Technical Research Centre

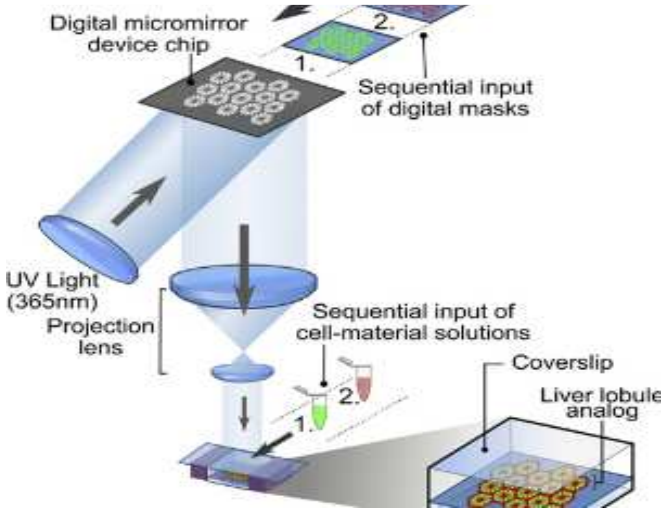
for Biomedical Devices

Technical Research Centre is a mission mode program funded by the Department of Science & Technology, Government of India. Many of these projects are in the proof of concept stage and the Institute looks forward to partner with the industry.

3D printing of liver tissue constructs for *in vitro* hepatotoxicity testing

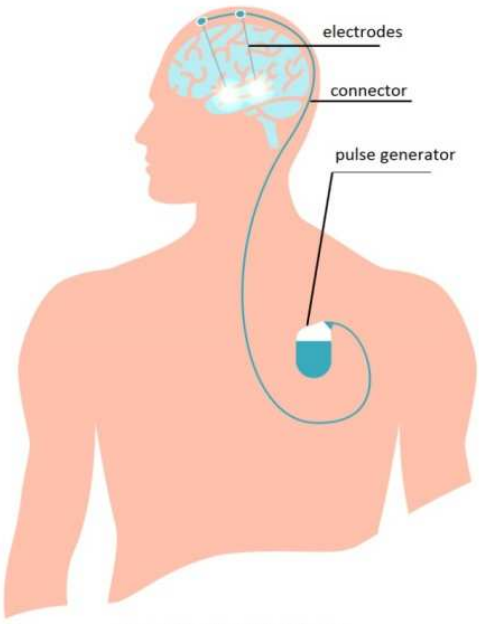
The liver is the most important target for toxicity caused by drugs. This vulnerability is a consequence of the functional features of the liver and its role in the metabolic elimination of most drugs. Therefore, evaluation of potential hepatotoxicity represents a critical step in the development of new drugs. Additive bio fabrication (3D bioprinting) is an advanced area of engineering and science that allows fabrication of precise geometries suitable for the cells to grow.

The project aims to develop an *in vitro* engineered, living, three-dimensional liver tissue construct with liver specific functions for hepatotoxicity analysis. Thus it is expected that a significant improvement in the current *in vitro* test methodologies for accurate assessment and prediction of adverse effects of drugs can be achieved using 3D printed hepatotoxicity system that performs as in vivo-like hepatic *in vitro* models. This would also help reduce the use of laboratory animals for drug toxicity assays.



Deep brain stimulator system

Parkinson's disease (PD) is a chronic neurological disorder that typically affects the elderly, and is caused by the loss of dopamine-producing neurons in the brain stem. Patients with PD suffer from a variety of movement related symptoms such as tremors, stiffness of limbs, slowness of movements and poor balance. In such situations deep brain stimulation (DBS) using electrodes implanted in the brain is used to inhibit the signalling disorder in neural circuits as a result of dopamine deficiency.

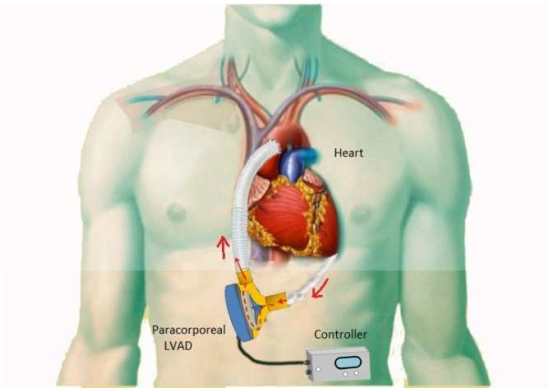


Deep Brain Stimulator

DBS consists of specially designed electrodes, an implantable pulse generator (IPG) and extension cables that run under the scalp and the skin of the neck and chest, which connect the electrodes to the IPG.

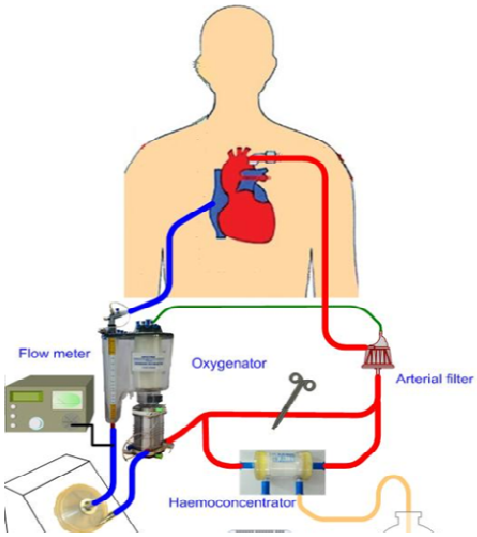
Paracorporeal Left Ventricular Assist Device (p-LVAD)

In Congestive heart failure which is a common cause of death worldwide; the heart becomes terminally ill and heart transplantation and support with mechanical heart assist devices are the only available options for treatment. For heart transplantation the patients have to wait till a donor heart is available. In such cases the heart can be partially assisted with the help of a Left Ventricular Assist Device (LVAD). Hence this device acts as a Bridge to transplant. It can also act as a bridge to recovery. The project envisages the design and development of LVAD which meets the requirements of relevant international standards. The LVAD consist of the pump along with drive, controller, power supply systems and necessary interconnections temporarily assisting the left heart for 15 days.



Centrifugal blood pump for extra corporeal cardiopulmonary bypass along with drive unit and flow meter

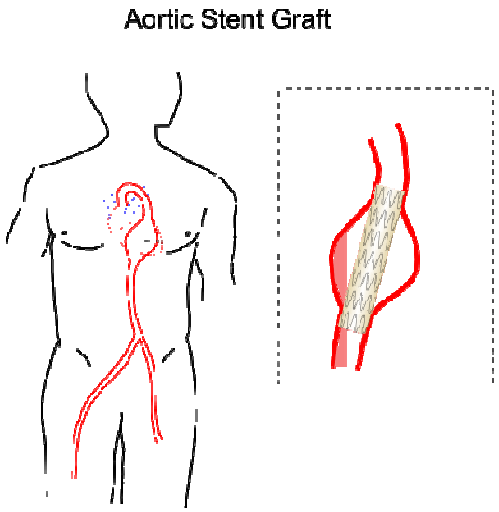
Extracorporeal cardiopulmonary bypass is a technique where the patient's heart has to be stopped or opened for doing a surgical procedure. Since the patient's heart and lungs are stopped, during this procedure blood flow in the body needs to be restored using artificial pumping mechanisms. The functions of the natural heart will be replaced by artificial pumping and natural lungs will be replaced by Membrane Oxygenators. An alternative is a centrifugal blood pump, in which blood is pumped using centrifugal action where the haemolysis can be reduced to one tenth as that of roller pump. Major components of such a system are a pump head for pumping blood, a drive unit providing the mechanical energy to the pump head for its rotation and controlling the flow rate, a flow meter for accurately measuring the flow in order to control the amount of blood flowing into the patient. The project envisages development of the same.



Centrifugal Bloodpump

Aortic stent graft for endovascular treatment of thoracic aortic aneurysms

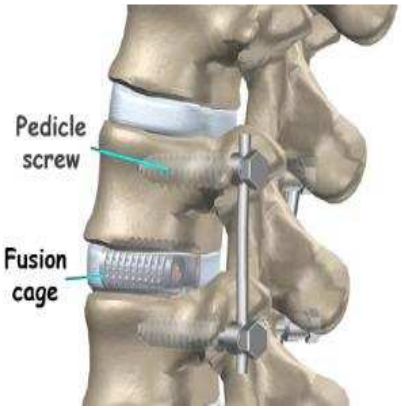
Endovascular aortic aneurysm repair (EVAR) is an endovascular procedure for treating aneurysms of the aorta. Aneurysms are balloon like bulges in the aorta caused by weakening of the vessel wall. An endovascular aortic stent graft, used for repairing these aneurysms, is a tube like device composed of a fabric lumen supported by a metal stent. The procedure is minimally invasive as the stent graft is implanted endovascularly via a catheter and involves lesser operation time and blood loss.



Early mortality rates have been reported to be lower, and it requires a shorter period of hospital stay for the patient. Further the time to recovery is also reduced. This project aims to develop the Aortic Stent Graft device and the target area will be the thoracic segment of the aorta without branches.

Bioactive intervertebral spacers for lumbar fusion

Instability of lumbar vertebral bodies due to degenerative disc disease, spondylosis (vertebral joint inflammation) and spondylitis (infections) often lead to crippling pain. Mitigation of the pain, in most of the chronic cases, is achieved surgically by fusing the unstable portion of the spine or immobilizing the vertebral motion segment. In the fusion procedure, the disc will be removed partially to place metallic spacers to maintain the disc space and the graft ('autograft' or patient's own bone) will be packed in the space. The metallic spacers are designed in 'cage-like' structure so that it can hold the graft material inside. The graft helps in joining the facing end plate of the vertebral bodies through natural healing.

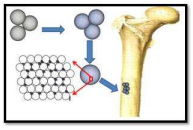


The project aims to design and develop inter-vertebral spacer-cages and coat them with bioactive material on the surface. The inter-vertebral spacer-grafts will also be developed using bioactive composite which can achieve osseointegration.

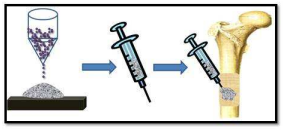
Bioactive material platform for drug delivery in bone

Bone and joint infections (osteomyelitis) remain one of the most dreaded complications of orthopaedic surgery especially implant associated infections. Blood supply into the bone and avascular cartilage remains poor, making systemic drug therapy less effective for bone infection. The known propensity for microorganisms to adhere to implants (notably steel) makes eradication of infection even more difficult. Typically implant associated infections run a protracted course with several surgeries to remove infected material and tissue debris. The objective of the work is to develop a bioactive material platform having new bioceramic composition, which has tuned porosity and osteoconductivity. The release of the drug shall be decided on the type of infection as in some cases like trauma a burst release is required whereas in some other cases a slow release proves effective. The shape and form of the carrier shall also depend on the type of infection. Hence the project addresses osteomyelitis which is a regular and disturbing problem.

BIOACTIVE MATERIAL PLATFORM FOR DRUG DELIVERY IN BONE



Nano porous drug delivery matrix

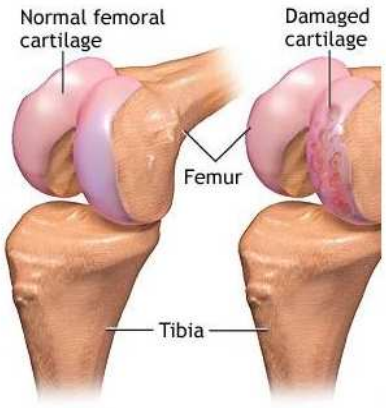


Injectable bioactive cement containing drug

An injectable hydrogel for repair of cartilage injury and growth plate defects

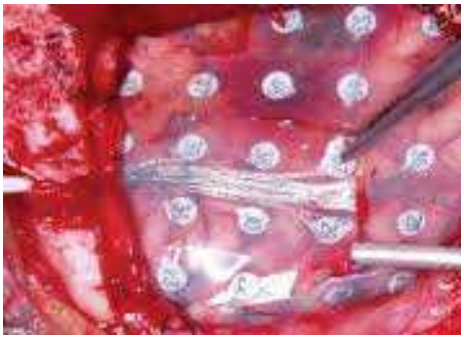
The incidence of cartilage injury or damage is quite common and may be traumatic or degenerative. Most of the trauma related injuries to the cartilage are often as a result of sports or accident related trauma. The incidence of cartilage injury or damage is quite common and may be traumatic or degenerative. Thus this technology will be a 'microfracture plus' therapy with added clinical effectiveness. Further the gel may be used as a delivery vehicle or a spacer for encapsulation of growth plate chondrocytes for the repair of growth plate defects.

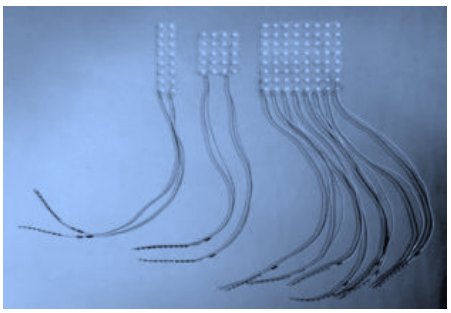
The aim of this project is to develop injectable hydrogel for repairing damaged cartilages. The gel can also be used as a vehicle to transport cartilage producing cells to the site.



Intracranial electrodes for use in acute and chronic electro – corticography for periods up to 15 days

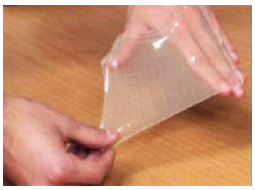
During epileptic seizures electrical discharges originate from certain regions of the brain. From a surgical perspective this tissue must be removed to ameliorate seizure activity. Identification of this tissue is usually done through intracranial grid monitoring using the intracranial electrodes. The device employ platinum electrodes with platinum-iridium alloy connection wires embedded in silicone rubber.





Chitosan/alginate based antioxidant polymeric wound dressings for controlled antibiotic delivery

Delivering antibiotics to wound on site is preferred over systemic administration. The factors that make chronic wounds difficult to heal is the elevated levels of pH, consequently elevated activity of proteases and free radicals such as reactive oxygen species (ROS) or reactive nitrogen species (RNOS). The project aims to develop a polymeric wound dressing for controlled antibiotic delivery and also develop a polymer with antioxidant property so that it can be explored further for treating non-healing wounds also. The wound dressing shall have the advantage that it gives the clinician the freedom to choose the drug of his / her choice.



Fabrication of a wound healing matrix from porcine-cholecystic-extracellular matrix

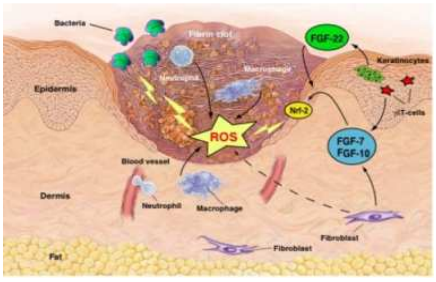
The extra cellular matrix of tissues of animal origin after removal of unwanted cells has a rich load of natural biomolecules that promote tissue regeneration. The objective of this project is to fabricate a matrix from porcine. The extracellular matrix from gall bladder will be developed for wound healing. The cholecystic extracellular matrix thus developed shall focus on applications like excision and burn wounds.

Lint free absorbent dressing for surgical and highly exudating chronic wounds

This project aims at development of a non-toxic medical dressing having a high fluid holding capacity which is fast wicking and lint free, even when cut or trimmed. The sponge used in the dressing should also be non-abrasive to delicate tissues and the size and geometry of the sponge pores should be regulated to conform to the desired pore size distribution required for fast wicking, high liquid holding capacity and precision design. It should also exhibit antibacterial characteristics and maintain a less moist environment especially in certain highly exudating chronic wounds.

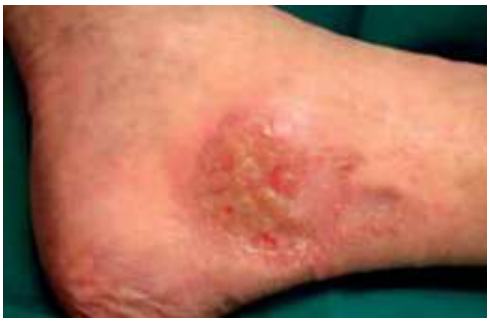
Alginate scaffold with recombinant growth for enhanced wound healing

Growth factors are substances secreted by the body whose function is to stimulate the growth of the cells involved in wound healing and inflammation. The project shall focus on two recombinant growth factors, for its potential application in wound healing.



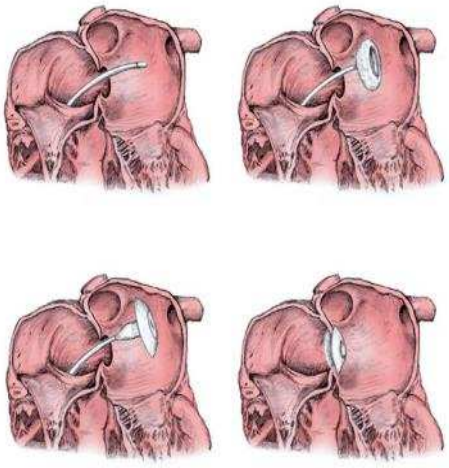
Evaluation of biodegradable PLGC-fibrin hemostatic graft for skin regeneration

Both the in vitro engineered skin with cells and a conductive/inductive scaffold with mechanical and biological properties that match the native tissue could be a valuable graft for treating non healing chronic wounds. In this project, an electro spun biodegradable polymer scaffold with appropriate degradation profile and physico-chemical properties shall be developed as a scaffold. On its implantation, undesirable contraction of the wound could be prevented.



Nitinol based occlusion devices for non surgical closure of Atrial Septal Defect (ASD)

An atrial septal defect (ASD) is an opening or hole in the wall that separates the two upper chambers of the heart. Conventional management technique is to perform an open heart surgery to close the hole.



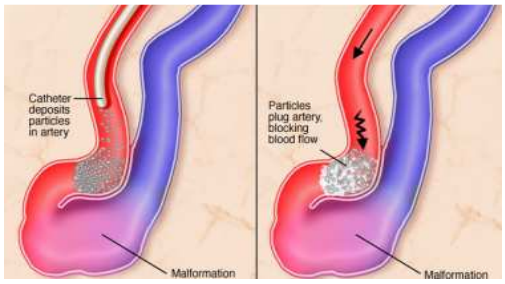
A special metal alloy (Nitinol) mesh is taken to the site using a catheter and then deployed to close the hole. Being a non-surgical procedure, the patient recovers fast and it requires a very short period of hospital stay.

Assay Platform and Sensing Device for PT / INR Monitoring

Cardiovascular and stroke disease management requires continuous and lifelong use of anticoagulants and need a close monitoring of Prothrombin Time (PT) in regular intervals ranging from alternate days to weeks. This causes a huge burden on the clinical labs, discomfort to the patients and over burdening clinicians for verifying the PT value alone. A cost effective home care monitoring system is planned in this project.

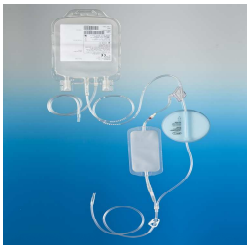
Radiopaque liquid embolization by chemical grafting of iodinated compounds to the ethylene vinyl alchohol co-polymer

Abnormal communication between small arteries and veins within the brain are described as arterio-venous malformation, causing seizures, intracranial bleeding, paralysis, visual loss or severe headache. Such defects are sealed with special sealants which set on contact with blood. Current ones use metal particles (tantalum) loaded sealants for radiographic visualisation.The project aims at development of a non-metallic sealant which would help improve MRI compatibility.



Development of Leukodepletion filter and its evaluation

The presence of white blood cells (WBC) in transfused blood creates many complications to the recipients. Leuko-reduction is the removal of white blood cells (or leukocytes) from the blood or blood components supplied for blood transfusion. The device proposed in the project employs special membranes which attracts and traps WBC as blood passes through it.



An optical Peripheral Nerve Stimulator (feasibility study)

The Standard approach to stimulating human nerve cells has been to use electrical current. Optical nerve stimulation overcomes many of the problems associated with electrical stimulation: it requires no physical contact with the nerve cells. Light source (normally a LASER) can be tuned to precisely hit a small desired area. The project focuses on the feasibility study of optical neural stimulation.

Standardization of Albumin and F-VIII production and IVIG purification method from 'small pool' human plasma

Blood plasma fractionation is the technique for separating the various components of blood plasma. For therapeutic use, human plasma proteins have been manufactured from large pools of plasma for over 60 years. These plasma pools used for production of proteins are derived by combining units from individual donations. The number of units combined into a common mixture for processing is known as "pool size." Most of the time, plasma pool sizes range from thousands to hundreds of thousands of individual units. Many products such as albumin, polyvalent IVIG, Factor VIII, and Factor IX are manufactured through the plasma fractionation. But in general the fractionation is done on large pool size.

This project proposes the concept that regional fractionation (small pool size) can reduce the cost of plasma transportation under cold chain. Proposed technology is suitable for small pool plasma processing to obtain viral safe products, that are cost effective and GMP compatible. The project aims to standardize isolation and bottling of viral safe F-VIII to treat hemophiliacs and Albumin for many indications.