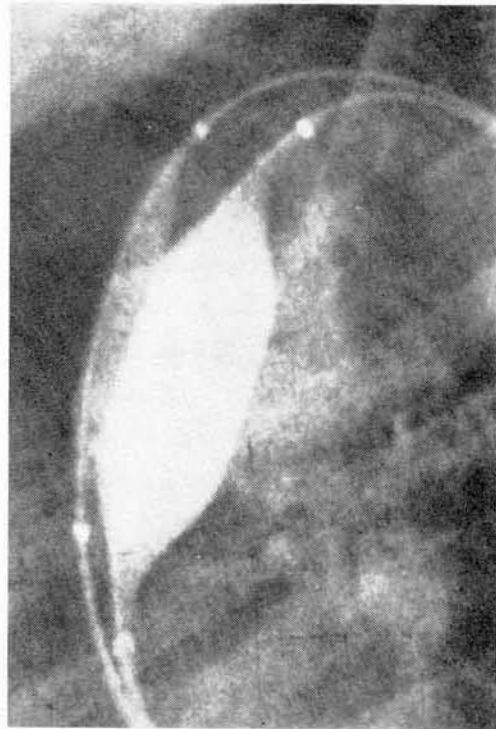


Fig. 9. Lateral view of chest with two balloon catheters across the pulmonary valve fully inflated.

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The following laboratory studies were undertaken in collaboration with other Divisions of the Institute.

1. Correlation of pulmonary vascular changes in lung biopsy with hemodynamic data in congenital heart disease with left to right shunts (Division of Pathology)
2. Correlation of electrocardiographic criteria of ventricular hypertrophy with ventricular hypertrophy in autopsied hearts (Division of Pathology)
3. Pilot study of serum lipoprotein profile in coronary atherosclerotic heart disease and normal population (Division of Biochemistry).

Holter monitor for 24 hour ambulatory ECG monitoring and programmed stimulation for electrophysiological studies of heart were added

during the year. Equipment for a modern cardiac catheterisation laboratory was expected to be installed during 1988.

Dr. K. G. Balakrishnan received training in PTCA for 3 months at New York University Medical Centre, New York, USA and 1 month at Henry Ford Hospital Detroit, USA. He participated in a National Workshop on the 'Development of super-specialities in Developing countries' at the Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow in February 1988.

Dr. P. K. K. Marikar, Asst. Medical Officer, Cochin Port Trust underwent training in echocardiography.

Two nurses from Health Services, Government of Kerala were trained in CCU and ICU management.

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**Department of Cardiothoracic Surgery:**

Dr. M. S. Valiathan, Ch. M. (L. Pool) FRCS (Edin), FRCS (Eng), FRCS (C), FACC, FAMS, FASc, FNA	Professor and Head of the department
Dr. M. P. Mohan Singh, FRCS (Eng), FRCS (Edin)	Professor
Dr. K. S. Neelakandhan, MS, M.Ch.	Assistant Professor
Dr. R. Sankarkumar, MS, M.Ch.	Assistant Professor
Dr. K. G. Shyamakrishnan, MS, M.Ch.	Assistant Professor
Dr. M. Unnikrishnan, MS, M.Ch.	Lecturer
Dr. Aruna Kashyap, MS, M.Ch.	Lecturer
Dr. Y. Nazer, MS, M.Ch.	Lecturer (on study leave)
Dr. Rajendra Prasad, MS	Candidate for M. Ch.
Dr. S. R. Krishna Manohar, MS	do.
Dr. V. M. Kurien, MS	do.
Dr. Shekar Rao, MS	do.
Dr. R. N. Hyderabad, MS	do.
Dr. Murtaza Ahamed Chesti, MS	do.
Dr. S. Mukhopadhyay, MS	do.

The volume of cardiothoracic surgery remained unchanged and cardiothoracic operations numbered 1150 as in the previous year. For the balanced and rapid growth of the various branches of cardiothoracic and vascular surgery, operating schedules and staff allocations were rearranged during the year to develop optimum workloads as well as specialised teams in four areas namely,

surgery for thoracic and vascular problems, congenital cardiac anomalies, valvular lesions and coronary artery disease. The restructuring of staff and operating schedules was no more than an important step towards attaining the annual target of 2000 procedures including 900 open heart operations over a three year period. The rapid growth in the volume and quality of surgery for congenital

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cardiac anomalies as well as thoracic and vascular diseases justified the hope that the overall targets could be achieved within the time limit. The scheduling of operations on the basis of computerised list of patients came into regular operation during the year.

The staff of the department continued to work in close collaboration with the Divisions of Artificial Internal Organs, Extracorporeal Devices and Biomaterials Technology in solving the remaining problems in the development of the valvular prosthesis and disposable oxygenator. The close interaction with engineering groups and the intensive trial of

devices in animals gave a flavour of their own to the practice and training in cardiac surgery in the Department. Prof. Mohan Singh rejoined the Department after a period of sabbatical leave at Belfast and Dr. Shyamakrishnan was appointed Assistant Professor. Dr. Shetty of the Kasturba Medical College, Manipal visited the Institute as Reeve Betts Fellow of the Association of Thoracic & Cardiovascular Surgeons.

Prof. Valiathan was elected a member of the Society of Thoracic Surgeons of the United States and a Fellow of the Indian National Academy of Engineering.

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### **Division of Microbiology**

Dr. J. Shanmugham, Ph. D, FIMSA	Associate Professor
Dr. Aruna Shahani, MD	Lecturer
Miss Molly Thomas, M.Sc., D.M.V.	Lecturer
Mr. M. Ravindranath, B.Sc.	Scientific Assistant
Mrs. K. Naseema, M.Sc.	Scientific Assistant

The routine workload in the Division increased by more than 10% over the last year. Currently the coagulase negative Staphylococci and non-fermenters are being identified upto species level by the help of biochemical reactions and blood culture is performed in biphasic medium. Thanks to these techniques the rapidity and the sensitivity of the reports could be increased. In virology, the test for Poliovirus antibody titration was standardised and introduced for routine diagnosis. During the year 1987, a large number of mycobacterial strains was isolated most of which were found to belong to mycobacterium tuberculosis followed by mycobacterium avium complex.

An ICMR research project on the study of SRHG technique was completed in September, 1987. The study showed that the SRHG tech-

nique was more sensitive and specific in detecting antibodies against mumps and measles viruses but not against Coxsackie-B and hepatitis simplex viruses.

A study on urinary tract infections among catheterised patients funded by DST, Kerala Government was initiated in March 1987 and made good progress. The preliminary data revealed that the meatus flora were dominated by various species of Staphylococci. But the common isolates from the patients were Klebsiella species, followed by E. coli and Proteus. Therefore the chances of ascending infection by Staphylococci were considered remote in patients. One was obliged to look elsewhere for the sources of Klebsiella and other gram negative bacteria which are being isolated predominantly from the patient's urine specimens.

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Project	Study of Urinary Tract Infections in patients undergoing cardiac and neurosurgery
Principal Investigator	J. Shanmugham
Co-Investigators	R. N. Bhattacharya K. G. Shyamakrishnan
Funding	Department of Science & Technology Government of Kerala
Duration	Two years
Status	Ongoing

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Study of 50 cases with carditis and mitral regurgitation showed that most of them were serologically positive for Coxsackie B viral infections, while about one third of them only showed elevated titres of ASO and/or ADNB. This study indicated the probable role of Coxsackie B viruses in the genesis of carditis with mitral regurgitation and called for further investigations.

Materials received from the Division of technical evaluation of biomaterials were tested in VERO cell lines for the evidence of cytotoxicity in tissue culture system.

The Division organised in collaboration with the department of Zoology, University of Kerala, the 2nd National Symposium on 'Vectors and Vector-Borne diseases' in Trivandrum from 8th to 10th of February 1988. Prof. M. G. R. Varma of the London School of Tropical Medicine gave the key-note address at the Symposium.

Dr. Aruna Shahani participated in the Asian Workshop on 'Anaerobic Bacteria and Infections in Man' held at S. G. Medical College and KEM hospital, Bombay in November 1987.

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Dr. J. Shanmugham made a presentation at the International Symposium on 'Strategies on the Control of RF/RHD,' held at PGIMER Chandigarh in December 1987. He was nominated as a member of the Board of Studies in Microbiology at 'Sri Padmavathi Mahila Viswa Vidyalayam', Tirupati.

Prof. R. C. Mahajan from PGIMER, Chandigarh and Dr. K. B. Sharma,

Deputy Director General of Health Services, Govt. of India visited the Division.

Dr. Prabha Unnikrishnan and Dr. B. Sulekha, Postgraduate students in MD Microbiology from Trivandrum Medical College underwent short term training in basic techniques in Virology and Tissue culture during January 1988.

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### Department of Neurology

Dr. P. K. Mohan, MD, DM	Associate Professor
Dr. John Tharakan, MD, DM	Asst. Prof. (on leave)
Dr. S. Sarada, MD, DM	Lecturer
Dr. Muralidharan Nair, MD, DM	Lecturer
Dr. M. Veerendra Kumar, MBBS, DM	Lecturer
Dr. T. A. Subramaniam, MD	Candidate for DM
Dr. Sanjeev Thomas, MD	do.
Dr. Lekha Bhaskaran, MD	do.
Dr. Jacob Daniel, MD	do.
Dr. Asha Vijayaraghavan, MD	do.
Dr. P. A. Suresh, MD	do.

As in previous years, the main activity of the department consisted of patient care services at the out-patient and inpatient levels. In addition, the special clinics for stroke, epilepsy and pain were streamlined for follow up cases. Specialised investigations like EEG, EMG and Evoked potential studies, carried out throughout the year, kept the neurophysiology laboratories busy with optimal utilisation of the equipment. Regular teaching programmes were conducted for DM trainees.

Dr. John Tharakan, on leave on Commonwealth Fellowship for one year at Guy's Hospital, London carried out immunohistochemical stud-

ies on peripheral nerves in Guillain-Barre Syndrome and experimental allergic polyneuritis in animals. He also actively participated in the ongoing research projects of Azathioprine trial in multiple sclerosis and plasmapheresis in Guillain-Barre Syndrome.

The Department collaborated with Dr. Pratap of the Cochin University in a quantitative analysis of EEGs applying non-linear analytical technique and employing Kolmogorov second entropy method. This analysis revealed interesting findings and suggested a divergence of the EEG of a normal person from the apparently "normal" interictal EEGs of patients with epilepsy and migraine.



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Further work in this field is in progress.

Postgraduate students from Medical College, Trivandrum underwent short-term training in the Department.

Dr. P. K. Mohan attended Regional Symposium on Evoked Potentials

and clinical uses of Neurophysiology, organised by the International Federation of Societies for EEG and clinical Neurophysiology, at Bali, Indonesia in September 1987. He visited Rigs Hospital, Copenhagen and spent 2 weeks in Electro-Neurophysiology Department of the hospital in October 1987.

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### Department of Neurosurgery

Dr. Damodar Rout, MS, M.Ch.	Professor
Dr. R. N. Bhattacharya, MS, M.Ch.	Associate Professor
Dr. A. K. Mishra, MS, M.Ch., MNAMS	Assistant Professor
Dr. Rajeev Sharma, MS, M.Ch.	Lecturer
Dr. Suresh Nair, M.Ch.	Lecturer
Dr. S. M. Rohatgi, MS, M.Ch.	Lecturer
Dr. M. P. Haroon, MBBS	Candidate for M. Ch.
Dr. Sarala Menon, MS	do.
Dr. Satish Krishnan, MBBS	do.
Dr. Subodh Darbari, MS	do.
Dr. Dilip Paniker, MS	do.
Dr. R. S. Diwanji, MS	do.
Dr. A. K. Chand, MS	do.

The department registered a steady increase in the volume of clinical work and operative procedures as compared to the previous year. Special attention was paid to vascular lesions of the brain as increasing numbers of patients were referred to the Institute from various parts of the country for the management of intracranial aneurysms and arteriovenous malformations. The department also accumulated the largest surgical experience of soft tissue anomalies at the cervicovertebral junction and colloid cysts of the third ventricle in the country. Other areas of interest with notably large surgical experience included microsurgical

total excision of cerebellopontine angle and other posterior fossa tumours. Interventional neuroradiological therapeutic procedures continued to grow in collaboration with the Department of Radiology.

The research project on the "Development of an indigenous viable hydrocephalic shunt system" made progress in collaboration with the Divisions of Artificial Internal Organs and Polymer Technology of the Biomedical Technology Wing.

The research projects of the post-graduate students included "Effect

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of various pharmacotherapeutic agents in the prevention of vasospasm/vasculopathy following experimental subarachnoid haemorrhage in dogs” and “study of Intracranial pressure changes in experimental subarachnoid haemorrhage in dogs”.

Cavitron Ultrasonic Surgical Aspirator (CUSA) arrived towards the end of the year and was awaiting installation. This equipment was expected to be highly useful for the total removal of various benign tumours and for reducing the operating time for large tumours in general.

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Project:	Development of an indigenous viable hydrocephalic shunt system
Principal Investigator	D. Rout
Co-Principal Investigator	G. S. Bhuvaneshwar
Co-Investigator	S. N. Pal
Funded by	DST
Status	Ongoing

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Prof. Rout attended the 7th Asian-Australasian congress of neurological surgery at Brisbane, Australia in October 1987 and presented three scientific papers on “infectious intracranial aneurysms”, “surgical management of syringo-hydromyelia: experience with 68 patients”, and “cerebral angiomatous malformations: experience with 180 cases”.

Prof. Rout served as a Visiting Professor for a week at the Postgraduate Institute of Medical Education and

Research, Chandigarh during the year. He was also appointed a member of the Board of Studies in Neurosurgery of the Banaras Hindu University.

Dr. Derek S Gordon, Chief of neurosurgery, Royal Victoria Hospital, Belfast and President, Society of British Neurological Surgeons visited the department in December 1987 and gave a lecture on the “Management of bilateral acoustic neurinomas”.

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### Division of Neurochemistry

Dr. Debkumar Basu, Ph.D.	Professor
Dr. P. S. Appukuttan, Ph.D.	Lecturer (on leave)
Mrs. K. I. Annamma, B.Sc.	Scientific Assistant
Miss Jyoti V. Nair, M.Sc.	Candidate for Ph.D.
Mr. Madhusudhanan Nambiar, M.Sc.	do.
Miss Yasmin Marikar, M.Sc.	do.
Mr. Bobby Zachharia, M.Sc.	do.

Alpha-galactose specific lectin of Jack Fruit (*Artocarpus integrifolia*) seeds was crystallised and found to be orthorhombic. The lectin specifically bound mammalian IgA class immunoglobulin and showed high affinity for a disaccharide  $\beta$ -gal(1 $\rightarrow$ 3) galNAC. The amino acid groups involved at active site are lysine and tyrosine. A fluorometric method for the saccharide and lectin binding

reactions using enhanced tyrosine fluorescence was developed.

An  $\alpha$ -galactosidase from the same seed was purified to homogeneity and shown to be a homotetramer of 9kDa. The enzyme did not agglutinate any native or trypsinised rabbit or human erythrocytes, but was found to hydrolyse galactomannan.

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Project	Structure of Enzymes, Glycoproteins, the role of their carbohydrate side chains and their interaction with lectins.
Principal Investigator	Debkumar Basu
Co-Investigator	P. S. Appukuttan
Funding	Department of Science & Technology
Duration	4 years (to be completed in June 30, 1988)
Status	Ongoing

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Beta-galactose binding lectin and  $\beta$  – galactosidase of human placenta was studied in detail. Tryptophan and arginine residues were involved at the substrate binding-site of the enzyme whereas arginine, lysine and

histidine were involved at the saccharide-binding site of the lectin. The antibody (raised in rabbits) against the lectin cross-reacted with  $\beta$  – galactosidase. The lectin did not have any enzyme activity.

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Project	Cell Surface Glycoproteins of Developing Brain
Principal Investigator Funding	Debkumar Basu Council of Scientific & Industrial Research
Duration Status	3 years Ongoing

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The objective of the project was to identify, characterise and isolate the cell surface glycoprotein markers of various cell types in developing brains. This required isolation and separation of neurons and glial cells of developing brains in near homogenous population.

The methodologies for the isolation and characterization of neurons and

glial cells of developing brain were established and a limited number of cells surface marker glycoproteins identified. The methods for labelling the oligosaccharide side chains were being developed.

The staff of the Department contributed to postgraduate teaching by lectures and seminars.

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### Division of Pathology

Dr. V. V. Radhakrishnan, MD	Associate Professor
Dr. C. C. Kartha, MD	Assistant Professor
Dr. S. Sandhyamani, MD	Assistant Professor
Dr. R. Renuka Nair, Ph.D	Lecturer
Dr. C. R. L. Shastri, MD	Lecturer
Mrs. Annamma Mathai, M.Sc	Scientific Assistant

The laboratory investigations in clinical pathology were transferred to the new Central Clinical Laboratory with consequent reduction in the service component of the Division. Nevertheless the laboratory investigations carried out was conspicuous by the introduction of several new immunological and other tests which are listed in the following Table.

**Table - 7**

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Complement assay T & B cell estimation, Immunglobulin estimation in sera and body fluids, Circulating immune complexes, Antinuclear factor assay	1200
Immunocytochemical tests (for pituitary tumours)	24
Non competitive Elisa tests	75
Histopathological tests	750
Frozen sections	230

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The staff of the Department took active part in the teaching programme for postgraduate students by holding weekly neuropathology demonstrations, autopsy meetings and cardiac pathology demonstrations.

To investigate the impressive autopsy finding of generalised deposition of mucopolysaccharide in arteries, Dr. Sandhyamani initiated a project which sought to induce arterial lesions in the primate model by dietary means.

In another investigation, antibodies to mycobacterial antigens were developed for the diagnosis of tubercular meningitis, using myelin basic protein which was purified from human brain. An indirect ELISA test was also established for the diagnosis of demyelinating disorders.

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Project	Cardiovascular changes in induced malnutrition
Principal Investigator	S. Sandhyamani
Funding	DST
Status	Ongoing

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A collaborative study was begun with the Department of Surgery of the Medical College, Trivandrum on complement polymorphism and tobacco protein in Buerger's disease. The study envisaged, among other things, the assay of protein C and S in these patients which had been suggested by Dr. Carl G. Becker of the

New York Hospital-Cornell Medical Centre, New York who paid a highly useful visit to the Division.

Postgraduate students in pathology from the Medical Colleges in Trivandrum and Kottayam spent short periods in the laboratories for training.

## Department of Radiology

Dr. V. R. K. Rao, MD	Professor
Dr. Ravimandalam, MD	Associate Professor
Dr. Arunkumar Gupta, MD	Assistant Professor
Dr. Sunil Kumar, MD	Assistant Professor
Dr. Madhavan Unni, MD	Lecturer
Dr. Santhosh Joseph, MD	Lecturer
Dr. A. S. Rao, MD	Lecturer
Dr. Sumit Roy, MD	Candidate for Postdoctoral Certificate course

Diagnostic and interventional procedures carried out during the year are shown in tables 8 and 9.

**Table-8 Routine activity**

Plain X-rays	13278
Tomography	33
Myelography	135
Aortography	122
Cardiac catheterizations	768
Coronary angiography	30
Neuro-vascular studies	212
C. T. Scans	4653
Internal patients	1835
External patients	2818 (60%)

**Table-9**

PTA of peripheral arteries	21
Thrombolysis	1
Balloon occlusions	5
Coil occlusions	4
Superselective embolization	8

While the procedures in clinical radiology absorbed much of the time of the faculty and postgraduate trainees, projects in applied research also received considerable attention. Investigative support was provided to Dr. Jayakrishnan of the Division of Polymer Chemistry in the development of radioopaque microspheres which could be used for embolisation of arteriovenous malformations. These beads of hydrogels were found to be nontoxic and potentially capable of delivery through microcatheters into selected sites. The hydrogel was applied to coat intravascular stents and occlusal umbrellas which were designed in the Division. Preliminary results of the implant of stainless steel stents in the canine inferior vena cava are shown in Fig. 10 A and B.

Similarly extruded stainless steel spring coils from the used guide wires were used for wiring arteriovenous fistulae and aneurysms which were unsuitable for surgical intervention (Figs. 11–13)





Fig. 10A  
Zig-Zag Stents in the IVC  
of a dog.



Fig. 10B  
Patent IVC after 3 months.



Fig. 11A  
A.V. Fistula in the popliteal  
fossa.

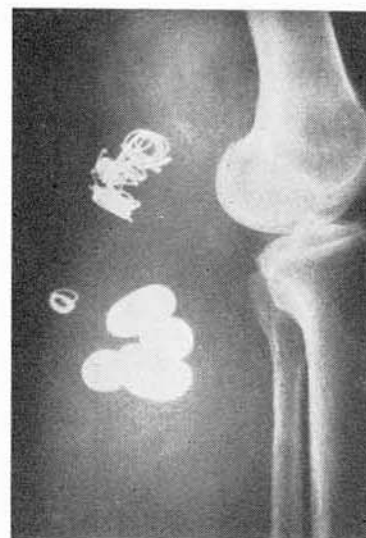


Fig. 11B  
A. V. Fistula in popliteal fossa  
occluded by coils and balloons.

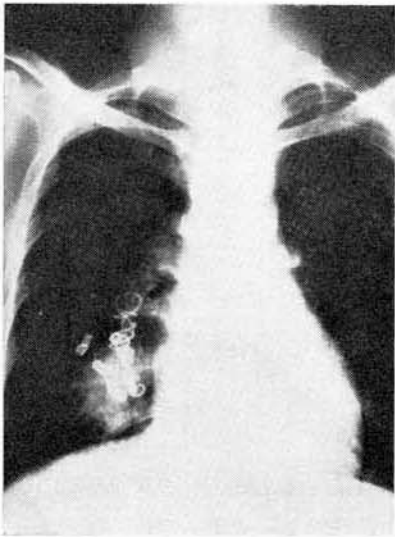


Fig. 12  
Pulmonary A V Malformation  
obliterated by Spring Coils.



Fig. 13A  
Abdominal aortic aneurysm.

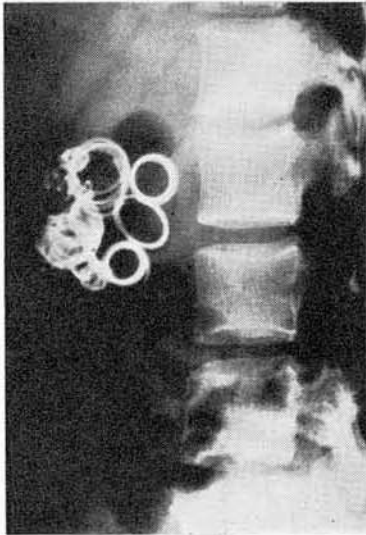


Fig. 13B  
Stainless steel spring coils in the  
aneurysm in profile view.



Fig. 13C  
Bunch of spring coils in the  
aneurysmal sac seen from front.

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Collaborative work with the Department of Gastroenterology of the Medical College was continued in the CT evaluation of the pancreas in patients with chronic tropical pancreatitis.

Dr. Ravimandalam and Dr. Rao were involved as investigators in the laser project which made a start with the arrival of the laser and radiological equipment at the Biomedical Technology Wing.

The following radiologists visited the Department for short periods of training in radiologic and intervention procedures.

1. Dr. Balachandran, JIPMER,  
Pondicherry
2. Dr. Javed Rehman do.
3. Dr. Jagga Rao do.
4. Dr. Rajan Williams, CMC,  
Vellore
5. Dr. Parameswaran, Medical  
College Hospital, Trivandrum
6. Dr. Vasu do.

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## **BIOMEDICAL TECHNOLOGY WING**

*Head:* Mr. A. V. Ramani, B.Sc. (Chem. Tech.)

### **Department of Biomaterials Science**

Division of Technical evaluation of Biomaterials:

Dr. M. Jayabalan, Ph.D.	Scientist
Mr. K. Sreenivasan, M.Sc.	Scientific Officer
Mrs. Prabha D. Nair, M.Sc.	Scientific Officer

A non-toxic linear segmented polyurethane was prepared using an aliphatic diisocyanate and a new formulation was adopted to get a balanced hydrophilic and hydrophobic character. The material was subjected to subcutaneous implantation in rabbits and evaluated after 9 months by physicochemical and histopathological methods. Out of the 3 implanted samples, the one which was more elastomeric showed changes in shape and physicochemical properties. The other two samples did not reveal significant changes in shape or physicochemical properties. These two materials exhibited favourable tissue compatibility with smooth fibrous tissue encapsulation and fibrous connective tissue in-growth. They also showed vascularity in the porous polymer matrix and absence of symmetric, progressive necrosis. However the regenerated, striated muscle formed

around the implant sites featured inflammatory cells and giant cells. The elastomeric material was associated with mild tissue reaction and liquefactive necrosis.

Another sample of polyurethane based on isophorone diisocyanate was also prepared for tissue compatible applications. One linear polyurethane and another crosslinked polyurethane were prepared and tested for their degradability. Linear polyurethane was found to be degraded extensively on treatment with methanol. The crosslinked polyurethane was found to have good physicochemical properties in comparison with those of linear polyurethane. These two polyurethanes were subjected to systemic toxicity, intracutaneous irritation test and hemolysis test which showed the materials to be non toxic.

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Another study related to elastomeric tissue adhesives which included new trials with polyurethane prepolymer adhesive. As a part of the ongoing Ph. D programme newer polymeric materials were developed using the technique of interpenetrating network (IPN). Full IPN of a hydrophobic segmented polyether urethane and hydrophilic polyacrylamide was prepared. The polyurethane parts constituted a biuret of diisocyanate, polyether polyol and a triol. The newer polymeric material possessed superior mechanical and thermal properties and proved to be non-toxic. The tests for biocompatibility are in progress.

In another Ph. D programme, studies on the interaction of biological components and segmented polyurethanes were carried out. An objective of the investigation was to elucidate the diffusional behaviour of representative biological components in segmented polyurethane

and induced alterations in the properties of the polymer. The data obtained from the studies on segmented polyurethane (Tecoflex, USA) with steroids and fatty acids showed variation in the mechanical, thermal and surface properties. The effect of the structural component of the segmented polyurethane was under current investigation.

The division offered its routine service facilities to the laboratories of Institute as well as to outside institutes as in previous years.

Dr. Jayabalan attended the Annual convention of chemists at the Shivaji University, Kolhapur and presented a paper. He and his colleagues Mr. Sreenivasan and Mr. Shunmuga Kumar also attended National Symposium on 'Recent trends in polymer science', sponsored by University of Madras and Society of polymer Science and presented three papers.

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**(ii) Division of Thrombosis Research**

Dr. M. Jamaluddin, Ph.D.      Scientist  
Mrs. Lissy Kalliyanakrishnan, M.Sc.      Scientific Assistant

The technology for the photometric measurement of agonist-induced single platelet recruitment into aggregates was developed for the first time. A paradigm of the aggregatory process of platelets was newly formulated in terms of the kinetics of agonist interaction with platelets, their shape-change reactions and interaction among shape-changed forms to form aggregates. Based on these two developments, the kinetic principles and modulatory mechanisms of interplatelet interactions were investigated with a view to understanding their role in the thrombotic process and designing better platelet suppressive therapies. The pro-

staglandin H2 receptor of platelets was purified and characterized for the first time.

Possible changes in the aggregatory properties of platelets in certain cases of congenital heart disease were investigated in collaboration with Dr. P. K. Mohan and assistance was provided to Dr. Nini Gupta in studying the aggregatory properties of platelets in endomyocardial fibrosis, employing the spectrophotometric method.

Dr. Jamaluddin presented two papers at the XIth International Congress on Thrombosis and Haemostasis, Brussels, Belgium, 4-11 July 1987.

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## Department of Biomedical Engineering

### (i) Division of Artificial Internal Organs

Mr. G. S. Bhuvaneshwar, B.Tech. MS    Biomedical Engineer  
Mr. C. V. Muralidharan, B.Tech.    Scientific Officer  
Mr. R. Sreekumar, B.Sc.    Scientific Assistant

#### Chitra Heart valve prosthesis:

The development of a tilting disc valve continued to be the major project of the division during this year. Consequent on the failure of the Sapphire disc/TiN coated Haynes -25 valves in a few animals during Dec '86 to March 1987, efforts to locate alternate materials for the disc were initiated. Screening was begun with the plastics already in use for implantable devices and these included the various grades of Delrin like 500, AF and ST, polyester/ptfe composite EKONOL and UHMW polyethylene.

Considering the extremely high toughness of UHMW-PE and its wear resistance, its good record of use in the artificial hip joints and also its use in a model of caged disc Starr-Edwards valve without any adverse reports so far, special emphasis was laid on the evaluation of this material. All the above selected plastics were tested in a pin-on-wheel tester for adhesive wear and a sand slurry

system for abrasive wear. UHMW-PE was found to have the maximum wear resistance in both types of wear. Early prototype testing in the accelerated wear tester of UHMW-PE discs in titanium and also TiN coated cages were carried out upto 200 million cycles and the wear rates were found to be very low and the combination to be highly satisfactory.

Subsequently, the fabrication problems of the disc were taken up. Mechanical polishing of UHMW-PE being next to impossible, a heat polishing technique was developed. Studies with the first polishing die were carried out to determine the optimum material volume and shape, starting finish and the time-temperature profile required to achieve the required mirror finish. Hot air ovens being not very suitable for this purpose, a direct heating oven with good temperature control was designed and fabricated to meet the special requirements.

Qualification of the UHMW-PE and the degradation due to the heat polishing cycle were studied using a pin-on-wheel wear tester (for adhesive wear studies) and a sand-slurry test system for abrasive wear. Early results showed that when UHMW is heated above 145°C it would lose toughness and develop increased abrasive wear. This factor was carefully looked into while the disc polishing technique was being optimised.

Assembly of the first test batch of these valves is expected to be completed in March 88 and implantation experiments in animals to follow.

#### **New Accelerated wear tester**

The Mark III test system assembled and commissioned last year developed problems with the main geared motor drive failing due to motor burn-out (poor power supply consequent to load shedding) and the poor quality of the gear box. To ensure long term trouble free performance and to avoid the problems associated with 3-phase supply, the drive motor and belt were changed with suitable alterations in the mounting arrangement to a 1420 rpm single phase motor. Trials runs are in progress following the modifications.

#### **Failure analysis of sapphire disc valves**

During the initial trials of the new wear tester, 23 size and 27 size sapphire/TiN coated Haynes valves were tested upto 20 million cycles at high pressures and flow rates. It was found that 9 out of the 10 size 23-valves tested failed due to sapphire disc fracture in a manner very similar to that in the animal. However, none of the 8 size-27 valves failed. This clearly suggested a dimensional factor as one of the parameters in the sapphire disc fracture.

Analysis of all the data collected from the implantation studies done in sheep of Titanium/Sapphire, Uncoated Haynes 25/Sapphire and TiN coated Haynes-25 / Sapphire indicated that there could be another factor partly responsible for the sapphire disc fracture. While there were 4 fractures in the 11 implants of the TiN coated valves (2 within 2 weeks of implantation), there were no fractures in any of the 16 implants with uncoated cages (13 titanium and 3 Haynes 25). This significant statistical difference suggested that TiN coating and the subsequent change in surface finish could be factors leading to disc fracture. Obviously the failure analysis of the sapphire disc demanded further studies.



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### **Valve design**

The design of the titanium valve cage was validated by the VSSC structural analysis group using finite element analysis techniques. It was noted that the earlier estimates of the division of the stresses in the cage were reasonably close to those of the detailed analysis, thus validating the design.

### **Chitra Humidifier**

Six units of the Mark I humidifiers were handed over to the Dept. of Anaesthesia for clinical trials. After six months of use 4 units were returned for repair. The causes of all the failure were being studied so that they could be rectified and nurtured for further use and evaluation.

The Mark II version designed last year with improved features like better safety, smaller size and easier cleaning of the patient circuit was evaluated in detail with various designs of the evaporator. The design was finalised after ensuring that the problems faced in the Mark I version would not recur. Components for the fabrication of 10 units for clinical trials were procured and Tool room availability sought for completion of the fabrication.

### **Hydrocephalus shunt project**

With Department of Neurosurgery and Division of Polymer Technology

the fabrication of the invitro test unit was completed and trials undertaken. With the completion of the first batch of moulding dies and the supply of components from the polymer technology division, trial assemblies and testing of the main control valve of this device was begun. The fabrication of slit valves required for the discharge tube was standardised and their performance studied.

The severe power cut during this year and also the limited capacity of the Tool room resulted in this project falling behind schedule by 6 months.

### **Computer programming**

(Library, BMT Wing)

The books catalog database system and an improved bibliography system was developed by the Division for the Library. The database systems using the well known DBASE III system was developed to work on the TURBO 1000 PC-XT computer which became available during this year. After successful testing, the systems progressed to an advanced stage of implementation. Another system successfully developed by the division was a demonstration version of a medical database system for use in the post-graduate training programme.

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**(ii) Division of Biomaterials Technology**

Mr. A.V. Ramani, B.Sc. (Chem.Tech.)

Mr. B. Ajit Kumar, B. Tech. Scientific Officer

In the absence of Sri Venkatesan, the challenge of redesigning the disposable oxygenator with a view to easing commercial production was taken up by the Division with the full support of other scientific groups in cardiac surgery, polymer technology, extra corporeal devices, engineering services, vivarium, toxicology, pathophysiology and technology transfer. The exercise of redesign also gained in no small measure from the guid-

ance of Prof. S. Ramaseshan. The revised model successfully passed the series of engineering and exvivo trials and reached the stage for final evaluation and pilot production at the time of this report.

Support was provided as in previous year to the final phase of the development of valvular prosthesis. A rotary high vacuum pump and Imec inverter were added to the laboratory.

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### (iii) Division of Biosurface Technology

Dr. Chandra P. Sharma,  
M. Tech., MS, Sc. D, MEBE Scientist  
Mr. Thomas Chandy, M.Sc. Scientific Assistant

Polyurethane elastomers are very useful in developing many implantable biomedical devices. They adsorb albumin preferentially upon contact with blood, attract less platelets and therefore gains improved blood compatibility. Attempts were made to develop haemodialysis membranes using polyether urethane urea (PEUU-1025) with improved permeability which would permit small molecules such as urea, creatinine etc. to pass. Membranes were prepared by precipitation techniques. It was observed that the permeability property could be increased by precipitating the films in low temperature medium and also in an organic solvent like methanol without affecting the mechanical property of the membrane. It was concluded that fabrication processes play an important role in the performance of the membrane.

Attempts were also made using polyvinyl alcohol to develop haemodialysis membranes with optimum properties for artificial kidney appli-

cations. Chemical cross-linking of polyvinyl alcohol with paraformaldehyde was developed and standardised to make it suitable for fabricating quality membranes. Further modifications of these membranes were carried out by blending them with polyelectrolyte in different proportions to enhance blood compatibility. Surface properties of these membranes like protein adsorption using  $^{125}\text{I}$  labelled fibrinogen and platelet adhesion with other parameters such as permeability characteristics, mechanical properties etc. were evaluated. The results were compared with those of standard cellulose acetate membranes. It was found that polyelectrolyte blended PVA membranes have a tendency to adhere less platelets than standard cellulose membranes. From the permeability point of view these membranes seemed to be superior or equivalent to standard membranes.

As the part of the search for a non-thrombogenic membrane with high

permselectivity, a series of membranes were prepared by air drying the thin layers of albumin: chitosan (a (1→4) — 2 — amino — 2 — deoxy — β — D — glucan) blends in a ratio of 7 : 3 (chitosan: albumin). The albumin blended chitosan membranes showed high permeability properties for low molecular weight compounds as reported last year. Nonthrombogenic albumin: chitosan blended membranes were derived by immobilizing bioactive molecules like PGE1, Hirudin, Heparin or AT-III on liposome modified membranes, via the carbodiimide functional moiety. Such novel membranes demonstrated good permeability properties for small molecules and showed dramatic reduction in platelet attachment though they had shown variable degrees of wettability. The interfacial changes occasioned by surface modifications did not significantly interfere with their permeability or mechanical properties. Studies are in progress to investigate the permeability and blood compatibility changes for such membranes due to various sterilization techniques.

The metal-blood and metal-tissue interactions at the interface largely determine the biocompatibility of metallic implants. However, the knowledge of these interactions and their relation to prosthetic failure is still inadequate. In the case of metallic implants it is recognised that surface cleaning and preparation are extremely important and essential prerequisites before implantation. An attempt was made to investigate the cleaning procedures of aluminium surface before an oxide layer coating is done by anodizing method. The results indicated that oxide layer increases the hydrophobicity of the surface with corresponding increase in the adsorption of proteins. But when glow discharge was used on a highly cleaned surface, the protein adsorption was less which may be due to its hydrophilic nature. It seems that various cleaning procedures and the thickness of the oxide layer (upto certain limits say, 250 Å) affect the surface energy of the coated material and subsequently the protein-material interaction.

In the collaborative project on artificial skin, progress was made by

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Project	“Studies on improving synthetic biomedical membranes for hameodialysis”.
Principal Investigator	C. P. Sharma
Co-Investigator	T. Chandy
Funding	Department of Science & Technology
Duration	Three years
Status	Ongoing (2 years completed)

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modifying thin membranes of polyether urethane urea (PEUU) with a dense layer of collagen and a thin albumin layer. The modified PEUU demonstrated improved wound healing properties compared to the con-

trol in guinea pigs. Further studies are being planned in guinea pigs to investigate the effect of cellular growth factors and the sterilization techniques for an improved artificial skin substitute.

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Project	“Surface modification–tissue Compatibility towards the development of artificial skin”.
Principal Investigator	C. P. Sharma
Principal Co-Investigator	K. Rathinam
Funding	Indian Council of Medical Research
Duration	Three years
Status	Ongoing (1 year completed)

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A Spectronic-20 was added to the laboratory facility. Miss Nirmala Balwalli and Miss. B. Vishalakshi, Ph. D. students of the Indian Institute of Science, Bangalore visited the division for two weeks to learn various techniques of surface modification and studies related to blood-material interactions.

Mr. Thomas Chandy completed his Ph. D. programme under Dr. Sharma by defending his thesis entitled "Fibrinogen Polymer interaction-Influence of plasma components" successfully.

Dr. Sharma continued to be the president of the Society for Biomaterials and Artificial Organs—India and Editor of 'Trends in Biomaterials & Artificial Organs' during 1987-88. He also accepted membership in the editorial board of Journal of Biomaterials Applications (Technomic Publishing Co., U.S.A.), Biomaterials, Artificial Cells and Artificial Organs (Marcel Dekker Inc) and in the Review Board of Journal of Colloid and Interface Science (Academic Press).

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**(iv) Division of Extracorporeal Devices**

Mr. V. S. Venkatesan, BE    Biomedical Engineer (on study leave)  
Mr. D. S. Nagesh, BE    Scientific Officer  
Mr. S. Vijayan    Scientific Assistant

With the departure of Mr. Venkatesan on study leave for the University of Saskatchewan, Canada for a year, the supervision of the scientific work of the Division was taken over by Mr. Ramani. The final report on the Variflo oxygenator which had been used successfully in 20 clinical perfusions was sent to the Department of Science and Technology and a document on the technological aspects of its production was also prepared for the National Research and Development Corporation. During the year the staff deputed by Peninsula Polymers Limited received training in the Division for the fabri-

cation of the soft shell oxygenator and Cardiotomy reservoir.

The main activity of the staff centred on the redesign of the Variflo oxygenator with a view to further improvement and greater ease in commercial production. As medical devices are never perfect and can always be improved the present effort of the extracorporeal group was neither unusual nor unjustified.

Mr. Venkatesan presented a paper on the Chitra Variflo Oxygenator at the 9th Annual Conference of IEEE/Engineering in Medicine and Biology Society in Boston during November 1987.

(v) A. **Division of Research Toxicology**

Dr. P. V. Vedanarayanan,  
B. V. Sc., Ph.D. Senior Materials Toxicologist  
Dr. A. C. Fernandez, Ph.D. Scientist

Work on the methods of extraction of DEHP contaminants in I. V. fluids was completed and the investigation on serum protein changes in rabbits in response to foreign body implants continued. Total protein

estimation and molecular weight determination techniques are being standardised.

Standardisation work on the primary cultures of various organs from animals is under progress.



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**(v) B. Division of Toxicological Screening of Materials**

Mr. K. Rathinam, M.Sc. Scientist

Safety/ Biocompatibility evaluation of different types of materials that go into the fabrication of Chitra Medical Devices was carried out as per internationally recognized protocols. The toxicity screening programme consisted of both in vivo and in vitro procedures. Total number of tests performed during 1987-88 was approximately hundred in number. Besides material safety assessment, a number of statutory tests such as Pyrogen tests and sterility tests were also carried out on finished Chitra Extracorporeal Devices.

The Division continued to be responsible for supervising a small Research Animal Facility involving breeding, supply, and management of small laboratory animals for its screening/research purpose as well as for the use of other Divisions in BMT Wing.

In the ICMR Research project for the development of artificial skin from polyurethane urea, biocompatibility studies using guinea pigs were carried out. During the last six months, subcutaneous implantation test and skin graft test done in

guinea pigs with autoclaved and glutaraldehyde sterilized test and control materials showed that the test material (PEUU Coated with Collagen & Albumin) causes quicker wound healing than the control material (Bare PEUU).

In the collaborative projects, toxicological characterisation and assessment of biocompatibility was carried out on polymethyl methacryl (PMMA) beads of three different sizes for the Division of Polymer Chemistry. Three polyurethane materials were tested for subcutaneous tissue compatibility using rabbits for the Division of Technical Evaluation of Biomaterials.

A BOD incubator was added to the list of equipment.

Mr. K. Rathinam, participated in the International Workshop on "Toxication and Detoxication Mechanism" held at Industrial toxicology Research Centre, Lucknow. He delivered an invited Lecture on 'The Role of toxicology in Biomaterial Research and Development' at VI Annual Conference of STOX-India held at Guwahati.

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**(vi) Division of Pathophysiology**

Dr. Mira Mohanty, MD     Scientist  
Mrs. T. V. Kumari, M.Sc.   Scientific Officer

The Division continued to provide histopathological, biochemical and haematological assistance to various units of the biomedical wing. Histopathology specimens comprised predominantly of specimens from the Toxicology division for evaluation of tissue response to biomaterial implants. These included intramuscular as well as subcutaneous implants. Regular haematological and biochemical investigations were carried out for the follow up study of sheep which had mitral valve replacement with Chitra valve.

The term of the project on 'Preparation and evaluation of haemoglobin solution as a blood substitute' being over, the final report on the work was sent to Department of Science and Technology. Though the solution had excellent in vitro characteristics,

it proved toxic to rabbits following intravenous infusion, with pulmonary vasoconstriction as a prominent finding.

Extensive survey on literature pertaining to the immunological and haematological changes during cardiopulmonary bypass was carried out and pilot experiments performed to open a new area of investigation. This work was done in collaboration with the Department of Cardiac Surgery.

Prof. David F. Williams of the University of Liverpool and Dr. C. G. Becker of the Cornell University Medical School visited the laboratories and held discussions on tissue-prosthetic interactions and the immunologic response to cardiopulmonary bypass.

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**(vii) Division of Polymer Chemistry**

Dr. A. Jayakrishnan, Ph.D Scientist  
Mr. Chithambara Thanoo, M.Sc Scientific Officer

The main activity of the division during 1987-1988 centred on the preparation, characterization and evaluation of hydrophilic polymeric microspheres for use as particulate emboli for the Department of Radiology. Smooth, spherical highly hydrophilic microspheres having large pore volumes were prepared from crosslinked poly (methyl methacrylate) beads by a procedure developed in the laboratory and their physical properties studied extensively. The microspheres were found to be non-toxic in systemic tests and biocompatible in subcutaneous implantation tests in rabbits. Since the final use of these microspheres is to effect the occlusion of arteries, they were used to embolize the renal arteries of dogs and a 3 month explant confirmed the occlusal effect produced by the microspheres. Complete histopathological evaluation was conducted both on the subcutaneous and the arterial implants of the material in rabbits and dogs which led to the conclusion that the microspheres could be successfully used as particulate emboli for endovascular embolization.

The microspheres were made radiopaque by the incorporation of barium sulphate and their x-ray contrast properties demonstrated in invitro experiments. Haemolysis studies conducted on these microspheres showed them to be non-haemolytic. They are awaiting in vivo evaluation at the time of report.

Microporous poly (2-hydroxyethyl methacrylate) microspheres with pores and channels were recently prepared in the laboratory with the aim of using them as particulate emboli, as drug carriers etc. The technique developed to prepare these microporous microspheres was found to be superior and simpler than the existing methods. The material was characterised for its radiopaque properties in vitro.

Hydrogel microspheres prepared from crosslinked poly (methyl methacrylate) was found to be useful as microcarriers for cell culture and for the propagation of anchorage dependent mammalian cells. Work carried out at the Centre for Advanced Research in Cardiomyopathy using fibroblasts and heart cells demonstrated that they could be used as a microcarrier for cell culture studies.

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**(viii) Division of Polymer Technology**

Mr. S. N. Pal, M.Sc. (Tech.)    Chemical Engineer  
Mr. V. Kallyanakrishnan, M.Sc.    Scientific Officer  
Mr. M. Muraleedharan, MS.    Scientific Officer

The demand on the services provided by the Division increased during this period. More than 15,000 components were moulded for customs pack and rigid shell oxygenator. 250 pieces of chest drainage systems were fabricated and supplied and more than 1000 devices were supplied to the Hospital Wing for clinical use. Two batches of Penpol blood bags were evaluated for integrity, optical, thermal, mechanical and chemical characteristics.

**Acrylics**

Substantial progress was made in the work on acrylics which have potential for applications in dentistry, neurosurgery and orthopedics. Synthesis parameters were standardised for reproducibility in end-product characteristics. Mechanical, physical and toxicological characterisation of the material was initiated. The work on acrylics also resulted in a possible spin off in so far as the acrylic system with some modifications were found to possess cementing property for dissimilar plastics by the Division of Biomaterials technology.

**Blood filter**

The identification of materials to be used for blood filter and fabrication trials was completed. Design of fabrication of jigs and test systems and preliminary evaluation of components were done and evaluation of finished product undertaken.

**PVC modification**

Hydrophilic Polymers could be successfully grafted and crosslinked onto PVC matrix in sheet form. The properties of migration, water sorption and mechanical strength were being evaluated.

Studies were also conducted on PVC based Poly-blends for blendability, processibility, permanance, blend morphology and many engineering properties.

**Hydrocephalus shunt**

Collaboration with the Department of Neurosurgery and Division of Artificial Internal organs for the development of hydrocephalus shunt entered the second year. Design

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of moulds for all the components was completed and characterisation of silicone compounds in terms of cure characteristics, mechanical properties, permeability and permanence carried out. Moulding conditions were established and sizable numbers were made and supplied to the Division of Artificial Internal Organs for assembly and testing. Samples were also fabricated and supplied for toxicological screening.

Dr. Hae Bang Lee of Korea Institute of Chemical Technology visited the Division.

Sri V. Kalliyanakrishnan was elected as a Fellow of Indian Chemical Society.

Sri SN Pal was elected as a corporate member of Plastics and Rubber Institutes (London) and a member of Society for Plastics Engineers (USA).

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**(ix) Division of Technology Transfer**

Mr. H. Vijayakumar, BE Biomedical Engineer  
Mr. D. Ranjit, BE Scientist

As part of the technology transfer agreement between NRDC and M/s Peninsula Polymers regarding the production of soft shell oxygenators and cardiotomy reservoirs, a demonstration-cum-training program was organised for the employees of M/s. Peninsula Polymers. Continuing technical assistance was given to this entrepreneur for the successful implementation of blood bag production. Preliminary technical documentation was produced for the stainless steel dental bands rigid shell oxygenators and cardiotomy reservoirs and distributed to prospective entrepreneurs.

Liaison with L. S. Davar & Co and the National Research Development Corporations for nine Indian and three foreign patent applications reached the final stage.

This division worked jointly with Extracorporeal Devices & Biotechnology Divisions in revising the design of the rigid shell oxygenator which would not only fulfil functional requirements but would also meet mass production requirements.

Given the growing need for computerised databases in biomedical engineering and sciences the division took up the development of easy to use data base package on standards and patents. These were designed to be functionally self-guiding and free of computer language knowledge to the users.

For the second year contract based production of 900 custom packs for the cardiac operating room was accomplished. Like the production of non-injectable crystalloids earlier this activity also attracted industrial enquiries.

The clean room facilities were fully utilised. Infrastructural improvements like automatic adhesive dispenser and sterilisation accessories were added.

The selective dissemination of information activity continued to attract several queries. Eight documents on various areas were of technology transfer were compiled for distribution.

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An exhibit on Chitra Devices was displayed during the Silver Jubilee celebration of T. D. Medical College, Alleppey.

Mr. H. Vijayakumar assumed charge of the BMT Wing Computer facility. He attended the programme on technology forecasting organised by Department of Science and Technology and National Petrochemical Corpor-

ation and presented a paper on "Cost effectiveness in technology transfer" in the COMPTECH International Congress at New Delhi, during November '87.

Mr. D. Ranjit presented a paper on GMP/QC Techniques related to rigid shell oxygenator manufacture in the CSI/ATCVSI Annual Conference at Bangalore.

## **Division of Tool Room and Engineering Services**

Mr. O. S. Neelakantan Nair, B. Sc.

(Engg.) Tool Room Engineer

The activities of this Division were seriously hampered by power cuts which became a regular feature during the year. Notwithstanding this handicap, the Tool Room succeeded in developing dies and fixtures for improving the surface finish and dimensional stability of the new occluder disc of the Chitra heart valve. As the material for the occluder was ultra high molecular weight polyethylene the problems of ensuring a high degree of surface finish and dimensional stability were not small. Similarly fabrication techniques were developed for the shell, heat exchanger tube and other

components of the rigid shell oxygenator which was being redesigned. A third device for which the Tool Room fabricated highprecision moulds was the hydrocephalus shunt.

A Mill-drill table was purchased to make profile milling and jig-boring easier and more accurate.

In providing supportive services, the Division took urgent steps for the purchase and installation of a diesel generator set and the creation of a new facility for housing primates. Regular operation and maintenance of equipment in various sections and units were carried out by the staff in Engineering Services.



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### Division of Vivarium

Dr. Arthur Vijayan Lal, B.V.Sc. Veterinary Scientist  
Dr. S. Bhaskara Rao, M.V.Sc., LL.B. Veterinary Surgeon

To streamline and improve the animal care facilities, the small animal unit in the hospital was transferred to the Biomedical Technology Wing and put under the charge of Dr. Bhaskara Rao. Besides maintaining and looking after rabbits, guinea pigs, rats and mice, the small animal facility also extended assistance to various Divisions in their research projects. These included studies as diverse as the role of chytosan in maintaining hemostasis, antibody response to a virulent bacterial antigen, preneoplastic changes produced by nitromethylurea, antibody response to neuron and glial cells and the embolic potential of new polymers.

The vivarium continued to be responsible for the 'preconditioning' of large experimental animals, their intraoperative management and postoperative care. The procedures un-

dertaken were mitral valve replacement with chitra valve, renal artery embolisation with hydrogel, in vitro evaluation of rigid shell oxygenator and the trial of intravascular stents. The staff of the vivarium functioned as members of a team with the scientists of the clinical and other departments in planning and carrying out all these procedures.

Dr. Bhaskara Rao presented a paper at the Indian Veterinary Surgery Society annual conference at Guwahati during October 1987 and the International Symposium on 'Animal Models in Biomedical Research' organised by DBT and ICMR at NIN, Hyderabad during January 1988.

Dr. J. M. Nigam, Prof. & Head of the Department of Surgery, Hissar Agricultural University visited the laboratory in December 1987.

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## ADMINISTRATIVE BODIES (1986-91)

### INSTITUTE BODY

President: Shri G. Parthasarathi

1. Prof. M. M. S. Ahuja,  
Head of the Department of  
Endocrinology & Metabolism,  
All India Institute of Medical  
Science, New Delhi.
2. Dr. N. Balakrishnan Nair,  
Chairman, State Committee on  
Environment, Science &  
Technology,  
Govt. of Kerala, Trivandrum.
3. Dr. G. Balamohanan Thampi,  
Vice Chancellor,  
Kerala University, Trivandrum.
4. Dr. D. D. Bhawalkar,  
Director, Department of  
Atomic Energy, Government  
of India, Indore.
5. Shri A. Charles,  
Member of Parliament,  
T. C. 1/1460, Burma Road,  
Kumarapuram, Trivandrum.
6. Shri B. K. Chaturvedi,  
Joint Secretary & FA,  
Ministry of Science &  
Technology, New Delhi.
7. Deputy Educational Adviser  
(T), Shastri Bhavan,  
26, Haddows Road, Madras.
8. Dr. V. R. Gowariker,  
Secretary to the Government  
of India, Ministry of Science &  
Technology, New Delhi.
9. Shri V. Krishnamurthy,  
Secretary to the Government of  
Kerala, Department of Health,  
Trivandrum.
10. Dr. R. A. Mashelkar,  
Deputy Director & Head,  
Chemical Engg. Division,  
National Chemical Laboratory,  
Pune.
11. Dr. K. K. G. Menon,  
Vice-President, Hindustan  
Lever Research Centre,  
Bombay.
12. Shri K. Mohanan,  
Member of Parliament,  
T. C. 16/826, Kochar Road,  
Jagathy, Trivandrum.

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13. Prof. B. Nag,  
Director, Indian Institute of  
Technology, Powai, Bombay.
  14. Prof. A. S. Paintal,  
Director-General,  
Indian Council of Medical  
Research, New Delhi.
  15. Shri A. V. Ramani,  
Head, Biomedical Technology  
Wing, Sree Chitra Tirunal  
Institute, Trivandrum.
  16. The Secretary to Government,  
Ministry of Health & Family  
Welfare, New Delhi.
  17. Dr. G. K. Vishwakarma,  
Director-General of Health  
Services, Nirman Bhavan,  
New Delhi.
  18. Prof. M. S. Valiathan,  
Director of the Institute
  19. Dr. R. M. Varma,  
Emeritus Professor,  
NIMHANS, Bangalore.
  20. Dr. N. H. Wadia,  
Director of Neurology,  
Jaslok Hospital and Consultant  
Neurologist, J. J. Group of  
Hospitals, Bombay.

## GOVERNING BODY

Shri G. Parthasarathi (Chairman)

1. Dr. N. Balakrishnan Nair  
Chairman  
State Committee on Science &  
Technology,  
Government of Kerala
2. Dr. V. R. Gowariker  
Secretary to the Government of  
India,  
Department of Science &  
Technology, New Delhi.
3. Dr. R. A. Mashelkar,  
Deputy Director and Head,  
Chemical Engineering division,  
National Chemical Laboratory,  
Pune.
4. Mr. A. V. Ramani  
Head,  
Biomedical Technology Wing  
Sree Chitra Tirunal Institute.
5. Dr. D. Rout,  
Professor of Neurosurgery,  
Sree Chitra Tirunal Institute.
6. Dr. M. S. Valiathan  
Director  
Sree Chitra Tirunal Institute
7. Dr. G. K. Vishwakarma  
Director General of Health  
Services,  
Government of India,  
New Delhi.
8. Dr. N. H. Wadia,  
Director of Neurology,  
Jaslok Hospital and Consultant  
Neurologist, J. J. Group of  
Hospitals, Bombay.

## STANDING COMMITTEES

### **Academic Committee**

Director (Chairman)

Prof. M. M. S. Ahuja,  
Prof. of Medicine & Head of the  
Department of Endocrinology &  
Metabolism, AIIMS, New Delhi.

Prof. N. Balakrishnan Nair,  
Chairman, State Committee on  
Science & Technology, Kerala,  
Trivandrum.

Shri G. Balamohanan Thampi  
Vice Chancellor,  
Kerala University, Trivandrum.

Dr. K. G. Balakrishnan,  
Head of the Department of Cardio-  
logy, Sree Chitra Tirunal Institute

Dr. J. S. Gujral,  
Prof. & Head, Department of  
Cardiovascular & thoracic Surgery,  
PGI, Chandigarh.

Dr. M. Jamaluddin,  
Scientist, Thrombosis Research Unit,  
BMT Wing,  
Sree Chitra Tirunal Institute

Dr. K. K. G. Menon.  
Vice-President,  
Hindustan Lever Research Centre,  
Bombay.

Dr. P. K. Mohan,  
Head of the Dept. of Neurology  
Sree Chitra Tirunal Institute

Mr. A. V. Ramani  
Head, BMT Wing,  
Sree Chitra Tirunal Institute

### **Building Committee**

Director (Chairman)

Mr. M. U. Bhakta,  
Construction Engineer,  
Vikram Sarabhai Space Centre,  
Trivandrum.

Prof. N. Balakrishnan Nair,  
Chairman, State Committee on  
Science & Technology,  
Government of Kerala, Trivandrum.

Head, Biomedical Technology Wing,  
Sree Chitra Tirunal Institute,

Financial Adviser & Chief Accounts  
Officer, Sree Chitra Tirunal Institute.

### **Ethics Committee**

Hon. Justice Shri K. Sukumaran  
(Chairman),  
High Court of Kerala, Ernakulam.

Director of the Institute

Dr. Leila Ramakumar,  
302, Sector 35A, Chandigarh.

Dr. G. K. Viswakarma,  
Director-General of Health Services,  
Government of India, New Delhi.

Dr. D. K. Basu,  
Prof. of Neurochemistry,  
Sree Chitra Tirunal Institute

### **Finance Committee**

Director (Chairman)

Financial Adviser to the Department  
of Science & Technology,  
Government of India.

Sri. V. Krishnamurthi,  
Secretary to the Government of  
Kerala, Department of Health,  
Trivandrum.

Member of the Institute Body  
representing Department of Science  
& Technology

Financial Adviser & Chief Accounts  
Officer of the Institute (Convenor)

### **Junior Staff Selection Committee**

Medical Superintendent of the  
Institute

Head, Biomedical Technology Wing  
of the Institute.

Dr. Jaisy Mathai, BTO,  
Sree Chitra Tirunal Institute

Mr. O. S. Neelakantan Nair,  
Tool Room Engineer,  
Sree Chitra Tirunal Institute

Miss Saramma Abraham,  
Nursing Superintendent of the  
Institute.

A representative of the Academic  
wing of the Institute nominated by  
the Director.

### **Senior Staff Selection Committee**

Director (Chairman)

Dr. R. M. Varma,  
Emeritus Professor,  
NIMHANS, Bangalore

A nominee of the Secretary,  
Department of Science and  
Technology of the Central Govern-  
ment.

Head, Biomedical Technology Wing  
of the Institute

An expert from outside the Institute  
nominated by the President.

A Professor of the Institute.

### **Research Advisory Committee**

Dr. K. K. G. Menon. (Chairman)  
Vice-President, Hindustan Lever  
Research Centre, Bombay.



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Director of the Institute

Prof. M. M. S. Ahuja,  
Prof. of Medicine & Head of the  
Department of Endocrinology &  
Metabolism, All India Institute of  
Medical Science, New Delhi.

Prof. N. Balakrishnan Nair  
Chairman,  
State Committee on Science &  
Technology,  
Government of Kerala, Trivandrum.

Dr. D. D. Bhawalkar,  
Director, CAT,  
Department of Atomic Energy,  
Government of India, Indore.

Dr. R. A. Mashelkar,  
Deputy Director & Head, Chemical  
Engg. Division,  
National Chemical Laboratory, Pune

Dr. B. Nag,  
Director,  
Indian Institute of Technology  
Powai, Bombay.

Dr. A. Jayakrishnan  
(Member-Secretary)  
Sree Chitra Tirunal Institute.

**Technology Development  
Committee**

Director (Chairman)

Dr. D. D. Bhawalkar  
Director, CAT,  
Department of Atomic Energy,  
Govt. of India, Indore.

Dr. A. D. Damodaran,  
Director,  
Regional Research Laboratory,  
Trivandrum.

Dr. R. A. Mashelkar,  
Chemical Engineering Division,  
National Chemical Laboratory,  
Pune.

Dr. Mira Mohanty,  
Scientist, BMT Wing,  
Sree Chitra Tirunal Institute

Prof. B. Nag,  
Director,  
Indian Institute of Technology,  
Bombay.

Dr. K. V. C. Rao,  
Head, Chemical Engg. Group,  
VSSC, Trivandrum.

Prof. S. Ramaseshan,  
Visiting Professor,  
Raman Research Institute,  
Bangalore.

Mr. A. V. Ramani,  
Head, BMT Wing,  
Sree Chitra Tirunal Institute.

Mr. V. S. Venkatesan,  
Biomedical Engineer, BMT Wing,  
Sree Chitra Tirunal Institute.

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**Technology Transfer Committee**

1. A senior technologist nominated by DST (Chairman).
2. A senior Officer of the DST nominated by Secretary, DST.
3. Manager, Technology Transfer Division, VSSC.
4. A nominee of Kerala State Industrial Development Corporation, Trivandrum.
5. Head of the Division of Technology Transfer, SCTIMST.
6. Head, Biomedical Technology Wing, SCTIMST.
7. Director's nominee (in the case of devices) Expert.
8. Principal Investigator (the corresponding person for each device to be called at appropriate time).
9. FA&CAO of Sree Chitra Tirunal Institute.

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## HOSPITALS REFERRING PATIENTS

### KERALA STATE — Districtwise

#### Alleppey

District Hospital, Alleppey  
Government Hospital, Noornad  
Medical College Hospital, Alleppey  
SNMM Hospital, Shertallai  
St. Thomas Hospital, Kattanam  
S. H. Hospital, Alleppey  
Taluk Hospital, Mavelikara  
Taluk Hospital, Chengannur  
GEMS Hospital, Mavelikara  
St. Thomas Mission Hospital,  
Malakkara  
Govt. Hospital, Haripad  
Govt. Hospital, Kayamkulam  
General Hospital, Shertallai  
Velayudhan Memorial Hospital,  
Shertallai  
Priya's Hospital, Kandellore  
St. George Hospital, Kayamkulam  
Matha Medical Mission Hospital,  
Kayamkulam  
Philip Memorial Hospital,  
Mavelikara  
Vijaya Dispensary, Kayamkulam

#### Calicut

Nirmala Hospital, Calicut  
Medical College Hospital, Calicut

#### Cannanore

District Hospital, Cannanore  
Archana Hospital, Cannanore  
Govt. Hospital, Kanhangad

#### Ernakulam

City Hospital, Cochin  
Janatha Clinic, North Parur  
Kunhali's Nursing Home, Cochin  
Lisie Hospital, Ernakulam  
Medical Trust Hospital, Ernakulam  
MOCM Hospital, Kolencherry  
Little Flower Hospital, Angamally  
Port Trust Hospital, Cochin  
General Hospital, Ernakulam  
Ananda Nursing Home,  
Kothamangalam  
Samaritan Hospital, Alwaye  
Santhinikatan Hospital,  
Moovatupuzha  
St. Joseph's Hospital,  
Kothamangalam  
Sree Krishna Nursing Home, Cochin  
Sudheendra Medical Mission,  
Ernakulam  
George Tharakan Hospital, Alwaye  
P. H. C. Neriamangalam,  
Sameksha Hospital, Cochin  
Mar Basilus Hospital, Kotha-  
mangalam

AAJM Hospital, Kottapuram  
ANVM Hospital, Banerji Road,  
Ernakulam  
Lourd Hospital, Ernakulam  
Indian Navy Hospital, Naval Base,  
Cochin  
FACT Hospital, Udyogamandal,  
Alwaye  
Govt. Hospital, Perumbavoor  
Vellukattil Hospital, Ernakulam  
Jubilee Hospital, Edappally,  
Ernakulam  
Philomina Hospital, Manjapra,  
Ernakulam  
Indira Gandhi Co-operative Hospital  
Cochin

#### **Idukki**

District Hospital, Idukki  
St. John's Hospital, Kattappana  
Karuna Hospital, Idukki

#### **Kottayam**

Carithas Hospital, Kottayam  
Good Samaritan Hospital, Kottayam  
Holy Family Hospital, Kottayam  
KVMS Hindu Memorial Mission  
Hospital, Ponkunnam  
Medical College Hospital, Kottayam  
M. G. D. Hospital, Kottayam  
Govt. Hospital, Vaikom  
Mundakapadam mandiram Hospital,  
Kottayam  
Kavakkattu Memorial Hospital,  
Anthinad

S. H. Medical Centre, Kottayam  
Bhavana Hospital, Kottayam  
E. S. I. Hospital, Vaikom

#### **Malappuram**

Govt. Hospital, Tirur  
Dist. Hospital, Manjeri  
Taluk Hospital, Tirur  
Wandoor Nursing Home, Wandoor  
C. S. I. Hospital, Codacal, Tirur

#### **Palghat**

Dist. Hospital Palghat  
Palat Memorial Hospital, Palghat  
7th Day Adventist Hospital,  
Ottapalam  
Taluk Hospital, Ottapalam  
Taluk Hospital, Mannarghat  
P. H. C., Palghat  
Govt. Hospital, Alathoor, Palghat  
Nainan's Clinic, Palghat

#### **Pathanamthitta**

Dist. Hospital, Kozhencherry  
G. K. Hospital, Tiruvalla  
Govt. Hospital, Tiruvalla  
Marthoma Medical Mission, Ranni  
NSS Medical Mission, Pandalam  
People's Clinic, Pathanamthitta  
Pushpagiri Hospital, Tiruvalla  
Tiruvalla Medical Mission, Tiruvalla  
M.M.M. Hospital, Kozhencherry  
Christian Medical Centre,  
Pathanamthitta

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Govt. Hospital, Pathanamthitta  
Medical Trust Hospital, Kulanada  
Govt. Hospital, Adoor  
Luke's Hospital, Pathanamthitta  
K. T. C. M. Hospital, Thottambala,  
Pathanamthitta

### **Quilon**

Benziger Hospital, Quilon  
Dist. Hospital, Quilon  
Deen Hospital, Quilon  
ESI Hospital, Asramam  
Holycross Hospital, Quilon  
Janatha Clinic, Quilon  
Taluk Hospital, Karunagapally  
Upasana Hospital, Quilon  
St. Joseph's Hospital, Anchal  
Dr. Nair's Hospital, Quilon  
Jayabharatham Nursing Home,  
Punalur  
Taluk Head Quarter's Hospital,  
Kottarakara  
Medical Trust Hospital, Kottarakara  
H. M. M. Hospital, Ayur  
Udayagiri Hospital, Paravoor  
Govt. Hospital, Neendakara  
Medical Trust Hospital, Puthoor  
A. M. Hospital, Karunagapally  
Vijayakumar Hospital, Kottarakara  
Govt. Hospital, Mayyanad  
Assisi Atonement Hospital,  
Perumpuzha  
ESI Dispensary, Perinad  
Govt. Hospital, Sasthamkotta  
PHC., Paripally

Victoria Hospital, Quilon  
Parakkadu Hospital, Anchal  
St. Vincent Hospital, Thoovayur  
Brother's Hospital, Pathanapuram  
V. V. M. S. Group Hospital, Isfield  
Estate Kaleuruthy  
Raj Sree Hospital, Ayoor

### **Trivandrum**

Cosmopolitan Hospital, Trivandrum  
General Hospital, Trivandrum  
Govt. Hospital, Peroorkada  
Govt. Hospital, Parassala  
Medical College Hospital,  
Trivandrum  
Nirmala Hospital, Trivandrum  
Sree Ramakrishna Mission Hospital,  
Sasthamangalam, Trivandrum  
Taluk Head Quarters Hospital,  
Chirayinkil  
Taluk Head Quarters Hospital,  
Neyyattinkara  
Taluk Head Quarters Hospital,  
Nedumangad  
VSSC Medical Division, Trivandrum  
W&C Hospital, Trivandrum  
Dr. Govindan's Hospital,  
Trivandrum  
Military Hospital, Pangode  
Al-Arif Hospital, Ambalathara  
Regional Cancer Centre, Trivandrum  
Air Force Hospital, Trivandrum  
Kalyan Hospital, Aryasala  
ESI Hospital, Peroorkada  
SAT Hospital, Trivandrum

Saji Hospital, Kazhakuttam  
P. H. C., Kanyakulangara  
Khan's Hospital, Parassala  
Sivagiri Medical Mission Hospital,  
Trivandrum  
Gayathri Medical Centre, Poojapura  
Govt. Hospital, Vamanapuram  
G. G. Hospital, Trivandrum  
Valsala Nursing Home,  
Vazhuthacaud  
Ophthalmic Hospital, Trivandrum  
V. K. K. Mission Hospital,  
Venjaramoodu  
Sree Uthradam Tirunal Hospital,  
Trivandrum  
T. B. Hospital, Pulayanarkotta  
S. R. Hospital, Beemapally  
Edava Hospital, Edava  
Prakash Memorial Hospital,  
Kilimanoor  
Prakash Clinic, Trivandrum  
Fort Hospital, Trivandrum  
P. R. S. Hospital, Trivandrum  
Stanley Hospital, Udyankulangara,  
Trivandrum

#### **Trichur**

Agrasala, Kodungalloor  
Amala Cancer Centre, Trichur  
Balya Children's Hospital,  
Veliyannur  
E. S. I. Hospital, Olarikara  
Jubilee Mission Hospital, Trichur  
Dist. Co-operative Hospital, Trichur  
Royal Hospital, Kunnamkulam

Dist. Hospital, Trichur  
Govt. Hospital, Choondal  
Taluk Head Quarters Hospital,  
Chavakkad  
Elite Mission Hospital,  
Koorkancherry  
Govt. Hospital, Irinjalakuda  
Metropolitan Hospital, Kokkalal

#### **Wynad**

Assumption Mission Hospital,  
Sulthan Bettery  
Govt. Hospital, Mannantody  
Wynad Hospital, Sulthan Batteri

#### **OTHERS — State-wise**

##### **Andhra pradesh**

N. S. General Hospital, Hyderabad

##### **Calcutta**

Postgraduate Institute, Calcutta

##### **Karnataka**

Jayadeva Institute of Cardiology,  
Bangalore  
Kasturba Medical College, Manipal  
Medical College Hospital, Bangalore  
St. John Medical College Hospital,  
Bangalore  
General Hospital, Bangalore

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**Maharashtra**

Dr. M. G. Pillai, Gayathri, Andheri West, Bombay

**Madhya Pradesh**

MPEB Hospital, Chachal  
Govt. Medical College, Jabalpur

**Pondicherry**

JIPMER, Pondicherry

**Tamil Nadu**

Chandran Hospital, Marthandam  
P. N. P. Hospital, Marthandam  
Biswas Hospital, Marthandam  
Catherine Booth Hospital, Nagercoil  
Jayasekharan Hospital, Nagercoil  
Jawahar Hospital, Nagercoil  
Kunneth Hospital, Padanthalmoodu  
Vin's Hospital, Kaliakkavila

Kanyakumari Medical Mission,  
Neyyore  
Mathai's Hospital, Nagercoil  
Merlin Hospital, Coimbatore  
Govt. Rajaji Hospital, Madurai  
Aravind eye Hospital, Madurai  
Kuppuswamy Naidu Memorial  
Hospital, Coimbatore  
General Hospital, Madras  
Medical College Hospital, Tirunelveli  
Taluk Hospital, Tiruchandoor  
Dist. Head Quarters Hospital,  
Nagercoil  
Gandhimathy Nursing Home,  
Tirunelveli  
Dominic Hospital, Kulasekharam  
Govt. Hospital, Tenkasi  
Abdul Kadar's Nursing Home,  
Nagercoil  
Annai Nursing Home, Tenkasi  
C. M. C. Vellore

**ABROAD**

Rasheed Hospital, Dubai, UAE  
Marfaq Hospital, Abudhabi

## ALUMNI PAGE

1. Dr. H. D. Waiker (PDCC 1983) Assistant Professor, Sree Chitra Tirunal Institute, Trivandrum.
2. Dr. N. S. Kodandaram (PDCC 1983) Assistant Professor, MS Ramiah Medical College, Bangalore.
3. Dr. R. Sankarkumar (M. Ch. 1984) Assistant Professor, Sree Chitra Tirunal Institute, Trivandrum.
4. Dr. S. M. Upadhyaya (PDCC 1984) Assistant Anaesthetist, Tata Memorial Hospital, Bombay.
5. Dr. M. V. Joseph Joy (DM 1985) Lecturer, Sree Chitra Tirunal Institute, Trivandrum.
6. Dr. K. Suresh (DM 1985) Assistant Professor, Medical College, Trivandrum.
7. Dr. Anand Kumar (DM 1985) Tutor, Medical College, Trivandrum.
8. Dr. (Mrs.) C. Sarada (DM 1985) Lecturer, Sree Chitra Tirunal Institute, Trivandrum.
9. Dr. M. Unnikrishnan (M. Ch. 1985) Lecturer, Sree Chitra Tirunal Institute, Trivandrum.
10. Dr. S. Gobisankar (DM 1985) Cardiologist, Govt. Hospital, Pondicherry
11. Dr. R. Krishnan (DM 1985) Civil Asst. Surgeon and Consultant Cardiologist, Trichy.
12. Dr. K. Venugopal (DM 1985) Assistant Professor, Medical College, Alleppey.
13. Dr. Ravisubramanya (DM 1985) Assistant Professor, Kasturba Medical College, Manipal.
14. Dr. H. L. Subba Rao (M. Ch. 1985) Assistant Professor, JJM Medical College, Davanagere.
15. Dr. KSVK Subba Rao (M. Ch. 1985) Professor, JIPMER, Pondicherry.
16. Dr. P. K. Neema (PDCC 1985) Consultant Anaesthetist, Shree Mahavir Hospital, Surat.
17. Dr. A. K. Gupta (PDCC 1985) Assistant Professor, Sree Chitra Tirunal Institute, Trivandrum.



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18. Dr. K. Venkateswarlu (DM 1986) Assistant Professor, Andhra Medical College & Neurophysician K. G. Hospital, Vishakapatnam.
19. Dr. K. Srinath (DM 1986) Assistant Professor, Nizam's Institute of Orthopaedics and Speciality, Hyderabad.
20. Dr. GM Wali (DM 1986) Lecturer, JN Medical Colleges, Belgaum.
21. Dr. S. Bhanumurthy (PDCC 1986) Lecturer Nizam's Institute of Orthopaedics and Specialities, Hyderabad.
22. Dr. A. Balthimmaiah (PDCC 1986) Assistant Professor, Kurnol Medical College, Kurnol
23. Dr. M. Sreenivasan (DM 1987) Cardiologist, Medical College, Madurai.
24. Dr. Shailender Singh (DM 1987) Assistant Professor, Nizam's Institute of Orthopaedics & Specialities, Hyderabad.
25. Dr. Suresh G Rao (M. Ch. 1987) Cardiac Surgeon, Institute of Cardiology, Vijaya Hospital, Madras.
26. Dr. J. T. Tolia (M. Ch. 1987) Cardiac Surgeon, Suhrday Surgical Clinic, Rajkot.
27. Dr. K. N. Krishna (M. Ch. 1987) Lecturer, St. John's Medical College, Bangalore.
28. Dr. R. V. Phadke (PDCC 1987) Lecturer in Radiology, Govt. Medical College, Nagpur
29. Dr. NLN Moorthy (PDCC 1987) Medical Officer, Directorate of Health Services, Hyderabad.
30. Dr. Rupa Sreedhar (PDCC 1987) Lecturer, Sree Chitra Tirunal Institute, Trivandrum.
31. Dr. M. V. Purohit (PDCC 1987) Lecturer, Sree Chitra Tirunal Institute, Trivandrum.
32. Dr. Raman Chadha (PDCC 1987) Medical Officer, RML Hospital, New Delhi.
33. Dr. Sunil Kumar (PDCC 1987) Assistant Professor, Sree Chitra Tirunal Institute, Trivandrum.
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**INDO-UK SYMPOSIUM ON BIOMATERIALS**

**MEETING REPORT**

Indo-UK Symposium on Biomaterials was held on 5th & 6th January 1988, at Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum to mark the Raman Centenary.

The coming years will undoubtedly see major advances in the development and applications of biomaterials. The pace of biomaterials research will quicken to the extent collaborative effort grows among interested scientists, engineers, doctors and the industry. In this context, the two-day Indo-UK Symposium on Biomaterials organised at the Sree Chitra Tirunal Institute for Medical Sciences and Technology Trivandrum, as part of the Raman Centenary Celebrations was trend-setting. The purpose of the Symposium was primarily to bring together a multidisciplinary group of scientists from the Indian universities for intensive interaction with experts from India and U. K. on the state of the art and frontiers of biomaterials research.

The inaugural session which was held at the enchanting ambience of the Kanakakkunnu Palace was marked by a sparkling keynote by Dr. Ramanna who stressed the vital need for self-reliance in biomaterials and devices technology as in other areas of technology development. The scientific sessions started with an interesting presentation by Dr. R. A. Mashelkar of the National Chemical Laboratories, Pune. He spoke on transport phenomena and reaction engineering in living systems. Providing a chemical engineer's view point, he drew analogy between the reaction processes in the living cell and those in a chemical plant. The human body, he pointed out, can be viewed as a chemical plant under the control of the brain. The conservation equations, such as the mass transfer, momentum transfer and energy transfer equations which applied to a chemical engineering plant apply to the human body as well. Future research should be based upon this basic premise, Dr. Mashelkar emphasised.

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Dr. Gopinathan of the Bhabha Atomic Research Centre, Bombay spoke on radiation processed polymers as biomaterials. He dwelt upon the advantages of using gamma radiation for the production of polymeric materials for biomedical applications. He discussed the work carried out at BARC on the development of haemodialyser using activated charcoal coated with poly (vinyl alcohol). Cross-linked poly (vinyl alcohol) films prepared by gamma irradiation had been used by his group to detect urinary bilirubin.

Dr. K. I. Petrak of U. K. highlighted the problems posed by the body's defence mechanism to the designing of materials for directed drug delivery. He discussed transdermal drug delivery systems which have assumed considerable importance in recent years. The thrust of the presentation of Prof. David Annis (U.K.) related to the development of small diameter vascular grafts. The University of Liverpool had been working on the development of a small diameter ( $< 6\text{mm}$ ) graft based on polyurethane fabricated by electrostatic spinning, a process developed by ICI Inc. Prof. Annis said that such small diameter grafts should be microporous so that blood percolates into the pores and clots and pro-

motes scar tissue formation. But for the biodegradability problems encountered lately and being overcome, polyurethane made by electrostatic spinning techniques holds promise for production of small diameter vascular grafts.

Prof. C. H. Bamford (U.K.) who spoke on the modification of polymers for medical applications, discussed various chemical methods to alter the surface properties of polymers, without affecting bulk properties, to make them more blood and tissue compatible. He said that incorporation of antiplatelet drugs into polymers could help overcome the problem of thrombus formation.

Dr. David Williams of U. K. discussed the development of dental materials and dental implants. In restorative dentistry, the development of non-mercurial amalgam-like systems in place of silver, tin and mercury amalgams was described. Many of the undesirable effects associated with mercury amalgams could be avoided, he pointed out. Modified composites such as polyurethane dimethacrylates cross-linked with triethylene glycol dimethacrylate had been successfully used, wherein the curing reaction could be easily done with visible light in less

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than a minute. Dr. Williams also discussed the work done using single crystal sapphire as dental implants.

Prof. K. J. Rao of the Indian Institute of Science, Bangalore, gave a lucid introduction to the dynamic nature of the complex chemistry of bones. Prof. S. Ramaseshan discussed the work done by his group at the National Aeronautical Laboratory, Bangalore, on the preparation of titanium prostheses for bone replacement by the ion-milling technique developed by his team. He also discussed the use of very high molecular weight polyethylene for acetabular cup replacement.

Prof. Bonfield (U.K.) spoke on the problems associated with total hip replacement in young patients. The success rate of this implant surgery had been very high (> 90%) in the age group of over 65 years, but in younger patients, the results have been rather disappointing. Polyethylene prostheses impregnated with hydroxyapatite has been shown to be better materials for bone replacement. The problems in sintering polyethylene with hydroxyapatite were highlighted and techniques to achieve satisfactory composites of the same discussed. The session

on bones came to a close after Prof. J. E. Davies (U.K.) gave an interesting account of the in vitro and in vivo models being used in investigations on bone-cell / biomaterial interactions.

Dr. A. Jayakrishnan (SCTIMST, Trivandrum) presented his work on the preparation and evaluation of hydrogel microspheres as artificial emboli for endovascular occlusion. Smooth, hydrophilic, perfectly spherical hydrogel microspheres of the desired size had been developed in his laboratory from cross-linked poly methyl methacrylate by a novel method. Preparation of radio-opaque microspheres by impregnating them with barium sulphate or coupling with iodine compounds was discussed. The potential clinical applications of artificial emboli were mentioned.

In the concluding scientific presentation, Dr. K. Shivakumar (SCTIMST, Trivandrum) touched upon the salient features of the phenomenon of cell adhesion and discussed the important application of microcarrier culture. He described the work that led to the successful culture of human skin fibroblasts and human lung and heart cells on the hydrogel microspheres developed by Dr. Jaya-

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krishnan. The hydrogel surface was found to be growth-supportive and cells grown on it were found to be functionally comparable with those grown on commercial tissue culture plates. Dr. Shivakumar spoke on the potential applications of the hydrogel microspheres in the large-scale culture of anchorage-dependent animal cells.

1. Dr. K. Shivakumar
2. Dr. M. Jamaluddin
3. Dr. A. Jayakrishnan

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

#### *Speakers*

Prof. David Annis  
Prof. CH Bamford  
Prof. William Bonfield  
Dr. J. E. Davies  
Dr. David Williams  
Dr. K. L. Petrak  
Dr. Raja Ramanna  
Prof. S. Ramaseshan  
Prof. K. J. Rao  
Dr. R. A. Mashelkar  
Dr. C. Gopinathan  
Dr. A. Jayakrishnan  
Dr. Shivakumar

#### **Delegates**

1. Dr. A. Anukanth,  
Baradhidasan University,  
Tiruchirapalli
2. Dr. G. Aruldas,  
University of Kerala  
Trivandrum
3. Dr. S. I. Ali,  
Jamia Millia Islamia  
New Delhi
4. Dr. N. S. Bhave,  
Nagpur University, Nagpur
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6. Dr. S. M. Bose,  
PGI, Chandigarh
7. Dr. Nirmala Balwalli,  
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8. Dr. S. Devanarayanan,  
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Trivandrum
9. Dr. Mohammad Fahim,  
V. P. Chest Institute, Delhi.
10. Dr. Joseph D. Francis,  
Cochin University, Cochin
11. Dr. S. K. Gupta,  
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Shillong

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| 12. Dr. Satish Chandra Goel,<br>Dept. of Orthopaedics,<br>Institute of Medical Sciences,<br>Banaras Hindu University,<br>Varanasi | 22. Dr. N. S. Poonawala,<br>Faculty of Production &<br>Industrial Engineering,<br>Bombay |
| 13. Dr. M. A. Ittyachan<br>Gandhiji University, Kottayam  | 23. Dr. V. N. Rajasekharan Pillai<br>Gandhiji University, Kottayam                       |
| 14. Dr. B. Krishnan,<br>Pondicherry University,<br>Pondicherry  | 24. Dr. P. Sivasankara Pillai,<br>Govt. Engg. College, Trichur                           |
| 15. Dr. K. N. Mehrotra,<br>Agra University, Agra  | 25. Dr. P. R. K. Reddy,<br>University of Hyderabad,<br>Hyderabad                         |
| 16. Dr. N. K. Mathur,<br>University of Jodhpur,<br>Jodhpur  | 26. Dr. (Miss) H. S. Rama,<br>M. S. University of Baroda,<br>Baroda                      |
| 17. Dr. R. C. Mahajan,<br>PGI, Chandigarh   | 27. Dr. M. Abdul Rahiman,<br>Mangalore University,<br>Konaje                             |
| 18. Dr. Unnikrishnan Nair,<br>University of Kerala<br>Trivandrum  | 28. Dr. Alok R. Ray,<br>IIT, New Delhi   |
| 19. Dr. K. Neelakantan,<br>Govt. Engg. College, Trichur   | 29. Dr. T. Ramakrishnan,<br>University of Calicut, Calicut                               |
| 20. Dr. C. S. Pande,<br>Himachalpradesh University,<br>Simla  | 30. Dr. S. C. Sinha,<br>Muzafarpur Inst. of Techno-<br>logy, Bihar                       |
| 21. Dr. Ravi Prakash,<br>Banaras Hindu University,<br>Varanasi  | 31. Dr. Amernath Singh,<br>Magadh University,<br>Bodh-Gaya                               |
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| 32. Dr. P. B. Bidya Sagar,<br>University of Poona, Pune                              | 38. Dr. K. P. Vijayakumari,<br>University of Kerala,<br>Trivandrum   |
| 33. Dr. M. K. Surappa,<br>Indian Institute of Science,<br>Bangalore                  | 39. Dr. V. K. Vaidyan,<br>University of Kerala,<br>Trivandrum        |
| 34. Dr. S. D. Varma,<br>Gujarat University,<br>Ahmedabad                             | 40. Dr. B. Vishalakshi,<br>Indian Institute of Science,<br>Bangalore |
| 35. Dr. A. Varadarjulu,<br>S. K. University, Ananthpur                               | 41. Dr. M. D. Nair,<br>SPIC, Madras                                  |
| 36. Dr. S. Vaidyanathan,<br>PGI, Chandigarh  | 42. Dr. S. Kandaswamy,<br>SPIC, Madras                               |
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