Sree Chitra Tirunal Institute for Medical Sciences and Technology

Trivandrum, Kerala, India 695011

ANNUAL REPORT
2020-2021

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विज्ञान एवं प्रौद्योगिकी विभाग
DEPARTMENT OF SCIENCE & TECHNOLOGY

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY

TRIVANDRUM - 695 011, KERALA

ANNUAL REPORT

2020-21

Annual Report 2020-21

Sree Chitra Tirunal Institute for Medical Sciences and Technology
Trivandrum

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History

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

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

Our Mission

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

Our Vision

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

Message from the President

Dr. V. K. Saraswat

It is a privilege to be closely associated with an organization that has consistently stressed the critical role of Science and Technology in clinical medicine and in doing so, has endeavored to sculpt its future in consonance with soaring societal needs in the realm of healthcare. In this context, it is my duty to acknowledge, with admiration and gratitude in equal measure, the commendable contributions of the Institute to the Nation's battle against the COVID-19 pandemic that has already taken a heavy toll on life and livelihood across the planet.

Encouraged by its past achievements and growing confidence over its ability to deliver on promises, the Institute firmed up its resolve to adopt an integrated approach to the challenge posed by the pandemic. In quick time, several important measures were initiated on multiple fronts, including clinical services in Cardiology and Neurology, testing for infection, designing test kits, and development of medical devices and technologies. I gather that a good number of patent applications have been filed and MoUs signed for COVID-related products developed at the Institute, which is extraordinary by any reckoning. These achievements are, as I had observed earlier, an unmistakable pointer to the fact that Sree Chitra is a "compelling example of how a creative team of clinicians and scientists working together seamlessly can leverage knowledge and infrastructure to make relevant breakthroughs". The product development activities continued through the Technical Research Centre showing remarkable progress.

The year saw the technology transfer of two high-risk implants – Atrial Septal Defect Occlusion device and the Flow Diverter Stent to M/s. Biorad Medisys Pvt. Ltd., Pune, a company engaged in manufacturing and marketing medical devices in the field of Cardiology, Orthopedics and Gastroenterology. These two products were developed in collaboration with National Aerospace Laboratories, Bangalore (CSIR-NAL). The technology of two other products – External Pneumatic Compression Device and Electromagnetic Flowmeter was transferred to M/s. enProducts Pvt. Ltd., Kerala. The commercialisation-related activities of the products like Left Ventricular Assist Device, Rapid Diagnostic Kit for urinary tract infection, Injectable hydrogel for cartilage repair, Lint-free absorbent wound dressing, poly vinyl alcohol sponge transferred during during the previous year also witnessed steady progress.

Various other technologies which were developed as the need of the time for supporting Nation to handle COVID-19 pandemic were transferred to the industries and couple of them is already made it to commercial space, like EBAS-Emergency Breathing Assist System, Rapid Viral RNA Isolation Kit – Chitra Magna, Nylon flocked swabs - nasopharyngeal and oropharyngeal for COVID testing, UV-based face mask disposal bin / multipurpose bin, Viral Transport Medium, 4-zone strategy for the design of mediCAB housing structures for the COVID-19 pandemic and Sample Collection Booth. The other technologies

which have been developed transferred to the industries and are progressing towards commercial space are Infected Secretion Solidification System (AcryloSorb), and RT-LAMP-based COVID testing device. Institute could also develop a novel RT-PCR kit for the diagnosis of the COVID-19 and the technology for the same was transferred to two companies M/s. Huwel Lifesciences Pvt. Ltd., Hyderabad and M/s. Meril Diagnostics Pvt. Ltd., Vapi. These achievements are commendable and also reflect how together we focused and put our efforts to fight COVID-19 pandemic to the best of our ability.

The Institute was also notified as the ICMR Validation Centre for COVID products extending the evaluation services to other entrepreneurs. It was encouraging to see that there were more positive approaches from the medical device industry towards technology transfers. Fifteen Indian and one International patent were granted during the year. The Institute continued and started collaborations with other scientific institutions for development of biomedical technology.

The hospital, an advanced Centre for neurological and cardiovascular diseases took the responsibility to cater to the medical needs of thousands of patients who needed the care during the COVID pandemic. The hospital offered treatment taking extreme care to prevent spread of infection among patients and health workers. Standard Operating Procedures for infection control were made by the hospital departments. Digital technology was used for tele-consultation and for ensuring safe patient care. The technology was also used for resident and student teaching, examinations and interviews.

Dissemination of knowledge in the form of training, publication etc. kept its pace amidst the COVID pandemic. There was constant engagement with the media by conducting programs and giving lectures on public health issues. It's quite evident that Institute continued its legacy to contribute for the social need in both clinical and research areas. I highly appreciate the dedication and sincere hard work of all the staff of the Chitra family, and believe that we will continue to serve our nation in the best possible way from indigenous technologies to modern medical treatment to the social services.

My best wishes to you as you continue to serve the people of this country with consummate skill.

2020-21: Looking back

Dr Jayakumar K, Director, SCTIMST

COVID-19 pandemic continued to pose challenges to the society for the second consecutive year. In this challenging time, the faculty and the staff were committed to contribute and participate in the fight against COVID-19 and to serve society. Various technologies were indigenized, developed and few of them even reached the commercial space; these included EBAS-Emergency Breathing Assist System, Rapid Viral RNA Isolation Kit – Chitra Magna, Nylon flocked swabs - nasopharyngeal and oropharyngeal for covid testing, UV-based face mask / multipurpose disposal bin, Viral Transport Medium, 4-zone strategy for the design of mediCAB housing structures for the COVID-19 pandemic and Sample Collection/Examination Booth. The other technologies which which were developed developed and transferred to the industries include Infected Secretion Solidification System (AcryloSorb), RT-LAMP-based COVID testing device, isolation pods, polyurethane swab etc.

Patient care in the hospital continued following strict Covid protocol. All the health care workers and rest of the staff and students were vaccinated in initial months of 2021. Tele-consultations of patients were done as per the prepared Institute protocols. This significantly reduced the need for patients and caregivers to come to the hospital for review. This also reduced crowding in the out-patient department. Every clinical department prepared SOPs and protocols to be followed in order to prevent the spread of infection. Digital technology was applied wherever and whenever required for patient care. The technology was also used for teaching, training programs, conducting interviews and examinations.

In the academic year, 183 candidates were offered admission to various teaching programs, including affiliated programs. The total strength of students on the rolls of the Institute was 424 as on March 2021 including the affiliated programs. During the year, we published 337 scientific publications in various international and national journals with an average impact factor of 3.53. Several publications from the Institute were also the outcome of the hard work of our DM/ MCh and PhD students, which testify to the research training the students' receive. The Institute faculty members were granted 15 Indian and one foreign Patent during the last one year. A total of 44 Indian patents and 19 foreign patents were filed. A total of 11 designs and 7 trademarks were registered. A total of 32 awards were received by our Faculties and students. Dr Manju S won the prestigious HarGobind Khorana - Innovative Young Biotechnologist Award 2020.

An international agency - 'Expertscape', that objectively ranks medical experts and institutions worldwide ranked the Cardiac Electrophysiology Division of SCTIMST as the ninth leading Centre in the world in terms of expertise in the field. SCTIMST was the only Centre from India to secure a place in the first 100

institutions at the international level. The team from Microbiology and Biochemistry Departments were selected as the Mentor Institute by ICMR for the state of Kerala, Union Territories of Lakshadweep and Andaman & Nicobar Islands to setup Molecular diagnostic laboratories for RT-PCR in all Government and Private Medical Colleges. New surgical procedures were performed by our neurosurgery faculty.

The Institute signed MoU with M/s. Tynor Orthotics Pvt. Ltd. for the co-development of diabetic foot ulcer off-loader and osteoarthritis knee brace. Technologies for External Pneumatic Compression Device for prevention of deep vein thrombosis and Blood Flow Meter were transferred to M/s. enProducts Pvt. Ltd. Two biomedical implant devices namely Atrial Septal Defect (ASD) closure device (Occluder) and intracranial Flow Diverter Stents were developed in collaboration with National Aerospace Laboratories, Bangalore (CSIR-NAL) using superelastic Nitinol alloys. The technology transfer agreement for these two products were signed with M/s. Biorad Medisys Pvt. Ltd. MoU was signed with M/s. Biogenix Inc. Pvt. Ltd. for collaborative development of rapid diagnostic kits for Procalcitonin detection for sepsis and Chlamydia trachomatis. A startup company M/s. Sascan Meditech Pvt. Ltd., which is incubated at TiMED, the Technology Business Incubator of our Institute launched Oral Scan, a hand held imaging device for screening, detection and biopsy guidance of oral cancer.

The foundation stone of Medspark, the Medical Devices Park envisaged as a joint initiative of our institute and Kerala State Industrial Development Corporation (KSIDC), the industrial and investment promotion agency of Government of Kerala was laid by the Hon'ble Chief Minister of Kerala at the Life Science Park, Thonnakkal, Thiruvananthapuram. Our institute participated in India International Science Festival 2020 organized by Ministry of Science & Technology and Ministry of Health and Family Welfare, Government of India. The institute organized and co-ordinated the first Open Day in the history of Biomedical Technology Wing prior to the COVID 19 restrictions. Labs were open to public as well as students from schools and arts, science and engineering colleges. This activity was to encourage young minds and to make them understand science behind bench to bed side.

I believe and trust that in future also, we will continue our hard work to serve the nation and society in all odd situation.

Highlights of the Year

INFRASTRUCTURE DEVELOPMENT

- The ICMR National Centre of Excellence in Heart Failure with a funding of INR 5 Crores is one of the flagship research initiatives of the institute. There are seven projects under this initiative including the first Heart Failure Biobank in the country. The National Heart Failure Biobank provides state-of-the-art storage facilities and is to be inaugurated by August 2021.

- PROGNOSIS PRORAD 2FC 600Ma, a state-of-the-art Digital Radiography System with features for faster and better quality image acquisition and post-processing was implemented from January 2021. The System is capable of performing the entire spectrum of radiographic imaging including spine stitching.

CONTRIBUTIONS TOWARDS NATIONAL MISSIONS

1. *"Make in India"*

- **Commercialization**
  - The technology of Emergency Breathing Assist System (EBAS) developed by the Division of Extracorporeal Devices was successfully commercialized by Wipro 3D Ltd., Bangalore.
  - The technology for bone graft products based on tricalcium phosphate and hydroxyapatite ceramics developed by the Division of Bioceramics was successfully translated to commercial product by M/s Onyx Medicals, Meerut, Uttar Pradesh. The Company received the manufacturing licence for the product in the trade name "FracLink".

- **Clinical Evaluation**
  - Clinical trials of the second-generation TTK Chitra heart valve jointly developed by SCTIMST and M/s TTK Healthcare Ltd. entered the clinical evaluation phase.

- **Collaborative Development**
  - Development of rapid detection kit for procalcitonin detection for sepsis and Chlamydia trachomatis with M/s Biogenix Inc. Pvt. Ltd., Lucknow, Uttar Pradesh.
  - Development of 'Off-loader' and 'OA Knee brace' devices with M/s Tynor Orthotics Pvt. Ltd., Mohali.

- **Technology Transfer**
  - **Atrial Septal Defect closure device (Occluder) and Flow Diverter Stent**

    The technology for Atrial Septal Defect Closure Device (Occluder) and Flow Diverter Stent was transferred to M/s Biorad Medisys, Pune on 14 January 2021. The products were developed in collaboration with National Aerospace Laboratories, Bangalore (CSIR-NAL).

- **Blood Flow Meter**

  The technology for Blood Flow Meter and External Pneumatic Compression Device was transferred to M/s enProducts Pvt. Ltd., Kerala.

- **Chitra AcryloSorb Respiratory Secretion Solidification System**

  The know-how of the Chitra AcryloSorb Respiratory Secretion Solidification System was transferred to Romsons Scientific and Surgical Pvt. Ltd., Uttar Pradesh.

♦ **Technical Research Centre for Biomedical Devices**

- 43 mission mode R&D projects aimed at developing medical device technologies were underway under the Technical Research Centre (TRC) for Biomedical Devices, funded by the Department of Science and Technology, Government of India.

- 12 projects aimed at development of technologies for the management of COVID-19 were taken up during the year

- 24 Technology Transfer Agreements were signed with various industries for scaling up and commercialisation of the devices developed. Of these, 7 medical devices reached the commercialisation phase during the year.

♦ **Technology Business Incubator**

TIMed, the Technology Business Incubator of SCTIMST received a funding of INR 9 Crores from NBM, BIRAC, to set up a "Technology Transfer Office" to enhance academia-industry interlinkages, strengthen bio-cluster ecosystem, protect intellectual property, translate knowledge into products and technologies and facilitate technology transfer activities.

2. ***"Skill India"***

♦ **Industry-Institute Partnership Cell**

The Industry-Institute Partnership Cell conducted 3 Workshops in virtual mode for the benefit of participants from industry and academia.

♦ **Competency Development Cell**

The Competency Development Cell organized four training programmes for the staff and other members of the Institute during the year.

3. ***"Digital India"***

♦ **The Computer Division undertook the following software-related activities :**

- Developed software to conduct patient consultation through the present Electronic Medical Records (EMR) software as Video Consultation/Telephone conversation and initiated sending prescription as SMS link.

- Implemented "SCTIMST Examinator", a new online portal for the Division of Academic Affairs for collecting question papers online, evaluating answer sheets and thesis evaluation.

- Established a Video Conference System based on Jitsi (meet.sctimst.ac.in) and a Virtual Classroom setup powered by Big blue button (vclass.sctimst.ac.in) for teaching and other academic activities.

- Integrated alternate payment gateway through Paygov for all online payments.

NETWORKING WITH OTHER INSTITUTIONS

♦ **The Institute executed the following MoUs with government departments, institutions and industries to facilitate networking:**

- With the University Hospital of Bern on the study titled "Early versus Late initiation of direct oral anticoagulants in post-ischemic stroke patients with atrial fibrillatioN" (ELAN).

- With the University of Lancashire on the study titled "IMPROVing Stroke care in India- Advancing the INSTRUCT Operations and Network - (IMPROVIS-ATION)".

- With Hamilton Health Sciences Corporation, Canada, and the Division of Clinical Research and Training, St. John's Research Institute, Bengaluru, on the study titled "EdoxabaNfoR Intra Cranial Hemorrhage survivors with Atrial Fibrillation (ENRICH-AF)".

- With IIT Chennai and TATA Consultancy Services on the study titled "A comprehensive frame work for treatment of impairment of the upper extremity due to stroke by combining computational modelling and virtual reality".

- With the Department of Computer Science, University of Kerala, on the study titled "New methodology for generating pseudo-CT images for evaluating brain lesions".

- With TKM College of Engineering, Karikode, Kollam, for development of algorithms and use of advanced techniques and software tools in the field of MRI.

NEW INITIATIVES

♦ The Division of Cardiac Electrophysiology and Pacing, Department of Cardiology, started a new Comprehensive Device Arrhythmia Clinic for a systematic and comprehensive evaluation of patients with cardiac devices and complex arrhythmias.

♦ The Department of Neurosurgery performed the first successful superficial temporal artery- anterior cerebral artery (A3) bypass, using a bridge graft for a complex DACA aneurysm. This rare surgery has been attempted only in a few Centres in the world and is the first such reported case from India.

♦ The Department of Imaging Sciences and Interventional Radiology initiated 3D printing and simulation for cerebral and aortic aneurysms for better patient management.

- The Department of Imaging Sciences and Interventional Radiology initiated Zero-TE MR imaging of the skull to demonstrate the bony abnormalities in brain MRI to reduce the radiation risk by eliminating the need for a CT scan.

- The Bioprinting Facility started offering the 3D Bioprinted liver constructs as a test system for *in vitro* hepatotoxicity assays in research.

- The SC/ST Cell in the Biomedical Technology Wing was inaugurated by Prof Asha Kishore, Director, SCTIMST, on 26 August 2020.

RESEARCH PROJECTS/PUBLICATIONS/PATENTS

- **Number of Research Projects newly initiated during the year: 26**
  - Nationally-funded: 25
  - Internationally-funded: 1

- **Number of Research Publications: 337**

- **Patents**
  - Granted: 16 (Foreign = 1, Indian = 15)
  - Applications Filed: 63 (Foreign = 19, Indian = 44)
  - Design Registrations filed/Trademarks: 18

HUMAN RESOURCE DEVELOPMENT/TRAINING

- **PhDs graduated: 18**

- **Research/Technical Manpower trained in DM/MCh/PDCC/PDF/MD in Cardiac and Neuro Sciences: 174**

- **Other Research/Technical Manpower trained in MPH/ DPH/ Diploma Courses/ Projects/ Apprenticeship/Observership: 499**

- **Manpower trained against affiliated programmes (CMC-Vellore, NIE-Chennai, IIPH-Delhi, IIITM-K, Trivandrum): 142**

- **Apart from these structured courses, the Institute also contributed substantially to manpower generation through Workshops/Conferences/Training Programmes/Popular Lectures/Awareness Camps/Seminars and Exhibitions, inside and outside the Institute.**

EVENTS/CONFERENCES/WORKSHOPS

- **Annual Convocation**

  The Annual Convocation Ceremony for the 36th batch of graduates was not conducted in 2020 due to COVID-19 pandemic. 176 students received their degrees/diplomas/ certificates.

- **"Heart Failure Conflux"**, an online event was organized by the ICMR Centre of Excellence in Heart Failure, SCTIMST, in collaboration with Heart Failure Association of India and the Indian Section of the International Academy of Cardiovascular Sciences from 5-7 February 2021. In the event, basic researchers and clinician-researchers discussed how to have better interaction and ways to remove roadblocks for collaborative research. Dr Harikrishnan S, Professor, Department of Cardiology was the organizing Secretary.

- **ISNR-2020**

  The 22nd Annual Conference of the Indian Society of Neuroradiology was organized by the Department of Imaging Sciences and Interventional Neuroradiology in virtual mode from 16-18 October 2020. More than 500 delegates attended. About 50 international and national faculty participated in the conference. The sessions were chaired by about 60 eminent neuro-radiologists in the country.

- The Division of Sleep Research organized an online conference titled **"Adverse developmental outcomes in offspring as consequences of sleep disorders during pregnancy"** for International Paediatric Sleep Association (IPSA) with international and national faculty on 5 and 6 February 2021.

- The Division of Toxicology organized the International Webinar Series on **"Food, chemicals and nanomaterials toxicity"** jointly with Central University of Kerala, Kasargod, Kerala, in virtual mode from 26-28 November 2020. About 420 delegates participated in the webinar.

- The Institute participated in the **India Healthcare Week 2020** with the theme "Redefining Healthcare Ecosystem", a virtual exhibition organized by Confederation of Indian Industry from 17-20 August 2020.

- The Institute participated in the **India International Science Festival 2020** online Exhibition organized jointly by DST, DBT, MoES, DHF, and CSIR from the Government of India and Vijnana Bharati (VIBHA) from 22-25 December 2020.

- **National Science Day 2021**

  The National Science Day 2021 was celebrated on 1 March 2021 at Biomedical Technology Wing. The theme of this year was "Future of STI: Impact on Education, Skills and Work". Sixty students from the Government Women's College, Thiruvananthapuram, attended the programme. The Chief Guest, Dr Rakesh K Mishra, Director of CSIR-Centre for Cellular and Molecular Biology, Hyderabad, delivered the Science Day message. The participants visited different laboratories at BMT Wing to learn about their facilities and research activities.

- **Institute Day**

  The Institute day celebrations were held at AMCHSS auditorium on 1 March 2021. The key note address was delivered by Prof Ashutosh Sharma, Hon'ble Secretary, Department of Science and Technology. Special messages were delivered by Dr Harsh Vardhan, Hon'ble Union Minister of Science and Technology and Earth Sciences, Government of India, Shri Arif Mohammed Khan, Hon'ble Governor of Kerala and Dr V K Saraswat, Hon'ble President of the Institute. On the occasion, a documentary titled "The Chronicle - ta khronika Chitra" was released.

- **International Yoga Day**

  The International Yoga Day was observed on 21 June 2020 (in virtual mode), as per the instructions from the Government of India. The theme this year was "Yoga at Home and Yoga with Family". On 21 June, there was a formal programme inaugurated by Prof Asha Kishore, Director, SCTIMST, followed by an online Yoga Practice Session, under the guidance of Dr Arun Thejaus K P, with active participation by staff, students and their family members. In addition, 10 online sessions of Interactive Yoga Training sessions starting from 14 June 2020 were conducted by Dr Arun Thejaus K P and Mr Saji K S, Computer Division.

- **Progressive use of Hindi**

  The Institute complied with the provisions relating to the Official Language Act, Rules and Instructions and Directives from the Government of India. Hindi Fortnight/Hindi Day was observed, and Hindi Workshops and competitions for the employees were organized. The Institute participated in the Town Official Language Implementation Committee (TOLIC) Meeting. "Chitralekha", the in-house Hindi magazine was selected for the Rajbhasha Award under special category in 2019-2020.

- Voter Awareness Programme **SWEEP (Systematic Voters Education and Electoral Participation)** was organized with the help of district administration, SUCHITWA Mission, Department of Science and Technology and Staff Benevolent Fund on 29 March 2021.

- **Pension Adalat**

  The Institute organized a Pension Adalat on 6 January 2021 in virtual mode with the objective of prompt and quick redressal of pensioners' grievances within the frame of extent policy guidelines.

- **The Vigilance Awareness Week 2020 and Rashtriya Ekta Diwas 2020 were observed with pledge taking ceremony.**

- **Events were organized in connection with:**

  Hand Hygiene Day - 5 May 2020, International Nurses Day - 12 May 2020, National Voluntary Blood Donation Day - 1 October 2020, International Epilepsy Day - 8 February 2021, World Social Work Day - 16 March 2021, World Sleep Day - 19 March 2021.

- **Scientific presentation in Conferences by staff and students: 85**

- **Number of Conferences/Workshops organized by the Institute: 127**

AWARDS

- The Institute was designated as the **"Best Vascular Surgery Institute"** - amongst all vascular surgery teaching institutes in India during the competition held at MIDTERM MEET 2020 (virtual meeting).

- **Prof Harikrishnan S,** Department of Cardiology, was elected **Fellow of the International Academy of Cardiovascular Sciences (FIACS) 2020,** Vancouver, Canada.

- **Dr P N Sylaja** was selected as the **Global Co-chair South Asia and National Co-chair** for Mission Thrombectomy 2020.

- **Dr T V Anilkumar,** Scientist G, Division of Experimental Pathology, was awarded **FRCPath** by the Royal College of Pathologists, UK. He is the first veterinarian in India to receive this honour.

- **Dr Jeemon Panniyammakal** was awarded the **Senior Clinical Fellowship** from the DBT-Wellcome Trust-India Alliance (IA).

- **Dr Lizymol P P,** Scientist F, Division of Dental Products, received the award for the innovation entitled "Development of bio-active, radiopaque, non-cytotoxic, bone cement based on a novel in-situ polymerizable oligomer for orthopedic applications" under the category of "Polymers in Medical and Pharmaceutical Applications" at the **10th National Awards for Technology Innovation in Petrochemicals and Downstream Plastics Processing Industry** by The Department of Chemicals and Petrochemicals, Ministry of Chemicals and Fertilizers, Government of India. The award was presented by Shri D V Sadananda Gowda, Hon'ble Minister for Chemicals and Fertilizers at a function held at Vigyan Bhavan, New Delhi on 23 February 2021.

- **Dr Manju S**, Scientist D, Division of Dental Products, received the **HarGobind Khorana-Innovative Young Biotechnologist Award 2020** from the Department of Biotechnology, Government of India.

- **Mr Sarath S Nair** received the **SBAOI MAHE Young Scientist Award 2020** for the paper titled 'Residual drug volume detection in implantable micro infusion pump for targeted drug delivery using magnetic methods'.

- **Awards won by students, Faculty and Staff in conferences: 32**

CORPORATE SOCIAL RESPONSIBILITY FUNDS RECEIVED

- The Kerala State Industrial Development Corporation (KSIDC) contributed 20 Lakhs to the Institute as CSR donation.

- M/s Tata Elxsi Ltd. contributed CSR donation of 79 Lakhs as financial assistance to economically poor patients treated at SCTIMST during the year.

REVENUE GENERATED BY THE INSTITUTE

- Revenue generated by the Institute during the current financial year was Rs 75.50 Crores, which was 24% of the grant-in-aid received from the Department of Science and Technology.

- The Institute has a balance of Rs 15 Crores under the Emergency Reserve Fund, which was created out of patient care income of previous years.

FINANCIAL SUPPORT FROM DST

- **Total grant received from the Department of Science and Technology for 2020-21 was Rs 310 Crores (as against Rs 186.14 Crores for 2019-20)**

  - Revenue Grant: Rs 265 Crores

  - Capital Grant: Rs 45 Crores

- **Total Extramural Funding received by the Institute from Government Agencies, Non-Governmental Agencies and International Agencies during 2020-21: Rs 9.62 Crores**

- **DST and SERB Contribution**

  - Funding for Ad hoc Research Projects: Rs 4.60 Crores

  - Total number of ongoing research projects funded by DST and SERB was 26, out of which 10 were initiated during 2020-21.

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

COVID-19 PANDEMIC: RAPID RESPONSE OF THE INSTITUTE TO MEET NATIONAL NEEDS

TECHNOLOGY DEVELOPMENT

- **Commercialization of Technologies**

  Following technologies developed by the Institute were commercialized:

  - EBAS-Emergency Breathing Assist System: by Wipro 3D Ltd., Bangalore
  - Chitra Magna - Rapid Viral RNA Isolation Kit: by Agappe Diagnostics Ltd., Kochi
  - ChitraEmBed - flocked nylon swabs (Nasopharyngeal and oropharyngeal): by M/s Mallelil Polymers Pvt. Ltd., Kerala
  - Bin-19 face mask disinfection bin and UV Spot multipurpose disinfector: by VST Mobility Ltd., Kochi
  - Universal Transport Medium by Origin Diagnostics and Research, Karunagappalli, Kerala and Levram Life Sciences Pvt. Ltd., Mumbai
  - Deployable Modular Field Hospitals by M/s Debrique Creative Labs
  - Sample Collection Booth, Examination Booth: by M/s HLL Lifecare Ltd., Kerala

- **Technology Transfer**

  Following technologies developed by the Institute were transferred to Industry:

  - Chitra AcryloSorb - Infected Secretion Solidification System to M/s Romsons Scientific and Surgical Pvt. Ltd., Uttar Pradesh
  - RT LAMP-based COVID testing device to M/s Tata Sons Pvt. Ltd., Mumbai and M/s Agappe Diagnostics Ltd., Kochi
  - Isolation pods to M/s HMT Machine Tools Ltd., Kerala
  - UV-based facemask Disposal Bin, Examination Booth, Swab Collection Booth, Isolation Pod and Innovative sanitizing technology (Sanitizer Bracelet) to M/s Kerala State Drugs Pharmaceuticals Ltd.

- **MoU**

  30 MoUs were signed with various industrial partners with regard to the development of COVID-19-related products.

- **ICMR designated Validation Centre**

  The Institute was designated by ICMR as Validation Centre for COVID-19-related products. The Institute successfully completed evaluation of products such as antimicrobial coating, surface disinfectant, UV-based devices from manufacturers across India.

MEDICAL SERVICES

The essential and emergency services of the Hospital Wing continued unhindered all through the pandemic.

- All the clinical departments started Tele-consultations for patients in accordance with prepared protocols. Standard operating procedures prepared by all departments involved in patient care were strictly followed to ensure uninterrupted services to the patients.

- **Infection Control in the Hospital**

  The following COVID-related Protocols were prepared, implemented and publicized for health care workers:

  - Risk grading of patients, PPE Guidelines and protocols for aerosol handling in operation theatres, Cath Labs, Imaging Suites and ICUs
  - Clinical Protocol for management of patients in operation theatres and ICUs
  - Airway management protocols and guidelines on sterilization of airway and anaesthesia equipment in management of COVID-19 patients
  - Guidelines and protocols for transport of COVID-19 patients in the hospital and management protocols for various diagnostic procedures

- **COVID Testing**

  49410 samples from the State and 22148 samples from the Institute were tested for SARS CoV2 by RT-PCR and Reports were issued by the COVID Lab at the Hospital Wing. 3574 samples were tested by the BMT Wing COVID testing team.

PUBLIC HEALTH INITIATIVES

- The Achutha Menon Centre for Health Science Studies was involved in supporting COVID-19-related activities of the Government of India and Government of Kerala.

- Dr Rakhal Gaitonde continued to serve as a Member of the National Task Force on COVID-19, Indian Council of Medical Research.

COVID VACCINATION

- The COVID-19 Vaccination Programme for staff, students, pensioners and dependents of the institute was started from 30 January 2021 as per Government guidelines.

Comprehensive Device and Arrhythmia Clinic inaugurated by the Director, SCTIMST, Prof Jayakumar K on 4 February 2021

Inauguration of the International Webinar Series on Food, Chemical and Nanomaterials Toxicity by Prof Jayakumar K, the Director, SCTIMST on 26 November 2020

Inauguration of the SC/ST Cell by Prof Asha Kishore, Director, SCTIMST on 26 August 2020 at BMT Wing

Heart Failure Conflux - virtual conference from 5-7 February 2021

Inauguration of India International Science Festival (IISF) 2020 curtain raiser

Hon'ble Prime Minister Sri Narendra Modi inaugurating the 6th edition of India International Science Festival (IISF) 2020 by virtual mode on 22 December 2020

National Science Day on 1 March 2021

Institute Day celebrations on 1 March 2021

International Yoga Day on 21 June 2020

Systematic Voters Education and Electoral Participation Programme on 29 March 2021

Pension Adalat held on 6 January 2021

74th Independence Day celebrations

72nd Republic Day celebrations

Wipro 3D Chitra Emergency Breathing Assist System

Chitra Magna – RNA isolation kit

ChitraEmBed – flocked nylon swab

UVC disinfection devices

Universal Transport Medium

Deployable Modular Field Hospital

Inauguration of COVID-19 vaccination programme

HOSPITAL WING

HOSPITAL ADMINISTRATION

Hospital Administration of the institute includes Office of the Medical Superintendent and other Departments which support patient care services. The Mission of Hospital Administration can be summarized as:

- Improve the patient health outcomes
- Increase patient satisfaction
- Decrease in medical errors, costs and waste
- Serve the underserved

Activities

The annual statistics of hospital services for the year 2020-21 are shown in Figures 1-7. During the year, various services in Cardiology, Neurology, Cardiac Surgery, Neurosurgery and Imaging Sciences and Interventional Radiology registered 12018 new patients (Figure 1). A total of 6697 patients were admitted for treatment including surgical and interventional procedures (Figure 1). It may be noted that the patients who were newly registered and patients who were getting admitted in the hospital had an increasing trend till the year 2020 that marked the onset of COVID-19 pandemic. The hospital continued to provide valuable services related to non-COVID conditions during the pandemic period. The Out Patient Department registered 97042 review patients in different departments including Specilality Clinics (Figure 2). The Institute provided free treatment to 0.98% of inpatients and subsidised treatment to 33.97% of inpatients which was based on their socio-economic background.

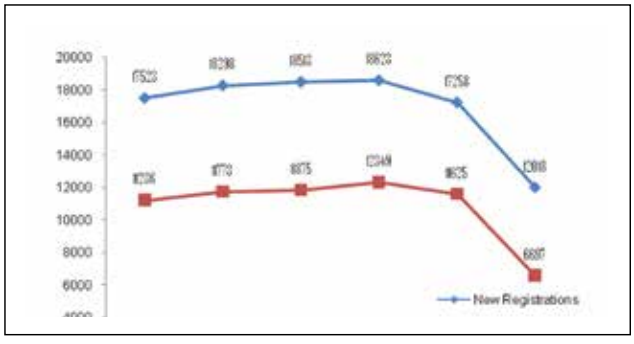


Figure 1. New registrations and admissions

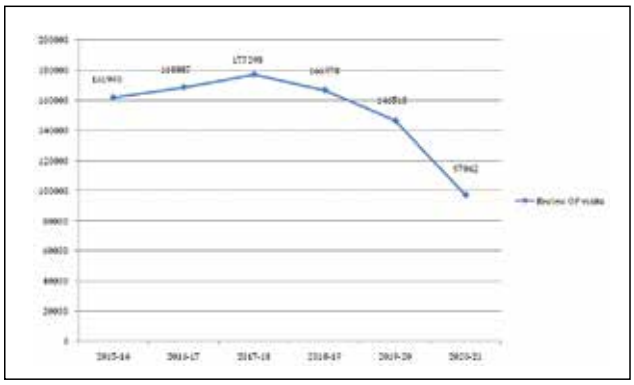


Figure 2. Review patients

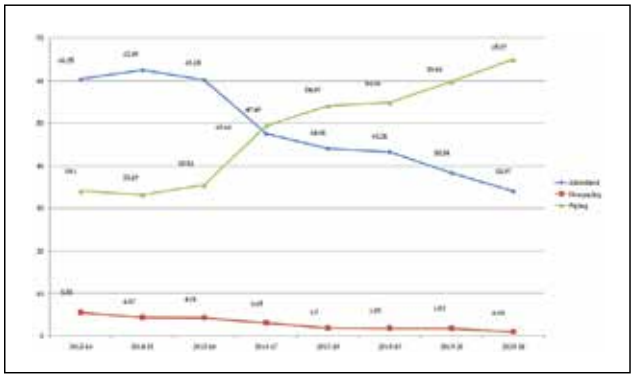


Figure 3. Paying, non-paying and subsidised treatment groups for inpatients

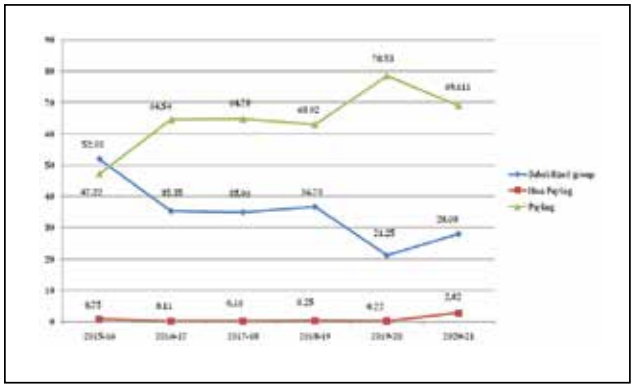


Figure 4. Paying, non-paying and subsidised treatment groups for outpatients

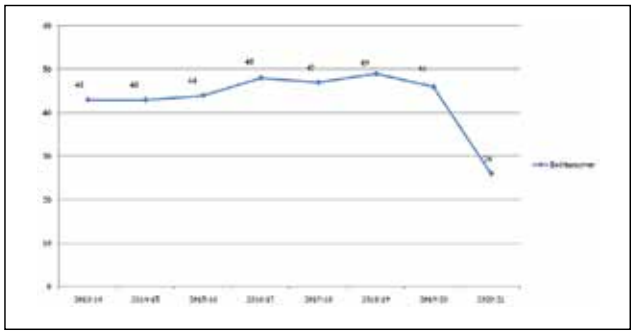


Figure 5. Bed turnover trend

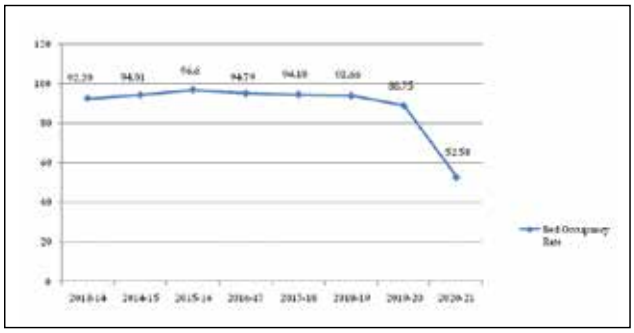


Figure 7. Bed Occupancy Rate

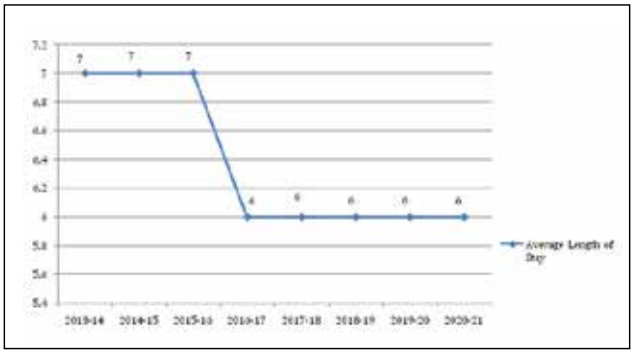


Figure 6. Average length of hospital stay

The number of patients who availed various financial schemes during the year are summarized as below:

Scheme	Number of Patients	
	IP	OP
RBSK	276	11595
RBSK New	91	0
CGHS	74	1743
Thalolam	832	0
Prime Minister's Relief Fund	0	0
Rashtriya Arogya Nidhi (RAN)	55	0
Sneha Santhwanam	0	4
Others	21	31
Total	**1349**	**13373**

New Initiatives

1. Telephonic Consultation for patients was started in April 2020 in view of the travel difficulties posed due to COVID-19 pandemic.
2. COVID-19 Infection Control Manual was published and released by Infection Control Team on 22 April 2020.
3. Code Orange protocol was released by Code Blue Team during April 2020.
4. Empanelment of Rajiv Gandhi Centre for Biotechnology (RGCB) for providing lab services to patients for the tests that was not available at SCTIMST during May 2020.
5. Institute facilitated COVID-19 insurance for its employees through public sector insurers during August 2020. An Insurance Camp was held in Swasthy Hall on 6 August 2020.
6. State-of-the-art Digital Radiography System in OPD was inaugurated by the Hon'ble Director, Dr Jayakumar K, on 1 January 2021.

7. COVID-19 vaccination for all staff and students of the Hospital and BMT Wings began on 29 January 2021. The vaccination drive was inaugurated by the Hon'ble Director, Dr Jayakumar K.
8. Comprehensive Device and Arrhythmia Clinic (CDAC) was inaugurated by the Hon'ble Director, Dr Jayakumar K, on 4 February 2021.
9. Web-based Lab Information System was implemented in Molecular Genetics and Neuro-Immunology Unit in March 2021.

Events Organized

1. International Yoga Day celebration (online) was held on 21 June 2020.
2. Traditional Onam feast (Onasadya) was provided to staff on duty in hospital on 31 August 2020 at staff canteen, Hospital Wing.
3. Institute Day celebrations were held at AMCHSS auditorium on 1 March 2021.
4. World Social Work Day was celebrated on 16 March 2021 with the theme 'Ubuntu - I am because we are'.
5. Voter Awareness Programme, SWEEP (Systematic Voters Education and Electoral Participation) was held with the help of district administration, SUCHITWA Mission, Department of Science and Technology and Staff Benevolent Fund on 29 March 2021. Voters Pledge and VVPAT machine demonstration were also conducted

Staff

Hospital Administration

Dr Rupa Sreedhar, Medical Superintendent

Dr Krishnakumar K, Associate Medical Superintendent

Dr Rahul D Nambiar, Administrative Medical Officer

Ms Archana Rajan D A, Assistant Administrative Officer (OMS) - A

Nursing Services

Ms Nirmala M O, Nursing Superintendent

Ms Hepzibah Sella Rani J, Deputy Nursing Superintendent

Ms Gracy M V, Assistant Nursing Superintendent

Ms Smitha A S, Assistant Nursing Superintendent

Ms Anasooya R, Assistant Nursing Superintendent

Physical Medicine and Rehabilitation

Dr Nitha J, Assistant Professor

Central Sterile Services Department

Ms Prasannakumari K, Senior Nursing Officer (Ward)

Infection Control Unit and Biomedical Waste Management

Ms Shiny Biju, Infection Control Nurse

Construction Wing

Col (Rtd) Vijayan Pillai K, Construction Engineer

Security & Safety

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

Dietary

Ms Leena Thomas, Senior Dietician - B

Ms Jyothi Lekshmy S, Deputy Dietician - A

Laundry

Mr Umesh Sankar S, Laundry Supervisor - B

Medical Social Work

Ms Rosamma Manuel, Scientific Officer & In-charge OPD services & Patient Management Services

Dr Jiji T S, Medico Social Worker - A

Medical Records

Mr Sivaprasad R, Senior Medical Records Officer - A

Pharmacy

Ms Deepa K Nair, Senior Pharmacist

Transport

Mr Saji M S, Transport Supervisor

MEDICAL RECORDS DEPARTMENT

Medical Records play an important role in the functioning of any hospital in terms of giving vital information for conducting research, statistical data on utilization of hospital services, mortality and morbidity profiles, and evaluating the performance of clinical facilities. Medical Records Department (MRD) is responsible for maintaining medical records in a standardized and professional manner to protect patient confidentiality while allowing adequate access to providers to promote quality patient care.

Activities

1. Managed patient registration, admission and maintained staggered appointments.
2. Initiated medical record by creating and processing the patient care record folder.
3. Reviewed and processed requests on medical records by healthcare providers, patients, insurance providers and Government and Non-Government Scheme providers.
4. Concurrent and retrospective review of medical records to solve conflicting, incomplete records for improving clinical documentation practices.
5. Assisted doctors in virtual consultations during ongoing Covid-19 pandemic.
6. Gathered patient information on demographic details from a variety of sources; interacting with registration counters and physicians at theoutpatient department.
7. Maintained record availability by processing patient files in the department using record mark-off procedures and facilitating record location activities.
8. Delivered patient records to assigned areas of the hospital by following established routing procedures.
9. Digitized medical records and implemented Electronic Medical Records.
10. ICD-coding and indexing of diseases and procedures and preservation of records.
11. Provided study materials and healthcare statistics for academic and research activities.
12. Generated and managed hospital statistics and sharing them with the administrators and Head of the Departments periodically.
13. Handled patient care-related correspondence and maintained patient confidentiality by preserving patient records.
14. Processed and issued various certificates to patients.
15. Online reporting of overseas patients to Foreigner's Regional Registration Officer, and deaths to the Corporation of Thiruvananthapuram.
16. Printed, stored and supplied all Medical Record Forms.
17. Conducted academic programmes in Medical Records Science.

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

Activity	Number
New Registrations	12018
Admissions	6697
Reviews	97042
Bed Occupancy Rate	52.58%
Bed Turnover Rate	26 discharges/bed
Average length of stay	6 days
Records released for study/ research	38779
Certificates processed/ issued	5151
Insurance claims processed	579
Records scanned and uploaded	597117
Electronic Medical Records processed	91166

Geographic distribution of patients

	Out Patient		In Patient	
Kerala	10183	84.73%	5776	87.71%
Tamil Nadu	1408	11.72%	626	9.51%
Karnataka	24	0.20%	4	0.06%
Andhra Pradesh	27	0.22%	8	0.12%
Maharashtra	27	0.22%	10	0.15%
Other States	339	2.82%	157	2.38%
Outside India	10	0.08%	4	0.06%
Total	**12018**	**100%**	**6585**	**100%**

New Initiatives

1. Steps were taken to increase the adoption rate of Electronic Medical Records and reduce the burden of electronic documentation for clinicians.
2. Devised operational methodologies for Revenue Cycle Management.
3. Implemented uniform national standards for data and security by bringing forth SNOMED-CT into the computerized patient records and its secondary databases.
4. Implemented virtual consultation so that doctors continued to treat elective cases during the Covid-19 pandemic.
5. Initiated steps to enhance the training of students in use of computers and computerized patient care systems.

Staff

Mr Sivaprasad R, Senior Medical Records Officer - A

Ms Susan Jacob, Medical Records Officer - C

Mr Christudas J, Medical Records Officer - A

Ms Manna George, Assistant Medical Records Officer

Ms Manju K K, Medical Records Assistant - B

Ms Asha Krishna R O, Medical Records Assistant - B

Ms Suma B, Medical Records Assistant - B

Ms Remya L T, Medical Records Assistant - B

Mr Ragesh D V, Medical Records Assistant - A

Ms Sandhya C K, Medical Records Assistant - A

Ms Suma K K, Medical Records Assistant - A

Ms Sreena T, Medical Records Assistant - A

Mr Sumesh P S, Medical Records Assistant - A

DIVISION OF NURSING SERVICES

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

Activities

1. Orientation to the newly joined nurses and cleaning attendants.
2. Training on COVID-19 precautions, hand hygiene, personal protective equipment, cleaning and disinfection.
3. Infection control Link Nurses Meeting - 8 sessions were conducted.
4. Clinical teaching by Nursing Officers in all units were conducted regularly.
5. The Division was actively involved in COVID-19 vaccination programme of the institute. Nursing Officers - Ms Thanuja, Ms Vidya S Nair, Mr Midhun, Mr Sreekesh and Mr Vijaya Krishnan were selected as vaccinators and underwent training.
6. Ms Anjusha was a resource person in international conference on "Challenges and success in COVID scenario".
7. Ms Shiny Biju was a resource person in Kerala State Women's Development Corporation Nursing training program for a session on "Organizational preparedness for prevention and control of COVID-19" on 28 January 2021.
8. Ms Prasannakumari K was a resource person for the webinar on "Role of GDA in Central Sterile Supply Department" for VHSE students of GVHSS Pathanamthitta and Peruva, Kottayam.
9. Ms Shani was the resource person for the webinar on "Stroke Care: Acute to rehabilitation" for the students of Government College of Nursing, Alappuzha.
10. Ms Shani was a resource person in the National webinar on innovations and trends in Neuroscience nursing about "COVID 19 challenges to Neuroscience nursing".
11. Ms Sumakumari L, Ms Preethamol M and Ms Jisna Jose were panelists for Heart Failure Certification Programme for Nurses organized by HFAI and TNAI on 13 September and 11 October 2020.

Events Organized

1. Hand Hygiene Day was celebrated on 5 May 2020. As part of the celebration various programmes were organized: Hand hygiene steps performed by the staff in the clinical area was evaluated, an awareness programme on hand hygiene was conducted for patients and relatives in the waiting area and hand hygiene awareness posters were displayed in out-patient and in-patient units.
2. International Nurses Day 2020 was celebrated on 12 May 2020 with Nurses Pledge taken by all nurses (Figure 8). A Blood Donation Camp was conducted by the Nursing Officers and lunch packets were distributed to patients and relatives attending the OPD.
3. Ms Shiny Biju conducted an online interactive session for students of Pathanamthitta GVHS School on Hospital Infection Control on 11 February 2021.
4. Workshops conducted:
   - Management of patient on ventilator, with COVID perspective at Auditorium 2, SCTIMST (271 participants, Figure 9).
   - Biomedical waste management, cleaning and disinfection at Auditorium 2, SCTIMST (382 participants).

- Hand Hygiene and PPE donning and doffing at Auditorium 2, SCTIMST on 18 July 2020 (115 participants, Figure 10).

5. Webinars organized:
   - COVID-19 associated ARDS on 17 July 2020
   - Nursing care considerations in COVID-19 on 18 August 2020
   - Prevention and Management of COVID-19 in a non-COVID health care setting on 13 March 2021

Awards and Honours

The Division received a Certificate of Appreciation for the contribution towards "Essential upskilling for nurses on COVID-19 pandemic management" from Generation.

Staff

Ms Nirmala M O, Nursing Superintendent

Ms Hepzibah Sella Rani J, Deputy Nursing Superintendent

Ms Gracy M V, Assistant Nursing Superintendent

Ms Anasooya R, Assistant Nursing Superintendent

Ms Smitha A S, Assistant Nursing Superintendent

Figure 8. Nurses Pledge being taken as part of International Nurses Day 2020 celebration

Figure 9. Workshop on management of patient on ventilator

Figure 10. Workshop on Hand Hygiene and PPE donning and doffing

PHYSICAL MEDICINE AND REHABILITATION

Physical Medicine and Rehabilitation (PMR) Department specialises to restore and enhance functional ability and quality of life to those with physical impairments or disabilities. Multidisciplinary comprehensive rehabilitation is provided by a team of qualified professionals including a Rehabilitation Specialist (Physiatrist) and seven physiotherapists. The services provided by PMR include outpatient and inpatient consultations, interventional procedures for pain management, and various therapies to improve strength, flexibility, balance, coordination and functional abilities. The therapeutic approaches range from bedside mobility to virtual reality gaming, and robotic-assisted training. The Department provides clinical services, two academic courses as well as contributes to technology development.

Activities

Clinical Activities

Services	Number
Inpatient	15732
Outpatient	2063

Research Programmes

1. Dr Nitha J is the co-investigator and clinical expert for industry-funded project for the development of offloading orthotics.
2. Dr Nitha J is the Co-Principal Investigator for the project “Comprehensive and novel model of health care on geriatric pain conditions in India”.
3. Ms Redhu, Advanced Certificate Programme student, completed the thesis titled “Functional status and pain of ambulatory patients after three months of coronary artery bypass graft surgery: a cross sectional observation study" under the guidance of Dr Nitha J.

Academic Programmes

Two courses on Advanced Certificate Programme in Physiotherapy in Cardiovascular and Neurological Sciences are being conducted by the PMR Department. Regular academic sessions including theory classes and bedside clinical sessions are being offered for the students. Physiotherapy interns who enrolled as observers in the department were trained intensively.

Other

Mr Amal, Physiotherapist A, gave a talk on “Internet and Health” in an All India Radio programme (Prakashadhara).

Staff

Faculty

Dr Nitha J, Assistant Professor

Technical

Deepa G, Chief Physiotherapist

Aji K, Physiotherapist - B

Rahool S, Physiotherapist - B

Jijimol George, Physiotherapist - B

Paul Jose, Physiotherapist - A

Amal M G, Physiotherapist - A

DEPARTMENT OF ANAESTHESIOLOGY

The Department of Anaesthesiology has two Divisions that were implemented in 2010: Division of Cardiothoracic and Vascular Anaesthesiology and Division of Neuroanaesthesia and Neurocritical Care. Both Divisions conduct 3 year DM and 1 year PDCC Programmes. The Department also has a 2 year Diploma in Operation Theatre and Anaesthesia Technology (DOTAT) Programme.

DIVISION OF CARDIOTHORACIC VASCULAR ANAESTHESIOLOGY

Activities

Clinical Activities

The Division provides anaesthesia for patients with cardiothoracic and vascular diseases in four adult and two paediatric operating rooms, three catheterisation labs, two DSA labs, two MRI suites and one CT room. The anaesthetic cover is given for both diagnostic and therapeutic procedures. The Division focuses on high quality invasive and non-invasive peri-procedural care which includes intraoperative transesophageal echocardiography, percutaneous tracheostomies, bedside trans thoracic echocardiography and lung ultrasound, ultrasound-guided vascular cannulations, regional oximetry and depth of anaesthesia monitoring, regional nerve blocks and highly effective intravenous and neuraxial pain relief practices.

During the COVID-19 pandemic, faculty and senior residents were actively involved in various aspects of its control like making hospital protocols, management of COVID patients with cardiac illnesses, infection control practices and teaching and training of staff and students of other departments.

The list of procedures/surgeries covered by the Division during the year is summarized in the Table below:

Location	Number of Surgeries/ Procedures
Adult Cardiac Surgery OTs	825
Congenital Heart Surgery OTs	588
Cardiology Catheterisation Labs	411
Radiology CT, MRI & DSA Lab	92
Intensive Care Units	1170
Total	**3086**

Academic Activities

All working Saturdays were exclusively dedicated to well-structured departmental academic activities which included introductory classes, symposia/ seminars, practise guidelines and pro-con sessions, systematic review and meta-analysis sessions, problem-based learning discussions, journal clubs and case presentations.

Research Programmes

Faculty and senior residents were actively involved in research and publications. Furthermore, faculty collaborated with the BMT Wing in development of biomedical devices and patenting.

1. Successfully completed the Project entitled "Universal airway device for selective lung isolation". The product developed was submitted for design patent (Funded by: TDF, SCTIMST, PI: Dr Suneel P R).
2. Intraoperative quantification of left ventricular volumes and ejection fraction by real-time three-dimensional transesophageal echocardiography: Comparison with cardiac magnetic resonance imaging (Funded by: TDF, SCTIMST, PI: Dr Saravana Babu).

3. Geriatric Pain Clinic for Regenerative Services (Externally-funded by: Kusma Trust, UK, PI: Dr Subin Sukesan).
4. Bio-inspired total foot pressure off-loading device for diabetic foot ulcer management in geriatric population (Externally-funded, Co-Investigator: Dr Subin Sukesan)
5. Design and functional evaluation of three biomedical devices (EBAS-Emergency Breathing Assist System, Low-cost Portable Ventilator and Intubation Isolation Box) in collaboration with BMT Wing (Investigator: Dr Thomas Koshy).
6. Development of chondrocyte-regenerating platelet rich plasma-based formulation for potential application in arthritis (Investigators: Drs Subin Sukesan & Saravana Babu).
7. Comparison of haemodynamic parameters measured by thoracic electrical bioreactance and 3D transesophageal echocardiography in adult cardiac surgery patients (Investigators: Drs Nithiyanandhan P, Prasantha Kumar Dash, Rupa Sreedhar).
8. Grading aortic stenosis with mean gradient and aortic valve area: A comparison between preoperative transthoracic echocardiography and precardiopulmonary bypass transesophageal echocardiography (Investigators: Drs Vasanth, Suneel P R, Thomas Koshy).
9. Comparison of four different techniques for estimation of left ventricular volumes using intraoperative Real-time-3D transoesophageal echocardiography - A prospective observational study (Investigators: Drs Murukendiran & Shrinivas Gadhinglajkar).
10. A study of incidence and risk factors for new onset postoperative atrial fibrillation among adult patients undergoing elective coronary artery bypass graft surgery (Investigators: Drs Devarakonda Bhargava Venkata & Rupa Sreedhar).
11. Comparison of transoesophageal echocardiography guided modified 2-Dimensional and M-Mode tricuspid annular plane systolic excursions with transthoracic echocardiography guided M-mode tricuspid annular plane systolic excursion in adult and paediatric cardiac surgeries for assessment of right ventricular function (Investigators: Drs Mamatha Munaf & Thomas Koshy).
12. The efficacy and safety of intravenous levosimendan compared with milrinone in preventing low cardiac output after corrective cardiac surgery in tetralogy of Fallot (Investigators: Drs Aspari Mahammad Azeez & Dr Unnikrishnan K P).
13. Assessment of diastolic function in paediatric tetralogy of Fallot patients - An intraoperative transesophageal echocardiographic study (Investigators: Drs P Nagarjuna, Saravana Babu, Thomas Koshy).
14. Metabolic alkalosis in the paediatric cardiac intensive care unit– A prospective observational study (Investigators: Drs Diana Thomas & Suneel P R)
15. Ultrasound guided-Bilateral single shot Erector Spinae Block: Role as a pre-emptive analgesic adjunct in paediatric patients undergoing sternotomy with routine fast tracking in Atrial Septal Defect closure for post-operative Intensive Care Unit pain relief and achieving desired sedation scores.Dr Pradeep AP, Dr SubinSukesan
16. Comparison of efficacy of ultrasound guided bilateral erector spinae block and pectoralis nerve 2 block in paediatric cardiac surgeries via median sternotomy. (Investigators: Drs Tony Jose & Rupa Sreedhar).
17. Correlation between intraoperative renal Doppler flow and renal infrared spectroscopy in predicting postoperative acute kidney injury in patients undergoing coronary artery bypass grafting (Investigators: Drs A Jagadish & Saravana Babu).
18. Superior vena cava and right pulmonary artery junction as an intraoperative transoesophageal echocardiographic landmark for central venous catheter tip position in patients undergoing cardiac surgery (Investigators: Drs A Jagadish, Prasanta Kumar Dash, Saravana Babu).

19. Effect of haemoglobin levels on NIRS monitoring in cyanotic congenital heart diseases (Investigators: Drs Kartheek Hanumansetty & Suneel P R).

20. Comparison of biplane transoesophageal echocardiography and surface ultrasound technique for cannulation of internal jugular vein in patients undergoing adult elective cardiac surgery (Investigators: Drs Markose L Paret & Shrinivas Gadhinglajkar).

21. Comparison of TIVA Vs inhalational maintenance of anaesthesia for early postoperative delirium in adult cardiac surgery: Prospective randomized single blinded study (Investigators: Drs Varsha A V & Unnikrishnan K P).

22. Evaluating the Real-time three dimensional transesophageal echocardiography (RT 3D TEE) and two dimensional transesophageal echocardiography in predicting annuloplasty ring size in mitral valve repair: A Prospective observational study (Investigators: Drs Aspari Mahammad Azeez & Unnikrishnan K P).

23. Association of arterial lactate levels with ratio of oxygen delivery to whole body carbon dioxide production during cardiopulmonary bypass for paediatric cardiac surgery (Investigators: Drs Devarakonda Bhargava Venkata & Shrinivas Gadhinglajkar).

24. Comparison of arterial partial pressure of carbon dioxide with that at oxygenator exhaust during cardiopulmonary bypass for paediatric cardiac surgery (Investigators: Drs Devarakonda Bhargava Venkata & Shrinivas Gadhinglajkar).

25. Incidence of acute kidney injury in the postoperative management of neonates following arterial switch repair: A retrospective observational study (Investigators: Drs Sharmila S, Devarakonda Bhargava Venkata, Shrinivas Gadhinglajkar).

26. Effect of sevoflurane versus propofol on strain quantification in patients with severe aortic stenosis undergoing aortic valve replacement- A prospective study (Investigators: Drs Markose L Paret & Shrinivas Gadhinglajkar).

27. Perioperative cardiovascular outcome in patients with coronary artery disease undergoing major vascular surgery - A 10-year single centre retrospective observational study (PI: Dr Saravana Babu).

Patents

Biological fluid component separator - Product patent filed (Dr Subin Sukesan).

New Initiatives

1. A new TEE machine (Philips CX 50) with paediatric TEE probe was purchased for paediatric cardiac anaesthesia.

2. 3D software was added to the existing TEE machine for adult cardiac anaesthesia (Figure 11).

3. Revised the syllabus and curriculum of DM and PDCC Cardiothoracic Vascular Anaesthesia

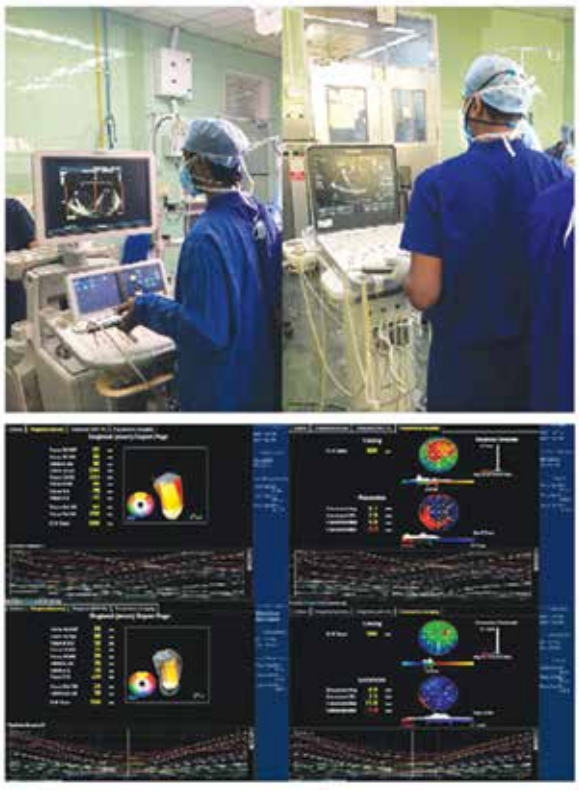


Figure 11. Intraoperative 3D transesophageal echo with regional wall motion assessment

4. Guidelines were issued for final year senior residents that every thesis submission should be accompanied by a 3000 word condensed write-up ready for submission to a journal This was later adopted by the Division of Academic Affairs for all DM/MCh courses.

5. Consultants' Feedbacks were collected from doctors from different Centres across the country for the Wipro-Chitra jointly developed Emergency Breathing Assist System (EBAS).

6. Diploma in Operation Theatre Technology (DOTT) course was renamed as Diploma in Operation Theatre and Anaesthesia Technology (DOTAT)

7. Compiled and uploaded the report about the three Wings of the Institute in Wikipedia.

Awards and Honours

1. Prizes won by Senior Residents:

   - Dr Devarakonda Bhargava Venkata, won the 1st Prize for his free paper titled "Pan cycle aortic incompetence and total pulsus alternans – a dreaded clinico-echocardiographic duet - When ECHO saved the day" at the 5th International IACTA TEE Webinar and 14th Annual IACTA TEE Conference organized by Narayana Hrudayalaya, Bengaluru, on 27 August 2020.
   - Dr Devarakonda Bhargava Venkata won the 1st Prize for his free paper titled "Surprise VSD – Two cases of additional VSD detected by intraoperative TEE" at the Society of Transesophageal Echocardiography Imaging Award 2020 conducted by PGIMER, Chandigarh, on 12 September 2020 (Figure 12).
   - Dr Pradeep A P won the 1st Prize for his free paper titled "Role of TEE in troubleshooting in a case of electromechanical dissociation following double valve replacement" at the 15th Annual Perioperative and Critical Care Echocardiography Conference at PGIMER, Chandigarh, on 13 March 2021 (Figure 13).
   - Dr Diana Thomas won the 2nd Prize for her free paper titled MV repair surgery - when the right ventricle is not just an innocent bystander" at the 15th Annual Perioperative and Critical Care Echocardiography Conference at PGIMER, Chandigarh, on 13 March 2021.

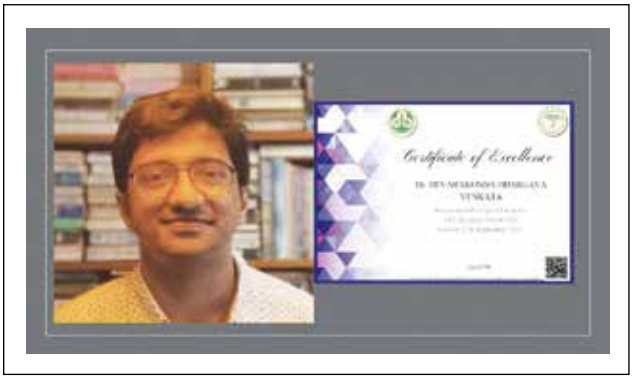


Figure 12. Dr Devarakonda Bhargava Venkata, first prize recipient at Imaging Award 2020

Figure 13. Dr Pradeep A P first prize recipient at Annual Perioperative and Critical Care Echocardiography Conference

2. Dr Suneel P R was the Treasurer of Kerala State Chapter of Indian Society of Anaesthesiologists (ISA).

3. Dr Thomas Koshy was the Registrar of Indian College of Cardiac Anaesthesia, the academic body of Indian Association of Cardiovascular Thoracic Anaesthesiologists (IACTA).

DIVISION OF NEUROANAESTHESIA AND NEUROCRITICAL CARE

Activities

Clinical Activities

The clinical activities performed include perioperative care of patients with neurological conditions needing elective and emergency neurosurgery, diagnostic and interventional neuroradiological procedures and imaging. The Division Is actively involved in acute care of patients admitted to neurosurgical, stroke, neuromedical and neuroradiological intensive care units.

In the neurosurgical patients, we perform perioperative evaluation, intraoperative management and postoperative care of patients in the intensive care unit. Specialized intraoperative neuromonitoring (Figure 14) like EEG, intraoperative evoked potentials, cranial nerve monitoring, awake craniotomies, functional MRI, WADA test, ultrasound and echocardiogram and ICP monitoring are performed.

Figure 14. Near infrared spectroscopy and intraop processed EEG monitoring

In the radiology suite, the neuroanaesthesiologists are involved in perioperative management of various diagnostic and neurointerventional procedures like carotid stenting, management of intracranial aneurysms, AV malformations and vein of Galen malformations. The Division is part of the Team managing acute stroke patients along with stroke neurologist and neuroradiologists in Cath lab and stroke ICU.

The Division provides neurocritical care for patients admitted in neurosurgical, stroke, interventional radiological and neuromedical ICU. Patients with various neurological illnesses requiring ventilatory and hemodynamic care, percutaneous tracheostomy, plasmapheresis and pain and sedation management are undertaken by our staff and residents.

The list of procedures/surgeries covered by the Division during the year is summarized in the Table below:

Location	Number of Surgeries / Procedures
Neurosurgery	1015
Neuro Cath lab	151
MRI	230
Neurosurgery ICU	1000
Neuro medical & Stroke ICUs	480
Radiology ICU	151
Total	**3027**

Academic Activities

The academic activities included teaching and training of residents undergoing DM and PDCC (Neuroanaesthesia) Programme, Diploma in Operation Theatre and Anaesthesia technology and nursing students. The teaching modalities included didactic lectures, Pros and Con debates, Journal clubs, practical sessions and video conferencing. In addition, interdepartmental academic programmes, dissemination of knowledge via Conferences, Seminars, Workshops as well as internet was actively undertaken by the faculty and residents of the Division.

Research Programmes

The faculty and residents were involved in the clinical research and biomedical device development.

1. Development of portable, low-cost disposable defibrillator for cardiac arrest management

(Funded by: DST, Investigators: Dr Manikandan S, Er Manoj G S).

2. Design and development of cerebral microdialysis device and methodology for estimation of cerebral metabolites (Funded by: TDF, SCTIMST, PI: Dr Ajay Prasad Hrishi).
3. General anaesthesia vs sedation - Cognitive decline in elderly- a randomized controlled trial in patients with chronic subdural hematoma (Funded by: CSRI, DST, Investigators: Drs Smita V & Dr Manikandan S).
4. Comparison of the efficacy of virtual airway and physical airway assessment as a part of preanaesthetic evaluation of patients presenting for neurosurgery with relevance to COVID-19 pandemic. A prospective observational study (Funded by: NICE, Investigators: Drs Ajay Prasad Hrishi, Unnikrishnan P, Ranganatha Praveen, Smita V & Manikandan S).
5. Cranio-vertebral junction anomalies : clinical and radiological outcome evaluation after surgical intervention (Funded by: SERB-DST, Investigators: Drs Ganesh Diwakar, Krishnakumar K, Ranganatha Praveen).
6. Comparison of SNAP index and bispectral index (BIS) in patients undergoing neurosurgical procedures (Investigators: Drs Ajay Prasad Hrishi, Unnikrishnan P, Ranganatha Praveen, Smita V, Manikandan S).
7. Transport of critically ill patients – The Man and the Machine (Investigators: Drs Arulvelan A, Ajay Prasad Hrishi, Unnikrishnan P, Smita V, Manikandan S).
8. A comparison of the effect of hyperventilation on cerebral oxygenation in patients undergoing supratentorial tumour excision with sevoflurane or propofol as maintenance of anaesthesia - a randomised control study (Drs Salini Varma & Smita V).
9. Anaesthetic requirements in patients with medically refractory seizures undergoing neurosurgery (Investigators: Drs Shilpa N & Smita V, completed in December 2020).
10. An evaluation of changes in cerebral oxygenation using Near infrared Spectroscopy during various positions (supine, prone & lateral) in patients undergoing elective neurosurgery - An observational study (Investigators: Drs Ashutosh Kumar, Manikandan S, Ranganatha Praveen).
11. Monitoring of cerebral oxygenation trends with Near Infrared spectroscopy in patients undergoing therapeutic management of supratentorial arterio-venous malformation and evaluating its efficacy in detecting periprocedural complications and therapeutic prognostication - An observational pilot study (Investigators: Drs Jithumol Thankom Thomas, Ajay Prasad Hrishi, Ranganatha Praveen, Manikandan S).
12. Evaluation of Transcranial Doppler (TCD) spectral signatures and assessment of cerebral oxygenation using Near Infrared Spectroscopy (NIRS) in patients undergoing neurosurgical procedures as a novel marker for clinical outcome and prognostication - An observational study (Drs Jeeva George, Manikandan S, Ranganatha Praveen).

New Initiatives

1. Intraoperative cerebral blood flow mapping in neurovascular surgeries using indigocyanin green injection was started (Figure 15).

Figure 15. Delineation of intracranial blood vessels using indigocyanin green injection

Awards and Honours

1. Dr Aishvarya Shree won the 2nd Prize for the poster titled "Anaesthetic challenges during mechanical thrombectomy for acute ischaemic stroke" at the Neurocritical Care Society of India Conference held in October 2020.
2. Dr Sapna Suresh won the 3rd Prize for the poster titled "Rare case of recurrent pneumothorax in a patient with connective tissue disorder - case report" at the Neurocritical Care Society of India Conference held in October 2020.
3. Dr Jithumol Thomas won the 2nd Prize for the poster titled "Unexplained prolonged dyspnoea after neurosurgery - surprise diagnosis of mysathenic crisis - case report", at the Neurocritical Care Society of India Conference held in October 2020.
4. Dr Aisvarya Sree received the V K Grover Award for the paper "Comparison of preoperative visual field assessment using clincal testing, static automated perimetry and visual evoked potential on postoperative visual outcome in endoscopic resection of sellar and suprasellar lesions" at the 22nd Annual Conference of the ISNAAC on 26 January 2021.
5. Dr Ashutosh Kumar won the 1st Prize for free paper titled "Evaluvation of cerebral oxygenation using NIRS and cerebral velocities using TCD changes during various positions in neurosurgery" at the 22nd Annual Conference of the ISNAAC on 26 January 2021.
6. Dr Jeeva George won the 3rd Prize in Quiz Competition at the 22nd Annual Conference of the ISNAAC on 26 January 2021.

Staff

Faculty, Division of Cardiothoracic Vascular Anaesthesiology

Dr Thomas Koshy, Professor (Senior Grade), Head of Department and Division

Dr Rupa Sreedhar, Professor (Senior Grade)

Dr Shrinivas V Gadhinglajkar, Professor

Dr Prasanta Kumar Dash, Professor

Dr P R Suneel, Professor

Dr K P Unnikrishnan, Professor

Dr Subin Sukesan, Associate Professor

Dr Saravana Babu M S, Assistant Professor

Faculty, Division of Neuroanaesthesia and Neurocritical Care

Dr Manikandan S, Professor and Head of the Division

Dr Smita V, Associate Professor

Dr Ajay Prasad Hrishi P, Associate Professor

Dr Unnikrishnan P, Assistant Professor

Dr Ranganatha Praveen, Assistant Professor

Technical

Binu Thomas, Senior Scientific Assistant

Shibu V S, Senior Technical Assistant

Baiju Bavura S, Senior Technical Assistant

Tiny Babu, Technical Assistant - B

Pradeep S L, Technical Assistant - B

Sumesh T M, Technical Assistant - B

Damodara Sarma E, Technical Assistant - B

Archana S, Technical Assistant - A

Manju R S, Technical Assistant - A

DEPARTMENT OF BIOCHEMISTRY

The Department of Biochemistry comprises three sections: research laboratories, the Central Clinical Laboratory (CCL) and Molecular Genetics and Neuroimmunology Unit (MGNU). The Research Wing has been pursuing the molecular basis of disease processes affecting the vascular system leading to neurological and cardiovascular disorders. The main areas under investigation include: a) Impact of Chloroquine and its derivatives on cardiac mitochondrial metabolism b) Changes in mitochondrial metabolism in glioma cells under hyperglycemia c) Exosomal microRNA and proteins in neurodegenerative disease; d) Glucocerebrosidase assay development for the assessment of lysosomal dysfunction in neuronal disorders e) the role of glycation products in neurodegenerative diseases.

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

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

Activities

Clinical Activities

Central Clinical Laboratory

Fully automated equipment used at CCL include Dade-Behring/Siemens RXL, Aspen A1c HPLC Analyzer LD 500, Mindray 5-part Hematology analyzer-BC 5180 and BC 5000, Gem Premier 3000-ABG analyzer, CobasU 411(Roche) urine analyzer and Amax (Germany) coagulation analyzer. The Central Clinical Laboratory performed a total of 653272 investigations during the year. The various tests performed are summarized in the Table below:

Investigations	Number
Arterial Blood Gas	38043
General Chemistry	295701
Hematology and Coagulation	220661
Clinical Pathology (CSF, Stool, Urine)	97444
Neurochemistry	19
Plasma Amino Acids	1404
Total	**653272**

Molecular Genetics and Neuroimmunology Unit

The MGNU performed 39 Sanger sequencing tests during the year.

Research Activities

Three research laboratories supervised by faculty members continued to train 3 PhD students at various stages of their PhD Programme. This included: regular seminars and work presentation every Tuesday, mid-course comprehensive examinations and PhD thesis preparation.

1. Impact of chloroquine and its derivatives on cardiac mitochondrial metabolism

Deleterious impact of chloroquine and its derivatives on cardiac mitochondrial metabolism was investigated. As myocardial cells rely heavily on mitochondrial metabolism, derangements in mitochondrial dynamics and function can affect the cardiac output, thus constituting a strong basis for the development of cardiomyopathies. Our results showed that chloroquine induced mitochondrial fragmentation, accumulation of damaged mitochondria and increased mitochondrial ROS production (Figure 16). These effects could result in mitochondrial dysfunction leading to heart failure.

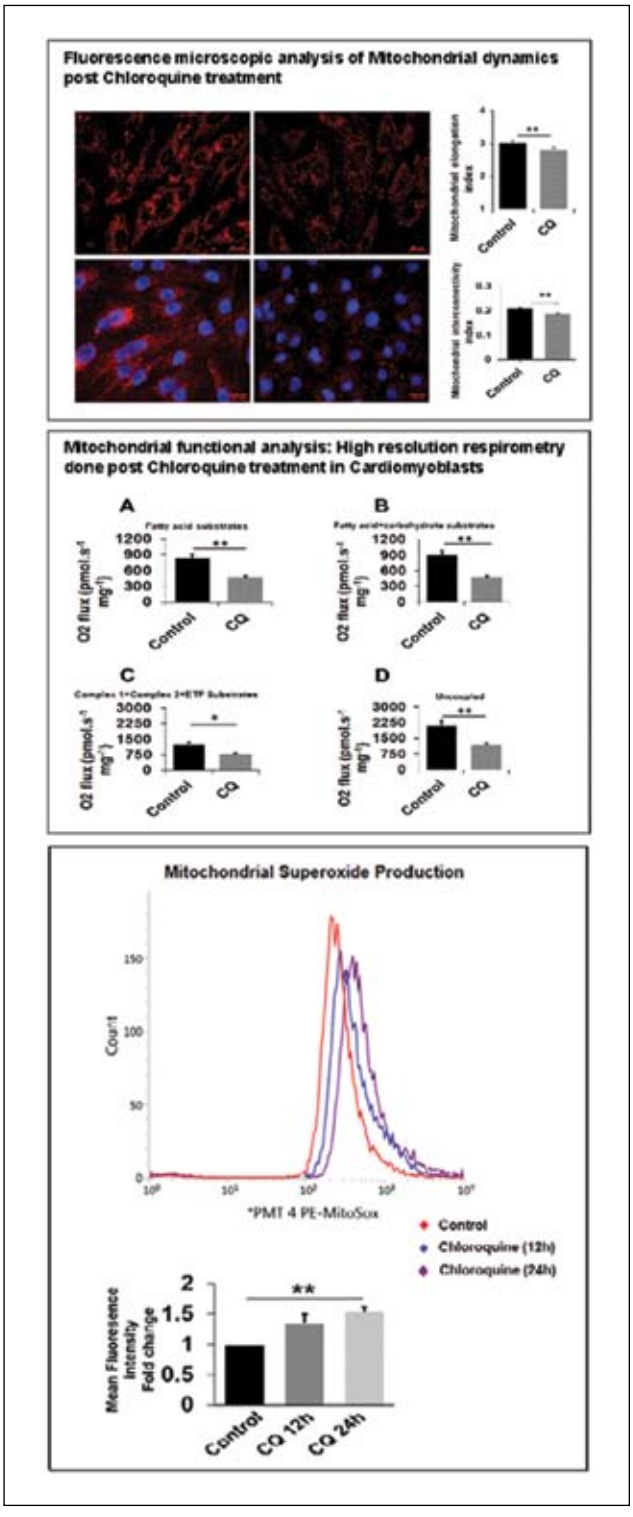


Figure 16. Impact of chloroquine on mitochondrial metabolism

2. Changes in mitochondrial metabolism in glioma cells under hyperglycemia

The hyperglycemic stress in glioma caused the reduction in mitochondrial oxidative phosphorylation i.e., increased Warburg effect. We determined the molecular events that caused decline in mitochondrial dependency and if blocking these could reverse the mitochondria-based metabolism. We observed three events that happened as a result of hyperglycemic stress in the glioma cells. The first was mitochondrial fragmentation through activation of Drp1 (involved in mitochondrial tethering). The effect of blocking Drp1 activation through pharmacological inhibitor Mdivi (5 μM) on mitochondria-mediated respiration was studied. The second observation was that under hyperglycemic stress, the autophagy in the cell declined. Increasing the cellular autophagy through Torin1 (100nM) improved the mitochondrial metabolism. The third event was the production of nitric oxide under hyperglycemia. The nitric oxide synthase blocker, L-NAME (6 mM), improved mitochondrial metabolism. Based on these observations, it was inferred that hyperglycemic stress reduced mitochondrial oxidative phosphorylation which was mediated by decreased autophagy and increased nitric oxide production, and reversing these events with pharmacological agents caused a reversal in mitochondrial dependency (Figure 17).

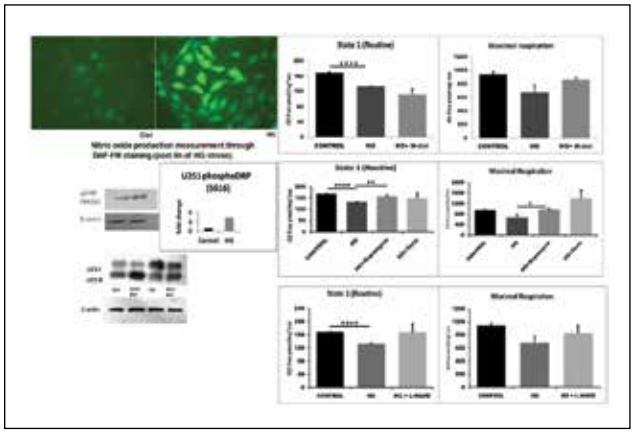
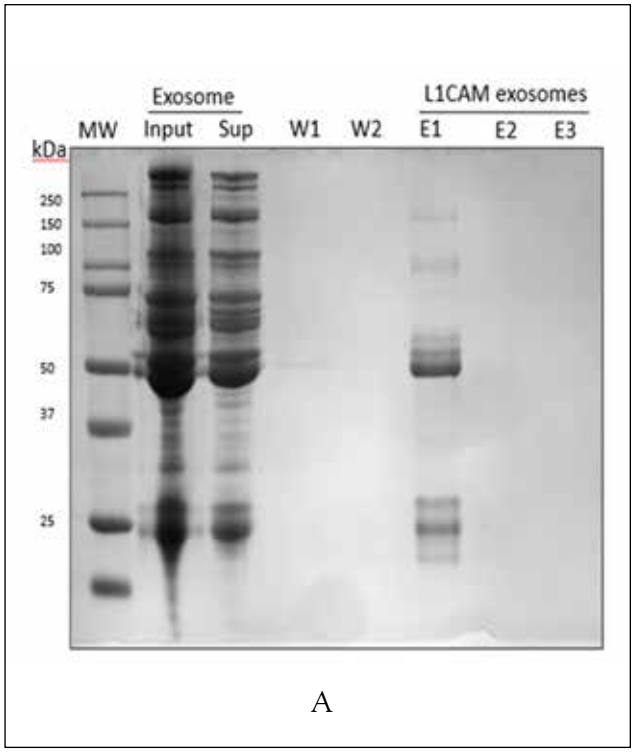


Figure 17. Changes in mitochondrial metabolism in glioma cells under hyperglycemia

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

The main objective was to identify dysregulated miRNA and proteins in neuronal- derived exosomes isolated from plasma of patients with Parkinson's disease using next generation sequencing and mass spectrometry. Total plasma exosomes were isolated using commercially available kits. From this total exosomal pool, neuronal-derived exosomes was isolated using CD171 antibody- based (specific to brain-derived exosomes) immunoprecipitation. Figure 18A shows the SDS-PAGE and Coomassie staining of proteins in the exosomal preparation after immunoprecipitation. Western blot analysis confirmed the presence of exosome-specific markers (CD63, TSG 101) and neuronal-specific CD171 marker in the eluted samples (Figure 18B). The morphological characteristics of isolated exosomes were analysed using Transmission Electron Microscopy (TEM, Figure 18C). and the homogeneity of exosomes analyzed by dynamic light scattering (DLS, Figure 18D).



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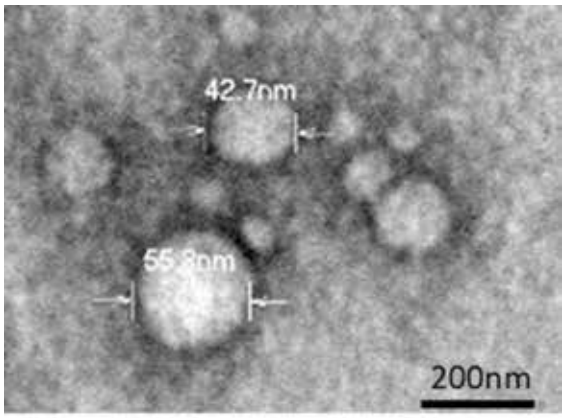

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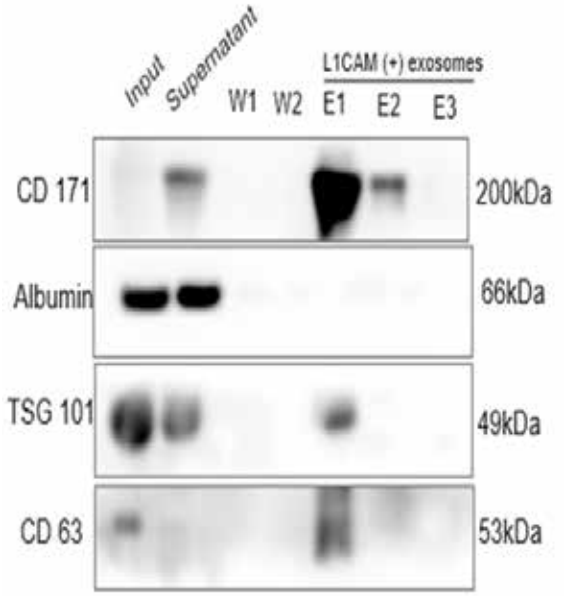

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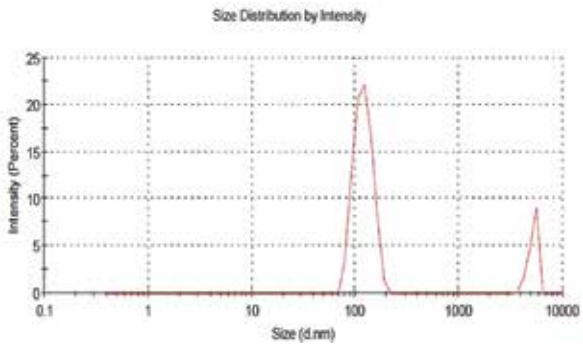


D

Figure 18. Isolation of neuronal-derived exosomes in Parkinson's disease

4. Glucocerebrosidase assay development for monitoring lysosomal dysfunction

Lysosomal dysfunction, due to either gene mutations or ageing, could result in cell death by impairing cellular homeostasis. As it is already established that fully functional lysosomes are necessary to prevent age-associated neuronal protein accumulation and cell death, quantitative and accurate measurement of lysosomal functionality with ageing is important for initial screening for their susceptibility to neuronal disorders. The susceptibility of a person with defective lysosomal function, even in the absence of any gene mutation, to neurodegeneration disease development or disease progression cannot be predicted by the existing biochemical assays or by genetic testing. Therefore, development of a specific and sensitive biochemical assay is critical for monitoring the lysosomal function in age-related diseases. The modified assay will be validated using samples from: (a) Gaucher disease patients where mutations in Glucocerebrosidase gene (GBA1) have been confirmed (b) Parkinson's disease patients where an inverse correlation between GCase activity and αSynuclein accumulation has been reported. This study is expected to provide accurate values of GCase activity that could be used as an indicator of lysosomal functional status in our populations.

5. Genetic basis of inherited disorders

Studies were initiated to obtain the mutation spectrum in Parkinson's disease, cardiac channelopathy, cardiomyopathies and epileptic encephalopathy patients.

6. Advanced glycation end products and neurodegeneration

With the increasing age and number of diabetes patients in India, the incidence of neurodegenerative diseases is expected to increase by at least four folds in the coming years and there are limited/no treatment options for most of the neurodegenerative diseases. It has been proposed that deficits in vascular function (blood-brain-barrier disruption) within the central nervous system can be a triggering factor for the initiation of neurodegeneration. This project studies the role of basement membrane modifications like Advanced Glycation Endproducts (AGEs) and alteration in brain pericyte function and in turn the dysfunction of the blood-brain-barrier (BBB). This work investigates the role of two components of the BBB viz human brain pericytes and basement membrane. Knowing the mechanisms behind AGE-mediated alteration of pericyte function can lead to potential therapeutics in neurodegenerative diseases. This work would also be a prelude to developing an in vitro model system to study the functions of blood-brain-barrier.

Academic activities

The following students successfully completed their PhD thesis viva-voce examination conducted online:

1. Ms Dhanya Krishnan on 30 June 2020
2. Mr Anand C R on 7 December 2020
3. Ms Bhavya Bharathan on 23 December 2020
4. Ms Raji S R on 25 January 2021

Activities related to COVID-19

Dr Srinivas G took charge as co-ordinator of COVID-19 testing at SCTIMST from 8 July 2020. The duties and responsibilities included: co-ordination of discussions with Private Medical Colleges in Kerala for setting up BSL-2 Level RT-PCR Laboratories and participation in ICMR Mentorship and Institute COVID Cell Meetings.

Figure 19. Covid-19 Vaccination Programme at the Institute

The Department co-ordinated the COVID-19 Vaccination Programme for staff, students, pensioners and dependents of the institute starting from 30 January 2021 (Figure 19).

Awards and Honours

Mr Ashok S, PhD student in the Department was awarded 2nd Prize for oral presentation entitled "Mitochondrial damage as a means of chloroquine-induced cardiotoxicity" in the International Seminar on 'Recent Biochemical Approaches in Therapeutics (RBAT-VII)' held on 9-11 February 2021, organized by Department of Biochemistry, University of Kerala.

Staff

Faculty

Dr Srinivas G, Scientist F and Acting Head

Dr Madhusoodanan U K, Assistant Professor

Dr Cibin T R, Assistant Professor

Technical

Thomas TA, Scientific Officer (Lab) (till 31-04-2020)

Jayasree K K, Scientific Officer (Lab)

Dr Geetha M, Junior Scientific Officer (Lab)

Vijayalekshmi L, Junior Technical Officer (Lab)

Sreenivas N C, Junior Technical Officer (Lab) (till 30-09-2020)

Sumitha K C, Technical Assistant (Lab) - B

Santhosh Kumar R, Technical Assistant (Lab) - B

Sheeja M, Technical Assistant (Lab) - B

Sreedevi V S, Technical Assistant (Lab) - B

Dr Deepa D, Technical Assistant (Lab) - B

Sreekala Balan P, Technical Assistant (Lab) - B

Manju G Nair, Technical Assistant (Lab) - B

Saritha Gopakumar, Technical Assistant (Lab) - A

Sunitha S, Technical Assistant (Lab) - A

Siju K S, Technical Assistant (Lab) - A

Divya T Nair, Technical Assistant (Lab) - A

Anooja V, Technical Assistant (Lab) - A

Mangalamma H R, Technical Assistant (Lab) - A

Valsala B, Sr. Unit Assistant

Shaji V, Unit Helper - A

Shamnad J, Cleaning Attendant - A

DEPARTMENT OF CARDIOLOGY

The Department of Cardiology is nationally renowned with state-of-the-art patient care, research and academic programmes. The training programmes include post-doctoral course- DM cardiology, Post DM Fellowship and Post graduate DCLT with 6 DM trainees, 3 Fellows and 3 cath-lab technician trainees annually. The Department continued to have one of the largest numbers of indexed journal publications in the speciality across the country. The subspecialties of the department such as the Adult Cardiology and Intervention, Electrophysiology and Paediatric Cardiology continued to set new benchmarks in patient care.

The Department played a major role in the development and implementation of the COVID-19 protocols in the institute during the year. Telemedicine systems were evaluated and established as a routine for management of stable outpatients and minimized physical consultations. An efficient system of triaging was developed and implemented after a series of mock drills. The Department conducted training programmes regarding COVID-19 protocols and updates in management. Training programmes on COVID-19 were also conducted for the public through publications, webinars, invited talks and blogs. (Figure 20)

Review > Indian Heart J. Mar-Apr 2020;72(2):75-81. doi: 10.1016/j.ihj.2020.04.012. Epub 2020 May 13.

Cardiological society of India position statement on COVID-19 and heart failure

S Harikrishnan [1], P P Mohanan [2], V K Chopra [3], Roy Ambuj [4], G Sanjay [5], Manish Bansal [6], R N Chakraborty [7], Sharad Chandra [8], S S Chattarjee [9], H K Chopra [10], Cibu Mathew [11], P K Deb [12], A Goyal [13], K C Goswami [4], R Gupta [14], S Guha [15], V Gupta [16], P K Hasija [17], Harsh Wardhan [18], A Jabir [19], P B Jayagopal [20], D Kahali [21], V K Katyal [22], P G Kerkar [23], N N Khanna [24], B Majumder [25], M Mandal [26], C B Meena [27], N Naik [4], V K Narain [8], L A Pathak [28], S Ray [29], D Roy [30], S N Routray [31], D Sarma [32], S Shanmugasundaram [33], B P Singh [9], S K Tyagi [34], K Venugopal [35], G S Wander [36], Rakesh Yadav [4], M K Das [37]

Affiliations + expand

PMID: 32405088 PMCID: PMC7219407 DOI: 10.1016/j.ihj.2020.04.012

Free PMC article

Figure 20. Departmental role in the development and implementation of COVID-19 protocols

Activities

DIVISION OF ADULT CARDIOLOGY AND INTERVENTIONS

The ICMR Centre for Advanced Research and Excellence (CARE) in Heart Failure (HF) with a funding of 5 Crores is one of the flagship research initiatives of the institute. As part of the CARE initiative, the National HF Biobank Facility provides state-of-the-art storage facilities and was awaiting inauguration. The genetic study in patients and family members of hypertrophic cardiomyopathy continued with identification of few novel mutations which require validation by Sanger sequencing. Nation-wide multicentric research activities including assessment of economic impact of heart failure and 2x2 factorial trial on HF management progressed as part of the CARE initiative. Another key activity of CARE was the development of a point-of-care device for estimating biomarkers (NT Pro-BNP) in patients with heart failure in collaboration with Biomedical Technology Wing of our institute and Rajiv Gandhi Centre for Biotechnology.

The Departmental Percutaneous Aortic Valve Implantation Programme continued with referrals from various Centres. The Department participated in the clinical trial of the indigenous TAVR system, MyValTM which was approved by the DCGI and is available in the market at more affordable price than the imported variants.

Due to the COVID-19 pandemic, the number of interventional procedures was relatively lower this year. Nevertheless, the Department performed complex coronary interventions such as left main coronary artery interventions, rotational atherectomy and bypass graft interventions. These interventions were guided by the state-of-the-art technologies like Intravascular Ultrasound (IVUS), Optical Coherence Tomography (OCT) and Fractional Flow Reserve (FFR) estimation. Resting Flow Cycle Ratio (RFR), a recently introduced technique is part of the routine physiology assessment protocol at the institute.

The other major specialized clinical services of the Department during the year included structural heart disease interventions and valve interventions, percutaneous (non-surgical) closure of - paravalvular leaks, congenital and acquired defects, balloon dilatation and stenting of aortic coarctation. The Department continued to be a Referral Centre for balloon mitral valvotomy with significant number of pregnant patients undergoing the procedure during the second and third trimester of pregnancy.

To ensure optimal delivery of the services during COVID-19 pandemic, the Heart Failure ICU was relegated for management of patients presenting with acute cardiovascular illnesses while awaiting their COVID-19 status. This enabled provision of uninterrupted and focussed cardiovascular care to all patients during the pandemic.

DIVISION OF CARDIAC ELECTROPHYSIOLOGY AND PACING

One of the leading Interventional Electrophysiology Centres in the country, the Division performed more than 350 ablations and electrophysiology procedures during the year, one of the largest in the country. In addition, the number of device implantations (including ICDs and cardiac resynchronization devices) was about 250. The use of 3D electro anatomical mapping systems, CARTO 3 and Ensite Velocity continued to aid complex ablation procedures. Our Device Clinic follows-up nearly 2000 cases every year. We upgraded the Clinic to better cater to our patients and to maintain a database of our device cases. The focus of the Division continued to be on expanding the expertise in VT ablations. The request from the Asia Pacific Heart Rhythm Society (APHRS) for an additional seat for Postdoctoral Fellowship in Electrophysiology was under process. We are also in the process of increasing seats for postdoctoral fellowships as the demand and opportunities for training has significantly improved. This year, a cardiologist from the Republic of Maldives was undergoing fellowship in Cardiac Electrophysiology.

The Electro-Anatomical Ablation Workshops conducted by the Division is attended by electrophysiologists across the country interested in developing these programmes in their institutions, who also visit the division for short-term observer ship. The Division is the national co-ordinating Centre for a nationwide Channelopathy Registry, which will catalogue various causes of inherited abnormalities of cardiac ion channel functions that predispose to sudden cardiac death at a young age. The editorial

office of the indexed medical journal, Indian Pacing and Electrophysiology (Elsevier publishers) is also located with the Division. The Division initiated a Physiological Pacing Programme wherein the conduction system is directly paced and performed this procedure in more than 20 cases. The Division also started a Comprehensive Device Arrhythmia Clinic (CDAC) for a systematic and comprehensive evaluation of patients with cardiac devices and complex arrhythmias.

An international agency-'Expertscape', that objectively ranks medical experts and institutions worldwide ranked the Division of Cardiac Electrophysiology and Pacing as the ninth leading centre in the world in terms of expertise in the field of Atrioventricular Nodal Re-entry Tachycardia. SCTIMST was the only Centre from India to secure a place in the first 100 institutions at the international level.

DIVISION OF PAEDIATRIC CARDIOLOGY

The Paediatric Cardiology Section of the Department of Cardiology is the most sought-after hub of care for congenital heart diseases in the state. Paediatric Cardiology along with the Congenital Heart Surgery Division of Cardiac Surgery serve as the nodal centre of the Hridyam Programme of the Government of Kerala to support children with congenital heart diseases. We offer a one-year Postdoctoral Fellowship Programme in Paediatric Cardiology. The Division also trains postdoctoral observers and nursing trainees in paediatric cardiology.

The Division offers foetal echocardiography and follow-up of high-risk foetuses with structural heart diseases and cardiac dysrhythmias. The Division caters to references from all over Kerala, and adjoining states. Services offered include antenatal counselling, planned pregnancy and delivery management in liaison with the Departments of Obstetrics and Gynaecology, and Neonatology, Government Medical College Thiruvananthapuram. The Division takes the lead in follow-up and management of foetuses with critical congenital heart diseases, structural cardiac abnormalities and arrhythmias with involvement of Congenital Heart Surgery and Cardiac Electrophysiology Divisions.

We perform an average of 500 paediatric cardiac catheterizations annually, which is one of the largest in the government sector in India. Device closure of atrial septal defects, ventricular septal defects and patent arterial ducts with multi-modality imaging are done with minimal radiation exposure to the child. The institute has pioneered non-fluoroscopic device closures of ASD and PDA and has a database of over 1000 such procedures. Other routinely undertaken procedures in the catheterization laboratory include valvuloplasty, ductal stenting, RVOT stenting, coarctation angioplasty, pulmonary artery and pulmonary venous angioplasty.

Our Division works closely with Congenital Heart Surgery Division of Cardiac Surgery for hybrid interventions, comprehensive postoperative care and long-term rehabilitation of children with complex congenital heart diseases. We also offer comprehensive follow-up care for optimization of care for univentricular hearts including cardiac catheterization and percutaneous interventions, growth and development monitoring, multidisciplinary rehabilitation and counselling. The various Clinics functioning under the division include New-born infant Clinic, CCHD Clinic and Foetal Clinic.

Research Programmes

1. The Centre of Excellence in Heart Failure – One of the 11 National Centres of Excellence under the CARE Program of ICMR (2019). There are seven projects under this initiative including the first Heart Failure Biobank in the country (PI: Dr Harikrishnan S, Funded by: ICMR).
2. National Heart Failure Registry (PI: Dr Harikrishnan S, Funded by: ICMR).
3. International Study of Comparative Health Effectiveness with Medical and Invasive Approaches (PI: Dr Ajit Kumar V K, Funded by: NHLBI, US)
4. PROLIFIC Study - Family based randomised controlled trial of cardiovascular risk reduction in individuals with family history of premature coronary artery disease (CAD) in India (PI: Dr Harikrishnan S, Funded by: DBT Wellcome Trust)
5. Contemporary outcomes in cardiac channelopathies guided by genotype and

phenotype-based management (PI: Dr Narayanan Namboodiri K K, Funded by: ICMR)

6. Biophysical evaluation of various bipolar configurations in RF ablation of ventricular myocardium in a bovine model and a prototype design of a custom-made bipolar RF ablator model (PI: Dr Narayanan Namboodiri K K, Funded by: Indian Heart Rhythm Society).
7. Conduction system pacing - clinical and echocardiographic follow-up: A prospective multicentric study (Investigators: Drs Narayanan Namboodiri K K, Ajit Kumar V K, Krishna Kumar M, Funded by: Heart Rhythm Society).
8. Prognostic value of circulating microRNAs in heart failure (PI: Dr Sanjay G, Funded by: ICMR).
9. Kerala Registry of Infective Endocarditis - KIND Registry (PI: Dr Arun Gopalakrishnan, Funded by: CSI-Kerala Chapter)
10. Trivandrum Congenital Heart Disease Registry for Newborns (PI: Dr Deepa S Kumar, Funded by: ICMR).
11. Association and impact of 22q11.2 deletion in conotruncal defects: a prospective observational study (PI: Dr Deepa S Kumar, Funded by: Paediatric CSI).

Industry-funded Projects

1. A prospective, multicentric, single-arm, open-label study of MyValTM Transcatheter [Aortic Valve Replacement System in the treatment of severe symptomatic native aortic valve stenosis] (PI: Dr Ajit Kumar V K, Funded by: Meril Lifesciences, India)
2. Practical evaluation of Fractional Flow Reserve (FFR) and its associated alternate indices during routine clinical procedures (Pressure Wire Study) (PI: Dr Ajit Kumar V K, Funded by: Abbot India)

Product Development

The Department has Projects in collaboration with other departments of the hospital and BMT Wing of the institute, RGCB, Trivandrum, and NIT, Calicut for technology development.

1. Development of Nitinol-based occlusion devices for non-surgical closure of atrial septal defect-technology transferred to M/s Biorad Medisys Pvt. Ltd., Bangalore. (Clinical PI: Dr Bijulal S, Funded by: TDF, SCTIMST).
2. Development of TiN-coated coronary stent (Clinical investigators: Drs Harikrishnan S, Sanjay G, Krishna Kumar M, Funded by: TRC, SCTIMST).
3. Novel technique of developing transcatheter heart valve from human homograft for percutaneous pulmonary valve replacement (Clinical PI: Dr Bijulal S, Funded by: BIRAC).
4. Development of an automatic implantable cardioverter-defibrillator (Clinical Investigators: Drs Narayanan Namboodiri K K, Ajit Kumar V K, Krishna Kumar M, Funded by: TRC, SCTIMST)
5. Development of an automated external defibrillator system (Clinical PI: Dr Narayanan Namboodiri K K, Funded by: TDF, SCTIMST).
6. Non-invasive measurement and monitoring of pulmonary congestion in emergency rooms – joint project with DCE, SCTIMST and NIT, Calicut (Clinical PI: Dr Harikrishnan S, Funded by: DST-DDP).
7. Developing point-of-care device for BNP - collaborative project with BMT Wing, SCTIMST and RGCB, Trivandrum (Clinical PI: Dr Harikrishnan S, Part of CARE HF - ICMR).
8. Development of a device incorporating a new computer algorithm to aid in managing anticoagulation in patients requiring oral anticoagulant drugs - collaborative project with NIT-Calicut (Clinical Investigators- Drs Harikrishnan S, Sanjay G, Jeemon P).

New Initiatives

1. Training webinars for cardiologists, residents and physicians of the country by consultants of the department in association with the various professional/ academic societies in Cardiology such as Cardiological Society of India, Heart Rhythm Society and Heart Failure Association of India.

2. The Division of Cardiac Electrophysiology and Pacing started a new Comprehensive Device Arrhythmia Clinic for a systematic and comprehensive evaluation of patients with cardiac devices and complex arrhythmias.
3. The Division of Cardiac Electrophysiology and Pacing started the physiological conduction system pacing services for eligible patients.

Events Organized

1. "Heart Failure Conflux", an online event, where basic researchers and clinician-researchers discussed how to have better interaction and discussed ways to remove the roadblocks in collaborative research. The event was jointly organized ICMR Centre of Excellence in Heart Failure, SCTIMST, Heart Failure Association of India and the Indian Section of the International Academy of Cardiovascular Sciences from 5-7 February 2021. Dr Harikrishnan S was the organizing Secretary.
2. A six-week certificate course on "Holistic approach to Heart Failure Management" was conducted in association with Heart Failure Association of India from 24 June 2020 to 29 July 2020. Dr Harikrishnan S was the Course Director.
3. Heart Failure Clinics - monthly virtual bedside clinics Dr Harikrishnan S was the Course Director and Dr Arun Gopalakrishnan was the Course Co-ordinator.
4. Monthly Seminar- Heart Failure Confluence, from September 2020; Course Coordinator- Dr Harikrishnan S (Heart Failure Association of India)
5. The Paediatric Cardiology Team conducted a series of eight Workshops in Paediatric cardiac catheterization and structural cardiac interventions at the Cardiac Catheterization Laboratory, SAT Hospital, Government Medical College, Thiruvananthapuram from December 2020 to February 2021.

Awards and Honours

1. Dr Harikrishnan S was elected Fellow of Academy of Medical Sciences (FAMS), 2021.
2. Dr Harikrishnan S was elected Fellow of the International Academy of Cardiovascular Sciences (FIACS) 2020, Vancouver, Canada.
3. Dr Harikrishnan S was member of the Committee developing the universal definition of etiologies in heart failure as part of the Global Burden of Disease Heart Failure Study Group.
4. Dr Harikrishnan S was selected as an Affiliated Member of the National Heart Failure Societies and Working Groups Committee of the Heart Failure Association of the European Society of Cardiology.
5. Dr Narayanan Namboodiri K K was the member of writing committee for two consensus statements by Heart Rhythm Society and European Heart Rhythm Association.
6. Dr Narayanan Namboodiri K K was ranked 9th and Dr Krishna Kumar M was ranked 14th in terms of contributions and expertise in atrioventricular nodal re-entry tachycardia by 'Expertscape', an international agency that objectively ranks medical experts and institutions worldwide.
7. Dr Abhilash S P completed a 1-year Fellowship in Electrophysiology and Device Therapy from Canberra Hospital, Australia.
8. Dr Narayanan Namboodiri K K continued to serve as a nominated member of Janamaithri Police, Medical College, under Government of Kerala.
9. Ms Rasmi Mohan received the Best Speaker award in the session titled 'Tackling the Electric Circuit of Life' at the annual conference of the Society of Paramedics, Cardiac Interventional Technologists Association of India in December 2020.

10. Awards won by Senior Residents in Cardiology

- Dr Deepanjan Bhattacharya was awarded the PCSI Research Grant for the period 2020-21 for the study entitled "Association and impact of 22q11.2 deletion in conotruncal defects: A prospective observational study".
- Dr Deepanjan Bhattacharya won the best paper award for the paper entitled "Cardiac MRI in right ventricular outflow tract arrhythmia: A retrospective analysis" at the Annual Conference of the Cardiological Society of India - Kerala Chapter on 31 October 2020.
- Dr Rohit Walse won the 2nd prize for oral presentation in the category, 'Conventional EP cases' at the annual IHRS Conference in October 2020.
- Dr Vishnu S was awarded the best free paper award for the paper titled "Pattern of LGE in cardiac MRI predicts clinical events in cardiac sarcoidosis" at the annual national conference of the Cardiological Society of India in December 2020.
- Drs Vishnu S and Gayathri Kartha won 2nd Prize in the Echocardiography Quiz organized by the Kerala Chapter of the Indian Academy of Echocardiography in February 2021.
- Dr Vishnu S won the best moderated abstract award for the paper entitled "Eisenmenger syndrome - long term outcomes" at the Heart Failure Association of India Virtual Conference in February 2021.

Staff

Faculty

Dr Krishnamoorthy K M, Professor and Head of the Department

Dr Ajit Kumar V K, Professor (Senior Grade)

Dr Harikrishnan S, Professor

Dr Narayanan Namboodiri K K, Professor

Dr Bijulal S, Professor

Dr Sanjay G, Additional Professor

Dr Abhilash S P, Additional Professor

Dr Krishna Kumar M, Associate Professor

Dr Deepa S Kumar, Associate Professor

Dr Arun Gopalakrishnan, Assistant Professor

Technical

Mr Suji K, Junior Scientific Officer

Mr Subrahmanya H R, Junior Technical Officer

Ms Resmy P V, Senior Technical Assistant

Ms Sheeja S, Technical Assistant - B

Ms Sethu Parvathy V K, Technical Assistant - B

Ms Rasmi Mohan, Technical Assistant - B

Mr Midhun S V, Technical Assistant - B

Ms Princy V, Technical Assistant - A

DEPARTMENT OF CARDIOVASCULAR AND THORACIC SURGERY

The Department of Cardiovascular and Thoracic Surgery (CVTS) has been one of the premier centres of the country since its inception in 1976. The Department functions as three separate Divisions: Adult Cardiac Surgery, Congenital Heart Surgery and Vascular and Thoracic Surgery.

The Division of Adult Cardiac Surgery has five dedicated surgeons. The surgical services are offered as elective and emergency in all complex adult cardiac operations like CABG, valve repair and replacement, minimally-invasive procedures, aortic aneurysms, aortic dissections and heart failure surgeries. The Division of Congenital Heart Surgery consists of 4 consultant paediatric cardiac surgeons and is adequately supported by paediatric cardiologists and anaesthetists. All simple and complex procedures are performed in the Division with a cumulative mortality rate of less the 3%. Vascular Division, over the years, has produced outstanding results in open and endovascular repair of complex aortic aneurysms. It has a dedicated faculty member who performs major and peripheral vascular procedures as well as general thoracic operations.

Heart failure, TAVI and TEVAR are Collaborative Programmes with departments of Cardiology and Radiology. The Department has active academic and research programmes.

Activities

Clinical Activities

Due to the COVID-19 Pandemic, there was an overall decrease in the clinical work, driven by the lockdown and hesitancy of people to travel. Detailed guidelines for the triage and management of COVID-19 positive, suspected and negative patients were prepared after multiple discussions within the department and infectious disease specialists. In total, 536 adult cardiac surgery cases were performed during this period. The Division of Congenital Heart Surgery developed a Covid response protocol for patients with congenital heart disease who would come to the outpatient department. In total, 4650 patients were seen in outpatient department and 444 procedures were performed. However, opting out of the state government-funded programme (Hridyam by Kerala RBSK) resulted in a sudden decrease in the inflow of patients, especially neonates and infants.

The Division of Vascular and Thoracic Surgery operated on 240 patients which included more than 100 major arterial surgeries during the year.

Research Programmes

Newly Initiated Projects:

Effect and outcome determinants of right ventricular function in postoperative tetralogy of Fallot: a retrospective descriptive cohort study (PI: Dr Baiju S Dharan, Funded by: ICMR).

Ongoing Projects in collaboration with BMT Wing:

1. Tichval 2 pilot study for TTK Chitra - the clinical trials on second-generation Chitra valve (Tichval 2) was started (PI: Dr Jayakumar K, Funded by: TTK)
2. Centrifugal blood pump with blood flowmeter (Clinical PI: Dr Vivek V Pillai , Funded by: TRC)
3. Mitral Annuloplasty System (Clinical PI: Dr Vivek V Pillai , Funded by: TRC)
4. Left ventricular Assist Device (Clinical PI: Dr Vivek V Pillai , Funded by: TRC)
5. Bioprosthetic heart valve project (Clinical PI: Dr Vivek V Pillai , Funded by: TRC)
6. Multi-layered warp knitted polyester in strengthening valve annulus after valve repair (PI: Dr Varghese T Panicker, Funded by: TDF, SCTIMST)
7. A suction retractor device for aortic valve replacement in adult cardiac surgery, (PI: Dr Bineesh K R, Funded by: TDF, SCTIMST)

New Initiatives

A DFM 100 defibrillator biphasic monitor was added to the Department.

Events Organized

A webinar on "Newer devices used in proximal anastomosis in CABG surgery" was organized on 12 December 2020.

Awards and Honours

1. The Institute was designated as the "Best Vascular Surgery Institute" - amongst all vascular surgery teaching institutes in India during the competition held at MIDTERM MEET 2020, a virtual meeting.
2. Dr Vineeth Kumar, vascular surgery senior resident was selected as the best resident of the year at MIDTERM MEET 2020, a virtual meeting.

Staff

Faculty

Dr Baiju S Dharan, Professor and Head of the Department

Dr Jayakumar K, Professor (Senior Grade)

Dr Vivek V Pillai, Additional Professor

Dr Varghese T Panicker, Additional Professor

Dr Sabarinath Menon, Additional Professor

Dr Bineesh K R, Associate Professor

Dr Sudip Dutta Barua, Assistant Professor

Dr Sowmya Ramanan V, Assistant Professor

Dr P Shivanesan, Assistant Professor

Dr Renjith S, Assistant Professor

Technical

Ms Beegum Thaslim, Senior Scientific Assistant

Ms Maya L, Perfusionist - B

Mr Sujith V M, Perfusionist - B

Mr Don Sebastian, Perfusionist - B

Mr Shanu P S, Perfusionist - B

Mr Rijesh S R, Perfusionist - A

Mr Sujesh S, Perfusionist - A

Ms Beena B Pillai, Transplant Co-ordinator - A

DIVISION OF CLINICAL ENGINEERING

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

Activities

The Division ensured proper equipment management by promoting the use of standard-based approach that imparted safer, efficient and high-quality management of medical equipment. For assuring safe, effective care and treatment of patients, DCE took part in the selection of suitable equipment to support the services of the Institute and conducted training programmes and classes on medical equipment for the institute staff. DCE assessed the need for regular technical support and devised strategies for calibration, inspection, maintenance, and repair services of medical equipment.

Clinical Engineers, the medical technology experts worked towards bringing as much in-house technical support as possible and performed many activities in various stages of equipment life-cycle such as pre-purchase evaluations, equipment recommendations, purchasing assistance service, incoming inspections, equipment servicing, contract management, user training, regular preventive maintenance, performance testing, calibrations, breakdown work, equipment installations, replacement recommendations, biomedical networking, user-error tracking and maintenance of equipment history.

Activities of the Electrical and Mechanical Sections during the year included: routine operation and maintenance of HT panel, transformer, DG sets and hospital electrical system; overhauling shutdown maintenance for ACB in a substation, completing the commissioning of the solar power plant in institute rooftop, electrical work in the up-gradation of DR system, routine operation and maintenance of AC plants, AHUs, medical gas systems, central sterilization units and laundry equipment.

During the year, the Division extended its services to the Institute by successfully managing more than 9500 work requests registered through the computerized complaint-management system. They included testing and certification of the newly- installed equipment, maintenance and repair of the existing equipment and infrastructure facilities and modification of electrical and air-conditioning systems. The Division also monitored and documented the activities of Service Engineers from Companies that were executed during warranty and service contract period.

The work requests managed during the year are summarized in the Table below:

Subdivision	Complaints attended
Air Conditioning	902
Communication	849
Electrical	1746
Biomedical/Electronics	4189
Fitting/ Medical Gas Line	1860
Office Equipment	24
Total	**9570**

Major Equipment Installed during the year

Sl. No.	Equipment	Approximate Cost
1	Agilent G2939BA Bioanalyser	Rs 1764000
2	1.5T Magnetom Avanto Fit MRI System	Rs 75733286
3	Conmed Sternal Saw, COnmed Sagittal Saw	Rs 910318.5
4	Prognosys Prorad 2FC DR System	Rs 5992000
5	Zoll EMV and Portable Ventilator	Courtesy Ministry of Health and Family Welfare, Government of India
6	Hamilton Compact ICU Ventilator Model-C3	Courtesy Ministry of Health and Family Welfare, Government of India

Research Programmes

The Division was engaged in the following Projects:

1. Development of portable low-cost disposable defibrillator for cardiac arrest management, (Funded by: DST, Co-PI: Mr Manoj G S)
2. Development of autonomic function monitor based on combined heart rate variability (HRV) and galvanic skin conductance, (Funded by: TDF, SCTIMST, Co-PI: Mr Manoj G S)
3. Development and Evaluation of Air-Borne Infection Control Systems for Healthcare Facilities (Funded by: DST, PI: Mr Shaj Upendran)

Others

1. Six students completed their internship in the Division.
2. The Faculty actively participated in the MTech Programme in Clinical Engineering.
3. Around 20 apprentices with BTech, Diploma and ITI qualifications were trained in the Biomedical, Electrical and Mechanical Sections of DCE.
4. The Division was actively involved in the COVID-19 preparedness and modified air-conditioning systems of ICUs and OTs. 18 new ventilators received from Ministry of Health and Family Welfare. Government of India, were installed.
5. The Division provided technical support to many government institutions in Trivandrum, including Regional Cancer Centre, Rajiv Gandhi Centre for Biotechnology, Government Homeopathic Medical College and Medical College, Trivandrum.

New Initiatives

1. DCE was actively involved in the planning, designing and construction of the new Hospital Block infrastructure facilities. This included: planning and evaluation of services (electrical power, air conditioning, water supply, drainage, medical gases, vacuum) prepared by CPWD and monitoring the progress of the work with the help of Construction Wing and consultants.
2. New air compressors were commissioned and installed.
3. New Digital X-ray Facility was commissioned.
4. Layout of Medical gas pipeline systems and Modular operation theatres were prepared with the help of M/s. STAT Consultancy Pvt. Ltd. For the new Hospital block and started the tendering process.
5. Commissioned a UV disinfected pH controlled centralised water purification system for the entire Medical Block.
6. Initiated steps for reducing oxygen loss and modification of oxygen manifolds.

Events Organized

"HEATS" (Hospital Equipment Awareness Training Series) for imparting advanced technical training on various medical equipment continued its endeavour since 2013. During the year, DCE organized 5 Workshops, the details of which are provided below:

Title & theme of the event	Date & venue	Organizers/ Co-organizers
HEATS-59 - Agilent G2939BA Bioanalyser	30-05-2020 at Biochemistry	DCE in association with Premas life science
HEATS-60 - 1.5T Magnetom Avanto Fit MRI System	18-09-2020 at IS&IR	DCE in association with SIEMENS
HEATS-61 - Prognosys Prorad 2FC DR System	16-01-2021 at IS&IR	DCE in association with Prognosys Medical Systems Pvt. Ltd.
HEATS-62 - Zoll EMV and Portable Ventilator	19-12-2020 at ICUs	DCE in association with MGM Associates
HEATS-63 - Hamilton Compact ICU Ventilator Model-C3	05-01-2021 at ICUs	DCE in association with Hamilton

Staff

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

Mr Manoj G S, Engineer C

Mr Anoop Jose, Engineer C

Mr Vishal V P, Engineer B

Mr Praveen James, Engineer B

Mr Ganesh P, Assistant Engineer (Electrical)

Mrs Neelima Muraleedharan, Engineer B

DIVISION OF CELLULAR AND MOLECULAR CARDIOLOGY

The Division focuses on basic and translational research in cardiovascular biology. The current focus is on molecular regulators of myocardial tissue response to injury that could be therapeutically targeted to prevent or minimise cardiac dysfunction. During the year, the Division provided guidance to 3 PhD students, an ICMR project staff and the Principal Investigator under the DST Women Scientists' Scheme. Allen Sam Titus was awarded PhD during the year. The Division carried out collaborative research with other departments of the Institute. Ongoing work on cardiac fibroblasts and cardiac progenitor cells resulted in one major publication and four conference presentations.

Activities

Research Programmes

1. Discoidin Domain Receptor 2 (DDR2) - a "master switch" in cardiac fibroblasts

The Division carried forward the ongoing work on molecular mechanisms underlying cardiac fibroblast growth, which is an unmistakable feature of myocardial disease. The ability of cardiac fibroblasts to resist apoptosis, undergo phenotypic transformation into active myofibroblasts, proliferate and produce collagen is a major determinant of myocardial repair post-injury. Identification of cardiac fibroblast-specific factors and mechanisms underlying apoptosis resistance and proliferation is therefore of immense scientific interest and clinical relevance. During the year, our studies employed gene knockdown and over-expression approaches, western blot analysis and promoter pull-down assays and confirmed earlier observations that Discoidin Domain Receptor 2 (DDR2), a mesenchymal cell-specific collagen receptor tyrosine kinase, facilitates the coordinated regulation of apoptosis resistance and cell cycle progression in mitogen-stimulated cardiac fibroblasts by exploiting a common regulatory mechanism involving activation of ERK1/2 MAPK and Serum Response factor. (Figure 21) The investigations uncovered a novel mechanism that would facilitate cardiac fibroblast survival and function in the injured myocardium. The work was published in the prestigious American Journal of Physiology-Heart and Circulatory Physiology, 2020. Further, the presentation entitled "Is DDR2 a therapeutic target in the management of heart failure?" won the Best Oral Presentation Award at The Heart Failure Conflux 2021, and at the Annual Meeting of the Heart Failure Association of India, held on 12 February 2021.

As a sequel to these findings, it was also found that DDR2 has an obligate role in Yes-activated Protein (YAP)-mediated transcriptional up-regulation of fibronectin gene expression by Ang II in cardiac fibroblasts. Further, it was observed that DDR2-dependent fibronectin expression mediates Ang II-stimulated collagen type I expression and cIAP2-dependent apoptosis resistance in cardiac fibroblasts exposed to ambient stress. Another finding of immense importance was that fibronectin mediates Ang II-stimulated expression of the Ang II receptor, AT1R, which would link extracellular matrix signalling to Ang II signalling that is known to profoundly impact cardiac fibroblast function. It was also found that the regulatory role of fibronectin in cardiac fibroblasts is mediated by Integrin-β1 signalling. In view of its predominant localisation in fibroblasts in the heart, and its role as a critical regulator of cardiac fibroblast function, DDR2 emerges as a potential drug target to prevent or minimise adverse fibrotic remodelling of the heart following injury.

2. Role of connexins in the phenotypic transformation of cardiac fibroblasts and extracellular matrix synthesis in cardiac diseases

Conditions such as heart failure and atrial fibrillation, which are associated with altered activity of cardiac fibroblasts, are marked by significant variations in the distribution of the gap junction protein, Connexin

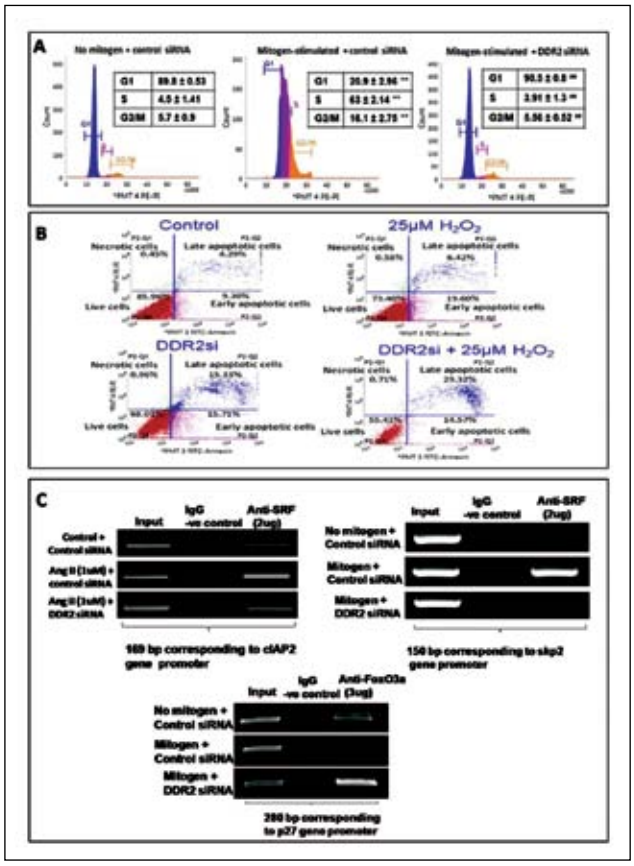


Figure 21. A) Cell cycle analysis using flow cytometric analysis demonstrate that knockdown of DDR2 in mitogen-stimulated cardiac fibroblasts causes cell cycle arrest at G-1 phase. B) Representative flow cytometry scatter plot of Annexin/PI-stained cardiac fibroblasts from indicated treatment conditions demonstrate that knockdown of DDR2 causes apoptosis under basal condition and the effect is more pronounced when cells are challenged with ambient oxidative stress. C) Chromatin Immunoprecipitation assays of various gene promoters under indicated conditions: cIAP2 gene promoter with SRF antibody (Top left panel), Skp2 gene promoter with SRF antibody (Top right panel) and p27 gene promoter with FoxO3a antibody (Lower panel).

43 (Cx43). As part of an ICMR-funded project, we explored whether Cx43 was under the regulatory control of DDR2 and was a key player in the DDR2-collagen axis in cardiac fibroblasts. Cardiac fibroblasts were isolated and characterised as per standardised protocol (Figure 22). DDR2 knockdown and DDR2-overexpression studies in cardiac fibroblasts confirmed that Cx43 is under the regulatory control of DDR2. Experiments to identify the underlying molecular mechanisms were ongoing. The study is expected to unravel novel mechanisms of DDR2-mediated regulation of Cx43 expression in the heart in a setting of injury and fibrosis. In the long-term, this could potentially pave the way for the development of novel therapies for cardiac fibroblast-driven fibrosis, Cx43-mediated conduction abnormalities associated with fibrosis and consequent pump dysfunction. This work entitled *"Discoidin Domain Receptor 2 (DDR2)-mediated regulation of Connexin 43 in cardiac fibroblasts: Implications for conduction abnormalities in cardiac fibrosis" was presented at the Heart Failure Conflux organised by the Centre for Advanced Research and Excellence in Heart Failure (CARE-HF), SCTIMST, HFAI, ICMR & IACS, 2021.*

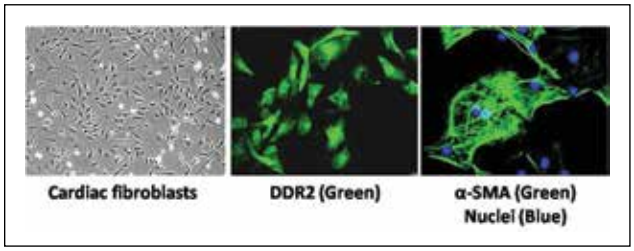


Figure 22. Cardiac fibroblasts in culture and immunofluorescent staining of collagen receptor, DDR2, and α-SMA, indicating the activated phenotype

3. Regulation of progenitor cell functions in the heart

The adult mammalian heart has a small heterogeneous group of cells called cardiac progenitor cells (CPCs) that exhibit self-renewal, clonogenicity and multipotency. CPCs are known to secrete cardio-protective paracrine factors that enhance angiogenesis, reduce apoptosis of cardiomyocytes and decrease fibrosis during the repair process post-myocardial injury. However, the hostile micro-environment of the damaged myocardium affects the survival and functional activity of CPCs.

We identified endogenous CPCs in the adult myocardium using different surface markers such as c-kit, sca-1, CD105 and CD90, and expression of transcription factor, GATA4. Cluster of explant cells derived from rat atrium were positive for c-kit and GATA4 (Figure 23). Immunostaining and western blot data also confirmed the presence of c-kit protein in sorted cells. RT-PCR data showed increased relative

mRNA levels of c-kit, GATA4 and OCT4 in sorted cells, indicating enhanced purity. The cells enriched for c-kit are currently used for survival and functional analysis of CPCs in the presence of molecules that are known to be up-regulated in the injured myocardium. Preliminary data from this ongoing study entitled "Survival and function of Progenitor Cells in the injured myocardium: Isolation and Characterization of Cardiac Progenitor Cells" were presented at the International Seminar on Recent Biochemical Approaches in Therapeutics (RBAT-VII) – 2021, 9-11 February 2021, organised by the Department of Biochemistry, University of Kerala, Trivandrum.

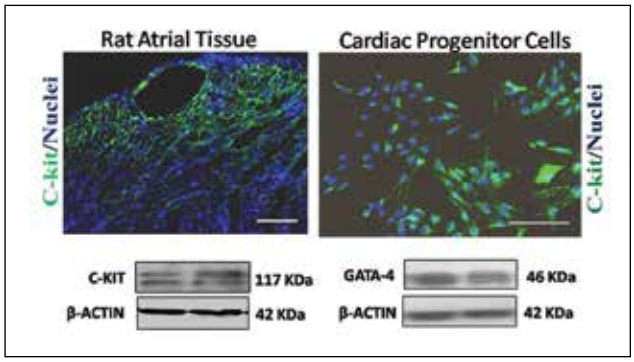


Figure 23. Immunofluorescent staining of c-kit in rat atrial tissue and in cardiac progenitor cells. Western blots showing expression of c-kit and GATA4 in cardiac progenitor cells isolated from atrium of two different rats.

Events Organized

As part of an Outreach Programme, the Division conducted an online Workshop, "Molecular Capsule", to demonstrate modern molecular biology techniques to students. More than 75 students of 11th Standard attended the Workshop.

Awards and Honours

1. Dr Allen Sam Titus won the Best Oral Presentation Award for the talk entitled "Is DDR2 a therapeutic target in the management of heart failure?" at the Annual Meeting of the Heart Failure Association of India, on 12 February 2021.
2. Dr Allen Sam Titus won the Best Oral Presentation Award for the talk entitled "Is DDR2 a therapeutic target in the management of heart failure?" at the Heart Failure Conflux 2021, virtual conference from 5-7 February 2021.

Staff

Faculty

Dr Neethu Mohan, Scientist D and Acting Head of the Division

Technical

Ms Hima V M, Technical Assistant Lab - A

COMPUTER DIVISION

The Computer Division has primary responsibility for incorporating the power of modern computers into patient management, biomedical programmes, research initiatives and administrative procedures. It serves as a scientific and technological resource for different Wings of the institute with capacity for biomedical and statistical computing and data storage needs. Further, in the pandemic season of COVID-19, the Division provides in-house solutions for virtual meetings, organising remote training sessions and online screening and selection of human resource recruitment using latest information technology with state-of-the-art infrastructure.

Activities

1. Maintenance of online software, updating and development of new forms and reports.
2. Website (Intranet, Internet) maintenance, site updates and new development.
3. Network monitoring, management, maintenance and new cabling work.
4. Tuning, backup activities and maintenance of higher end servers (18 numbers).
5. Tender publishing, online recruitment of staff and students.
6. Updating and maintenance of all Portals (Blood Donor, Vendor, Pension, CSC, Patient), D Space, e-learning, amongst others.
7. OMR evaluation, Form changes for recruitment (SSC, JSC) and academic admissions.
8. Report generation for Auditors, IT Committee and DST.
9. Hardware and software maintenance of servers, storage, PCs, routers, switches, scanners and printers with a remarkable uptime of 99.98% (Total 1652 devices).
10. Monitoring of Data Centre, management of servers and storage and network.
11. Data backup, maintenance of data and network security.
12. Monitoring e-payment status.
13. Monitoring of medical equipment integrated to EMR and surveillance.
14. Work related to COVID-19 for conducting VC Meeting for various departments.
15. Training for apprentices, staff and students.
16. General help to staff and students on IT-related issues.

New Initiatives

1. Developed software to conduct patient consultation (with online payment) through the present Electronic Medical Records (EMR) software as Video Consultation/ Telephone conversation with facility to send prescription as SMS link.
2. Purchased 15 numbers all-in-one units and installed in outpatient departments for conducting video consultation.
3. Implemented "SCTIMST Examinator", a new online portal for the Division of Academic Affairs for collecting question papers online, evaluating answer sheets and thesis evaluation.
4. New software for monitoring new equipment purchases was made operational.
5. New software module for LTC (Administration) was developed and added with Special Cash Package
6. Established Data backup in BMT Wing VM Server and configured to copy backups from two DC backup servers.
7. Established a Video Conference System based on Jitsi (meet.sctimst.ac.in) and a Virtual Classroom setup powered by Big blue button (vclass.sctimst.ac.in).

8. Made a setup for VPN Server for EMR Access from home/remote places.
9. Implemented the Lab Information System for Molecular Genetic and Neuro Immunology Lab.
10. Integrated alternate payment gateway through Paygov for all online payments.

Staff

Mr Suresh Kumar B, Engineer E and Head of the Division

Dr Geetha G, Scientist G

Mr Rejith L R, Programmer - B

Mr Saji K S, Programmer - A

Mr Manoj M, Technical Assistant (Computer) - B

Mr Anish R, Technical Assistant (Computer) - B

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

Ms Haseena L, Technical Assistant (Computer) - B

DEPARTMENT OF IMAGING SCIENCES AND INTERVENTIONAL RADIOLOGY

The Department of Imaging Sciences and Interventional Radiology (IS and IR) caters to the radiological needs of the institute. It runs separate DM Programmes in Neuroimaging and Interventional Neuroradiology, Cardiovascular Imaging and Vascular Interventional Radiology and a 2-year Diploma in Advanced Medical Imaging Technology (DAMIT). There are 6 permanent faculty, 9 technologists, 15 senior residents, 6 DAMIT students, 4 PhD/ Research fellows associated with the Department. The Department runs a teaching programme from 8-9 AM in the morning and is part of multi-disciplinary clinical meets with the Neurology, Neurosurgery, Cardiology and Cardiac Surgery departments. The department runs a separate OPD for interventional Neuroradiology and Vascular Radiology with a dedicated ICU and ward for the patients undergoing interventional procedures.

Activities

Clinical Activities

After initial glitches due to COVID-19, we were able to streamline the procedures in utilising the available human resources rationally, following government guidelines. However, there was some reduction in the number of cases compared with the pre-COVID time.

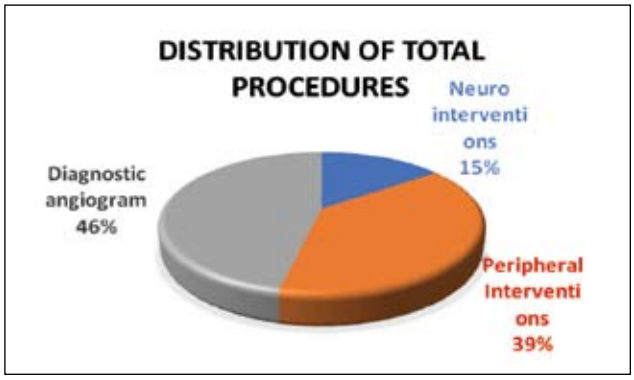


Figure 24. Distribution of major interventional procedures during the year

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

Modality	Number
MRI	4216
USG	1957
CT	3245
X-Ray	35188

Research Programmes

Major research activities included:

1. MoU was signed with the Department of Computer Science, University of Kerala, for a Project on "A new methodology for generating Pseudo-CT images for evaluating brain lesions."
2. MoU was signed with TKM College of Engineering, Karikode, Kollam, for development of algorithms and use of advanced techniques and software tools in the field of MRI.
3. A new artificial intelligence tool for detection of COVID-19 infection was evaluated with future prospective of including pleural effusion and peripheral lung evaluation in collaboration with IIT Palakkad.
4. A multi-institutional collaborative project on stroke evaluation and management using artificial intelligence was initiated with IIT Patna and NIT Surathkal.

New Initiatives

1. A new state-of-the-art Digital Radiography System - PROGNOSIS PRORAD 2FC 600mA with features for faster and better quality image acquisition and post-processing was inaugurated on 1 January 2021 (Figure 25). The System is

capable of performing the entire spectrum of radiographic imaging including spine stitching.

Figure 25. Inauguration of digital radiography System by the Hon'ble Director, Dr Jayakumar K

2. New procedures performed in interventional radiology:

- Radial artery approach for dialysis AV fistula management (Figure 26).

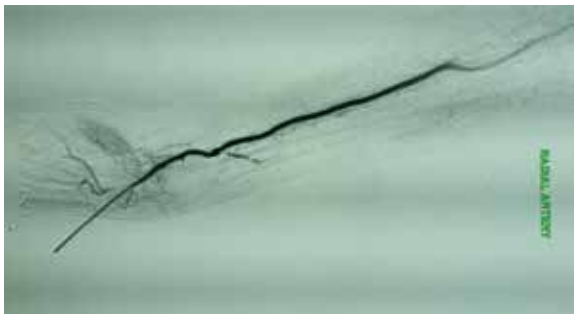


Figure 26. Radial artery approach

- 3D printing for cerebral (Figure 27) and aortic aneurysm and simulation in Angio Suite was initiated. This aids in understanding the complex anatomy for better patient management.

Figure 27. 3D printing for cerebral aneurysm

- Radial approach for intracranial interventions
- Balloon-assisted maturation of AV fistulas for the early maturation of dialysis fistula (Figure 28).

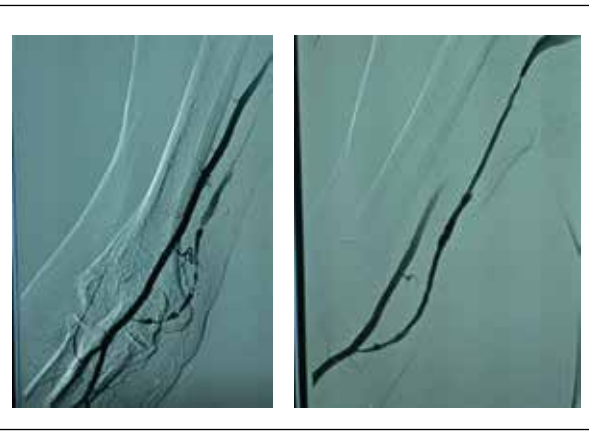


Figure 28. Balloon assisted maturation of fistula

3. New initiatives in imaging

- Zero-TE MR imaging of the skull to demonstrate the bony abnormalities in brain MRI to reduce the radiation risk by eliminating the need for a CT scan (Figure 29).

Figure 29. Zero TE MR imaging of skull

- Synthetic MRI in the evaluation of multiple sclerosis
- 4D Flow MRI in heart and aorta (Figure 30) for better delineation of cardiac and aortic pathologies and to visualize the expansion rate of aortic dissection.

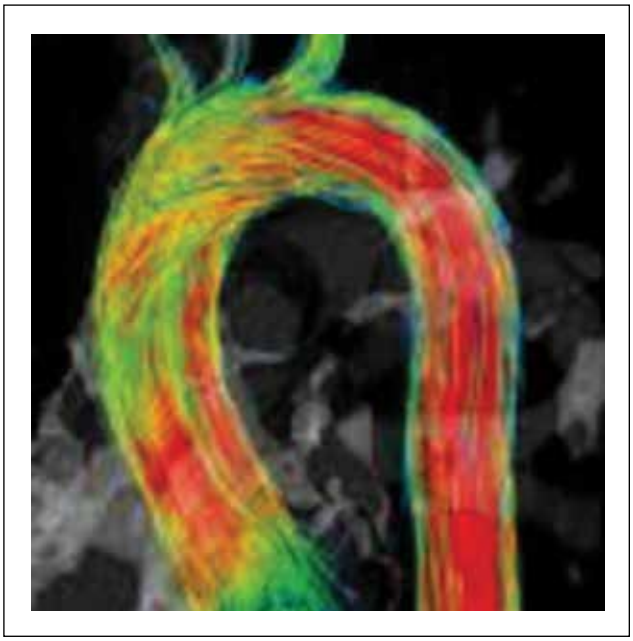


Figure 30. 4D Flow aorta imaging

- Cardiac MR strain imaging

4. Our Faculty took the initiative in neuroradiology to start a YouTube channel on neuroimaging (Figure 31).

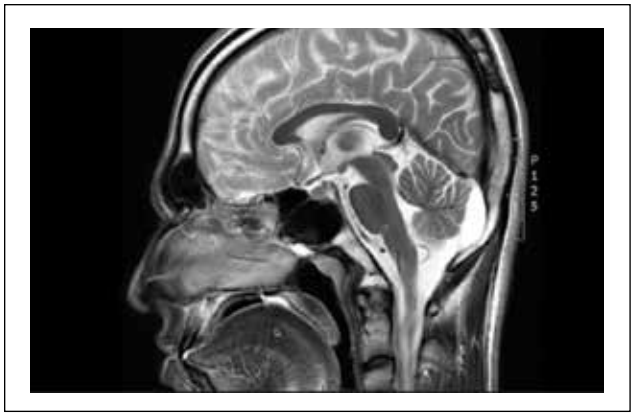


Figure 31. YouTube channel in neuroimaging

Events Organized

1. The 22nd Annual Conference of the Indian Society of Neuroradiology, ISNR-2020, was organized online from 16-18 October 2020. More than 500 delegates attended. About 50 international and national faculty participated in the conference. The sessions were chaired by about 60 eminent neuro-radiologists in the country. There were 22 scientific sessions, each session containing around 3-4 lectures delivered by experts in the field of Neuroradiology (Figure 32).

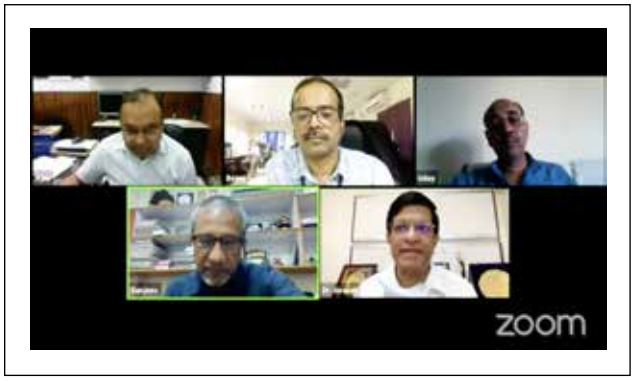


Figure 32. Virtual ISNR 2020

Awards and Honours

1. Dr Arun, DM Neuroradiology resident won 1st Prize in oral presentation at the 22nd annual conference of Indian Society of Neuroradiology.
2. Dr Devprakash, DM Neuroradiology resident, won the 1st Prize in "Radaspire Quiz in Neuroradiology" organized as an online quiz by GE and NIMHANS, Bangalore on 5 September 2020.
3. Dr Arun, DM Neuroradiology resident, won the 2nd second Prize in "Radaspire Quiz in Neuroradiology" organized as an online quiz by GE and NIMHANS, Bangalore on 5 September 2020.
4. Dr Vimal Chacko, DM Cardiovascular radiology resident, won the best poster award for "Percutaneous glue embolization in gastric varices" at the Yorkshire Imaging and Interventional Symposium 2021.
5. Dr Bejoy Thomas was awarded the EK Zavoisky Stipend Award at ISMRM 2021.

Staff

Faculty

Dr Bejoy Thomas, Professor and Head of the Department

Dr C Kesavadas, Professor

Dr E R Jayadevan, Additional Professor

Dr Santhosh Kannath, Additional Professor

Dr A Anoop, Assistant Professor

Dr Jineesh V, Assistant Professor

Technologists

Ms Githakumari V, Junior Scientific officer

Mr Alex Jose D, Senior Technical Assistant

Ms Sheeba Kumari R, Senior Technical Assistant

Mr Johnson C, Senior Technical Assistant

Mr Krishna Kumar N, Senior Technical Assistant

Mr Vikas .N, Senior Technical Assistant

Mr Mahesh P S, Senior Technical Assistant

Mr Joyi K, Senior Technical Assistant

Ms Sandhya V S, Senior Technical Assistant

DEPARTMENT OF MICROBIOLOGY

The Department carries out the following functions:

- Provide accurate and quick reports on all specimens sent to the Laboratory and COVID Lab.
- Give a consultant clinical microbiology service, antibiogram sharing and antibiotic stewardship.
- Outbreak investigation and containment using microbiological methods
- Train MD and MSc Microbiology students as observers and as Apprentice trainees, respectively.
- Liaison with Hospital Infection Control Unit.
- Control of HCAI and COVID-19 - test, trace contacts and quarantine, follow-up and monitoring of adherence to COVID protocol
- Enhance and support research activities of all Wings of the institute.
- Support ICMR and State Government in COVID-19 testing and reporting.

Activities

Clinical Activities

Due to the pandemic, there was a significant fall in the number of samples received in the first half of the year, which came back to almost normal in the second half of the year.

1. Bacteriology

Total samples - 6436

There were 9 cases of infective endocarditis. Of these, 3 were due to viridans group of streptococci, 1 due to nutritionally variant streptococci, 2 due to Enterococcus faecalis, 3 due to Candida parapsilosis, of which one was isolated from valve tissue.There were 2 cases of salmonellosis, both due to S.Enteritidis. Rare isolates included Shigella flexneri bacteremia and Burkholderia pseudomallei from pus (Figure 33).

2. Mycology

There were 64 fungal isolates of which 58 were Candida species and 6 mould fungi, one being Cladophialo phorabantiana (Figure 34) from a case of brain abscess. The most common yeast was Candida tropicalis followed by C parapsilosis and C albicans.

3. Mycobacteriology

87 samples were processed for culture with 4 isolates. There was one isolate of Mycobacterium tuberculosis from parietal area of brain. One atypical mycobacterium was isolated from sputum.

4. Serology

There were Total 3275 samples comprising: CRP-2282, Rheumatoid Factor - 669, ASO -151, TPHA - 134, RPR -19, WIDAL - 6, Brucella - 6 and Malaria card test - 8.

5. Viral Serology

Automated VIDAS (Enzyme - Linked Immunofluorescent Assay) and ARCHITECT-(Chemiluminescence - Linked ImmunoAssay) combined were maintained, calibrated and utilised to provide rapid results for HIV, HBsAg, HCV, TFT, syphilis and procalcitonin. Hepatitis B antibody titre was measured for health care personnel using ARCHITECT systems to assess their immune protection levels post-vaccination and after health care accidents like needle stick injuries.

Total samples processed: HIV - 5250, HBsAg - 5251, HCV - 5234, TFT - 9720 and Procalcitonin - 2132. Various rapid card tests like Tridot were also used for confirmation and emergency purposes.

6. Molecular Diagnosis

Samples were received from SCTIMST, MCH, SATH, SUT, Gokulam Medical College and Holy Cross, Kottayam.

- BioFire Film Array Multiplex PCR System

  33 tests were performed using three different panels - Respiratory (n=21), Meningitis/ Encephalitis (n=12). 7 tests were positive. Major pathogens identified were: Rhino/ Entero virus - 2, Adeno virus -– 2, Respiratory syncytial virus - 2 and Chlamydophila pneumonia - 1

- CE- IVD approved standard PCR tests

  Viral encephalitis (n=49) and tropical fever agents (n=6) using respective panels. There were a total of 3 positive results. Major pathogens identified were: HSV2-EBV co-infection, VZV and adenovirus in the encephalitis panel and Samonella and Dengue co-infection from the tropical fever panel.

7. Homograft Valve Bank

18 valves harvested during the period and 12 homografts (6 aortic and 6 pulmonary) were implanted. 10 homografts were stored at the Valve Bank. The number came down due to withdrawal of the RBSK Scheme of the Government

8. COVID Lab

The State Government had included this lab as one of its approved free testing facility in April 2020 and continued its work during the year (Figure 35). To run samples for RTPCR for the state and for the institute, 2 research officers, 6 technicians, 3 lab assistants and 3 data entry operators were assigned to the Lab and were paid by National Health Mission. The details of the tests performed from 1 April 2020 to 31 March 2021 are as below:

- RT-PCR for SARS CoV2

  State samples: total 49,410 (6760 positive) and SCTIMST samples: total 22148 (621 positive)

- Rapid Antigen test: total 1312 (67 positive)

  This was done for all staff and for patients when requested for. It is indicated only in symptomatic (for a quick result and isolation) and as a screening for RT-PCR positives after 14th day.

- Antibody test for COVID

  This was introduced on the VIDAS ELFA platform. Indications to do antibody test were: a) RT-PCR negative, but clinically suggestive of COVID sequel, b) Indeterminate RT-PCR, but clinically suggestive c) Post-vaccination testing – IgG – 64 tests (24), IgM – 60 tests (8).

9. Infection Control

- Outbreak/cluster control

  Four potential outbreaks of COVID-19 among staff and patients were controlled by proper contact tracing and taking steps to isolate cases and quarantine the high-risk contacts in Neurosurgery (2), Cardiac Surgery and Neurology Units.

- COVID ICT Meetings

  Conducted more than 10 meetings throughout the year, as and when required. Rounds of respective wards, were conducted with COVID ICT members in each unit to train and inspect different preparedness activities.

- ICT meeting and Link nurses meeting with presentation of cases – several times during the year

Research Programmes
Projects initiated and ongoing

1. A prospective cohort study on infective endocarditis- microbiological profile and outcomes (PI: Dr Kavita Raja)
2. Role of novel Biomarkers and clinical Scoring systems in predicting progression to Sepsis in infected post-Cardiac Surgery patients (BioSSCaS study) (PI: Dr Dinoop K P, Funded by: SCTIMST Seed Grant).
3. Prospective study on EVD infections titled "A prospective study on cerebrospinal fluid (CSF) diversion catheter-related infections in a tertiary referral neurosurgical care center" (PI: Dr Dinoop K P, Funded by: ICMR Extramural Adhoc Scheme).

4. Development of real time RT-PCR assay for detection of SARS-CoV-2 (PI: Dr Jyothi E K, Funded by: TDF, SCTIMST).
5. Prosthetic valve endocarditis: A 10-year single-center retrospective cross-sectional study from a tertiary cardiac referral hospital (PI: Dr Dinoop K P).
6. A retrospective study on cerebrospinal fluid (CSF) diversion catheter-related infections – Experience from a tertiary referral neurosurgical center (PI: Dr Dinoop K P).
7. Development of a rapid technique for identification and characterization of clinical Acinetobacter baumannii Isolates by Raman spectroscopy (Figure 36) (PI: Dr Jyothi E K).

Projects in collaboration with BMT Wing:

1. Development of antigen based assay kit for SARS-CoV2 (Co-Investigators: Drs Jyothi E K & Dinoop K P, Funded by: MPLAD fund).
2. Rapid diagnostic kit for SARS-CoV-2 Detection (Co-Investigators: Drs Jyothi E K & Dinoop K P, Funded by: MPLAD fund).
3. Development of Rapid diagnostic kits for sepsis and chlamydia trachomatis (Clinical PIs: Drs Jyothi E K & Dinoop K P, Funded by: TRC).

Patents filed (Indian):

1. Rapid detection of COVID-19 IgG/IgM antibodies using immunochromatographic technique.
2. A test kit for the determination of procalcitonin (PCT) and the process thereof.
3. A rapid detection test kit for Chlamydia trachomatis and the process thereof.

New Initiatives

1. COVID Infection Control Manual released by the Director.
2. Enhanced testing for SARS CoV2 by RT-PCR – up to 300 and later, 500 samples/day.
3. SARS CoV2 Antigen testing in August 2020.
4. SARS CoV2 Antibody testing in December 2020.
5. Mentorship for the state of Kerala to start RT-PCR/ Truenat/CBNAAT for SARS CoV2 in all Medical colleges, 6 Government and all private medical Colleges and private labs, including Andaman and Nicobar islands and Lakshadweep.
6. Antimicrobial stewardship with streamlining of antibiotics used for surgical prophylaxis was started in Neurosurgery.
7. Supported COVID 19 Vaccination drive in the Institute - initiated training of Vaccination Team during the first phase.
8. Supported COVID Research and Development experiments in the Institute.

Events Organized

1. Organized a webinar on "Genomics of SARs CoV2" with AMCHSS (Keynote speaker: Vinod Scaria, CSIR- IGIB, New Delhi) in January 2021.
2. Organized a webinar on "Control and Prevention of COVID 19 in a non-COVID hospital" with Nursing Division and Hospital Infection Control Unit in March 2021.

Awards and Honours

1. Prof Kavita Raja was re-elected as Vice-president of Academy of Clinical Microbiologists. (2020-23).
2. Prof Kavita Raja was selected as Panel Member of Commonwealth Scholarship Commission (CSC) Alumni Advisory Panel (2020-21).
3. Prof Kavita Raja was selected as Assessor for National Medical Council (NMC) in March 2021.
4. Dr Dinoop K P was elected Assistant Editor of Journal of Academy of Clinical Microbiologists.

Staff

Faculty

Dr. Kavita Raja, Professor and Head of the Department

Dr Dinoop K P, Assistant Professor

Dr Jyothi E K, Scientist C

Technical

Ms Sujatha, Scientific Officer

Ms Soja Rani, Scientific Assistant

Ms Reeja Rani, Technical Assistant (Lab) - B

Ms Smitha, Technical Assistant (Lab) - B

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

Ms Cinta, Technical Assistant (Lab) - A

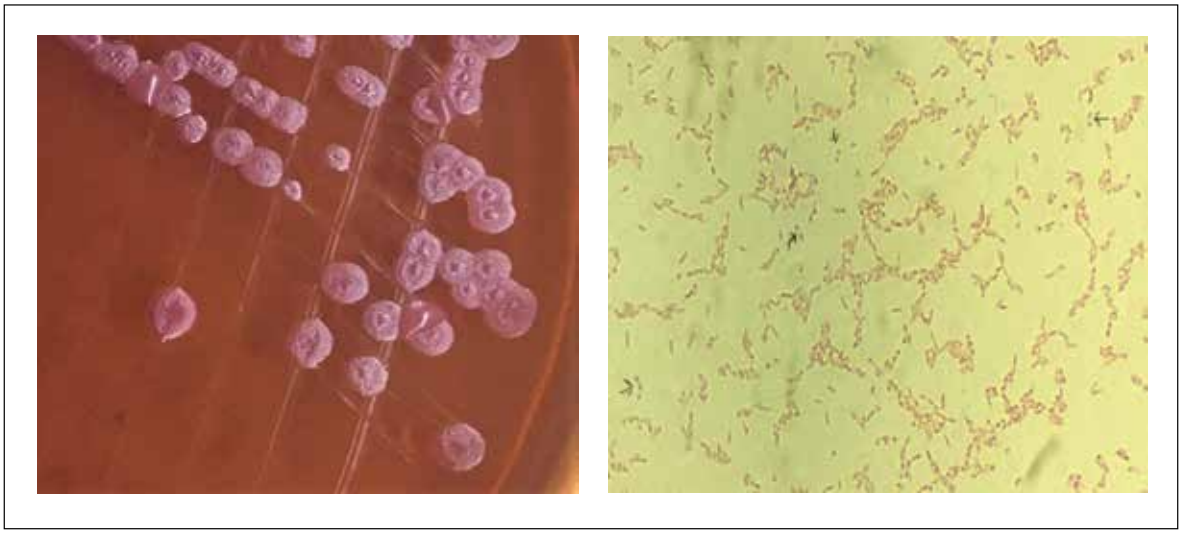


Figure 33. Burkholderia pseudomallei - Flat wrinkled colonies on Mc Conkey Agar and safety pin appearance (bipolar staining) on Gram stain (arrows)

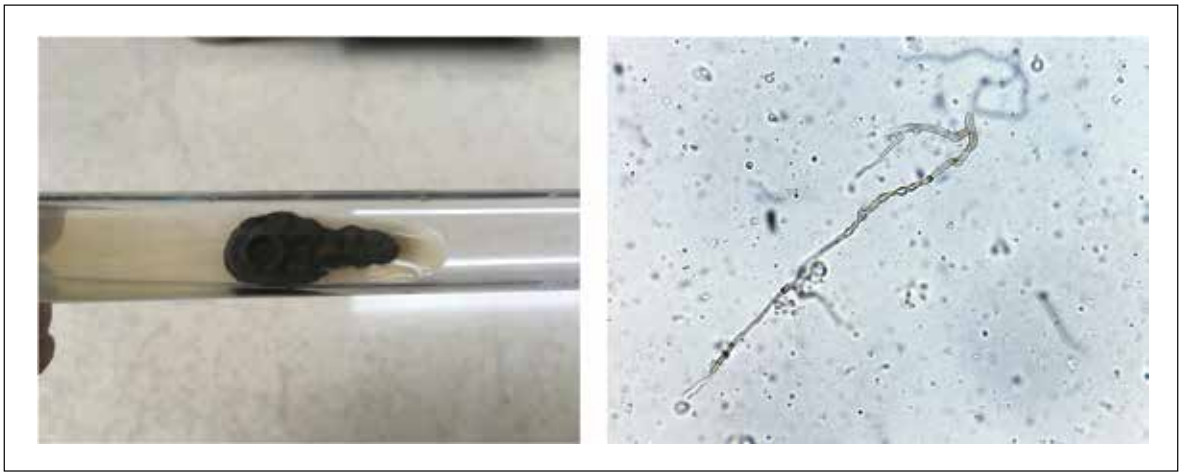


Figure 34. Cladophialophora bantiana- pigmented colonies on SDA and KOH mount of the pus from brain abscess showing fungal hyphae

Figure 35. COVID Lab:RT-PCR steps for SARS CoV2 detection from throat/nasal swab

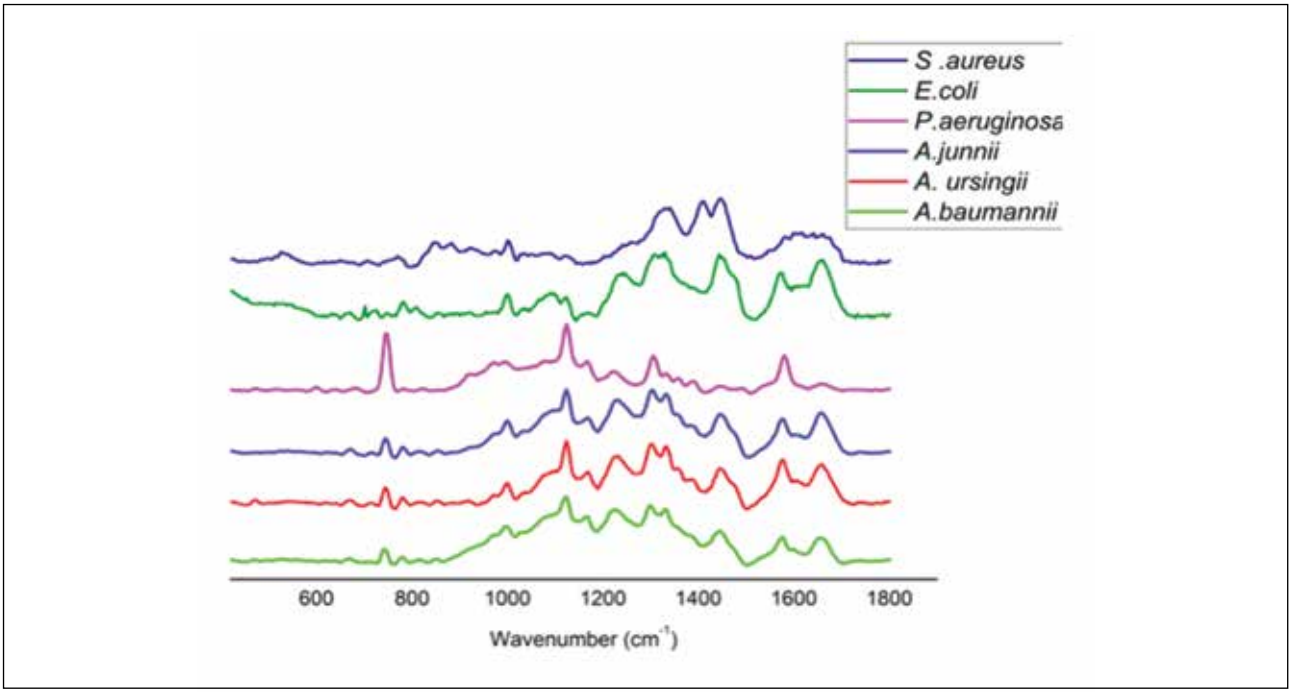


Figure 36.The signature Raman Spectra obtained for the common pathogens studied as part of study on rapid identification of common pathogens

DEPARTMENT OF NEUROLOGY

The Department of Neurology comprises multiple subsections that provide specialized and comprehensive care to patients with various neurological disorders. The Department conducts General Neurology Outpatient Clinics daily from Monday to Friday as well as weekly Speciality Clinics for review of patients under different subsections.

During the year, a total of 18124 outpatients were seen in General Neurology which included 14067 reviews and 4057 new registrations, and 10813 patients were seen in Speciality Clinics. The inpatient number was 1697. There were 27 deaths during this period.

The faculty and students participated in many national and international conferences and received several prestigious awards during the year. The Department continued to pursue major research projects and produced notable publications. The Department conducted many Patient Outreach Programmes including the Athiyanoor Clinic Outreach Programme. The activities of the various subsections during the year are elaborated below.

NEUROLOGY INTENSIVE CARE UNIT

The Table below and Figure 37 provides information about the number of patients treated and other relevant performance-related details of the Neurology ICU during the year.

Neurological condition	Number of admissions
Status epilepticus (all had autoimmune encephalitis)	11
Super refractory	6
CNS demyelination • Anti-MOG and Anti-Aquaporin receptor • RRMS/PPMS	30 12 18
Myasthenia gravis	9
Meningitis	6
CIDP	5
Metabolic Encephalopathy	5
CNS tumours	4
Others	18
Total	**109**
Mortality	**5 (4.58%)**

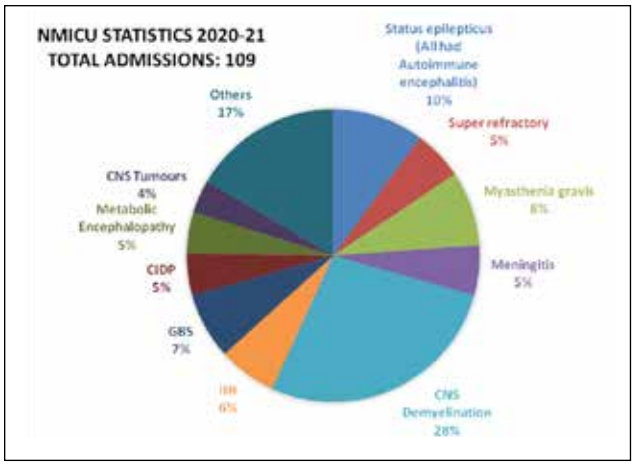


Figure 37. Neurology ICU Statistics

Like in the previous year, CNS demyelination was the leading cause for admission to the Neurology ICU (30 patients, 28% of the total admissions). Among this, 18 had Multiple Sclerosis and 12 had Anti-MOG/Anti-Aquaporin antibody-mediated demyelination.

Mortality remained less than 5% for the fourth consecutive year. Five patients expired and had the following diagnosis: CNS demyelination, autoimmune encephalitis, dementia with acute kidney injury, metabolic encephalopathy with sepsis and diffuse midline glioma, WHO grade IV.

Special procedures

Plasma exchanges (PLEX) were given for 28 patients, IV IgG for 17, Rituximab for 36 and cyclophosphamide infusion for 8 patients. These were in addition to

other routine procedures like muscle biopsies, lumbar punctures and mini-tracheostomies.

Other developments

In 2020-21, 5-bedded area from the ICU was isolated and designated as "COVID screening ICU" and those who tested positive for COVID were subsequently shifted to COVID designated hospitals for further care and were not admitted to the Neuro Intensive Care unit.

New Initiatives

A Comprehensive Neurointensive Care Programme was approved and initiated with three consultants from the Department of Neurology spearheading a Comprehensive Multidisciplinary Team for better co-ordinated patient care in the NMICU.

COGNITION AND BEHAVIOURAL NEUROLOGY SECTION

The Cognition and Behavioural Neurology Section (CBNS) provides clinical services to children and adults with cognitive problems in disorders like MCI dementia, epilepsy, stroke and childhood developmental disorders. It conducts a Memory and Neurobehavioral Disorders Clinic every week. It also provides advice and technical support to the Alzheimer's & Related Disorders Society of India (ARDSI), a voluntary organization that helps dementia patients and care givers. The Section also carries out clinical and basic science research in the fields of dementia, cognition and behaviour, and traumatic brain injury.

Activities

The annual activities of the Section are summarized in the Table.

Comprehensive assessment of patients with cognitive problems admitted to the institute and counselling of caregivers of patients with dementia along with psychosocial support was done. Also research activities on structural and functional neuroimaging in dementias as well as development and validation of neuropsychological batteries were carried out.

Activity	Number
Speech and Language Evaluation	1440
Speech Therapy	266
Audiological Evaluations	30
Videofluroscopy Swallow study	8
Neuropsychological Testing	446
IQ Assessments	67
Counseling Sessions	45
Memory and Neurobehavioral Clinic Attendance	418
Cognitive Retraining	25

Research Programmes

Ongoing Projects:

1. The AADAR Dementia Science Programme titled "Dementia Science Programme: Incidence/ Prevalence/ Risk/ Intervention analysis of dementia and basic research thereof"- Multicenter study in collaboration with, All India Institute of Medical Sciences (AIIMS), New Delhi, National Institute of Mental Health And Neuro Sciences (NIMHANS), Bengaluru, Bangur Institute of Neurosciences (BIN), Kolkata, National Brain Research Centre (NBRC), Manesar and University of Calcutta, Kolkata (PI: Dr Ramshekhar N Menon, Funded by: Department of Biotechnology, GOI).
2. Development, validation and standardization of aptitude-based digital cognitive retraining module in comparison with non-aptitude manual cognitive retraining module in the cognitive rehabilitation of traumatic brain injury: A study among hospital based clinical samples (PhD Project).
3. Longitudinal cognitive outcomes in persons with Mild Cognitive Impairment.
4. The human brain mapping project a resting state fMRI study of healthy controls and patients with mild cognitive impairment (MCI) and degenerative dementia of the Alzheimer's type (AD).

5. Cognitive assessment of patients with minor stroke and subtyping of cognitive impairment following stroke in collaboration with the Comprehensive Stroke Care Centre
6. Control-based validation of neuropsychological test batteries for material specific memory impairment in patients with medically refractory temporal lobe epilepsy due to hippocampal sclerosis.

Completed Projects:

1. The influence of sleep architecture on the severity of memory disruption in amnestic mild cognitive impairment
2. Validation of memory fMRI paradigms and its utility in pre-surgical evaluation of patients with refractory temporal lobe epilepsy
3. Development and validation of a comprehensive clinical and neuropsychological battery for use in the Indian context for patients with vascular cognitive impairment
4. Non-Linear analysis of EEG signals of patients with Alzhiemer's disease

Events Organized

Dr Ramshekhar N Menon conducted a virtual workshop on 21 September 2020 on Mild Cognitive Impairment (MCI) and identification of early dementia. Speakers included Dr C Kesavadas (Imaging), Dr Raviprasad Varma (Epidemiology) and Dr Ramshekhar Menon (Clinical identification).

COMPREHENSIVE CARE CENTRE FOR MOVEMENT DISORDERS

The Comprehensive Care Centre for Movement Disorders (CCCMD) deals with the Neurological sub-speciality of Movement Disorders. "Movement Disorders" include the well-known Parkinson's disease (PD), other Parkinsonian disorders, various tremor disorders and some other conditions like chorea and dystonia. The CCCMD provides comprehensive medical and surgical care to patients affected with such conditions and trains Neurologists in the management of movement disorders. The Centre is also involved in clinical research pertaining to the sub-speciality, including externally- funded research projects and Research and Development Projects related to the field, collaborating with the Biomedical Technology Wing of the Institute. Two students are currently doing their PhD Projects with the support of CCCMD, two post-doctoral fellows completed their training and two new fellows joined, during the year. Five scientific articles were published in medical journals. The faculty also made presentations in several scientific conferences. Following superannuation of Dr Asha Kishore who was in-charge of the Subsection, Dr Syam K, assumed charge.

Activities

Clinical Activities

The clinical activities of CCCMD include the weekly Movement Disorders Review Clinic, Botulinum Toxin Injection Clinic and the Movement Disorders Surgical Programme. There was a significant reduction in the number of patients physically visiting the hospital for availing these services, as a consequence of the ongoing Covid-19 pandemic. CCCMD started doing regular tele-consultation services during the pandemic and an increasing number of patients are using this facility to access the doctors. CCCMD was running a Motor Physiology Lab for electrophysiological investigations like tremor analysis (Figure 38) and research activities like transcranial magnetic stimulation. Around 270 patients with various Movement Disorders were referred to the CCCMD from all over India and got newly registered during the past year. In addition, the Movement Disorders Review Clinic had 1078 review consultation visits (physical visits) by already registered patients. There was around 60% reduction in the number of physical consultation visits made by patients (both new cases and reviews), compared to previous years. However, there was a remarkable increase in the number of tele-consultations – there were a total of 991 virtual consultations. 214 botulinum toxin injection sessions were undertaken in the fortnightly Botulinum Toxin Injection Clinic.

There were 22 deep brain stimulation and related surgical procedures (like replacement of stimulator) done during the year. 58 deep brain stimulation programming sessions were done on patients on follow up.

Product Development

The CCCMD, collaborating with the Biomedical Technology Wing of the Institute, is engaged in the development of a low-cost and efficient Deep Brain Stimulation system for Movement Disorders. The project is progressed and prototypes were getting ready for animal implantation studies. Bhabha Atomic Research Centre (BARC) is collaborating with the Centre for technical support for this project.

Research Programmes

An externally-funded (Department of Biotechnology, Government of India) research project explored the utility of susceptibility weighted MRI in quantifying mineralization (iron deposition) in various brain regions in Parkinsonian disorders. This Project was completed in November 2020 and found that the mineralization in some of the deep grey matter structures in the brain could be measured using "quantitative susceptibility mapping" techniques and could differentiate various types of neurodegenerative Parkinsonian disorders. (Figure 39). An ongoing international collaborative Project (Genetic Architecture of Parkinson's disease in India) examines the genetic mechanisms underlying Parkinson's disease in Indian population and is funded by the Michael J Fox Foundation, USA. SCTIMST plays a lead role in this multicentre project, in which other centres like NIMHANS, Bengaluru, All India Institute of Medical Sciences, New Delhi and Nizam's Institute of Medical Sciences, Hyderabad are also participating. A third research project, which is ongoing, is funded by the Indian Council of Medical Research and examines the role of the microbial flora of gut in the genesis of Parkinson's disease. Cochin University of Science and Technology (CUSAT) is the collaborator for this project. There are several other internally funded / non-funded projects ongoing. An ongoing functional MRI (fMRI) based study explores the connections between cerebellum and basal ganglia structures, and their role in movement disorders (Figure 40). Other ongoing studies explore various clinical aspects of movement disorders, like the cognitive outcome of DBS surgery, and non-motor symptoms like pain in Parkinson's disease.

Awards and Honours

Dr Syam K was appointed to the Honorary post of Dean of the Faculty of Modern Medicine, Kannur University, by the Hon'ble Governor of Kerala.

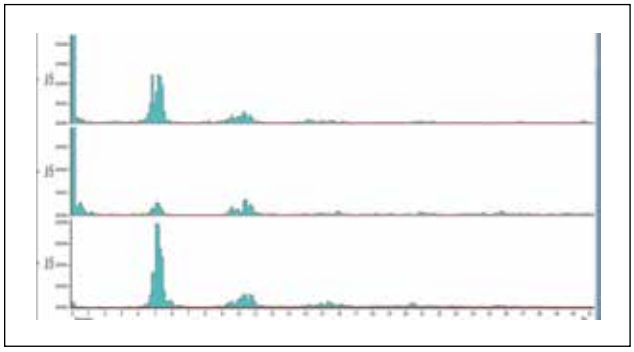


Figure 38. Fourier analysis of the electromyographic and accelerometric data showing the tremor frequency in a patient with Parkinson's disease. The peak around 5Hz indicates the major frequency in PD, and the minor peaks around 10 and 15 Hz indicate frequency harmonics.

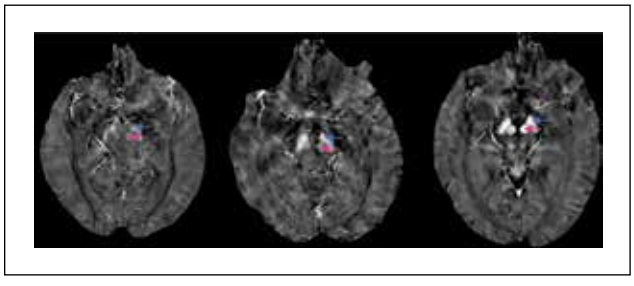


Figure 39. Processed images showing the differences in iron content in brain regions called substantia nigra and red nucleus (arrows) in a healthy volunteer (first image), compared to Parkinson's disease (middle image) and progressive supranuclear palsy (third image)

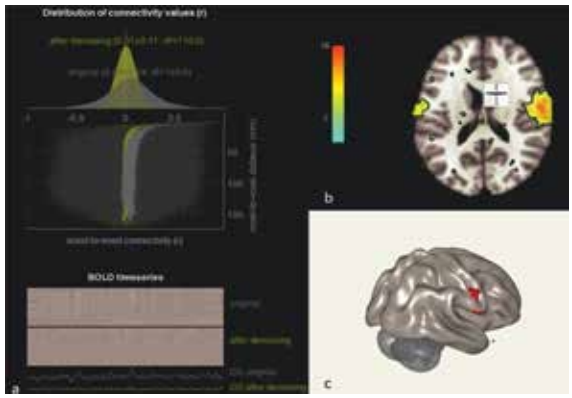


Figure 40. A fMRI and Diffusion-Tensor Imaging-based connectivity analysis from patients with PD a) Distribution of connectivity values before and after denoising fMRI data b) Activations in the sensorimotor network during the early stages of Parkinson's disease after administering levodopa treatment c) The above result being rendered on a high-resolution 3D brain model.

COMPREHENSIVE CENTRE FOR SLEEP DISORDERS

Comprehensive Centre for Sleep Disorders is engaged in mainly clinical care of patients with sleep disorders.

Activities

Clinical Activities

Sleep Outpatient Clinics are conducted weekly on Thursday afternoon, where new and review patients are seen, investigations are planned and treatment initiated. 168 patients attended the Clinic during the year. The Polysomnography Lab started functioning in March 2021 and 10 diagnostic procedures were performed.

Research Programmes

A study entitled "A randomized, multi-centric, double-blind, placebo-controlled trial of SDA-217 as an add-on therapy in patients of chronic insomnia" was initiated (PI: Dr Ashalatha R, Funded by: ICMR).

COMPREHENSIVE STROKE CARE PROGRAM

The aim of the Comprehensive Stroke Care Program is to provide comprehensive care for patients with stroke. It is a 11-bedded unit with 7 ICU beds. It facilitates intravenous thrombolysis for acute ischemic stroke patients, mechanical thrombectomy for acute patients with major vessel occlusion, decompressive hemicraniectomy for malignant strokes, haematoma evacuation in haemorrhagic strokes, Moyamoya revascularization surgeries and carotid endarterectomy and stenting for stroke prevention. The Stroke Team involves neurologists, neurosurgeons, vascular surgeons, interventional radiologists, cardiologists and neuroanaesthetists. We provide comprehensive rehabilitation to stroke survivors by a team involving speech therapist, physiotherapist, occupational therapist, stroke nurse and medical social worker. A Stroke helpline (0471-2524333) is available through which emergency acute cases get referred to our institution.

Activities

Clinical Activities

The Program conducts Stroke Clinic every Friday for Review and follow-up of stroke survivors. As a part of secondary prevention, the Stroke Team is committed to providing education regarding the symptoms and risk factors of stroke and the importance of adherence to medication for patients and primary caregivers. We also have a patient management conference every Friday by a multidisciplinary team which includes neurologists, neurosurgeons, vascular surgeons, cardiologists and interventional radiologists. The team will discuss the most challenging cases and take decisions in consensus regarding the treatment plan for the patient.

The clinical activities during the year are summarized in the Table.

Areas / Procedures	Number
Stroke Clinic Attendance (Direct)	1489
Stroke Clinic Attendance (Teleconsultation)	325
ICU Admissions	339
Carotid endarterectomy	21
Carotid stenting	7
IV thrombolysis	21
Mechanical thrombectomy	15
Moyamoya revascularization	13
Decompressive hemicraniectomy	8
Hematoma evacuation	2

Research Programmes
Newly initiated Projects:

1. IMPROVing Stroke care in India- Advancing The INSTRUCT Operations and Network-(IMPROVIS-ATION). This project is in collaboration with the University of Lanchashire, UK. A MoU was signed between the University of Lancashire and SCTIMST (PI: Dr Sylaja P N, Funded by: National Institute for Health Research (NIHR), UK).
2. EdoxabaNfoR Intra Cranial Hemorrhage survivors with Atrial Fibrillation (ENRICH-AF). A MoU was signed between Hamilton Health Sciences Corporation, Canada, Division of Clinical Research and Training, St. John's Research Institute, Bengaluru and SCTIMST (PI: Dr Sylaja P N, Funded by: Population Health Research Institute, Canada).
3. Prevalence of atrial cardiopathy in cryptogenic strokes in comparison with strokes of known etiology (PI: Dr Sapna Erat Sreedharan, Funded by: ICMR).

Ongoing Projects:

1. Secondary Prevention by Structured Semi-Interactive Stroke Prevention Package in India Study (SPRINT Study): This study aims to use structured semi-interactive stroke prevention package to reduce the risk of recurrent strokes, myocardial infarction and death in patients with sub-acute stroke after one month. It was initiated in May 2018 and funded by Indian Council of Medical Research. We are also the south Indian Monitoring Centre for the trial under ICMR.
2. Improving Stroke Care in India (IMPROVISE): This study was initiated in November 2018 in collaboration with the University of Central Lancashire, UK. Its aim is to develop and explore the feasibility and acceptability (staff, patients and carers) of delivering these evidence-based interdisciplinary care bundles for the management of stroke in Stroke Unit. It is a multicentre study including CMC Ludhiana, AIIMS, New Delhi, and SCTIMST.
3. A randomised controlled trial (RESTORE) Ayurvedic treatment in the rehabilitation of ischemic stroke patients in India: The study is funded by Indian Council of Medical Research and was initiated in November 2018. SCTIMST is the National Co-ordinating Centre for this project.

Memorandum of Understanding

The Institute executed the following MoUs:

1. With IIT Chennai and TATA Consultancy Services on the study titled "A comprehensive frame work for treatment of impairment of the upper extremity due to stroke by combining computational modelling and virtual reality"
2. With the University Hospital of Bern on the study titled "Early versus Late initiation of direct oral anticoagulants in post-ischemic stroke patients with atrial fibrillatioN" (ELAN).

Awards and Honours

1. Dr P N Sylaja was elected as the CME Convenor of the Indian Academy of Neurology for 3 years (2020-2023).
2. Dr P N Sylaja was awarded the Fellow of the Indian Academy of Neurology.
3. Dr P N Sylaja was selected as the Global Co-chair South Asia and National Co-chair for Mission Thrombectomy 2020, which is a global campaign to increase endovascular thrombectomy by the Society of Vascular and Interventional Neurology.

NEUROMUSCULAR AND MULTIPLE SCLEROSIS DIVISIONS

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

Activities

Clinical Activities

The Neuromuscular Clinic functions every Tuesday. In 2020-21, the Clinic recorded 1267patient visits. The Multiple Sclerosis (MS) Clinic recorded 35 patient visits during the same period.

The studies conducted in the Electrophysiology Lab during the year are summarized in the Table below:

Study	Number
Nerve conduction studies	690
Electromyography	424
Repetitive nerve stimulation	62
Single fibre electromyography	4
Visual evoked potential	177
Brainstem auditory evoked potential	35
Somatosensory evoked potential	72

Research Programmes

1. The Project titled "Structural and functional correlates of cognitive dysfunction in multiple sclerosis" (PI: Dr Sruthi S Nair, Funded by: CSRI, DST) was completed in June 2020 and final report was submitted.
2. SCTIMST was invited to be part of the "Indian Multiple Sclerosis and Allied Demyelinating Disorders Registry and Research Network" funded by Indian Council of Medical Research.
3. SCTIMST was also part of the Guillain-Barre syndrome (GBS) Consortium which collected data from multiple Centres across India on change in clinical patterns of GBS during COVID-19.
4. Newly initiated intramural projects included: studies on phenotypical and genotypical correlation in Charcot Marie Tooth disease, accuracy of diagnostic criteria in multiple sclerosis diagnosis and patterns of clinical presentation of multiple sclerosis over the last two decades.

Science Outreach Programmes

1. Dr Sruthi S Nair gave a short radio commentary on multiple sclerosis on the occasion of World Multiple Sclerosis Day in May 2020.
2. As part of the COVID-19 related activities, Dr Sruthi S Nair was a panel member for the webinar on 'Managing multiple sclerosis and related disorders during COVID 19' organized by Indian Academy of Neurology on 24 May 2020.

New Initiatives

A proforma-based evaluation for genetic neuromuscular diseases was initiated to accurately administer and follow-up physiotherapy and supportive treatment.

Events Organized

Dr Sruthi S Nair organized a webinar and question and answer session for persons with multiple sclerosis on the topic 'Multiple sclerosis and COVID 19' on account of World Multiple Sclerosis Day 2020 on 30 May 2020.

Awards and Honours

1. Dr Sruthi S Nair was awarded the Fellowship of Royal College of Physicians (Edinburgh) in April 2020.

2. Drs Harikrishnan R and Naveenkumar P, senior residents, secured 1st Prize for their papers on "Clinical course and outcomes of pregnancy in myasthenia gravis" and "Neuropsychological profile of persons with relapsing remitting multiple sclerosis in Kerala, India", respectively at the Virtual Agrim Neurology Update in October 2020.
3. Ms Gauthami Nair, Junior Research Fellow, was adjudged 'summa cum laude' for the poster. titled "Thalamic functional connectivity in relapsing remitting multiple sclerosis" in the Indian Society of Neuroradiology Conference in October 2020.
4. Dr Sruthi S Nair was selected as a Member of the Kerala State Technical Committee for Multiple Sclerosis for the implementation of a support programme for multiple sclerosis patients. This programme is spearheaded by the Kerala Social Security Mission, Government of Kerala.

PAEDIATRIC NEUROLOGY DIVISION

The subdivision has Comprehensive Care Centre for Neurodevelopmental Disorders (CCCND) for management of children with various neurodevelopmental disorders like autism, attention-deficit hyperactivity disorders and cerebral palsy has completed three years of functioning. A Speciality Clinic for autism and other similar disorders are conducted every first and third Saturday. Comprehensive management of children diagnosed with autism spectrum disorder and other neurodevelopmental disorders is offered through the Clinic. The management of various neurological disorders in children are conducted as out-patient and inpatient services.

Activities

Clinical Activities

During the year, the Centre had 232 new registrations, 52 paediatric neurology admissions and 126 cases were seen in the Autism Clinic. The distribution of cases is summarized in the Table.

Disorder	Number
Autism spectrum disorder	61
Intellectual developmental disorder	78
Social communication disorder	63
Motor disorders	85
Learning disorder	63

Research Programmes

1. The project tilted "Emotional face recognition: Understanding the underlying neural connectivity in high functioning adolescents with autism" (PI: Dr Soumya Sundaram, Funded by: CSRI, DST) was initiated during the year. This is a multicentric project between SCTIMST, IIT Gandhinagar and National Institute of Speech and Hearing, Trivandrum. This is an experimental research study comparing the functional connections between high functioning adolescents with autism spectrum disorder and typically developing adolescents.

Science Outreach Programme

Dr Soumya Sundaram gave a talk on 'Common co-morbid disorders among children with neurodevelopmental disorders' in a webinar conducted as part of World Disability Day on 11 December 2020 organized by a Community Based Disability Management Model by Calicut University, Government of Kerala.

New Initiatives

1. A structured programme for detection of Developmental Co-ordination Disorder was started.
2. Tele-rehabilitation was started for the speech and behavioural therapy and physical therapy for children with neurodevelopmental disorders in view of the COVID-19 pandemic.

R MADHAVAN NAYAR CENTRE FOR COMPREHENSIVE EPILEPSY CARE

R Madhavan Nayar Centre for Comprehensive Epilepsy Care (RMNCEC) provides comprehensive care for all types of adult and paediatric epilepsies to patients from all parts of India and the neighboring countries. It is the main Centre for epilepsy surgery in India and South-east Asia and offers world-class yet affordable comprehensive epilepsy care, comparable to any other Centre in the world. The mission of the Centre is as follows: (1) to provide comprehensive medical, surgical, psychosocial and occupational care for patients with epilepsy with a special emphasis on the surgical treatment of medically refractory epilepsies, (2) to undertake advanced clinical and basic science research in various areas of epilepsy, (3) to enhance epilepsy awareness among the primary care physicians and general public and (4) under the subsection of Kerala Registry for Epilepsy in Pregnancy (KREP) to address issues pertaining to women with epilepsy.

Activities

Clinical Activities

During the year, the Centre completed 2286 epilepsy surgeries to become the first and only Centre in India to have completed more than 2000 epilepsy surgeries.

The activities of the Centre during the year are summarized in the Table below:

Activity	Number
Epilepsy Clinic attendance	4763
KREP Clinic attendance	373
Epilepsy Ward admissions	545
Electroencephalogram (outpatient)	2145
Video EEG monitoring	514
Epilepsy surgery	49
Intraoperative electrocorticogram	45
WADA test	4
Intracranial monitoring	2

RMNCEC team continued its services in comprehensive epilepsy care. Since 2020-2021 has been the year of the COVID-19 pandemic, additional telephone and virtual video consultation services were also offered. The Centre continued to perform short-term and long-term video telemetries and indoor ward admissions for comprehensive evaluation of children and adults with complex epilepsies. The reputed epilepsy surgery services were also continued with regular post operative follow-up. Palliative vagus nerve stimulation and ketogenic diet services were also provided. Dedicated paediatric epilepsy services were provided on all Wednesdays, including ketogenic/modified ketogenic dietary advice, genetic testing and genetic counselling for parents of children with complex epilepsies. The Kerala Registry for Epilepsy in Pregnancy (KREP) services also continued to deliver care to women with epilepsy and monitored children born to these women from a clinical and developmental perspective. The Centre was also involved in training, academic activities and research projects of postdoctoral fellows in epilepsy and senior residents in neurology.

The Weekly activities of the Centre are as follows:

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

Research Programmes

Ongoing Projects

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

   This study aims to analyze the genetic basis of a wide spectrum of complex epilepsies with age of onset spanning from the neonatal period to late childhood (<12 years age).

Study objectives include:

- Streamline diagnosis by correlating phenotype to genotype .
- Streamline therapeutic intervention-prognostication by correlating phenotype to pharmacogenotype.
- Ascertainment of the frequency, type, inheritance patterns of pathogenic or likely pathogenic variants in complex epilepsies.

2. Quantitative EEG and Multi-model neuro-imaging biomarkers of memory dysfunction in epilepsy (PI: Dr Sanjeev V Thomas, Funded by: DST)

Completed Projects

Proof-of-concept phase - Intracranial electrode development for use in acute and long term electrocorticography (PI: Dr Ramshekhar N Menon)

Other activities

Dr Ashalatha R was the Chair and co-ordinator for a series of Epileptology related topics, 2 per month, since May 2020 (during COVID times as virtual meet) for students, junior and senior Neurologists from India and abroad with an attendance of 100-150 every session.

New Initiatives

Started Teleconsultation and Video consultation for those who cannot appear physically during this pandemic situation

Events Organized

International Epilepsy Day was observed virtually in RMNCEC on 8 February 2021. Drawing, elocution and singing competitions were held for children with epilepsy and prizes were distributed. Malayalam film actress, Ms Ahaana Krishna Kumar was the Chief Guest. Professor Jayakumar K (Director), Prof Sanjeev V Thomas, Prof Ashalatha R, Prof Mathew Abraham, Dr Ramshekhar Menon, Dr George Vilanilam and Dr Ajith Cherian gave talks on epilepsy care.

Awards and Honours

Prof Ashalatha R received the Venus International Award for Best Professor in Neurology – 2020.

Staff

Faculty

Dr Sanjeev V Thomas, Professor (Senior Grade) and Head of the Department

Dr Sylaja P N, Professor

Dr Ashalatha R, Professor

Dr Syam K, Professor

Dr Sajith S, Professor

Dr Ramsekhar N Menon, Additional Professor

Dr Sapna Erat Sreedharan, Additional Professor

Dr Ajith Cherian, Associate Professor

Dr Sruthi S Nair, Associate Professor

Dr Soumya Sundaram, Associate Professor

Dr Divya K P, Assistant Professor

Mr Praveen James, Engineer - B

Technical

Ms Nandini V S, Senior Scientific Assistant

Ms Preetha Govind G, Senior Technical Assistant

Ms Salini K R, Technical Assistant - B

Mr Pradeep M J, Technical Assistant - B

Ms Shana N Nair, Technical Assistant - B

Mr Anees C A, Technical Assistant - B

Ms Deepa Paul Miranda, Technical Assistant - A

Therapists

Ms Aley Alexander, Senior Psychologist

Mr Gangadhara Sarma, Psychologist - B

Ms Lincy Phillip, Occupational Therapist - B

Ms Manju Mohan, Speech Therapist - A

Ms Vipina V P, Speech Therapist - A

Ms Sushama S R, Psychologist - A

DEPARTMENT OF NEUROSURGERY

2020-21 was a year punctuated by the COVID-19 pandemic. In spite of the pandemic, the Department of Neurosurgery continued to serve patients in need of advanced neurosurgical treatment. In the pursuit of excellence, the department provides world-class neurosurgical care, advance neurosurgical knowledge through research and innovation and the best academic environment for neurosurgical education.

Activities

Clinical Activities

Despite a few setbacks due to the COVID-19 pandemic, outpatient clinics, intensive care for inpatients and operative procedures in all fields of neurosurgery, including skull base, vascular, epilepsy, neuro-oncology, functional neurosurgery and minimal access neurosurgery, continued in a co-ordinated manner, 5 days a week. The Department catered to 1804 newly registered patients and 14119 Review patients. A total of 967 surgeries were performed during the year, encompassing various subspecialities of neurosurgery and spanning a spectrum of complexity. Academic inter-departmental meetings were conducted on-line, on working Saturdays, where meticulous planning of the surgical strategy for patients who were awaiting surgery was done along with inter-departmental neuroradiology discussions. Neuropathology Sessions and departmental Surgical Audit Sessions were conducted as per schedule.

Milestones achieved

- The Department (Dr Krishnakumar K), partnering with Movement Disorders Division, Department of Neurology, completed 250 deep brain stimulation surgeries for Movement Disorders.
- The Department (Dr B Jayanand Sudhir), partnering with the Comprehensive Stroke Care Program, Department of Neurology, completed 100 brain-bypass revascularisation surgeries for Moyamoya disease.

Science Outreach Programmes

- Dr Easwer H V participated in live phone-in programme (Samoohya padam) on organ donation following brain death by Doordarhsan, Trivandrum.
- Dr Mathew Abraham participated in a live phone-in programme (Samoohya padam) on Brain Tumours conducted by Doordarshan, Trivandrum.

Research Programmes

Newly initiated Projects

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

Ongoing Projects

1. Cavity conformable self-retaining stent retractor-Design and Proof-of-Concept (PI: Dr George C Vilanilam, Funded by: TDF, SCTIMST)
2. Development and evaluation of Dural substitute made by electrospinning of polycarbonate urethane (PI: Dr Prakash Nair, Funded by: TDF, SCTIMST)
3. Prospective observational study of patients undergoing microneurosurgical procedures through a interhemispheric transcallosal approach (PI: Dr Mathew Abraham, Funded by: CAREF)
4. Prospective observational study of outcomes of different transcranial approaches for craniopharyngiomas (PI: Dr Mathew Abraham, Funded by: CAREF)

5. Predictors of visual outcome and recurrence following surgical resection of medial sphenoid wing meningioma (PI: Dr Mathew Abraham, Funded by: CAREF)
6. Real time assessment of shift of ICA during extended endoscopic skullbase surgery using intraoperative doppler and the role of tumour consistency in causing ICA displacement. (PI: Dr Prakash Nair, Funded by: DST - SERB)

Patents

1. Process for the manufacture of nanoporous bioceramic bodies for bone implantation, drug delivery and tissue engineering (Dr Easwer H V, Dr H K Varma, Suresh Babu) (Granted patent)
2. Cavity conformable brain retractor with tunable expansion ratio (Dr George C Vilanilam, Figure 41) (Patent Filed)
3. Level A personal protective equipment with continuous air supply for medical/ surgical use (Dr B Jayanand Sudhir) (Patent Filed)

New Initiatives

1. Started Telemedicine services for outpatients considering the COVID-19 scenario. This significantly reduced the need for patients and caregivers to come to the hospital for review.
2. Drs Krishnakumar K, Tobin George and Ganesh Divakar, initiated minimally invasive surgery (Tubular retractor assisted mini-open excision) for the management of spinal tumours.
3. Dr B Jayanand Sudhir perfomed the first successful superficial temporal artery- anterior cerebral artery (A3) bypass, using a bridge graft for a complex DACA aneurysm. This rare surgery has been attempted only in a few Centres in the world and is the first such reported case from India (Figure 42).
4. Dr B Jayanand Sudhir also performed a unique insurance brain bypass surgery for the management of a complex giant brain aneurysm with a good outcome.
5. Dr Prakash Nair introduced transnasal endoscopic approach for orbital tumours, a minimally invasive procedure and cosmetically excellent results were obtained.

Events Organized

Online CME sessions were conducted inviting International Faculty:

1. Prof Ken Kazumata, Professor of Neurosurgery, Hokkaido University Graduate School of Medicine, Sapporo, delivered a talk on High-flow cerebral bypass on 6 November 2020.
2. Dr Nitin Mukherjee, Consultant Neurosurgeon, James Cook University Hospital, UK, delivered lectures on Cerebral Bypass Techniques (4 November 2020) and Flourescence-aided neurosurgery (15 November 2020).

Awards and Honours

Dr Easwer H V was awarded the Karma Shreshta Award.

Staff

Faculty

Dr Easwer H V, Professor and Head of the Department

Dr Mathew Abraham, Professor

Dr Krishna Kumar K, Professor

Dr George C Vilanilam, Additional Professor

Dr Jayanand Sudhir B, Associate Professor

Dr Prakash Nair, Associate Professor

Dr Tobin George, Assistant Professor

Dr Ganesh Divakar, Assistant Professor (Tenure)

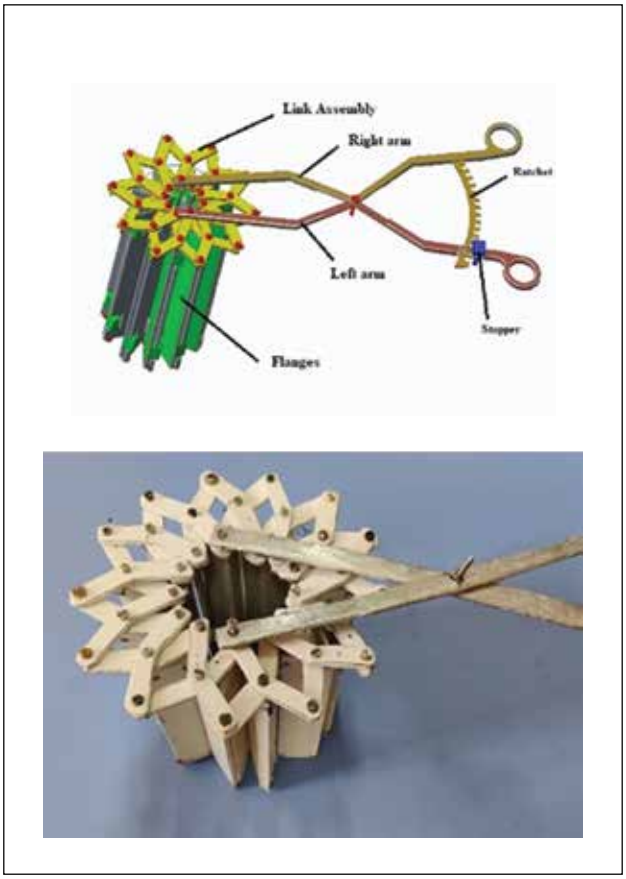


Figure 41. Cavity-conformable brain retractor

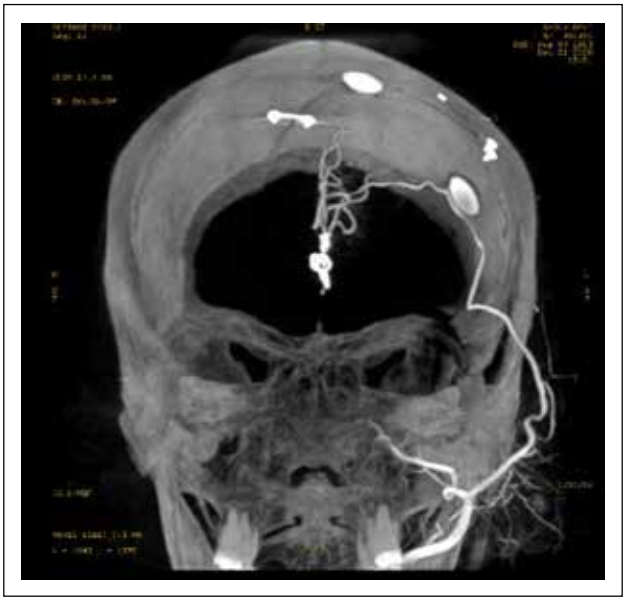


Figure 42. Angiogram showing the STA-ACA bypass performed

DEPARTMENT OF PATHOLOGY

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

Activities

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

Category	Number
Neurosurgical biopsies	789
Cardiovascular & thoracic biopsies	156
Muscle biopsies	16
Frozen sections	354
Cytology	156
Immunohistochemistry	3941
Immunopathology	4164

Research Programmes

Both extramural-funded and intramural non-funded research projects continued during the year. One new extramural project was initiated during the year. The extramural projects during the year were:

1. Molecular, clinico-radiologic and pathological characterization of oligodendrogliomas with CIC and FUBP1 mutations (PI: Dr Deepti A N, Funded by: DST-SERB)
2. Dynamic modelling of αsynucleinopathy pathology using hiPSC-derived cerebral organoids for biomarkers and drug screening application (PI: Dr Divya M S, Funded by: Accelerator program for Discovery in Brain disorders using Stem cells - ADBS)
3. DNA methylation profiling of gangliogliomas and dysembryoplastic neuroepithelial tumors (PI: Dr Rajalakshmi P, Funded by: DST-SERB)

New Initiatives

Three new tests for patient care were introduced during the year:

1. Immunology tests:
   - Autoimmune Encephalitis Panel
   - Myositis Antigens Profile IgG
2. Molecular test:
   - Interphase Fluorescence In Situ Hybridization (FISH) for assessment of 1p/19q status in gliomas

Events Organized

1. Dr Divya M S, Scientist C, conducted a webinar entitled "Introduction to CRISPR genome editing technology and its applications" on 31 October 2020.
2. Dr Rajalakshmi P was a member of the Organizing Committee for the observance of International Yoga Day 2020.

Faculty

Dr Deepti A N, Associate Professor and Acting Head of the Department

Dr Rajalakshmi P, Assistant Professor

Dr Divya Mundackal Sivaraman, Scientist C

Technical Staff

Ms Sushama Kumari P, Scientific Officer (Lab)

Mr James T, Scientific Officer (Pathology)

Ms Neena Issac, Technical Assistant (Lab) - B

Ms Resmi S R, Technical Assistant (Lab) - B

PAIN CLINIC

The uniqueness of Comprehensive Multidisciplinary Pain Clinic is that critical patient-management decisions reach broad-based consensus under a single roof. This approach is facilitated collectively from the Pain Clinic Team from various specialities of the Institute. The key services provided in the Clinic are Outpatient Clinic on Fridays and facilitation of the following highly skilled intervention procedures:

1. Regenerative Prolotherapy - Platelet-Rich Plasma therapy using the patient's own blood component for regenerative and healing therapy
2. Spinal transforaminae injections, fluoroscopy-guided
3. Trigger-point injections, ultrasound-guided
4. Musculoskeletal infiltrations - Ultrasound/ Fluoroscopy
5. Ultrasound-guided sacroiliac and other joint interventions and musculoskeletal infiltrations
6. Selective dorsal root ganglia radiofrequency ablation ultrasound-guided and nerve and ganglion ablations
7. Vertebral facet joint interventions, fluoroscopy-guided
8. Epidural steroid and anaesthetic injections
9. Ozone therapy

Activities

During the year, despite COVID-19 restrictions, 1642 patients were registered in the Clinic and 348 patients were catered to in the Clinic and Intervention suites, the details of which are provided in the Table.

The Outpatient Clinic offered services on Fridays from 2 PM onwards. Major interventions were performed in the Digital Subtraction Angiography or Radiology Cath Lab and minor interventions in the OPD procedure room/observation room adjacent to the Cath Lab.

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

Activity	Number
Total registered patients	1642
Outside Referrals	3
In House Referrals	276
Rehabilitation autologous PRP prolotherapy interventions	46
Minor interventions	19
Major interventions (Gasserian ganglion radiofrequency)	1
Trigger point and musculoskeletal infiltration	2
Rehab joint aspiration and Infiltration	1
Total	**1990**

Research Programmes
Ongoing Projects:

1. The Faculty of the Clinic were part of the research initiative and technology transfer for 'Biological fluids component separator and mechanism thereof'. The Project progressed towards attaining technology readiness level 4 with approval pending from the external funding agency.
2. Work on pre-clinical studies for regenerative therapies in pain with osteoarthritis in collaboration with Dr Prabha D Nair, Division of Tissue Engineering and Regeneration Technologies, Dr Naresh K, Division of Tissue Culture, BMT Wing, continued.
3. Basic science studies and development of new point-of-care kits for Platelet Rich Plasma (PRP) separation continued in collaboration with Drs Renjith Nair and Anugya Bhat, Division of Thrombosis Research, BMT Wing, continued.
4. Drs Subin Sukesan and Nitha J were co-investigators in the new research initiative undertaken by Mr Subhash N and Mr Muraleedharan C V, Engineers, Division of Artificial Internal Organs, BMT Wing, in collaboration with TynorOrthotics Pvt. Ltd. (Tynor).

New Initiatives

The specialized geriatric care from the Pain Clinic Team was initiated exclusively for patients older than 60 years with chronic musculoskeletal non-cancerous pain conditions, under the Project titled "Comprehensive and novel model for health care on geriatric pain conditions in India: Project mode implementing a unique 5-year comprehensive program model approach on chronic musculoskeletal and neuropathic pain conditions for elderly aiming at point integrated health solutions (regenerative therapy services, rehabilitation and research) in pain care" with the generous funding of 31.25 Lakhs from Kusuma Trust, UK (Figure 43). Funds were received on 28 March 2021. The Clinic for exclusive Geriatric Pain Care and Regenerative Intervention Services (GPRIS) runs on all working days.

Faculty

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

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

Dr Easwer H V, Professor, Department of Neurosurgery

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

Dr Nitha J, Assistant Professor and Head of Physical Medicine and Rehabilitation

Figure 43. Specialized geriatric care initiated in project mode by the Pain Clinic

DEPARTMENT OF TRANSFUSION MEDICINE

The Department of Transfusion Medicine has grown over the years from a small Blood Bank Unit to a fully-equipped modern blood component separation Unit with facilities for plateletpheresis. The Department is involved in: providing round-the-clock services for blood and blood components to the Institute, state-of-the-art research initiatives in collaboration with the Clinical Team and Biomedical Technology Wing and training future physicians and technicians in transfusion medicine.

Activities

Clinical Activities

1. During the year, 4821 blood units were collected, of which 1099 units were collected from outdoor blood donation camps and 3722 units from in-house collection. Nucleic Acid Amplification testing was carried out on all donated blood units which significantly increased the blood safety.
2. 40 outdoor blood donation camps were held during the year from which 1099 units were collected.
3. A total of 6910 units of blood were cross-matched (6540 units for in-house patients and 370 units for out-house patients).
4. 15664 blood grouping were performed on patients (15049 for in-house patients and 615 for out-house patients).
5. 4821 units of blood collected were processed into various blood components – 4786 units into various types of packed red cells, 4159 units into fresh frozen plasma, 781 units into cryo-poor plasma and 1154 units into platelets.
6. 7 single donor platelets were prepared by Apheresis method.
7. 73 units of platelet-rich plasma were prepared for Pain Clinic under Regenerative Medicine Programme and platelet-rich plasma therapy was performed in 46 patients jointly with Pain Clinic.
8. 42 therapeutic plasma exchanges performed on 8 patients at Neurology ICU were supported by residents and faculty from the Department.

Research Programmes

1. Collection of convalescent plasma from patients recovered from COVID-19 for treating moderately affected patients with COVID-19.
2. A pilot study to assess vitamin D and serum ferritin levels among prospective blood donors with low haemoglobin levels (PI: Dr Debasish Gupta, Funded by: Contingency Grant of KSACS).
3. A study to assess the effectiveness of autologous platelet-rich fibrin membrane as therapy in secondary healing of harvest site wound in patients post coronary artery bypass grafting (CABG) (PI: Dr Amita, Funded by: Seed Funding, SCTIMST).
4. A comparative analysis of factors influencing haemoglobin content in RBC units.

Science Outreach Programmes

1. Dr Amita R delivered talks on COVID-19 and blood donation (14 June 2020), the fear of COVID-19 in blood donors (14 August 2020) and Women and blood donation (1 October 2020) on Ananthapuri FM Radio.
2. Dr Amita R published articles on: "Convalescent Plasma therapy for treatment of COVID-19 infections - a few FAQS answered" (May 2020) and "Apheresis - things to know" (August 2020) in Nammude Arogyam Magazine.
3. Dr Amita R delivered the keynote address as a webinar on "Blood Donation Awareness" on the International Women's Day jointly organized by APJ Abdul Kalam Technological University NSS Unit and Terumo Penpol on 8 March 2021.

Events Organized

1. The National Voluntary Blood Donation Day was celebrated on 1 October 2020. On this occasion, regular voluntary blood donors and voluntary blood donation camp organizers were felicitated, observing full COVID protocol.
2. The Department conducted a training programme for DM Neuroanesthesia students on Appropriate Blood Transfusion Practices.
3. The Hospital Transfusion Committee Meeting chaired by Dr Debasish Gupta was convened by Dr R Raj Bharath on 4 July 2020.

Awards and Honours

1. Dr Debasish Gupta was appointed as a Resource Person for Training Programme of South-East Asia Region (SEAR) countries on Hemovigilance, organized by WHO, SEARO.
2. Dr Debasish Gupta was appointed as the Chairperson of Board of Studies - Life Sciences, SCTIMST for a period of 3 years.
3. Three 1-day National Training Programmes for Blood Bank doctors of all licensed Blood Banks functioning in Tamilnadu, Puducherry, Kerala and Lakshadweep were organized by Hemovigilance Programme of India, Ministry of Health and Family Welfare along with State Drug Controller of Tamilnadu and Kerala. Dr Debasish Gupta being the Executive Member of this National Programme was invited as a Resource Person to conduct the training programme.
4. Dr Amita R received the Vanitha Ratnam Award by Prem Nazir Suhurth Samithi for work in blood donation awareness and motivation on 8 March 2021.
5. Dr Amita R received the Kerala Blood Donor Society Award for work in promoting voluntary blood donation during COVID-19 pandemic on 8 March 2021.
6. Dr Amita R received the 2nd Prize in Hindi Essay Writing Competition and 3rd Prize in Hindi Short Story Writing Competition during Hindi Fortnight Celebration at SCTIMST in September 2020.

Staff

Faculty

Dr Debasish Gupta, Professor and Head of the Department

Dr S Sathyabhama, Scientist G

Dr R Raj Bharath, Associate Professor

Dr R Amita, Assistant Professor

Technical

Ms Sheela Devi K S, Scientific Officer

Ms Sindhu P N, Junior Scientific Officer

Mr Sivakumar S, Junior Technical Officer

Ms Baby Saritha G, Junior Technical Officer

Ms Jyothi M, Senior Technical Assistant

Mr Sunil K P, Technical Assistant - B

Ms Sindhu M S, Technical Assistant - B

Ms Renjini P, Technical Assistant - B

Ms Manju K Nair, Technical Assistant - B

Ms Preethy Prakash, Technical Assistant - B

Mr George Paul Thaliyath, Medical Social Worker

Ms Girija C, Nursing Officer D

BIOMEDICAL TECHNOLOGY WING

DEPARTMENT OF APPLIED BIOLOGY

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

The Department of Applied Biology comprises the Divisions of:

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

DIVISION OF EXPERIMENTAL PATHOLOGY

The Division has three activities:

1. It offers consultancy services to researchers on all aspects of animal experimentation. The focus area of the consultation is experimental pathology based on gross and histomorphology for internal and external customers.
2. Disease/health monitoring in laboratory animals.
3. Sponsored research projects on biomaterial evaluation and biomedical device development.

Histopathology Laboratory of the Division is unique in the country as a *COFRAC*- accredited laboratory having facilities to undertake routine as well as a wide range of specialized techniques for evaluation of biocompatibility of various biomaterials as per international standards and pre-clinical evaluation of medical devices as per approved protocols

Developmental Activities

The Division developed an innovative non-detergent/ enzymatic method for preparing biomaterial grade scaffolds from porcine cholecyst (gall bladder) and established that this can be used as wound healing matrix. This technology was transferred to M/s Alicorn Medical Pvt. Ltd., enrolled as an incubatee in the TiMed at SCTIMST. They are licensed to manufacture a class D biomedical device for testing purpose from the the Central Drugs Standard Control Organisation (CDSCO).

Research is ongoing:

- to check the potential of this scaffold for cardiac application
- to prepare various formulations of cholecyst scaffold-like powder, gel etc and evaluate the potential for various applications
- to prepare hybrid products for hernia repair

New Initiatives

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

Research Programmes

1. Programme support on translational research on biomaterials for orthopaedic and dental applications

Implantation study in rabbit femoral condyle to evaluate osseous integration post- three months was conducted. The results of the gross and histopathological evaluation and histomorphometry evaluation indicated that the acid etched implant is biocompatible and has good osseointegration property three months after implantation in a rabbit femur

model. The expression of osteogenic genes (COL1A1, RUNX2, SPARC and SPP1) and angiogenic gene (VEGF) were quantitatively determined using RT-PCR. The expression of COL1A1, RUNX2, SPARC and VEGF genes was up-regulated and SPP1 was down-regulated in the acid etched implant. These results supported new bone formation at implant-material interface.

2. Preclinical evaluation and commercialization of anti-snake venom (Igy, anti- hemotoxins and anti-neurotoxins

Repeated dose toxicity of drug conjugate in mice was conducted as per OECD guidelines and gross and histopathology were completed.

Testing and Evaluation

1. Necropsy and histological evaluation of three Rabbits from the Division of Laboratory Animal Sciences.
2. Necropsy and histological evaluation of three samples from external customer.
3. At the Histopathology Laboratory, a total of 188 tissue specimens were received which included: bone with implant for biocompatibility evaluation as per ISO 10993-6, 10; preclinical evaluation specimens such as pig mandible with bone graft, dural substitute experiment, wound healing studies, neuroembolisation using liquid embolic agent in pig rete mirabile cerebri, centrifugal blood pump as part of LVAD, bioprosthetic valves and scaffolds seeded with cells using 3D bioprinting technique (Figure 1).
4. 33 test reports, both accredited and non accredited test reports and necropsy reports were issued during the year. *COFRAC* external audit via online mode was completed successfully. The Laboratory has maintained quality system for the past 18 years and retained *COFRAC* accreditation successfully for intramuscular, subcutaneous and bone implantation tests and mucosal irritation tests.
5. Histopathology Laboratory received the certificate of registration for medical devices testing from CDSCO for evaluation of biocompatibility for medical devices under the Medical Devices Rules, 2017.
6. Gross and histopathological evaluation was completed or ongoing for the following medical devices developed under Technology Research Council (TRC) Fund:
   - Evaluation of alginate scaffold in rabbit knee cartilage regeneration
   - Lint-free absorbent: rabbit ear with venous ulcer wound healing
   - Rabbit skull with parietal calvarial defect and dural substitution using the fibrous mesh sheets as scaffolds for increasing the area of neovascularisation in Moyamoya disease
   - Respiratory toxicity of 0.5% H2O2 vapour exposure to rat at different time points as per OECD 412 guidelines
   - Rabbit skull with periosteal defect implanted with degradable metal alloy plates for 3 months to study the degradation and biocompatibility of metal alloy
   - Pig mandible bone with bone graft and metal screw implant to study new bone formation and implant integration with the newly formed bone
   - Development of paracorporeal left ventricular assist device
   - Decellularised bovine jugular vein bioprosthesis as mitral valve replacement in sheep

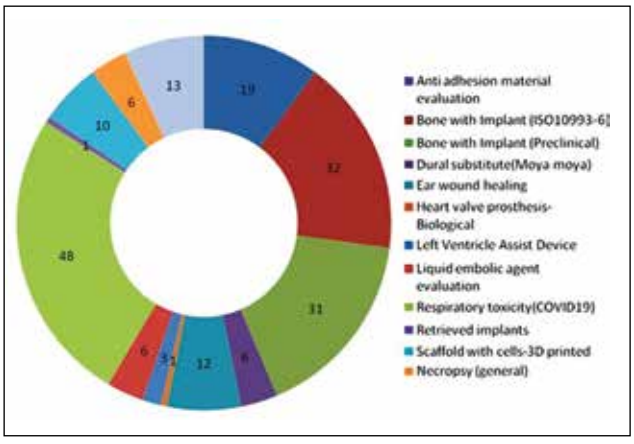


Figure 1. Summary of specimens evaluated at the Histopathology Laboratory

Awards and Honours

1. Dr T V Anilkumar was awarded FRCPath by the Royal College of Pathologists, United Kingdom. He is the first veterinarian in India and second non-medical pathologist in Kerala to receive this honour.
2. Ms Manjula P M, PhD scholar, won the best oral presentation award, for the paper entitled "A modified porcine cholecystic extracellular matrix scaffold for diabetic wound healing application" in Health Sciences Session of the 33rd Kerala Science Congress from 25-30 January 2021 at Thiruvananthapuram.

DIVISION OF LABORATORY ANIMAL SCIENCE

The Division facilitates research and testing of small laboratory rodents and rabbits by imparting care, welfare and management as per ISO standard 10993 Part-II of the quality system based on ISO/IEC 17025; 2005. The primary mandate of the Division of Laboratory Animal Science (LAS) is to breed, stock and supply good quality small laboratory animals for testing and research. The Division is under surveillance of quality system, *COFRAC* for producing, maintaining and supplying animals for accredited testing. The LAS is registered with the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) and has to its credit many work procedures maintained as per international guidelines.

Developmental Activities

The Division offered technical support for chitosan/ alginate-based antioxidant polymeric wound dressings for controlled antibiotic delivery.

New Initiatives

1. Development of mucoadhesive polymer-coated ferrous sulphate for treating anaemia - a study initiated with HLL.
2. The proof-of-concept evaluation of a biomaterial to treat meniscus tear in rabbit surgical model was initiated.
3. A study on feasibility and efficacy of "Emuloid" a novel iodine-based contrast agent for CT imaging, funded by Bioroot India Pvt. Ltd., was initiated.

Research Programmes

1. Development of mucoadhesive polymer-coated ferrous sulphate for treating anaemia - a study initiated with HLL.
2. Animal experiments were initiated.in the Project "Stem cell-derived exosome therapy for clinical management of lung damage in critically-ill corona viral pneumonia patients" funded by SERB (Dr V S Harikrishnan: Co-investigator).
3. The proof-of-concept evaluation of a biomaterial to treat meniscus tear in rabbit surgical model was initiated in January 2021. The procedures were completed in 17 out of 18 animals.
4. A study on feasibility and efficacy of "Emuloid" a novel iodine-based contrast agent for CT imaging, funded by Bioroot India Pvt. Ltd., was initiated.

Testing and Evaluation

1. Animals were supplied to various Divisions in the BMT Wing for accredited biomaterial testing.

The animals supplied by the Division for testing and research during the year are summarized in the Table below:

Animal	Number
Rabbits	134
Rats	669
Mice	890
Guinea Pigs	85

2. The Division successfully underwent *COFRAC* Audit as well as *CPCSEA* Annual Inspection and maintained accreditation.
3. The Division conducted 5 IAEC meetings on 16 May, 27 July, 2 December 2020 and 12 February and 31 March 2021 and sanctioned B-Forms to conduct animal studies in the Institute.

DIVISION OF MICROBIAL TECHNOLOGY

The Division of Microbial Technology has the dual role of supporting medical device development and understanding medical device-associated infections. In supporting medical device development, the Division functions on a quality platform, offers a number of tests based on international standards and is ISO 17025 accredited. It also offers training of manpower to industries on quality systems in microbiology. In its role of supporting medical device development and medical device industry, the Division offers a number of tests to external customers and to researchers within the institute. It is also involved with health monitoring of small and large animals to ensure high quality animals for experimental purposes, biocompatibility assessments and preclinical studies.

The research in the Division focuses on understanding cell-material-microbial interactions, microbial biofilm and its molecular biology, development of in vitro tissue-engineered systems to study material-cell-microbial interactions, research and development of rapid diagnostic devices for microbial infections.

The Mission of the Division is to support medical device development and use of knowledge in Microbiology to fill gaps in infectious disease management by understanding the molecular level interactions between the host, the microbe and the device and develop rapid diagnostics to facilitate it.

Developmental Activities

New Initiatives

Selected for ICMR validation of Rapidogram, a rapid diagnostic kit for UTI with antibiogram.

Technology Transfer Activities

Viral Transport Medium (VTM) technology was transferred to 3 companies:

1. Levram Lifesciences Pvt. Ltd., Mumbai
2. Origin Diagnostics and Research, Kerala
3. Ultimate Moulds and Products, Thrissur

Research Programmes

Ongoing

1. "An easy and rapid detection platform for viral diseases from saliva: COVID-19 and beyond" (Funded by: DST-SERB).

2. Microbial route to synthesis of Nano-hydroxyapaptite

Synthesis of hydroxyapatite is an energy intensive process. Microorganisms like Serratia marcesens and Pseudomonas have the ability to synthesise nanohydroxyapatite at low temperatures efficiently. This is being explored.

3. Ms Keerthi S submitted her thesis titled "Immunomodulation by pseudomonas biofilms".

4. Nanoparticles as inducers of pulmonary fibrosis

Pulmonary fibrosis is an inflammatory disease that occurs when lung tissue becomes damaged and scarred. The lung damage caused by pulmonary fibrosis cannot be repaired, but medications and therapies can sometimes help ease symptoms and improve quality of life. Carbon black nanoparticle (CBNP) is a material produced by the incomplete combustion of heavy petroleum products. Carbon black nanoparticle of size 10-40nm could reach as far as the gas exchange regions of lungs, escaping all the defense mechanisms eliciting a fibrotic response. So, a detailed understanding of the alveolar responses would help in addressing the pathologic fallout of alveolar fibrosis (Figure 2). In this study, it was observed that carbon black induced lysosomal membrane permeabilization in alveolar epithelial cells. A dose-dependent reduction in MMP was observed in alveolar epithelial cells exposed to CBNP. This was evidenced by loss of red fluorescence and gain of green fluorescence in CBNP exposed cells (Figure 3). To understand the molecular mechanism expression of various genes such as TNF a, IL-1α TGF αand caspase 1 were analysed by RT-PCR.

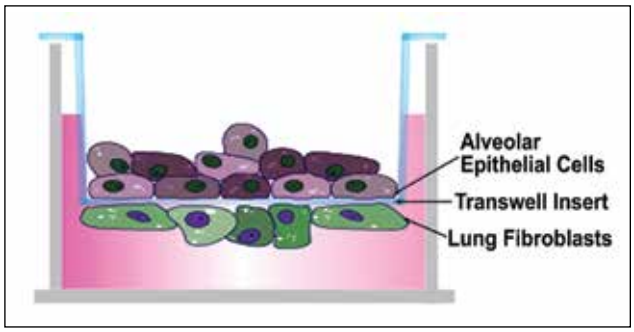


Figure 2. In vitro model system of alveolar epithelial and fibroblast cells for studying cell interactions

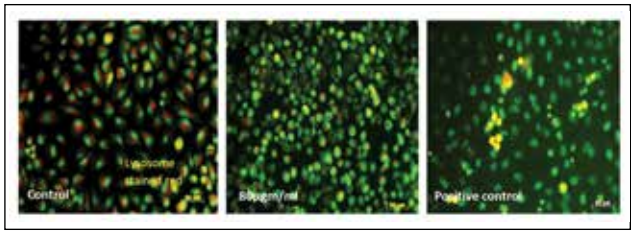


Figure 3. Acridine orange staining of A549 cells exposed to carbon black shows loss of lysosomal membrane permeabilization in a dose-dependent manner indicated by loss of red fluorescence and gain of green fluorescence

5. Clostridioides difficile immune modulation in gut epithelial cells

Clostridioides difficile is an anaerobic bacterium that invades gut of human beings and is the causative agent of *Clostridioides difficile* infection. It is a gastrointestinal disease that is caused by excessive use of antibiotics and prolonged hospitalisation is also a major risk factor. It is the most frequent cause of nosocomial antibiotic-associated infection. It induces colitis, a costly health care-associated infection with more than half a million annual infections and a mortality of 29000 deaths annually in the USA alone. The underlying cause is the change of gut microbiome due to antibiotic usage leading to its colonisation and subsequent infection. The progression of asymptomatic to symptomatic infection is not completely understood, although a role for gut microbiome is recognised. The host immune system has a central role and this needs to be delineated to understand the development of disease and possible therapeutic strategy. A study on Clostridioides difficile biofilm interaction with gut epithelium and role in immune modulation is underway.

Testing and Evaluation

Testing was done for a total of 145 samples in 73 work orders.

The tests performed are summarized in the Table below:

Test	Number of Requests	Number of Samples
Accredited tests		
Sterility test	5	7
Ames test	1	1
Bioburden analysis	3	3
In support of accredited facilities		
Air monitoring	17	40
Water analysis	18	44
Spore viability test	2	2
Non-accredited tests		
Anti-microbial activity testing - Agar diffusion method	19	29
Bacterial adhesion studies	1	1
Culture/ Staining	3	3
Growth promotion study in media validation	3	14
PCR	1	1

Microbiological evaluation of devices to combat COVID-19

In-house samples

Name of Device	Microbiological evaluation done
UVC-based face mask disposal bin	Checking the bactericidal and fungicidal effect after UV exposure
Disinfection Gateway	• Microbiological monitoring of air in the disinfection gateway before and after exposure • Microbiological evaluation of sterilant used in the disinfection gateway • Checking efficacy of disinfection by hand swabbing before and after exposure • Testing inhibition of bacteria on fabric after exposure to disinfection gateway
Development of universal Viral Transport Medium, its technology transfer and commercialisation	Preparation and standardisation and validation of Viral Transport Medium and suitability for NAAT assay
Sample collection swabs	Bacterial recovery study, Sterility test and Bioburden analysis

External Samples

Name of Device	Microbiological evaluation done
Coir mats	Checking the bactericidal and fungicidal effect of sodium hypochlorite-impregnated coir mats
UVC sterilizer	Checking the bactericidal, fungicidal and virucidal effect after UV exposure
Ozone sterilizer	Checking the bactericidal, fungicidal and virucidal effect after ozone exposure
Depurator hand wash device	Checking the bactericidal and fungicidal effect
Disinfectants	Checking the bactericidal, fungicidal and virucidal effect after UV exposure
Go Corona UV sterilising machine	Checking the bactericidal and fungicidal effect after UV exposure

Clinical Activities – COVID-19 Testing

The BMT Wing COVID testing team was constituted with faculty, staff and students of Department of Applied Biology under the leadership of Dr A Maya Nandkumar. They teamed-up with the ICMR-approved COVID Testing Laboratory at the Hospital Wing. A total of 3574 samples were tested by RT-PCR and reported.

Desktop evaluation of Covid technologies as per ICMR guidelines

Dr A Maya Nandkumar evaluated and reported 20 submissions in the category of surface disinfectants.

DIVISION OF MOLECULAR MEDICINE

The Division of Molecular Medicine focuses on two major research areas: (i) Aspects of molecular neurobiology, especially on learning and memory pathways in brain and (ii) Development of innovative diagnostic tools for diseases like tuberculosis, cervical cancer and COVID-19.

Developmental Activities

1. Recombinant growth factors – TGF-alpha and VEGF

Both these growth factors have been cloned and expressed in prokaryotes. Animal studies using alginate scaffold incorporated with these growth factors were found to enhance the healing of chronic wounds. Preclinical studies were completed and results showed that combination of both these growth factors had a significant effect on the healing of skin wounds. These growth factors were developed at a low cost and expected to have an impact on the development of wound dressing materials for faster healing of chronic wounds. The technology was ready for clinical evaluation.

Figure 4. Signing of technology transfer agreement for multiplex RT-PCR kit for SARS-CoV2

Figure 5. RNA isolation kit was developed for SARS-CoV2

2. Point-of-care diagnosis for pulmonary tuberculosis and HPV using loop-mediated amplification of DNA

We have developed a modified real time LAMP reaction for faster detection of pulmonary tuberculosis and HPV.

New Initiatives

1. Multiplex RT-PCR kit for SARS-CoV2 was developed and independently validated by ICMR. Technology Transfer Agreement was signed for marketing the kit with Huwel Life sciences, Hyderabad (Figure 4).
2. Chitra Magna, a magnetic RNA isolation kit (Figure 5) was developed for SARS-CoV2 and independently validated by ICMR. Technology Transfer Agreement was signed for marketing the kit with Agappe Diagnostics, Kochi.

Technology Transfer Activities

1. Technology Transfer Agreement was signed for marketing the Chitra Multiplex RT-PCR kit with Huwel Life sciences, Hyderabad and Meril Diagnostics, Gujarat.
2. Technology Transfer Agreement was signed for marketing the Chitra Magna RNA isolation kit with Agappe Diagnostics, Kochi.

Research Programmes

Role of connectome in learning and memory

Learning and memory formation is one of the least understood processes in brain. Though it is known that neuronal plasticity has a role in this pathway, the exact mechanism by which neurons record and recall memory has not been elucidated. We use *Caenorhabditis elegans,* a nematode model to elucidate the conditional learning paradigm, especially in olfactory learning.

The neurotransmitters, dopamine, tyramine, insulin and glutamate are critical in the development of behaviour patterns in this organism. A series of genetic mutants were analysed by our group to confirm how the alterations in both neurotransmitter level as well as their receptor density affect the functioning of specific neurons in olfactory signal recognition.

We are studying the neuronal functional alterations during imprinting and olfactory learning paradigms (both in wild-type and in specific mutants). Our studies showed that a significant variation in animal behaviour occurred when the levels of neurotransmitters vary, especially that of dopamine, glutamate, tyramine and insulin. The crucial neuronal circuits involved in memory formation in the nematodes are AIY, AIA, RIM and CEP. Insulin pathway was found to have dopamine dependency in learning-associated changes. Mutations in genes involved in dopamine synthesis and its downstream pathways in C.elegans resulted in significant alterations in learning. Our studies showed that dopamine neurons, because of their strong involvement in reward recognition, were involved in adaptive olfactory memory recalling pathway (Figure 6).

We believe that there are incidences of consolidation of synapses during early development stages in the brain.

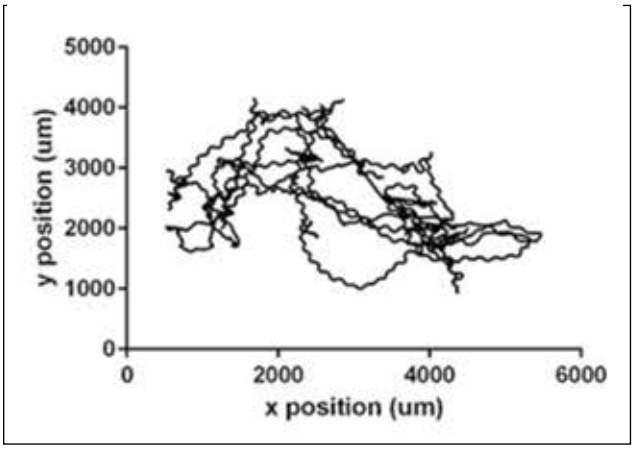


Figure 6. Tracking pattern of C.elegans in chemotaxis plates

In addition, neural circuits involving interneurons such as AIY, CEP and RIM are essential in memory recalling pathway. In olfactory learning pathway, a series of receptors including str-2, sra-11, glc-3, tdc-1, lgc-55, daf-2 and ins-1 play a critical role.

To further probe how neurodegenerative diseases like Alzheimer's Disease and Parkinson's Disease (PD) affect the memory pathway, we used mutant worms expressing human alpha-synuclein and beta-amyloid in nerve cells. As in PD patients, worms expressing human alpha-synuclein in their dopamine neurons showed neurodegeneration as the organism aged. These neuronal damages had a significant impact on memory pathway in the worms.

Awards and Honours

1. Dr Anoopkumar Thekkuveettil was an expert member in Workshop on 'Biopharma, Vaccines & Diagnostics' under the thematic area 'Medical and Healthcare' on 18 August 2020 to discuss the initiatives required towards preparing sector-wise roadmap for implementation, a step towards Atmanirbhar Bharat. The Workshop was organised by TIFAC, National Technology Think Tank, an autonomous organisation, under the Department of Science and Technology, Government of India.
2. Dr Anoopkumar Thekkuveettil is a Member of Biological Evaluation of In Vitro Diagnostic Medical Devices Sectional Committee, Bureau of Indian Standards, Government of India, from 2020 onwards.

3. Dr Anoopkumar Thekkuveettil is an Expert Member in SAG – Devices and Diagnostics, BIRAC, India, from 2019 onwards.
4. Dr Anoopkumar Thekkuveettil is a Member in "Independent Committee on Diagnostics Vertical", Department of Science and Technology, Government of India, from 2020 onwards.
5. Dr Anoopkumar Thekkuveettil is an Expert Member in BIG-Diagnostics – BIRAC, India, from 2020 onwards.

DIVISION OF SLEEP RESEARCH

The Division conducts studies to understand the functions and neural mechanisms of sleep and on emerging aspects of sleep medicine for improving human health. The Laboratory is equipped with state-of-the-art facilities to study the role of sleep in developmental programming for ontogenetic organisation of sleep-wakefulness and autonomic balance for an optimal cognitive development using insomnia model in rodents. Research output are published in International Journals and presented at international meetings and forums. The Division also provides extensive training in techniques used for sleep research in animal models and undertakes Sleep Awareness Programme.

Research Programmes

The effects of controlled sleep deprivation in dams during pregnancy on heart rate variability, sleep and emotional-cognitive behaviour in offspring immediately after birth until adolescence were monitored. Sleep was assessed using electrophysiological parameters by recording electrical activity of brain (EEG) and neck muscle activity (EMG). Electrodes were implanted under anaesthesia so that actual recordings can be taken in free moving animals. Sleep deprivation during pregnancy suppressed development of parasympathetic component of the autonomic system in pups and disturbed autonomic balance for heart rhythms in relation to sleep stages which were developing simultaneously.

Other Activities

1. Dr Kamalesh K Gulia completed Faculty Development Program online courses on "Machine Learning and Data Analytics using Python" (23 April to 1 May 2020) and "Deep Learning and its applications" (22-30 June 2020) conducted by Electronics and ICT Academy, IIT Roorkee.
2. Dr Kamalesh K Gulia delivered the Keynote lecture "Journey of Women in STEM: Thrills of Empowerment!" in a webinar on Women Leaders in STEM (Women-Opportunities-Entrepreneurship-Education) on 3 December 2020. The webinar was jointly organized by Kerala State Council for Science Technology and Environment, Government of Kerala and Department of Science and Technology, Government of India under the DST-supported Project titled "Assessment of Government of India's Gender Mainstreaming Programs for Women in Science".

Events Organized

1. The Division organized two International Symposia:
   - "Adverse Developmental Outcomes in Offspring as Consequences of Sleep Disorders during Pregnancy", for International Paediatric Sleep Association (IPSA) online conference with international and national faculty from 5- 6 February 2021. Dr Kamalesh K Gulia delivered a talk on "Gestational sleep loss linked to immature brain networks in offsprings".
   - "Is sleep essential for maintaining optimal networks for neurocognition: Novel evidences" as part of the XXXVIII Annual Meeting of Indian Academy of Neurosciences E-Conference with the theme "Basic and Clinical Neurosciences: Bridging the Gaps" from 4-7 October 2020. Dr Kamalesh K Gulia delivered a talk on "Sleep during perinatal window and cognitive development of offspring: Decoding conundrum!".
2. The 14th World Sleep Day with the theme "Regular sleep, Health future" was celebrated on 19 March, 2021 at the BMT Wing in a hybrid mode (Figure 7). On this occasion, Dr

Figure 7. 14th World Sleep Day celebrations

Harikrishna Varma, Head, BMT Wing delivered the inaugural address and emphasised the importance of sleep for good health in current changing lifestyle especially during the ongoing COVID-19 pandemic. Dr Maya Nandkumar A, Head of the Department of Applied Biology chaired the session and highlighted the role of sleep in developing better immune responses when COVID vaccinations are going on. Dr Kamalesh K Gulia delivered a talk on "Sleep & Wellbeing: A Redefined Link!"

Awards and Honours

Dr Kamalesh K Gulia is the founder and Editor-in-Chief of Chitra Dhwani, e-magazine of the Institute.

DIVISION OF TISSUE CULTURE

The Division of Tissue Culture conducts research and development activities, provides technical support for product development and participates in other academic programmes of the Institute. The Division offers in vitro cytotoxicity testing as per the ISO/IEC 17025 quality platform to internal and external customers. The tests are accredited by COFRAC, France. The Division also extends a range of in vitro tests to customers such as cell-material interactions, image analysis and cell- based assays. The research activities include cell interactions, stem cells, scaffolds for tissue-engineering, 3D bioprinting and in vitro tissue models. Two major areas of focus of the Division are: biofabrication of liver construct and corneal epithelial cell sheet engineering. Various other ongoing research programmes are: development of 3D bioprinted hepatotoxicity test system, efficacy evaluation of cell sheet technology for translation, studying role of Hsp70 in myoblast differentiation and bioengineered construct for myocardial repair.

The 3D Bioprinting Facility has advanced tissue and organ printing facility equipped with multi-technology 3D bioprinter. Basic and technology-oriented research programmes specifically on 3D bioprinting are carried out in this facility. The Division initiated the 3D Bioprinting and Biofabrication Programme on development of liver construct as the part of Institute's core research programme. Other research attached to the facility is development of 3D bioprinted in vitro skin construct and toxicity systems.

Developmental Activities

1. Bioink for 3D Bioprinting

The Division of Tissue Culture initiated the 3D Bioprinting and Biofabrication Programme under the Technical Research Center (TRC) Programme. A multi-dimensional approach catering to pre-printing, printing and post-printing aspects were adopted to bring forward the 3D bioprinting of functional tissues. One of the major elements required for 3D bioprinting is the bioink which is composed of biomaterial, cells and growth nutrients. The basic component of bioink is a hydrogel, prepared by functionalizing gelatin (GelMA). A novel multi-component extrudable bioink formulation was developed using GelMA with additional physiologically relevant free radical scavengers that would specifically protect the viability and functional capabilities of metabolically active cells like hepatocytes. The 'ultraviolet light-safe bioink' has gone through all basic and standard tests required for qualifying it as a biomaterial. The 3D printability of the bioink was evaluated by printing various patterns.

2. 3D Bioprinted in vitro hepatotoxicity test system

The process and methods for 3D bioprinting of liver constructs for in vitro hepatotoxicity testing was developed in the TRC Funded Project (Figure 8). The design of the constructs was prepared and cell-laden constructs were bioprinted based on a computer-aided design. Parenchymal liver constructs bioprinted using primary rat hepatocytes and human hepatosarcoma cell line expressed liver specific functions. The constructs responded to hepatotoxic drugs in a dose-dependent manner. The trend of hepatotoxicity expressed by the in vitro bioprinted system was compared with in vivo rat hepatotoxicity system. This technology can lead to the development of alternative test system for animal testing and as a prediction system for clinical evaluation of drugs. The test system is ready to be offered to external and internal customers. In order to validate the 3D bioprinted construct as an in vitro test system, a Non-disclosure Agreement was signed with an industry.

3. Regeneration of ocular surface by cell sheet engineering

Damage to the ocular surface of the eye is treated by transplantation using donated cornea. To meet the shortage of donor tissue, bioengineered corneal tissues are considered as potential technology. Cell-sheet engineering is a cell- based approach to develop tissues using a temperature-responsive culture substrate (Figure 9). A substrate, Poly(N-isopropylacrylamide-co-glycidyl methacrylate) (NGMA) polymer was developed in the Division. Under the TRC Programme, a systematic characterization of NGMA polymer was ongoing. The efficacy of this polymeric substrate was under evaluation using human corneal cells.

Limbal stem cell-deficient rabbit models were developed for the preclinical evaluation of cell sheets. Corneal cells sheets prepared from rabbit and human cornea were evaluated in vitro for tissue-specific characteristics.

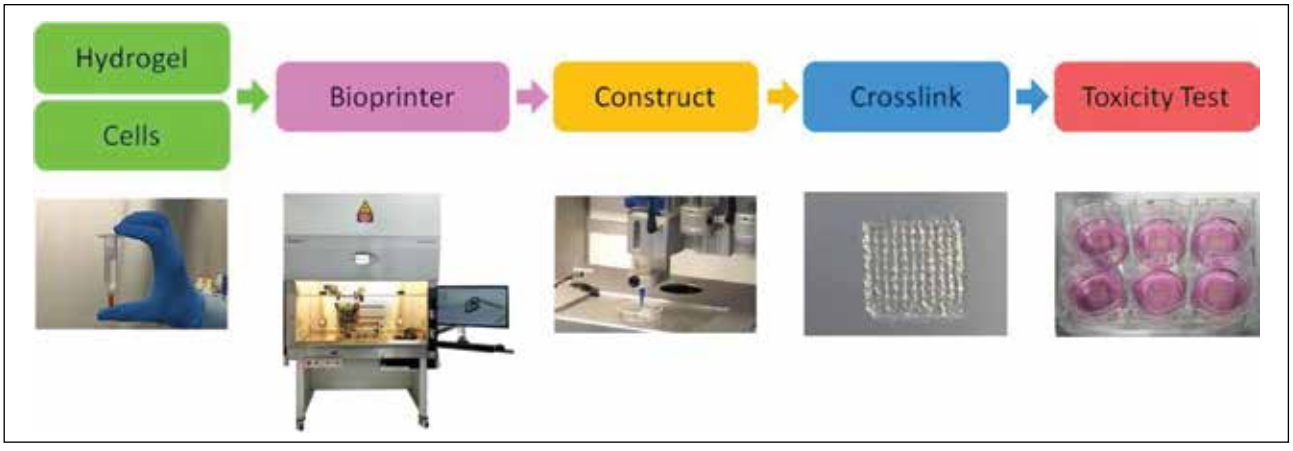


Figure 8. Work flow of hepatotoxicity test system

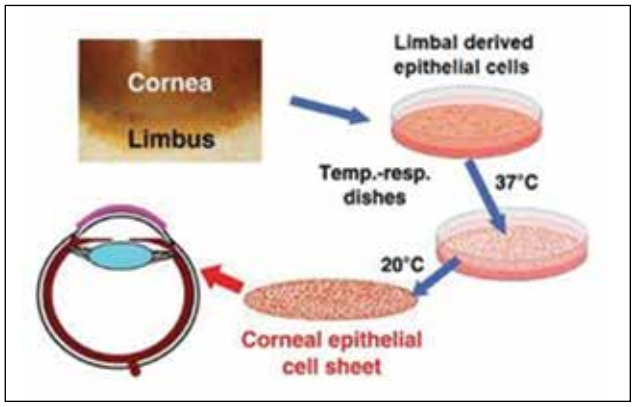


Figure 9. Schematic diagram of human corneal limbal-derived epithelial cell sheet technology using the thermoresponsive polymer as a substrate, wherein, the polymer changes phase and the cells come out as a sheet when the incubation temperature is reduced from 37 °C to 20°C or below

4. Development of an in vitro co-culture device

Cell-based in vitro models are being developed depending upon the need of a research problem. Cell-cell interaction is one of the key parameters that demands culture of more than one cell type together. In order to study direct and indirect cell-cell interaction, a novel device was developed under the TDF Programme. The device allowed culture of two different cell types in direct contact and a third cell type through indirect contact. It contained bio-inspired porous scaffold prepared from regenerated silk fibroin by electrospinning technology. The thin sheet of scaffold in the device supported cell attachment and growth at both sides allowing study of cell migration and interaction. This device can be used for co-culture studies to understand fundamental cell biology and develop in vitro cytotoxicity testing model. A co-culture of epithelial keratinocytes (HaCaT) and subcutaneous connective tissue fibroblasts (L-929) was established using the device.

5. Cell seeding and culture device for scaffolds with axially-aligned pores

Synthetic bone grafts are used as alternative to autologous bone harvested from the patient. Bioceramic scaffolds with axially-aligned pores have been proposed to overcome the limitation of conventional random porous scaffolds. However, seeding cells inside long capillary pores of the scaffold is challenging. A dynamic cell culture device was developed, which enhanced the cell seeding inside the longitudinally aligned pores of the bioceramic scaffold (Figure 10). This approach will provide new methods of cell culture for tissue-engineering of bone.

6. 3D Bioprinting of skin tissue constructs for in vitro testing

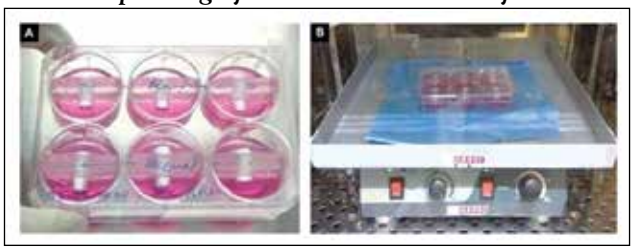


Figure 10. A dynamic culture system fit into a multi-well plate (A) well plate with scaffolds in position creating compartments after cell seeding in different compartments ready for incubation and (B) dynamic cell culture to enhance cell growth in axially-aligned porous scaffold.

A hydrogel formulation was developed in the TRC Programme to develop skin substitutes. Various formulations using modified alginate, gelatin and platelet-rich plasma (PRP) was extensively studied for 3D bioprinting. The 3D printability aspect and skin tissue characteristics were evaluated (Figure 11). The evaluation of skin construct as toxicity test platform and as a transplantable construct was ongoing.

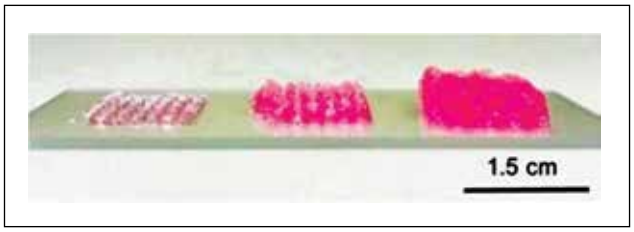


Figure 11. Printability aspects of alginate dialdehyde–gelatin–PRP bioink. Lateral view of single and multi-stacked constructs

New Initiatives

1. Validation of 3D bioprinted in vitro hepatotoxicity test system

A Non-Disclosure Agreement was signed between SCTIMST and M/s Vipragen Biosciences Pvt. Ltd. to collaborate on the validation of 3D bioprinted liver construct developed by SCTIMST in the TRC Project.

2. Efficacy evaluation of 3D bioprinted liver constructs established from niche-specific bioink:

Development of transplantable 3D bioprinted tissue and organ is a long term programme. The huge demand for donor tissue for transplantation can be tacked by rapid prototyping technology like 3D bioprinting. Here, functional tissues are biofabricated with multiple cell types with better cell distribution using a bioink. However, 3D microenvironment is a key factor that contributes to the maturation of bioprinted construct into a functional tissue. A Project funded by Science, Engineering and Research Board under Core Research Grant was initiated to develop methodologies for biofabrication of functional parenchymal liver construct from adult stem cells by 3D bioprinting. In order to get structurally organized tissue, liver niche specificity will be imparted to bioink using liver- derived extracellular matrix proteins to enhance the growth and multiplication of stem cells and differentiated hepatocytes.

3. Stem cell-derived exosome therapy for clinical management of critically- ill corona viral pneumonia patients

The 2019 Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV-2) causes several pathological conditions including pneumonia and acute respiratory distress syndrome (ARDS), eventually leading to respiratory failure and death. In this study funded by the Science Engineering and Research Board, a regenerative therapeutic approach was explored. The mesenchymal stem cell- derived extracellular vesicles were suggested as potential regenerative regime for lung regeneration in ARDS mice models. Human Wharton's jelly-derived mesenchymal stem cell was induced for exosome release and the exosomes were isolated by ultra-centrifugation method. The exosome characterization was ongoing at protein, nucleic acid and cellular level. Animal studies to evaluate performance of exosomes in lung regeneration in C57BL/6J mice were ongoing.

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

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

Research Programmes

1. Bioengineered cardiac mesenchymal construct for myocardial repair

This studies the role of collagen on cardiac mesenchymal cell (CMC) phenotype and the role of microRNAs on CMC reprogramming. Collagen type I was extracted from bovine Achilles tendon was modified and characterised. The CMCs grown in collagen scaffold expressed key adhesion molecules related to cardiac repair. The role of cardiac-specific miRNAs (miRNA-1, 133, 208, 499) in CMC differentiation was analysed by transiently transfecting cells with miRNAs. The target of miRNAs such as HDAC4, Snail1, Sox6 and myostatin was also evaluated by immunostaining and Western blot analysis The results revealed significant down-regulation of these genes upon miRNA induction in CMCs.

2. Defining the regulatory role of HSP70 in myoblast differentiation

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

3. Biofabrication of functional liver tissue construct by three-dimensional organoid bioprinting

Liver tissue function can be greatly attributed to the spatial organisation of hepatocytes and their interaction with non-parenchymal cells. Restoring such cellular microenvironment is crucial for engineering functional liver constructs. The inherent ability of hepatocytes for self-organisation in vitro was utilized as a method for biofabrication of partially organized tissue constructs. To attain tissue-mimetic structure in the bioprinted construct, a bioprinting approach utilizing organised cellular aggregate called organoid was used. Liver organoids were developed from co-culture of rat liver hepatocytes and non-parenchymal cells on thermoresponsive culture surface. Histological analysis of hepatic organoids revealed spatial organisation of different cell types similar to the native tissue (Figure 12). The organoids were viable and exhibited liver-specific functionalities such as albumin synthesis, urea synthesis and cytochrome P450 activity. The tissue organoids were subsequently bioprinted using a gelatin methacrylamide bioink. The bioprinted construct was under evaluation for liver-specific functions.

4. Pre-clinical evaluation of hydrogel formulations for bioink

Gelatin methacrylamide or GelMA is a well-known

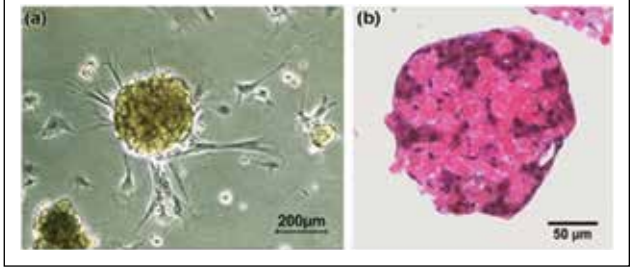


Figure 12. Liver organoid culture. (a) Phase contrast image of the liver organoid cultured on thermoresponsive substrate. (b) Hematoxylin and eosin-stained section of liver organoid depicting spatial organisation of cells

and widely used polymer obtained by modification of gelatin. GelMA has the capability to crosslink in the presence of ultraviolet (UV) light. The base formulation of bioink with GelMA showed good printability by extrusion-based bioprinting. GelMA can crosslink in presence of photoinitiator under UV exposure. To safeguard cells during photo crosslinking, UV-safe GelMA formulation was developed and when compared with commercial GelMA showed the advantages of UV-safe property with respect to cell viability and functions.

5. Development and optimization of tissue-specific bioink for 3D bioprinting of liver construct

To impart extracellular cues to stem cells and differentiated cells in a 3D construct, decellularised tissue components can be used in the bioink. When extracellular matrix (ECM) components are supplemented in bioink, the cells will organise and mature in the bioprinted construct. Porcine liver ECM was obtained by organ perfusion and was evaluated by histological staining. The base polymer for bioink was modified form of gelatin that forms the bulk component of bioink. The modification of gelatin was allyllated (GelAGE) and the modification was confirmed by 1H-NMR spectroscopy. The physicochemical and biological evaluation of the bioink was ongoing.

6. Silk fibroin films for corneal tissue engineering

The main challenge in developing artificial corneal equivalent is in realising the necessary optical properties. *Bombyx mori* cocoon-derived silk fibroin-based membrane was proposed as a biocompatible and a bioresorbable scaffold. Membranes from reconstituted silk fibroin were prepared under different conditions and the physico-chemical properties of the resultant films were investigated. To address the criticism on source-dependent variations of silk- based biomaterials we studied the optical properties of silk fibroin scaffold prepared from cocoons collected from various geographical locations. Results showed very positive indication towards development of biocompatible biomaterial for corneal tissue-engineering.

Testing and Evaluation

The Division of Tissue Culture actively participated in the preliminary cytotoxicity evaluation of the biomaterials and biomedical devices developed at the institute under various research programmes. Accredited and non-accredited tests were offered to

internal and external customers as initial screening of materials. In vitro cytotoxicity tests catering to the specific needs were offered to customers under study plan mode. The Division participated in internal audit and post-audit meetings organised by the Quality Cell. The Division also participated in inter-laboratory comparison to ensure the proficiency of testing activities.

Awards and Honours

1. Dr Anil Kumar P R was selected as Member of the National Advisory Committee for the study on "Technology Status and Foresight Report on Bioprinting Technology" by the Technology Information, Forecasting and Assessment Council (TIFAC), New Delhi.
2. Dr Anil Kumar P R was appointed as Visiting Professor at the Sree Anjaneya Institute of Dental Sciences, Kozhikode, from September 2020 to August 2025.
3. Dr Naresh Kasoju won 1st Prize for a presentation on "Future of Science Governance" in the Group Presentation Competition held as part of the 10th Training Program on Science, Technology and Emerging Trends in Governance from 8-12 February 2021 organised by the Indian Institute of Public Administration, New Delhi.

DIVISION OF TISSUE ENGINEERING AND REGENERATIVE TECHNOLOGIES

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

Developmental Activities

1. Indo-Danish Programme - MUSTER

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

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

The objective of this WOSA Project was to generate a tissue-engineered 3D bioprinted skin construct with embedded pits for the incorporation of hair follicle stem cells.

3. Research Projects in areas of wound dressing development and development of highly specific and biomimetic scaffolds for osteochondral, chondral, cardiovascular and pancreatic tissue engineering continued.

New Initiatives

Development of Nylon Flocked Swabs for COVID-19

A 6 month TRC Project 'Nylon flocked swabs (Nasopharyngeal and Oropharyngeal) for COVID-19 testing' was sanctioned during the year. This is a co-development project with M/s Mallelil Polymers Pvt. Ltd., initiated as part of COVID-19 activities of the Institute. The initial development and testing results were transferred to the Industry which helped them to obtain the manufacturing license and to start production. A patent was also filed in this regard. The technology was successfully commercialised.

Technology Transfer Activities

Nasopharyngeal and oropharyngeal swabs were co-developed with M/s Mallelil Polymers Pvt. Ltd. as part of the COVID-19 technology-based TRC activities of the Institute. The Industrial partner obtained their manufacturing license soon after the technology transfer and is now successfully developing almost 1 Lakh pieces per month at their Facility. The swabs are being sold to diagnostic labs both in Kerala and other states. They are available as sterile, ready-to-use devices with both the nasal and oropharyngeal swab variants (Figure 13).

Figure 13. Nylon flocked swab in product form

Research Programmes

1. Development of biomolecule KGN-conjugated gold nanoparticle-loaded gel for cartilage repair

Molecules that promote the selective differentiation of multipotent mesenchymal stem cells (MSCs) into chondrocytes may stimulate the repair of damaged cartilage in osteoarthritis. A specific biomolecule, KGN may induce chondrocyte differentiation from MSCs and protects articular chondrocytes in vitro. Our lab had previously developed an injectable hydrogel for cartilage repair. In this study, we focused on the development of injectable hydrogel with KGN-conjugated with gold nanoparticles for cartilage repair. The biomolecule-nanoparticle conjugate was developed so as to achieve sustained drug release of biomolecule from the gel. Subsequent characterisation studies of particle, cyotcompatibility of materials and drug release were carried out along with the ability of the biomolecule-nanoparticle-loaded gel to promote chondrogenic differentiation of adipose stem cells. Formation of chondrogenic nodules and release of glycosoaminoglycans suggested that the desired chondrogenic pathway is potentially possible and further studies were underway.

2. Assessment of the chondrogenic pellet formation enhancing property of the compounds, CATM and BCTM

The chondrogenic pellet formation potential of two compounds, CATM and BCTM, that were provided the Department of Chemistry, IIT Delhi, was assessed. In the preliminary step, a particular concentration of the compounds was used. The compound-coated 12-well plates were seeded with rat articular chondrocytes and the self-assembled chondrogenic pellet formation pattern was assessed for 14 days (Figure 14). It was found that CATM compound induced better chondrogenic pellet than BCTM compound. No pellet was formed in uncoated control wells. Further studies were underway.

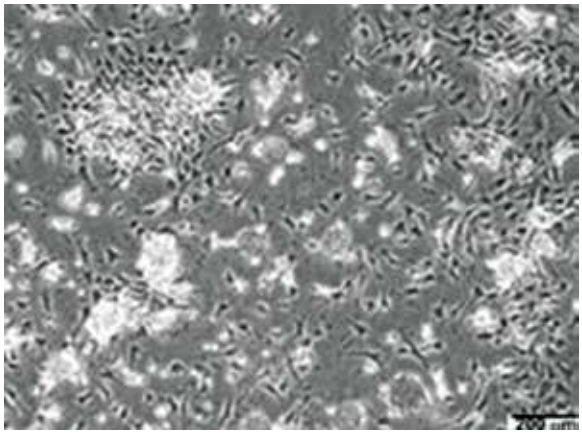


Figure 14. Testing of chondrogenic pellet forming property of the compound BCTM using rat articular chondrocytes

3. Evaluation of fibrous mesh sheets as scaffolds for increasing the area of neovascularisation in Moyamoya disease

The study envisaged the use of fibrous mesh sheet scaffolds as tissue extenders for neovascularisation to occur beyond the margins of the craniotomy in rabbit models. In this study, we compared the efficiency of electrospun nanofibrous sheets made of polymer blends. The materials used were: polycaprolactone/ Gelatin Vinyl acetate (P/GV) and Polycaprolactone/ Polycaprolactone - polytetrahydrofuran polycaprolactone (PCL/PCL-PTHF-PCL). The membranes were implanted intracranially in rabbits and were assessed for vascularisation. To enable better vascularisation, VEGF was incorporated in the membranes.

4. Development of Nylon flocked swabs for COVID-19

This work was undertaken owing to the shortage of such swabs during the pandemic. The Project was taken up as a co-development with M/s. Mallelil Polymers Pvt. Ltd., Cochin. The objectives of the Project included: design of the product, design verification, device validation and qualification tests. The objectives of the industrial partner included: packaging development, production, regulatory clearance and commercialization. The swab consists basically of a nylon fibre flocked-tip with flexible plastic handles (Figure 15) with proven efficiency in specimen collection, rapid elution of specimen into the liquid viral transport medium and good recovery of viral RNA collected using these swabs. The main features included: ergonomic design of the swabs which helped in improved specimen collection with minimum discomfort to patients, safe and convenient breakpoint ensured minimal contact of the health worker with the sample during the sampling process.

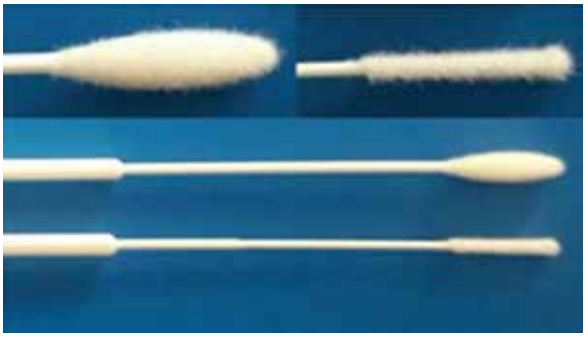


Figure 15. Nasal and oropharyngeal nylon flocked swabs

5. Modified emergency bandage with pressure pad and a haemostat for pre-hospital emergencies

In this Project, we designed a multifunctional emergency bandage using an elastic bandage with a 4-layer dressing that applies uniform pressure (Figure 16). The 4 layers comprised: a haemostatic layer (innermost layer in contact with wound surface), bubbled silicone pad (for uniform pressure application below the haemostatic dressing), an absorbent dressing pad and a backing layer with plastic coating (outer layer to prevent excessive blood leakage). The absorbent pad with plastic coating close to the crepe surface absorbs blood and prevents seepage to the surface. The absorbent pad was a chitosan-based absorbent dressing that could hold 20 times the quantity of simulated wound fluid.

Figure 16. Design and prototype of the multifunctional bandage

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

The aim of this project was to test the hypothesis that, localized hair follicle stem cells incorporated between keratinocyte and fibroblast-seeded scaffolds, can be induced to produce hair follicles, sweat and sebaceous glands if given stress- induced signals like oxidative, hypoxic, UV and shear stress that are expected in a wound area to create a skin substitute. The study also investigated the potential of 3D printing for placing

hair follicle stem cells in a full thickness tissue-engineered skin construct and also examined the role of stress-induced growth factors necessary for hair follicle development in follicle neogenesis. During the year, the fabrication of cell-free tissue-engineered skin construct with localised three dimensional pits to incorporate hair follicle stem cells via extrusion-based 3D printing was performed (Figure 17) and optimization of crosslinking condition based on the degree of crosslinking was carried out.

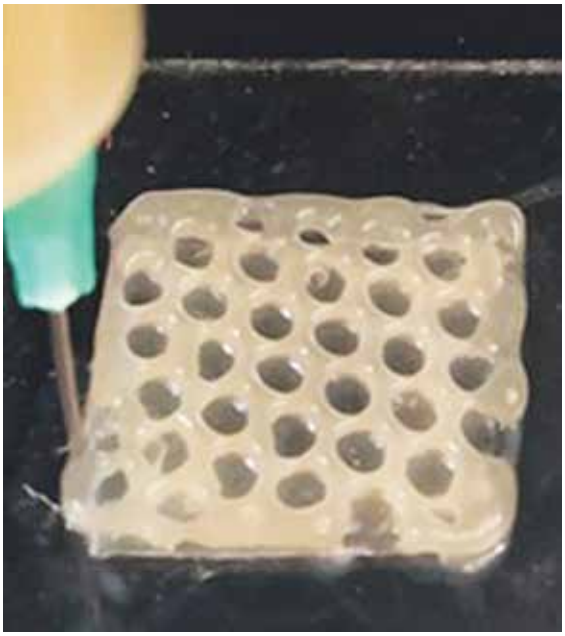


Figure 17. 3D printed gel construct with localised pits for hair follicle stem cell culture

7. Bio-engineering of a tracheal construct - identification of appropriate biomaterial scaffolds and conditions

The Project deals with the development of a tissue-engineered tracheal construct having 3D cell distribution and comparable mechanical properties as that of the native trachea. The study explored the synthesis of elastomeric materials and the feasibility of fabricating them into a 3D tracheal scaffold, emphasizing on the mechanical properties and 3D cell distribution of the tracheal construct. The major requirement of a tracheal scaffold is its elastic property, as implanting a mechanically rigid structure may cause mechanical mismatch and its failure. Having a 3D cell distribution is another important feature required for the successful regeneration of the cartilage rings. Having these mechanical properties and 3D cell distribution in one system is a challenge. In this work, we synthesized two elastomeric polymers - polyurethane urea, poly(lactide-co-caprolactone) and tested their feasibility to 3D print into a tracheal construct.

8. Enhancing insulin production of islet-like clusters derived from mesenchymal stem cells

The main objective of the work is to enhance the insulin production of islet-like clusters (ILCs) differentiated from MSCs by transfecting miRNAs. For the fabrication of tissue-engineered islet construct, DEXGEL scaffolds were prepared. In order to enhance the insulin secretion and islet viability and function, the scaffolds were further modified with two extracellular matrix (ECM) proteins, laminin and collagen. Studies were carried out to check whether coating of the scaffolds with ECM proteins increased insulin secretion and viability of islets. The groups of fabricated scaffolds were: laminin-coated (L), collagen-coated (C), vitronectin-coated (V), laminin-collagen-vitronectin-coated (LCV) and control group (CO). After modification, water contact angle measurement was determined to check the hydrophilicity of the scaffold. The hydrophilicity increased for LCV group and decreased for collagen-coated group as compared to the control. Change in surface energy was also observed in correlation with the change in hydrophilicity.

To check the islet survival and function on conjugated scaffolds, islets of Langerhans from rat pancreas were isolated and seeded on the scaffolds. After five days, immunofluorescence analysis for the expression of insulin protein was carried out. It was found that all groups of scaffolds supported islet survival and expressed insulin protein.

Since pancreatic islets are highly vascularised, it was important to check if the scaffolds supported angiogenesis. For that, CAM assay on chick embryo

was carried out. After 7 days of incubation, scaffolds were retrieved and analysed for the penetration by blood vessels. Embedded sections of the scaffolds stained with H and E was used to visualise the penetration of blood vessels. It was observed that all groups of scaffolds supported angiogenesis and branching of blood vessels were analysed.

9. Bilayered 3D-printed scaffolds for osteochondral tissue-engineering

In this study, we devised an effective strategy of 3D printing for fabricating bioactive factors-loaded biphasic and integrated scaffolds for osteochondral tissue-engineering. Polycaprolactone (PCL) and a synthetic polymer were used along with bioactive factors (chondroitin sulphate and beta tricalcium phosphate (βTCP) for the upper cartilage and lower bone layers, respectively. Disc scaffolds of 8 x 2 mm were fabricated for in vitro cell culture. Osteochondrogenesis was evaluated in vitro initially by biochemical analysis and System C showed enhanced sGAG production, ALP activity and calcium content when compared to Systems A and B. Based on the comparative study, the System C was selected for implantation in rat models and bilayered scaffolds of dimension 1.5 x 1 mm for implantation purpose were fabricated. In vivo surgical procedure of rat osteochondral defect model and implantation of developed bilayered scaffolds into defects was underway (Figure 18).

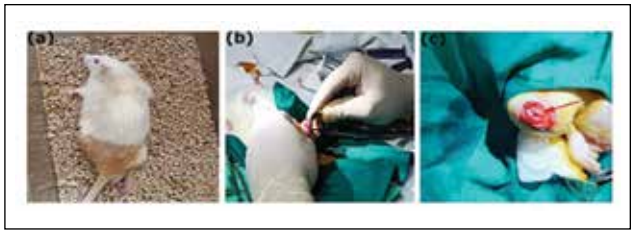


Figure 18. Surgical procedure for osteochondral defect creation and scaffold implantation (a) anesthetized male wistar rat (b) full-thickness critical size defect made in the medial femoral condyle (c) scaffold placed in position

10. Influence of the stiffness of carboxymethyl cellulose-based hydrogels on the encapsulation efficiency of chondrocytes

Substrate elasticity or stiffness can influence the phenotypic and functional characteristics of chondrocytes. Some of the major challenges in the development of an a hydrogel system for chondrocyte encapsulation has been the ease of preparation for non-invasive delivery intended for immediate use in surgical interventions and the maintenance of viability, stable phenotype and functionality of the chondrocytes that are encapsulated within the hydrogel environment. In this study, we aimed to evaluate the effect of the stiffness of methacrylated carboxymethyl cellulose-based hydrogels on the viability and functional characteristics of chondrocytes isolated from rabbit knee joint over a range of culture periods. Gels were prepared using 5 different ratios of carboxymethyl cellulose methacrylate (CMA) and polyethylene glycol diacrylate (PEGDA). The gels were found to be non-cytotoxic to the chondrocytes. Attachment assay and phalloidin staining was carried out to evaluate the attachment, spread and growth of chondrocytes in gels of different ratios corresponding to different stiffness modules assessed using AFM. The higher concentration of methacrylated carboxymethyl cellulose contributed to enhanced chondrocyte spread and proliferation.

Testing and Evaluation

Contact Angle Analysis Facility was extended for free on request to members of other labs on campus and external labs such as NIIST, IISER, IIST at TVM, NPOI and CUSAT, Cochin and NIT Calicut. Other free testing services provided to other labs on campus included inverted and upright fluorescence microscopes, lyophiliser, viscometer and Atomic Force Microscopy.

The samples received for various instruments are summarized in the Table below:

Instrument	Number
FTIR	32
Contact angle	96
Atomic Force Microscopy (AFM)	13
Microplate Reader (Synergy H1)	8
Microtome	5

Training/Outreach Programmes

Training for the staff of M/s Mallelil Industries Pvt. Ltd. for the preparation of nylon flocked swabs was completed in June 2020 (Figure 19).

Figure 19. Training and development for swab production at TIMed Facility

Awards and Honours

Dr Prabha D Nair was nominated as the subject expert of Biomaterials & Tissue Engineering in the setup of the Centre of Excellence in Biotechnology & Regenerative Medicine at Biochemistry Department of Sikkim Manipal Institute of Medical Sciences Tadong, Gangtok, Sikkim.

DIVISION OF THROMBOSIS RESEARCH

The Division of Thrombosis Research aims to uundertake high quality research, provide technical support for the product development activities of the Institute, develop blood-derived products and contribute significantly to the academic programmes. In research and development, our focus is 3D bioprinted skin tissue construct, combinational matrices and blood and blood-derived products. The Division is accredited with *COFRAC*, France, with more than 26 accredited tests for blood material interaction studies for medical devices and provides testing services for national and international medical device industries. We are working towards a 3D bioprinted skin construct, which can be used as a skin substitute as well as testing system for drugs/cosmetic. One new Project for stabilized blood control development as a quality control for the haemocompatibility testing was initiated.

Developmental Activities

1. Bioink Development

Bioink is the most critical component for bioprinting applications. We worked on different formulations and developed a novel Bioink formulation based on alginate-cellulose-gelatin and fibrinogen which was further optimised and characterised. Printability of the formulation was also assayed under different pressure conditions and flow rates. Rheological analysis showed shear thinning property which is a good indicator for bioprinting application. Printability was assayed by printing different patterns. This formulation was also analysed for its suitability in skin tissue- engineering (Figure 20).

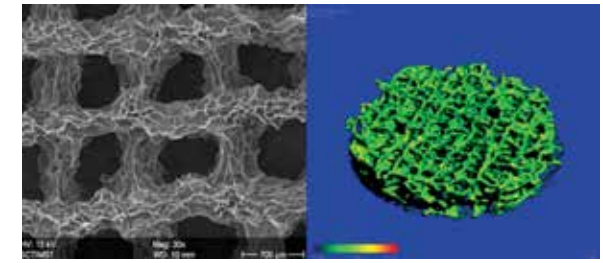


Figure 20. SEM and micro CT showing the porous hydrogel printed construct

2. Albumin and IVIG isolation from cryo-poor plasma

The technology for isolation of aqueous human albumin and IVIG from cryo-poor plasma was developed. Consistency batch evaluation of the technology was performed in our Class 10000 Small-Scale Plasma Fractionation Facility. The technology is ready to be transferred to industries.

3. Development of autologous PRP isolation device

A novel, cost-effective device capable of separating autologous platelet-rich plasma (PRP) from human blood was envisaged. A proof-of-concept design was developed and evaluated for the isolation of PRP. The device was modified based on the experimental results and the process of PRP isolation was optimized using the modified device. Experimental parameters were standardized for obtaining highly concentrated PRP by trying different speed and time combinations. The device was optimized to process a range of volume

(10-30cc) which is an achievement that no other commercially available PRP kits provide. The device design registration was approved and complete patent specification was filed (Figure 21).

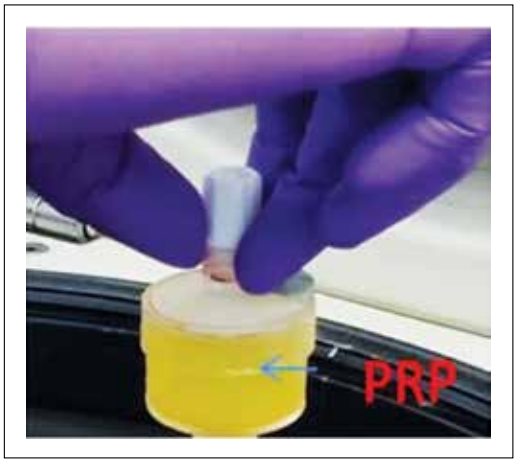


Figure 21. Autologous PRP isolation device

4. Prothrombin Time/International Normalized Ratio device development

The device was improved to meet the specification and accuracy requirements of the industrial partner. The working concept of the device was also modified and a simplified system was prototyped. Assays for different INR ranges were carried out and process parameters were optimised. Blood sample analyses in hospitals could not be taken up due to the current pandemic. The analyses and troubleshooting were ongoing simultaneously.

New Initiatives

1. Stabilized Blood Control

A new project was initiated under the TDF Scheme of the institute for developing indigenous techniques for stabilized blood control. Blood components were separated using centrifugation and individual components were fixed using different fixatives specific to the cell type like chromium chloride for white blood cells. Different methods and fixatives were tried. Studies were underway for the optimisation of fixative and stabilising agent for the individual blood components.

2. Platelet Adhesion Analysis

The Laboratory is trying to optimize a new method to analyze platelet adhesion on material using fluorescence. Standard curve was plotted for different concentrations of platelets tagged with fluorescence dye. The optimization of the method was ongoing.

3. The Division initiated Covid-related research for the development of the antigen and antibody detection assay.

Technology Transfer Activities

1. Prothrombin Time/International Normalized Ratio

The technology was transferred to Agappe Diagnostics Pvt. Ltd. in 2019. Training to the industry was completed in two batches in October 2020. Based on the suggestion of the industry partner, work was initiated to improve the sensitivity of the assay with good progress.

2. Curcumin-conjugated albumin

The technology for curcumin-conjugated human albumin was developed and transferred to EightOaks Bio Ltd., Kerala. As requested and funded by industry, a batch of curcumin-conjugated human albumin (SCTAC2010) was prepared in Class 10000 Facility of SCTIMST for further studies. Sterility of the prepared samples was established as per USP 41/NF 36, <71>. These samples were handed over to the to industry partner for further analysis and preclinical evaluation (Figure 22).

Figure 22. Curcumin-conjugated human albumin

3. Skin Regeneration Template

The Division developed two wound healing matrices as part of Wound Healing Projects funded by the Technical Research Centre. These products were ready to be transferred to industry and technology transfer documents were prepared. The Division was looking for industrial partners with the help of Technology Business Division to take up clinical trials for the wound healing matrices developed.

4. The Division also initiated the Viral Transport Media development programme, which was transferred to two industries and is commercially available at present.

Research Programmes

1. 3D Bioprintined dual layer skin tissue constructs

Fibroblast and keratinocytes were printed into an eight layer construct in 1:3 ratio. The cells were cultured up to 28 days and cell viability, skin structure and histological analyses were carried out. Culture conditions for dual skin construct and methodology for RNA extraction and gene expression analysis were optimised. Collagen, CK14 and CK 5 were analysed in the construct at different time points. Our results showed a viable construct which histologically resembled skin and expressed skin markers. IAEC approval was obtained for further in vivo studies.

2. Antigen detection kit for SARS-CoV-2

During the initial phases of pandemic, an early detection and diagnosis of SARS-CoV-2 was primary concern and RT-PCR was only available option. The Division had taken up antigen detection kit development activity for SARS-CoV-2 virus. Lateral flow-based and ELISA-based methods were developed for the detection of the antigen. However, sensitivity of the assay was below 90%. Simultaneously, we also worked on the SARS-CoV-2 antibody (IgG and IgM) level detection in serum for screening of the infected population. The kit was developed and validated, but IgM detection was not sensitive, may be due to the time point of sample collection. To increase the sensitivity of the assay, a buffer preparation was optimised.

Testing and Evaluation

1. Various COFRAC accredited and non-accredited tests were performed to evaluate materials/ components used for devices that come in contact with blood for various investigators as part of TRC Programmes. Haemolysis and coagulation tests were performed in sheep blood for the Left Ventricular Assisted Device Programme of the institute.
2. During the year, a total of 383 samples were tested under different categories and 53 test reports were issued. Several internal and external patient samples were tested for platelet functions as special service.
3. **Blood Bag Study**

   Commercial blood bag manufacturer, HLL Life Care Ltd. submitted 20 bags for storage analysis of whole blood. 35 tests were performed for different storage time periods and report was issued to the customer. Post-transfusion survival of RCC concentrate at various time points was also studied for HLL Life Care Ltd.. 35 animals were used for 7 time point studies, 70 tests were performed and the compiled report was issued to the customer.
4. The Division supported the quality control programme of the Institute's Blood Bank by testing components such as cryoprecipitate for factor VIII, fibrinogen and platelet-rich plasma for aggregatory response.
5. The Laboratory participated in Inter-laboratory comparison with an accredited laboratory for the year 2021.

Academic Activities

Faculty of the Division were involved in classroom teaching for academic activities of the institute like M Tech and M Phil Programmes and training programmes conducted by Training Cell of the institute.

Four students of the Division Were awarded PhD degree and one was awarded M Phil during the year.

Training/Outreach Programmes

Dr Anugya Bhatt was the Resource person in UGC Human Resource Development Centre, Guru Ghasidas Vishwavidhyalaya, Chattisgarh, for the Refreshing Course Winter School on Novel insight in Life Sciences research in online mode from 15- 27 February 2021.

Events Organized

Dr Anugya Bhatt conducted a Workshop in Basics of Flow Cytometry for Jiwaji University, Gwalior, in virtual mode on 20 January 2021.

DIVISION OF TOXICOLOGY

The Division is a premier laboratory in the country in the field of biomaterial toxicology and is accredited by COFRAC France as per ISO 17025. The Division has full-fledged facilities for the pre-clinical safety and toxicity evaluation of various materials and medical devices as per International Standards such as ISO, USP and ASTM. The toxicological studies are an integral and indispensible part of development of medical device technology. The main aims of the Division are: toxicity/biocompatibility evaluation of materials, medical devices, tissue-engineered products intended for the fabrication of medical products and investigation of potential safety/biological hazards of nanomaterials used for health care applications.

Developmental Activities

1. Validation of a kit for the evaluation of pyrogenicity and a methodology for preparing the same.
2. A composite sponge for haemostatic and wound healing applications.

New Initiatives

1. Development of "Human-on-a-Chip" device, an initiative supported by the Department of Science and Technology, Government of India.
2. Development of "Anti-microbial peptide-loaded multifunctional 3D collagen scaffold for vascularised bone tissue regeneration" is a new initiative under Indian-Japan Co-operative Science and Technology Programme (IJCSP), Government of India.
3. Multi-organ-on-a-chip with radial fluidic channel for biological evaluation supported by the Department of Science and Technology, Government of India.

Research Programmes

1. Development of 'Human-on-a-Chip' technology: A paradigm shift in biological evaluation and disease model

The 'human-on-a-chip' is a microfluidics system for living cells culturing in continuously perfused, micrometer-sized chambers in order to model physiological functions of tissue and organs. This technology aims to combine several organ equivalents within a human-like metabolizing environment or in vivo-like environment. The expected outcome will be to develop an indigenous human-on-a-chip device for the pre-clinical toxicity/safety evaluations and disease modelling.

2. Anti-microbial peptide loaded multifunctional 3D collagen scaffold for vascularized bone tissue regeneration

Development of a functional 3D collagen scaffold with antimicrobial activity and improved bioactivity that enhances not only osteogenesis/bone regeneration, but also neovascularisation in a bone defect model. This was achieved by the sustained release of LL37 in the vicinity of porous surfaces on the scaffold that will prevent bacterial infection and enhance bone regeneration and neovascularisation.

Testing and Evaluation

The details of samples tested are summarized in the Table below:

Test	Number
Samples received for testing/studies	83
Reports released	80
Accredited test reports	59
Non-Accredited test reports	24
Accredited tests:	49
Maximization test for delayed hypersensitivity	*12*
Animal intracutaneous reactivity test	*6*
Acute systemic toxicity test - Intravenous	*13*
Acute systemic toxicity test - Intraperitoneal	*12*
Pyrogen test	*1*
Muscle implantation	*5*
Subcutaneous implantation	*1*
Bone implantation	*4*
Animal irritation	*1*
Haemolysis	*2*
Details of Collaborative work:	
Physico-Chemical analysis of potable water	*16*
Inhalation toxicity	*1*
Haematology analysis	*68 samples in 3 work orders*
Biochemical analysis	*68 samples in 3 work orders*
In vitro pyrogen test – LAL test	*2*
In vitro genotoxicity	*1*
Wound healing assay	*1*
Air sanitizer evaluation	*1*
Acute oral toxicity	*1*
Sub chronic toxicity - muscle implantation	*1*

Quality system-related activities:

- Actively participated in the quality system improvement activities
- Successfully completed the COFRAC, France inspection without any noncompliance/ observations
- α8 accredited work procedures revised/ reviewed
- α72 non-accredited work procedures revised/ reviewed
- α2 Corrective and preventive actions generated and closed

Events Organized

1. The Division organized the International webinar series on 'Food, chemicals and nanomaterials toxicity' jointly with Central University of Kerala, Kasargod, Kerala in virtual mode from 26-28 November 2020. About 420 delegates participated in the webinar.
2. The Division organized the 40th Annual Conference of Society of Toxicology, India and International Webinar on 'Pharmacology and Toxicology', jointly with PGIMER, Chandigarh, and NIPPER, Mohali, from 29-30 January 2021.

Awards and Honours

1. Dr P V Mohanan was nominated as a Member in the Empowered Committee on the 'Rapid Response Regulatory Framework for COVID-19 to deal with applications for development of vaccines, diagnostics, prophylactics and therapeutics' under the Department of Biotechnology, Government of India.
2. Dr P V Mohanan was nominated as an Expert in the Review Committee on Genetic Manipulation, Department of Biotechnology, Government of India.
3. Dr P V Mohanan was nominated as an Expert in the Scheme for Young Scientists and Technologists (SYST), Department of Science and Technology, Government of India.

4. Dr P V Mohanan was nominated as an Expert in the Committee on Technology Interventions for Addressing Societal Needs (TIASN), Department of Science and Technology, Government of India.

5. Dr P V Mohanan was nominated as a Member in the Scientific Panel on Food Additives, Flavorings, processing aids and materials in contact with food. Food Safety and Standards Authority of India (FSSAI), Government of India.

6. Ms Ashtami Jayakumar, PhD Scholar was awarded the prestigious Fulbright-Nehru Doctoral Research Fellowship (FNDR Fellowship 2020) by the United States-India Educational Foundation, Fulbright Commission in India, New Delhi. The programme is envisaged for a period of 6 months at University of Houston, USA, under the mentorship of Prof Chandra Mohan.

7. Ms Athira S S, PhD Scholar, was awarded the prestigious SERB - Overseas Visiting Doctoral Fellowship for a period of one year at Purdue University, USA, under the mentorship of Prof Freeman Jennifer.

8. Ms Anju S won the Best Oral Presentation Award for the research paper entitled "Tungsten disulphide Quantum Dots mediated cellular responses in glioblastoma cell lines" at the 40th Annual Conference of Society of Toxicology, India and International Webinar on 'Pharmacology and Toxicology' from 29-30 January 2021.

9. Ms Prajitha N won the Best Poster Presentation Award for the research paper entitled "Cytotoxic potential of lipopolysacharide, lipoteichoic acid, phytohemagglutinin and 2,4,6-trinitrophenol using human monocytic leukemia cells" at the 40th Annual Conference of Society of Toxicology, India and International Webinar on 'Pharmacology and Toxicology' from 29-30 January 2021.

DIVISION OF IN VIVO MODELS AND TESTING

The primary objective of the Division is to support medical devices development at the Institute and in the country by deploying animal models, by conducting 'proof-of- concept' and preclinical animal evaluation of medical devices and biomaterials. In addition, the Division is involved in the development of tissue-based medical devices. To achieve the above objectives, the Division focuses on conduct of preclinical animal evaluation of medical devices and biomaterials using physiologically normal animals or disease-induced animal models under GLP compliant documentation. This is accomplished in either large animal or small animal models simulating actual clinical use in human patients for assessing its functional safety and performance. To achieve this objective, the Division is equipped with qualified and trained staff, infrastructure such as well-equipped operation theatre, catheterisation OT, clinical laboratory, research laboratory, acute care rooms, animal preparation/explantation rooms and CPCSEA-registered large animal house which provides healthy, traceable large experimental animals such as pigs and sheep. The Division is running Projects and guiding PhD students to achieve the research objectives.

Developmental Activities

The Division is actively involved in the TRC-funded Project 'Development of bioprosthetic heart valve'. As part of this, the major achievement made during the year is implantation of an improved prototype bioprosthetic heart valve in sheep model (Figure 23). The animal had completed more than 2 months and was thriving well without any adverse clinical effects. Two heart valve models were developed in this project and both completed in vitro steady flow and reverse flow tests. Accelerated durability testing of both these models was initiated. Test valves of external mounted design were prepared in 'clean room' and were ready for animal implantation. GMP Tissue Harvesting Facility for Medical Devices at MPI Ltd., Edayar, Koothattukulam, established as part of this project supplied 17 batches (12 pericardia per batch) biomedical quality bovine pericardium.

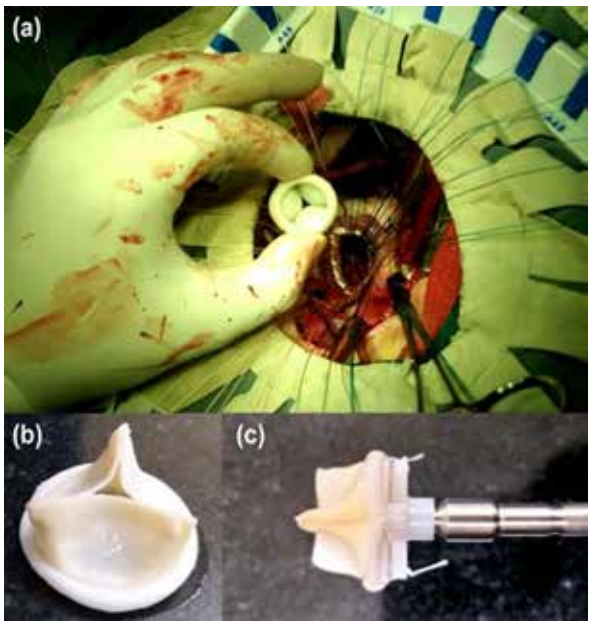


Figure 23. (a) Implantation of the improved prototype of externally mounted bioprosthetic heart valve in sheep (b) Bioprosthetic heart valve (external mounted design) (c) Valve attached to dedicated holder

New Initiatives

A TDF Project for improving the scope of application of decellularised porcine pericardium by enhancing its mechanical strength was sanctioned this year. Under this project, the methodology of a non-enzyme-based decellularisation was identified. Experiments to improve the mechanical strength of this material by impregnation and in situ precipitation of silk fibroin were underway. If successful, porcine pericardium which is naturally very thin (0.12 to 0.17mm) may find good application in paediatric cardiac surgery.

Research Programmes

1. ***Development of bioprosthetic heart valve***

   In this TRC Project, research was undertaken to develop a method for dry sterilization of bioprosthetic heart valve using ethylene oxide. Procedure for dry preservation such as sequential dehydration and preservation by glycerolization was studied. The moisture level of glycerolized valves was brought down to 0.45 ±0.09%. Studies were ongoing to bring down the moisture level further, to qualify it for ethylene oxide sterilization. The glycerolized valve could be rapidly hydrated to implantable state in less than a minute.

2. In the TDF project for improving the scope of application of decellularised porcine pericardium by enhancing its mechanical strength, biomedical quality porcine pericardium was sourced. The method of silk fibroin-gelatin impregnation for enhancing mechanical strength of liver scaffolds was utilized for this work.

3. The study entitled "Alginate dialdehyde-Gelatin as a post-surgical adhesion prevention material in thoracic surgery – A proof-of-concept study in swine models", involves developing alginate dialdehyde-gelatine hydrogel sheets and exploring its application as a surgical adhesion barrier material for thoracic surgery procedures. The processes for material preparation were ongoing and ethical committee approval for the large animal from CPCSEA was awaited.

Testing and Evaluation

During the year, several large animal studies were conducted for external and internal customers:

1. Dialysis cartridge evaluation in sheep model for industry.
2. Studies on bioprosthetic valve prototypes in sheep model
3. Evaluation of warp knitted polyester for mitral valve reconstruction in sheep model
4. Evaluation of neuroemboli in pig model
5. Evaluation of blood pump in sheep model

   Blood pump was tested in sheep model for 6 hours during standard cardiopulmonary bypass as part of TRC Project. The animals were observed for 72 hours for any adverse events, followed by detailed autopsy. The purpose of the experiment was to assess blood damage, activation of

coagulation and complement, pump thrombosis and thromboembolic incidents and device-related morbidity and mortality.

6. Animal implantation and explantation procedures were performed for the ongoing study titled "Development and evaluation of radiopaque liquid embolization device by chemical grafting of iodinated compounds onto the ethylene vinyl alcohol copolymer – Preclinical evaluation in swine model".

Staff

Faculty

Dr A Maya Nandkumar, Scientist G and Head of the Department

Dr Prabha D Nair, Scientist G (Senior Grade)

Dr Mohanan P V, Scientist G

Dr Anoopkumar Thekkuveetil, Scientist G

Dr T V Anilkumar, Scientist G

Dr P R Umashankar, Scientist G

Dr Sachin J Shenoy, Scientist F

Dr Kamalesh K Gulia, Scientist F

Dr A Sabareeswaran, Scientist F

Dr Anil Kumar P R, Scientist F

Dr Anugya Bhatt, Scientist F

Dr V S Harikrishnan, Scientist E

Dr Lynda V Thomas, Scientist D

Dr Remya N S, Scientist C

Dr Naresh Kasoju, Scientist C

Dr Renjith P Nair, Scientist C

Technical

Mrs Usha Vasudev, Scientific Officer (Lab)

Mr Anil Kumar V, Scientific Officer

Mr Pradeep Kumar S S, Junior Scientific Officer

Dr Geetha C S, Junior Scientific Officer

Mr Joseph Sebastian, Scientific Assistant

Ms Priyanka A, Technical Assistant - B (Lab)

Mrs Deepa K Raj, Technical Assistant - B (Lab)

Ms Sreeja K R, Technical Assistant

Mr Vinod D, Technical Assistant - B (Lab)

Mr Sarath Kumar R S, Technical Assistant Animal Lab -B

Mr Ranjith S, Technical Assistant

Ms Smitha P, Technical Assistant (Anaesthesia) - A

Mr Prem Mohan M, Technical Assistant (Lab) - A

Ms Vandana Unnikrishnan, Technical Assistant (Lab) - A

Mr Vishwanatham Naik, Technical Assistant

Mr Shaji S, Animal Care Taker

Mr Manoj M, Animal Handler - B

Mr Sunil Kumar M, Animal Handler - B

Mr Harikumar G, Animal Handler

Mr Sudheesan D, Unit Assistant (from 01-06-2020 onwards)

Ms Sajeev S, Unit Assistant (Till 30-05-2020)

Mr Biju V, Laboratory Animal Care Taker - A

Mr Manoj Kumar K, Laboratory Animal Care Taker - A

Mr Sunil L, Animal Handler - A

Mr Pradeep Kumar B, Animal Handler - B

DEPARTMENT OF BIOMATERIALS SCIENCE AND TECHNOLOGY

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

The Department of Biomaterials Science and Technology was instituted with a vision of being a Centre in the country for the synthesis and evaluation of biomaterials for various biomedical applications.

The Department of Biomaterials Science and Technology comprises the Divisions of:

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

DIVISION OF BIOCERAMICS

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

Developmental Activities

1. Development of automated platform for the industrial scale production of ceramic matrices

This platform allows the sequential dropping of ceramic slurry from a programmed dispenser system over a super-hydrophobic bed to make bead-like porous matrix structure (Figure 24).

The droppings, after drying and high-temperature sintering, could be used for bone defect filling and for local drug delivery in bone. Automated production avoids manual errors and provides for large scale production of matrices in desired sizes. Drug elution modelling for extended release periods was completed verifying the presence and activity of released moieties.

Figure 24. View of the automated dispenser system for production of ceramic matrices

New Initiatives

1. Bioceramic grafts with axially aligned pores

Conventional bioceramic grafts used in bone defect management, serve as scaffolds, helping in natural bone healing. However, in some situations faster healing and quicker site strengthening are needed, like intervertebral fusion and long bone fracture non-union. This can be achieved only if pores are introduced in the graft with sufficient pore space for the vasculature and flow of biological factors and nutrients, so that new bone formation can occur inside the graft.

In order to achieve this, special structural design of grafts were prepared using hydroxyapatite ceramics with axially aligned open channels in the graft piece (Figure 25). It was possible to create bioactive ceramic cylinders with 250 to 800 micrometer sized channels using slip casting route. If bone marrow is grafted, it will allow the local cells, factors and nutrients to penetrate into the central part of the graft which in turn will lead to vascularisation and formation of new bone throughout the graft through the space available in the channels.

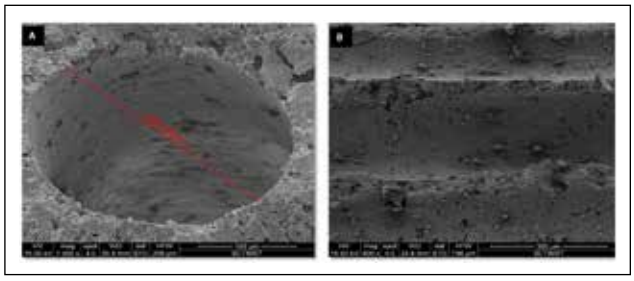


Figure 25. Bioceramic graft with aligned pore structure (A) Open end of a 250 micron pore (B) cross section of the graft

Technology Transfer Activities

1. Bone graft products based on tricalcium phosphate and hydroxyapatite ceramics were manufactured by M/s Onyx Medicals, Meerut, UP, based on the technology from the Division. The initial production batches in the trade name "FracLink" were evaluated to obtain test license (Figure 26).
2. The technology training for the production of bioactive ceramic composite and bioactive cement, subsequent to the technology transfer to M/s Prevest DenPro, Jammu, was underway.
3. Discussions were ongoing with M/s Onyx Medicals, Meerut, UP, regarding other bioceramic-based technologies. A Letter of Interest for the product "Bioactive Glass Composite HABG" developed in the Division was received.

Research Programmes

1. Degradable functionalized chitosan membranes containing nano-calcium phosphate

Water soluble chitosan was synthesized by adding a quaternary ammonium moiety into the chitosan backbone, calcium and phosphate ions in solution

Figure 26. The bone graft products based on tricalcium phosphate and hydroxyapatite ceramics

phase in super-saturation concentrations. Porous membranes from this solution were created by freeze-drying and treated with ammonia when nano-particulate calcium phosphate precipitated inside the material homogeneously. The degradable chitosan porous membrane with embedded calcium phosphate nano-particle will be useful for guided tissue regeneration of bone defects.

2. Bioactive endodontic cements containing silicates of calcium and strontium

New hydraulic calcium silicate-based endodontic cement was developed as an alternative which avoids harmful heavy elements. Different hydraulic setting formulations were synthesized using dicalcium silicate (Ca2SiO4) and/or tricalcium silicate (Ca3SiO5), with at least 40 wt% strontium orthosilicate (Sr2SiO4) for radio-contrast. The formulations were optimized with respect to density, water absorption, compressive strength, flexural strength, microhardness and dentinal marginal adaptation and radio-opacity. In vitro bioactivity, haemocompatibility and antimicrobial studies were done on the cement formulations.

The strontium orthosilicate-tricalcium silicate (40:60) composition exhibited superior results with respect to density, setting time, compressive strength, flexural strength and micro-hardness. The bioactivity of different compositions of cements was

established from their ability to form apatite layers after immersing them in simulated body fluid. The formulations were alkaline in nature with promising antimicrobial characteristics. Cytocompatibility studies, both qualitative and quantitative, proved the biocompatibility of the three formulations studied (Figure 27).

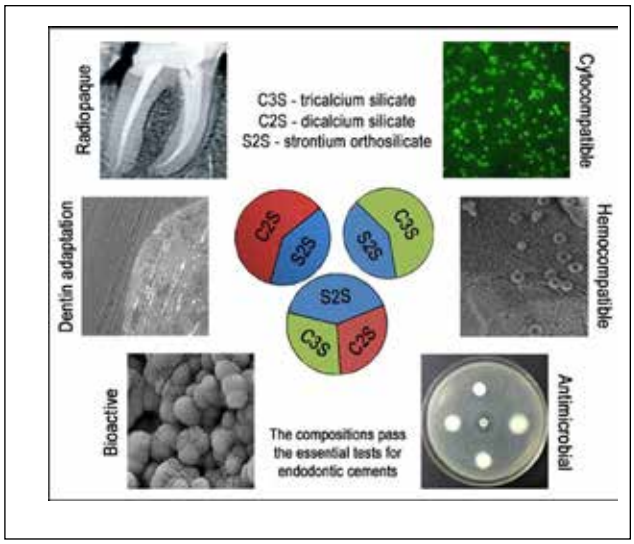


Figure 27. Design of endodontic cements containing silicates of calcium and strontium and their salient features

3. In vivo evaluation of bioactive cements as barrier grafts for periodontal regeneration

A bioactive calcium sulfate (BioCaS) self-setting cement was developed in an earlier project as a candidate for the alveolar bone graft substitute. The in vivo preclinical usage test was done in a rat maxillary alveolar bone defect model. On implantation, bilateral maxillary alveolar bone defects were created buccal to the first molars, using surgical micro motor hand piece. Approximately 2mm of alveolar bone surrounding the tooth root was removed and the cement was placed. The bone defects without the cements were considered as the sham control. At the end 1 month, the animals were euthanized the implanted area was harvested and embedded in clear Poly Methyl Methacrylate (PMMA). They were sectioned using a hard tissue microtome (Struers Accutome 100) to get sections of 100μm thickness.

The sections were stained with van Gieson for bone and Stevenel's blue for osteoblasts. The histopathology evaluation showed evidence of new bone formation when compared to the sham control (Figure 28). The presence of remnants of BioCaS cement particles was noted, with new bone formation evident at the cement interface. Cement resorption was also noted, and it was found to be at par with the new bone formation. The results confirmed the in vivo osteoinductivity of the cements.

Testing and Evaluation

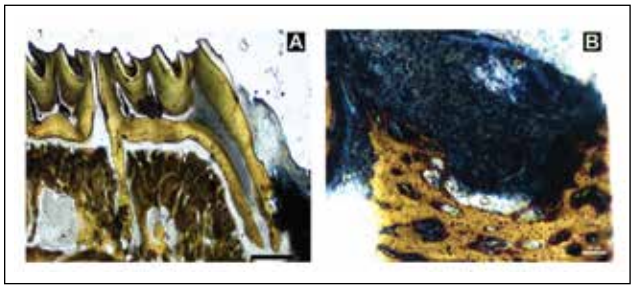


Figure 28. Histopathological results of the bioactive cement implanted in rat maxillary bone defects after 1 month (A) the region without any adverse event (B) new bone formation at the cement interface

The Division provided the following testing services for materials characterization:

- X-Ray Diffractmetry
- Microhardness testing
- Infrared spectrometry
- Elemental analysis using AES-ICP

Awards and Honours

1. Dr Eva C Das, PhD Scholar, won the Best Poster Award for the work entitled "Investigation of osteogenic potential of periodontal ligament cells on phosphate incorporated calcium sulfate cement - An in vitro study" at the National Conference on Recent Trends in Materials Science and Technology (NCMST-2020) jointly organized in virtual mode by the Indian Institute of Space Science Technology, Trivandrum, and the Society for Polymer Science India, Trivandrum Chapter from 7-9 December 2020.
2. Mr Nishad K V, Scientific Assistant (Instruments) received the PhD from NIT, Calicut.

DIVISION OF BIOPHOTONICS AND IMAGING

The main objective of the Division is to conduct high standard research in the field of nanomaterials for bio-nanophotonics applications. The key areas of our research include development and application of biomaterials, optical imaging, photodynamic and photothermal therapy and development of different sensor platforms for the detection of biomarkers. We also work on different spectroscopic techniques and spectral mapping and imaging for early diagnosis of various diseases and classification and discrimination of different pathologies using these techniques. The Division is also working towards the development of technologies related to the above fields for their biomedical application. These research programmes are based on the concept that optical pathology will be practical in the near future. The Division is committed to train students in the above fields, with international standards and strive to publish the outcomes in platforms of international repute.

Developmental Activities

In order to realize a robust and user-friendly circulating tumor cell (CTC) isolation platform that can be readily adapted to clinical settings, we have developed a custom-designed portable centrifugal prototype-based lab-on-a-filter CTC detection system for the rapid isolation of CTCs with high purity. The centrifugal prototype comprises of three independent chambers for whole blood sample loading, CTC filtration, and waste residual blood storage. The lab-on-a-filter platform utilizes centrifugal force to rapidly transfer unprocessed whole blood samples from one of the centrifugal prototype chambers to another (Figure 29).

Compared with the commercially available CTC detection system, the lab-on-a-filter system can offer more effective fluid control because it does not require external interconnectors. Instead, only a simple centrifuge is needed to actuate the fluid flow. Such advantages of the lab-on-a-filter system allow for a reduction in the manual handling steps between the filtration, staining and detection processes. To selectively isolate CTCs based on size differences between CTCs and the surrounding hematologic cells, we have integrated a track-etched polycarbonate (PC) membrane filter on the system.

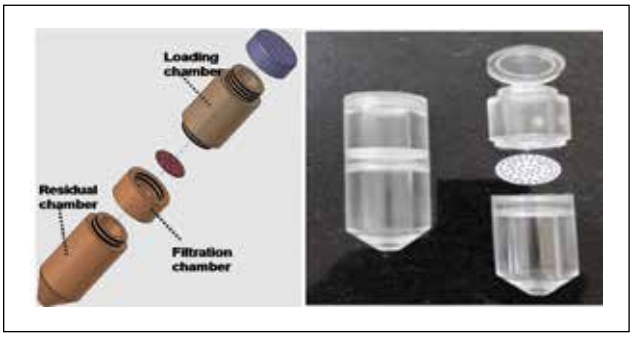


Figure 29. Design of the CTC filter (left) and the developed acrylic filter with different chambers (right)

New Initiatives

1. A new project entitled "An easy and rapid detection platform for viral diseases from saliva: COVID-19 and beyond" (Funded by: SERB, DST, PI: Dr Jayasree R S) was initiated. This project aims to detect the presence of the SARS-CoV-2 virus in saliva samples along with providing relevant information about the clinical progression of the disease. Recent studies have shown that saliva testing offers a greater sensitivity than nasopharyngeal swab testing. In this proposal, we intend to utilize the lateral flow assay to detect presence of the virus in salivary samples. While most of the detection tests rely on upper or lower respiratory tract swabs from the posterior pharyngeal wall, nasal middle turbinate mucosa, bronchial washings and lung tissue, we aim to detect the virus through customized aptamer-immobilized gold nanoparticles that will show variation in the colour gradient when the virus attaches to it. This change in colour can be easily detected by the unaided eye.

Research Programmes

1. Blood-brain-barrier permeable nanocarriers for diagnosis and therapy of neurodegenerative diseases

The aim of this project is to design potent therapeutic agents that cross the BBB, that will facilitate better treatment for neurodegenerative diseases.

The work focuses on a theranostics move towards Alzheimer's disease, which is one of the most common neurodegenerative diseases affecting the aged population. As part of this project, we have developed an in vitro model for Alzheimer's disease and studied the effect of nanoclusters on insoluble protein fibres called amyloid fibrils which are responsible for neural cell toxicity (Figure 30).

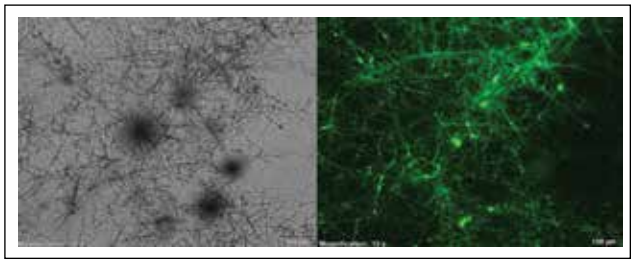


Figure 30. Microscopic images of Alzheimer's disease model showing amyloid fibril formation

2. Ultrasensitive surface for the detection of biomarkers of Alzheimer's disease

Ultrasensitive surface for the detection of biomarkers of Alzheimer's disease (AD) was developed using Surface Enhanced Optical Spectroscopy (SES). AD biomarkers can be used to identify the occurrence and development of the disease. The fingerprint characteristics and band intensities in SES spectra were used to identify different AD biomarkers like amyloid-beta and Tau with excellent sensitivity and selectivity.

3. Magneto-Optic sensor for cardiac biomarker detection under the India-Japan collaboration

The objectives of the project are: (i) Synthesis of a novel hybrid anisotropic magneto-optic nano system, (ii) Design and tuning of the properties of this hybrid system for cardiac biomarker sensing and (iii) Design a marketable device for the diagnosis of CVD, based on this concept. The project had two phases. In the first stage, the project looked into the synthesis and functionalization of hybrid nanosystem and highly armed gold nanostars with absorption above 600 nm. The gold surface was decorated with iron oxide nanoparticle by suitable ligand chemistry with the surface of iron oxide functionalized with antibody/ aptamer specific to troponin I and myoglobin. Characterization and optimization of functionalized nanostars were completed. During the first phase, Dr Jayasree R S and Ms Resmi V Nair visited RIKEN, Japan

4. An ultrasensitive sensor platform for the detection of CTC

This completed project focused on the development of an ultrasensitive sensor platform for the detection of circulating tumour cells. CTC capturing from cultured cells was done as a proof-of-concept. A centrifugal prototype was developed as part of this project for the efficient separation of cancer cells present in the blood stream. The developed prototype had provision for blood collection, removable filter holder and cavity to collect the residual blood. We also identified the filter material best suited for CTC detection.

5. Development of peptide stabilized fluorescent gold nanoclusters for bioimaging

Different fluorescent tripeptide-stabilized gold nanoclusters were designed and developed for simultaneous cancer imaging and therapy. The image-guided PDT efficiency of tripeptide-gold nanoclusters was confirmed in vitro. Fluorescent nano gene downregulator for simultaneous cancer imaging cum siRNA-based cancer therapy was also performed using a different oligopeptide gold cluster.

6. Characterizing and classifying molecular variations within biological samples using chemometric analyses

These studies are useful for determining the fundamental mechanisms of biological processes. Vibrational spectroscopy (IR and Raman), which is currently emerging as an important tool for biomedical research was used as the input data for these multivariate analyses.

7. Other major works in the Division were linked to the doctoral work of the students - mainly on the development of materials and devices for biophotonics applications in the field of sensing, imaging, diagnosis and therapy. Studies on basic biological interaction of nanomaterials in vitro and in vivo using various materials were also ongoing. The other area of interest was development of nanoparticle-based siRNA delivery vehicle for effective gene regulation in cancer.

Awards and Honours

1. Dr Jayasree R S was elected as the Fellow of Academy of Sciences, Chennai.
2. Dr Jayasree R S served as the Expert Committee Member of SUPRA and WOMEN POWER Schemes and Member of TETRA AWARD selection Committee of DST-SERB, Government of India.
3. Dr Jayasree R S was awarded the certificate of 'Good Clinical Practice' by the National Drug Abuse Treatment Clinical Trials Network. This was required to be a Member of the Human Ethics Committee of RCC, Trivandrum.

DIVISION OF BIOSURFACE TECHNOLOGY

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

Developmental Activities

Wound Dressing

As part of developing advance wound care biomaterials for treating chronic wounds, chitosan-based sponges were developed and evaluated. The technology was ready for transfer.

New Initiatives

1. Gellan gum-based advanced wound care biomaterials
2. Hemostatic wound dressings
3. Chitosan scaffold-based localized delivery of therapeutic molecules
4. Cell/tissue interaction with wound healing biomaterials and modulation of microenvironment for better wound healing

Technology Transfer Activities

Cologenesis Healthcare Pvt. Ltd. has expressed an interest in taking the technology for chitosan-based sponges developed as part of the Wound dressing project.

Research Programmes

1. Wound Dressing

Biopolymers have a wide application in wound management. However, due to the poor mechanical strength and fast degradability its potential is limited. A major example is that of alginate which has significant role in chronic wound management. Though alginate dressings are commercially available, the limitations associated with it are poor mechanical strength and deposition of alginate fibres in the wound bed initiating inflammatory reaction. We have developed alginate-grafted methacrylate-based xerogels for wound healing application. Various types of alginate-g-polymethacrylate xerogels were developed and physico-chemical characterization was performed. Besides evaluating these matrices for local delivery of various therapeutic molecules, we also investigated the wound healing effect of divalent cations such as strontium.

2. Gene Delivery

Gene therapy is found to be a promising strategy for treating cancer as it uses genetic materials as pharmaceutical agents. However, the lack of ideal gene delivery systems limits its application as a treatment modality. Our group have developed various haemocompatible polymers for gene delivery applications. Graft copolymers bearing cationic groups as well as thiol redox sensitive polymers were developed for this application. The nanoplexes formed by these polymer derivatives were less than 150nm in size, capable of forming stable complexes with DNA and protected DNA from degradation by DNase. These derivatives were cytocompatible and exhibited about 80% cell viability in C6 glioma, HeLa and L929 cell lines. Good cellular uptake was observed and polymer trafficking studies indicated that vector unpacking

occurred in the cytoplasm as DNA alone entered the nucleus. Immunostaining studies confirmed the expression of the p53 gene in various cancer cells. The efficacy was established in mice tumor model which demonstrated that p53 nanoplex reduced the tumor size when injected into the tumor.

Training/Outreach Programmes

Dr Rekha M R was the resource person and delivered a talk on "Drug Delivery Systems" in a TEQIP III sponsored seminar on "Advance Biomaterials for Biomedical Applications" jointly organized by our Institute and the Department of Medical Electronics, BMSCE, Bangalore from 17-22 March 2021.

DIVISION OF DENTAL PRODUCTS

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

Developmental Activities

1. Development of bio-active, radiopaque, non-cytotoxic, bone cement-based on a novel in-situ polymerizable oligomer for orthopaedic applications.
2. The technology for using 3D bio-printed liver as an in vitro toxicity model for drug screening was developed and further studies were underway in collaboration with Vipragen Mysuru Pvt. Ltd. A NDA was signed with Vipragen Mysuru and MoU was under process.
3. Development of Shell nacre-integrated bioactive composite materials for bone defect treatment was ongoing as part of ICMR project.
4. Optimisation of Dentactive using photoinitiators which can cure the product at 430-490nm wavelength region, its validation, documentation and TT activities were initiated as per the request from the industry (ASPR Chennai). 3 batches (20 g each) of the test material were issued to the industry for evaluation.
5. The mechanical properties of the Glass-Ionomer Cement (GIC) was improved. Prime Dental Product Pvt. Ltd., Maharashtra, was interested to collaborate in development of the improved GIC.

New Initiatives

1. Indigenous bone graft expander for Masquelet Induced Membrane Technique 2020-2022 (Funded by: TDF, SCTIMST, PI: Dr Lizymol P P).

2. ***Micro-needles Technology***

   A MoU to fabricate micro-needles on a scalable basis was under process with Central Manufacturing Technology Institute, (CMTI), Bangalore (PI: Dr Shiny Velayudhan).

3. The technology for Bioink was ready for transfer. The documents for floating Expression of Interest were handed over to Technology Business Division (PI: Dr Shiny Velayudhan).
4. Saliva absorption pad using biodegradable superabsorbent sponge (PI: Dr Manju).
5. Plasticizer-free acrylic denture softliners (PI: Dr Manju).
6. Mucoadhesive bandages for oral drug delivery application (PI: Dr Manju).

Technology Transfer Activities

1. ***Chitra AcryloSorb Respiratory Secretion Solidification System***

   Disposal of respiratory secretions of patients suffering from highly contagious diseases such as COVID-19, tuberculosis and influenza, poses high risk of infection among healthcare workers. The Chitra AcryloSorb canister liner bags (Figure 31) are highly effective for the safe management of infected respiratory secretions in hospitals. They can absorb 500 mL of fluid secretions and solidify it immediately. In addition, the whole system will

be decontaminated within no time because of the presence of disinfectant. Solidification and immediate disinfection occurring inside these bags eliminates the risk of secondary infections by avoiding spillage, and aerosol formation, thereby protecting healthcare workers and promoting safe work place management.

The know-how of the technology was transferred to Romsons Scientific and Surgical Pvt. Ltd., Uttar Pradesh and MoU was signed on 25 August 2020. Chitra AcryloSorb canister liner bags are presently available in the market.

2. ***Swabs along with Universal Transport Medium***

The technology for oropharyngeal and nasopharyngeal swabs along with Universal Transport Medium (UTM) for testing COVID-19 were transferred to Origin Diagnostics and Research, Karunagappalli, Kerala and Levram Life Sciences Pvt. Ltd., Mumbai.

3. ***Liver-specific bioinks***

Bioinks are polymeric hydrogels that are used to construct living tissues/organs in 3D Bioprinter. We developed liver-specific bioinks for printing functional liver. The technology invited interest from many industries (both national and international) and the formalities for floating Expression of Interest were underway.

4. ***3D bioprinted functional liver construct for hepatotoxicity testing***

This is an in vitro platform for screening drug toxicity. This technology will reduce animal experiments for drug toxicity and will aid in developing better drugs. A MoU with Vipragen Mysuru Pvt. Ltd. was under process to take up the validation studies.

5. ***Polymeric microneedles for vaccine delivery***

The prototype wass ready and animal studies had to be initiated. A MoU with CMTI, Bangalore, was under process to scale up this technology.

Figure 31. Chitra AcryloSorb canister liner bags

Research Programmes

1. ***Development of Shell nacre for bone substitute applications***

Shell nacre/mother of pearl is inner nacreous layer of the shell, which is made up of calcium carbonate crystals in aragonite form with organic layer inter-tiled between them in brick and mortar fashion. It is osteogenic, radiopaque, bioactive and osteoconductive. Shell nacre powder was prepared from the inner nacreous layer of oyster shell. Chemical characterisation, non-cytotoxic nature and cytocompatibility proved the eligibility of the material for biomedical application. With in-house synthesised resin, the shell powder was set into cement which could be used for filling any irregular bone voids or any bony defect in load bearing site. For non-load bearing site, a porous osteogenic scaffold was developed. Thus, shell nacre-based materials were useful for managing bone defects.

2. ***Development of soy protein-based biomaterial for periodontal tissue regeneration***

The development of soy protein-based biomaterial for periodontal tissue regeneration was ongoing and the study was approved by TAC.

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

The Division is involved in development of hydrogels, known as bioinks used for printing functional tissues/organs. We have developed bioinks with variety of gelatin modifications, with different flow properties and crosslinking chemistries so as to obtain bioinks with optimum printability.

4. ***Development of modified glass-ionomer cement to improve mechanical properties***

Glass-ionomer cement (GIC) is translucent dental material that is widely used in dentistry for many applications including restorative, core build up and luting cements. The advantages of GICs over other dental composites include strong adhesion to both enamel and dentin without the need for coupling agent or etching techniques, anti-cariogenic properties due to the release of fluoride, thermal compatibility with tooth enamel and better biocompatibility. However, conventional GICs have some disadvantages including inferior mechanical properties, brittleness and low abrasion resistance. The key modification on these aspects is resin-modified GICs (RMGICs). The project aims to modify the GIC using nanogel additives to improve its mechanical properties.

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

Denture soft liners are widely used in dentistry as it forms a cushioned layer between the hard denture base and the oral mucosa and have the potential of improving comfort to patients with ridge atrophy, thin and non-resilient mucosa and bony undercuts. Based on the clinical data, plasticized acrylic resin-based soft liners give better adhesion to denture prosthesis compared to any other materials including silicone elastomers. However, one of the major concerns is the use of high concentrations of plasticizers in acrylic denture soft liners, especially phthalate esters. The proposed study aims to develop acrylic denture soft liner formulation using nanogel additives without incorporating any small molecule plasticizer such as phthalate esters.

6. ***Development of mucoadhesive bandages for the treatment of desquamative gingivitis***

Multiple gel formulations for the treatment of various stages of desquamative gingivitis are available in the market. However, the retention of these drugs in the target gingival region is challenging as these common gel formulations are easily wiped away from the oral moist environment by food, liquids and even saliva. As there is a massive need for formulations that can enhance the retention of drugs in the target gingival region, the study proposed the development of mucoadhesive bandages having enhanced drug release kinetics.

7. ***Secretion solidification system for the safe management of infected respiratory secretions***

Disposal of infected secretions from patient poses a great challenge to every hospital. This is particularly so in the case of secretions of patients with highly contagious diseases such as COVID-19. Collection and disposal of such wastes puts the nursing and cleaning staff at high-risk. Generally, in the ICU, the secretions are sucked by a suction machine into bottles or canisters which have to be emptied when full, then subjected to a decontamination process in a sluice room and discarded through the waste fluid disposal system. Apart from the recontamination risk during the handling involved in these processes, there is need for well-equipped sluice rooms with disinfection facilities which can be an issue in less equipped hospitals or make shift isolation wards during epidemics. The project aimed at the development of a highly efficient superabsorbent material for respiratory and other body fluid solidification and disinfection.

Testing and Evaluation

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

Awards and Honours

1. Dr Lizymol P P received the award for the innovation entitled "Development of bio-active, radiopaque, non-cytotoxic, bone cement based on a novel in-situ polymerizable oligomer for orthopedic applications" under the category of "Polymers in Medical and Pharmaceutical Applications" at The 10th National Awards for Technology Innovation in Petrochemicals and Downstream Plastics Processing Industry by The Department of Chemicals and Petrochemicals, Ministry of Chemicals and Fertilizers, Government of India. The award was presented Shri D V Sadananda Gowda, Hon'ble Minister for Chemicals and Fertilizers at a function held at Vigyan Bhavan, New Delhi on 23 February 2021. Dr Lizymol P P was one of the four winners out of 273 nominations received.
2. Dr Manju S received the "HarGobind Khorana-Innovative Young Biotechnologist Award 2020" from the Department of Biotechnology, Government of India, on the 35th Foundation Day of DBT on 26 February 2021 via online mode.
3. Dr Lizymol P P won the Best Poster Award for the poster entitled "Turmeric during COVID-19 and its effect on storage stability of ginger" at the 33rd Kerala Science Congress in January 2021.

Staff

Faculty

Dr Manoj Komath, Scientist G and Head of the Department

Dr Jayasree R S, Scientist F

Dr Lizymol P P, Scientist F

Dr Rekha M R, Scientist F

Dr Shiny Velayudhan, Scientist D

Dr Manju S, Scientist D

Dr Francis Fernandez, Scientist C

Technical

Dr S Sureshbabu, Scientific Officer - Instruments

Dr Nishad K V, Scientific Assistant (Instruments)

Ms Susan Mani, Technical Assistant (Lab) - A

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

Dr Deepu D R, Technical Assistant (Instruments)

Dr Remya K R, Technical Assistant (Instruments) - A

Mr Jijo P T, Technical Assistant (Instruments) - A

DEPARTMENT OF MEDICAL DEVICES ENGINEERING

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

The Department of Medical Device Engineering comprises the Divisions of:

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

Apart from the above functions, the Department extends support services like regulatory affairs, rapid prototyping, ethylene oxide sterilization, package validation, material characterization and computer-aided design and analysis to other internal Divisions and external customers.

The Department made substantial contribution in its fight against COVID-19 by developing a number of devices such as Emergency Breathing Assistance Device (EBAS), Personal Protective Equipment, Bubble Helmet, UV Sterilization Bin to name a few. The EBAS and UV Sterilization Bin were successfully commercialised and are in use across the country

DIVISION OF ARTIFICIAL INTERNAL ORGANS

This Division executes research programmes that aim to develop high-risk medical devices. The core competency of the Division is in the areas of design, prototyping, in vitro evaluation, process development and technology documentation for medical devices.

Development Activities

1. Atrial septal defect occluder

An atrial septal defect (ASD) is a hole in the septum (wall) that separates the heart's two upper chambers (left and right atria). The ASD closure device/occlude (Figure 32) is used to close this defect without surgical intervention. The technology transfer agreement for the device was signed with M/s BioradMedisys, Pune, on 14 January 2021.

Figure 32. Atrial septal defect occluder

2. Flow diverter stent

The Flow diverter stent (Figure 33) is a device used for treating intracranial aneurysms inside the cerebral blood vessels so that blood is diverted away from the aneurysm and preserved within the parent vessel, thus preventing rupture and promoting healing of the aneurysm. The technology transfer agreement for the device was signed with M/s BioradMedisys, Pune, on 14 January 2021.

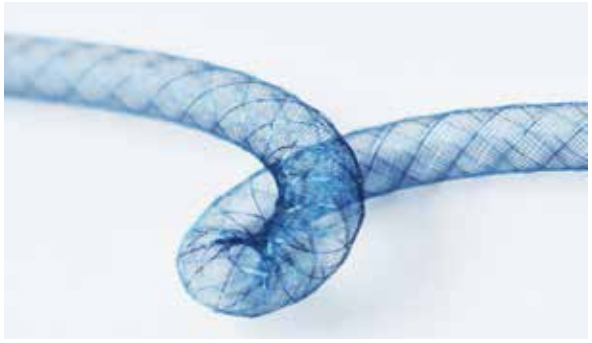


Figure 33. Flow diverter stent

3. Aortic stent graft

This device is used for the minimally invasive treatment of aortic aneurysm. The device was prototyped and was under evaluation along with its delivery system.

4. Annuloplasty ring

Annuloplasty ring is a device for correction of mitral regurgitation. The device restores the natural configuration of the mitral annulus and ensures mitral valve leaflet coaptation while closing. Pilot production of 3 sizes of the device was completed.

5. TiN-coated coronary stent

Coronary stents are usually made of metal alloy. They are introduced on a balloon catheter in the crimped state into the lumen of the diseased coronary artery and later expanded by inflating the balloon at the point of implantation. The project had reached pilot production stage and animal trials were being planned.

6. Polyaxial pedicle screws for thoracolumbar stabilization

The objective of the programme was to design and develop modified pedicle screw, connectors, rod, locking cap and instrumentation. Design, development, and pre-clinical evaluation of the newly developed spinal fixation devices were underway.

7. Programmable hydrocephalus shunt

This deviceconsists oftwo catheters connected toa valve and the valve opens at variable set pressures. The valve is implanted over the skull of a patient having hydrocephalus. One of the catheters (proximal) will be inserted into the cerebral ventricles and act as an inlet to the valve. Through the other catheter (distal) which is connected to the outlet of valve the cerebrospinal fluid is allowed todrain into the peritoneal cavity. This occurs when the intracranial pressure goes above a certain limit. Currently valve design is ongoing in the project.

8. Point-of-care device for measuring NT-ProBNP

N-terminal fragment of BNP precursor (NT-proBNP) is the biomarker produced in the blood during the initial stages of heart failure. A test kit was prepared to detect the presence of biomarker in blood samples.

9. High-strength Ti6Al4V castings for orthopaedic implants

The project aimed to develop downstream processes including heat-treatment for use with Ti6Al4V castings for strength enhancement. The target device is an anterior cervical plate, used to immobilize and stabilize spine against disorders. The project was in the design phase.

10. Reverse suction and suction arrester device setup

This is a novel suction device for use during neurosurgical procedures. The purpose of the suction device is to remove the fluid (usually blood) in the surgical region to provide a clear field. The new design is meant to minimize or avoid the risk of clogging of the suction tip by the dissected brain tissues or blood vessels. Two working models based on different concepts were demonstrated in the laboratory. Work on a clinically relevant design was underway.

New Initiatives

1. Orthotics and Rehabilitation

MoU was signed with M/s Tynor Orthotics Pvt. Ltd., Mohali, for the co-development of 'Off-loader' and 'OA knee brace' devices.

2. Cavity conformable surgical space stent retractor

This project is aimed at minimizing or eliminating injury due to high retraction pressures experienced by brain tissues during surgery. For this purpose,

a retractor that offers circumferential 360-degree expansion was designed. It is anticipated that the new design would reduce positioning time and offer better manoeuverability.

Technology Transfer Activities

Second-generation TTK Chitra heart valves

The second-generation heart valve jointly developed by the Institute and M/s TTK Healthcare Ltd. entered the clinical evaluation phase (Figure 34).

Figure 34. First batch of second-generation TTK Chitra heart valves being handed over to the Director, SCTIMST by the President, TTK Healthcare for clinical trials on 17 March 2021

Technologies for COVID-19 Management

1. Swab collection booths

The Chitra booths technology which was developed for the purpose of isolating the patient from the medical personnel collecting swabs was transferred to multiple industry partners.

2. UV-based facemask and disposal bin

The technology transfer MoUs were signed with multiple industrial partners.

3. Deployable Hospital Medicab

Four Zone Layout designed by SCTIMST and Team Modulus, IIT Madras Research Park, first line treatment of COVID-19.

4. Rapid SARS-CoV-2 IgM/IgG test kit

MoU was signed with M/s Origin Diagnostics & Research for joint development.

Research Programmes

Functional Near Infrared Spectroscopy-based brain-computer interface

The purpose of this research project is to develop a deep learning model that can delineate various brain states in real-time using Functional Near Infrared Spectroscopy (fNIRS) signals. The long term goal is to develop an fNIRS based brain-computer interface for: (i) motor rehabilitation such as for wheel chair control; and (ii) user interaction with a computer in real-time.

Testing and Evaluation

The Division conducted safety and efficacy evaluation of Fupro-Grace foot for M/s Fupro Innovation Pvt. Ltd., Chandigarh.

DIVISION OF EXTRACORPOREAL DEVICES

The Division is entrusted with the research and development of extracorporeal medical devices mainly focusing on the cardiopulmonary system. The major ongoing activities in the Division include development of para-corporeal left ventricular assist device, implantable infusion pump, membrane oxygenators, cerebral microdialysis device, transcutaneous energy transfer system, infrared energy-based technologies for blood warmers, infant warmers and vein viewers. The Division also supports various TRC Projects of the Institute.

Regulatory Affair Cell, a part of the Division, is focused on supporting the research teams and commercial partners of different technologies developed by the institute, for a range of regulatory activities. The Faculty continued to be part of the Materiovigilance Programme of India (co-ordinated by Indian Pharmacopeia Commission, Ghaziabad) as experts for providing technical support in the causality assessment of medical device adverse events reported by the manufacturers and other healthcare professionals across the country.

The services of Ethylene oxide sterilization and Rapid prototyping were extended to other Departments and Divisions of the institute as part of various research and development programmes.

Development Activities

1. Paracorporeal Left Ventricular Assist Device

Ventricular Assist Devices (VADs) are circulatory support devices that help to maintain a nominal cardiac output for various physiological functions of the human body in end stage cardiac failure patients. The Chitra Paracorporeal Left Ventricular Assist Device (pLVAD) is a magnetically levitated third generation LVAD which is composed of a centrifugal blood pump with a miniature brushless DC motor, a controller and a cable connecting controller to the pump (Figure 35). The technology was transferred to M/s Meril Lifesciences Pvt. Ltd., Gujarat.

In vitro evaluations using blood analogous fluid and animal blood were carried out and based on the results, design improvements were incorporated. These changes led to less damage to red blood cells, increased efficiency and reduced surface temperature. Integrated battery pack and battery charger were added. Control system was modified using surface mount electronic components. Evaluations using Left heart simulator for various clinical conditions were ongoing. Preliminary Ex vivo animal evaluation on sheep model was initiated (Figure 35).

Online training for the controller and battery pack was carried out to Meril Team as part of Technology Transfer.

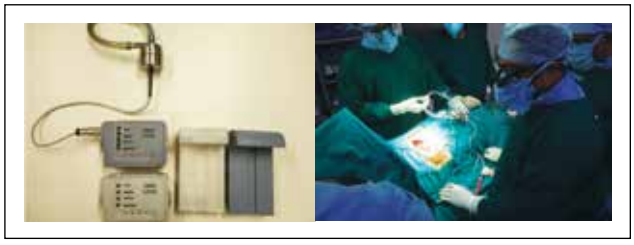


Figure 35. Chitra Paracorporeal Left Ventricular Assist Device (left) and Ex vivo evaluation of the device (right)

2. Implantable micro infusion pump

In this project, an implantable device for precisely delivering the drugs such as Baclofen/Morphine to targeted portions of the body was developed. The device has a storage unit and a driving unit with associated electronics to deliver drugs like insulin, chemotherapy and pain management drugs (Figure 36). The prototype was developed and discharge performance was checked through gravimetric techniques and HPLC techniques as per ISO standards. The performance was at par with the commercially available devices. The design was being scaled up with multiple prototypes for conducting in vivo animal evaluations.

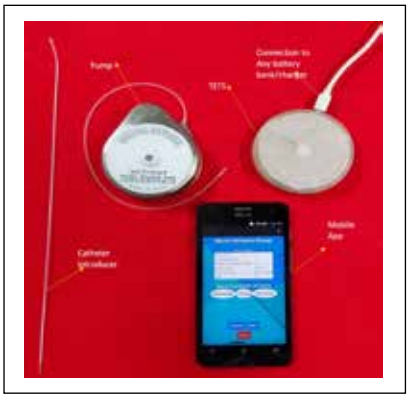


Figure 36. Implantable MicroInfusion Pump prototype and screen shot of the controller programme

3. Centrifugal blood pump with drive and flowmeter

In this project, a centrifugal blood pump with its associated drive was developed for maintaining systemic circulation during cardiopulmonary bypass surgery. The system consists of a disposable centrifugal pump and a miniature controller with detachable drive unit (Figure 37). The drive and the pump can be kept close to the patient to reduce the priming volume of the fluid required during the surgery. A portable, blood flow meter (Figure 37) measures the velocity of the blood flowing through the tubing and displays the fluid flow rate in litres/minute. Blood flow meter technology was transferred to M/s. enProducts Pvt. Ltd., Kochi.

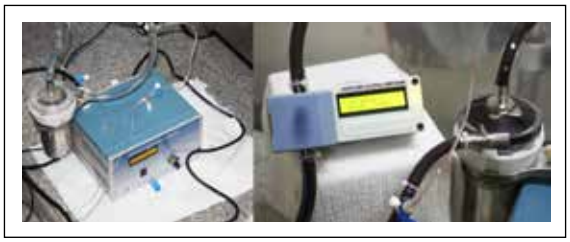


Figure 37. Chitra blood pump controller and drive unit (left) and Chitra blood flow meter (right)

4. Development of cerebral microdialysis device

The device is aimed at early estimation of biomarkers in cases like traumatic brain injuries with the help of a micro dialysis probe. Prototype evaluations were conducted in analogous fluid to establish proof-of-concept.

A couple of designs of hollow fibre-based microdialysis devices were developed and preliminary tests for qualification of membranes were performed. The device prototypes were successfully tested in vitro for glucose detection from a simulated cerebrospinal fluid (Figure 38).

Figure 38. Microdialysis device during in vitro evaluation

5. Suction retractor device for aortic valve replacement

A device for aortic valve replacement in adult cardiac surgery that supports both retraction and suction mechanisms was under development. The device helps in retracting aortic annulus for easy access to surgical area and also for removal of blood and any other fluids from the aortic annulus region which aids in the exposure of aortic annulus and maintaining natural anatomy for aortic valve replacement or repair procedures. Design of the device was created and stress analysis was performed (Figure 39).

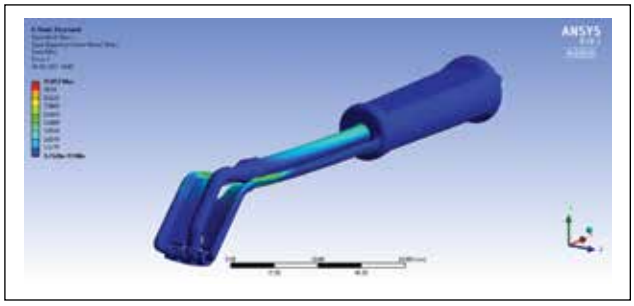


Figure 39. Suction retractor device for aortic valve replacement

New Initiatives

Initiated a new project entitled "Design and development of a microdialysis set-up for cerebral applications" (Funded by: BDTD-DST, PI: Dr Chhavi Gupta).

Technologies for COVID-19 Management

1. Development of Emergency Breathing Assist System

Emergency Breathing Assistance System (EBAS) is a device that employs motorized compression and natural decompression of a bag-valve-mask to provide positive pressure and volume-controlled ventilation to a patient requiring immediate assistance or emergency support in breathing. The essential parameters of ventilation such as tidal volume, breaths per minute, inspiration to expiration (I:E) ratio can be adjusted by the operator. The device computes and displays some of the important parameters in use and also has built-in alarms for out- of-range and SOS operations. For clinical application, the device will have to be used along with standard consumables like breathing tubes, PEEP valve and bacterial/viral filters before connecting to the patient. The knowhow and design of the EBAS were transferred to Wipro 3D in April 2020 and was commercially launched in September 2020 (Figure 40).

Figure 40. EBAS (left) and EBAS Airway Circuit (right)

2. Development of Isolation Pod for COVID-19 patients

This is a fully-enclosed, transparent, lightweight and foldable device with adequate strength and can retain its shape for carrying infectious patients from one place to another. The inside of the device is maintained at a negative pressure and the patient's exhaled air from the isolation pod is sucked and filtered out through

a High Efficiency Particulate (HEPA) filter before releasing into the atmosphere. It also has ports with gloves for nursing as well as providing oxygen lines and intravenous lines. This will provide complete safety to the people around the patient (Figure 41).

Figure 41. Isolation Pod

3. Intubation Isolation Box

A fully-enclosed, transparent, lightweight and foldable device with adequate strength and can retain its shape for isolating the patients during airway manipulation and airway-related procedures like endotracheal intubation, fibreoptic or endoscopic bronchoscopy. The device protects the clinicians and paramedical staff by containing the aerosol contamination from the patient's nose and mouth within the box. The device consists of a mechanical structure and a transparent cover to act as a shield between the patient and clinicians and paramedical staff to contain the aerosol (Figure 42).

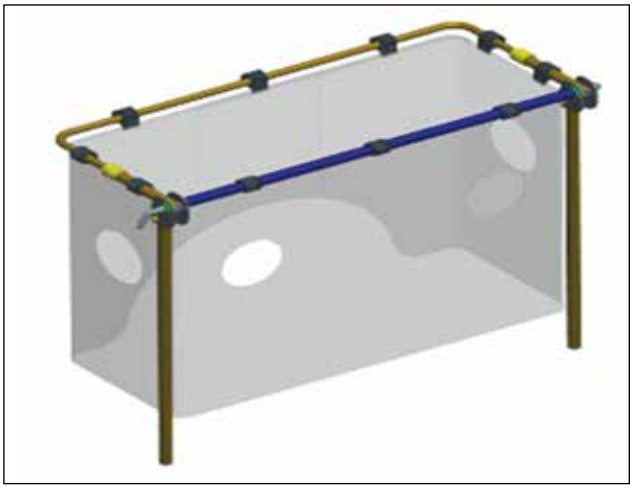


Figure 42. Intubation Isolation Box

4. Sanitizer bracelet

A bracelet which can store the sanitizer and dispense easily to the palm on pressing was developed (Figure 43).

Figure 43. Sanitizer bracelet

Research Programmes

1. Development of Transcutaneous Energy Transfer System

Mr Sarath S Nair, Engineer E, initiated research on developing Transcutaneous Energy Transfer System for powering implantable medical devices such as LVAD, TAH and implantable infusion pumps as part of his PhD work.

2. Particle Image Velocimetry

Work was initiated to validate the Particle Image Velocimetry techniques for flow evaluation of medical devices based on Food & Drug Administration (FDA) benchmark models. Particle image velocimetry is a technique for instantaneous velocity vector measurements. Small tracer particles are added to the flow domain. The plane of interest within the flow is illuminated twice by means of a laser light sheet. The light scattered by the tracer particles is recorded via a high quality lens on two separate frames of a cross-correlation digital cameras. These recorded images are used to detect and extract complex flow quantities of interest (Figure 44).

Figure 44. Particle Image Velocimetry

3. Modelling/In silico simulation and validation studies

These studies are meant to support the design and development of Left Ventricular Assist Devices (LVAD) using computational fluid dynamics (CFD) and left heart simulator. A number of CFD simulations of different LVAD designs for the optimization of performance parameters were performed.

4. Functional and operational aspects of Left Heart Simulator

The following studies were completed: functional and operational aspects of left heart simulator with the help of M/s Vivitro Labs, Canada and instrumentation and data acquisition methods for the performance evaluation of LVAD (Figure 45). In addition, a work procedure was developed for the operation of the left heart simulator to evaluate the performance of ventricular assist devices.

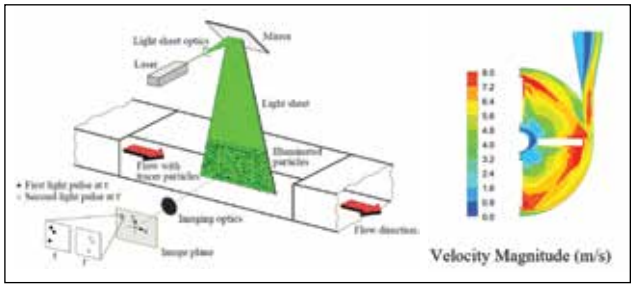


Figure 45. Test set-up for the performance evaluation of left heart simulator

Testing and Evaluation

A number of test set-ups were designed and fabricated for the evaluation of medical devices (Figure 46) such as Left Ventricular Assist Device and implantable micro infusion pumps according to ISO 14708/IEC 60601 standards. They included:

- Impact test set-up
- Pressure test set-up
- Infusion Pump Motor Durability test set-up
- Catheter Durability test set-up
- TETS test set-up

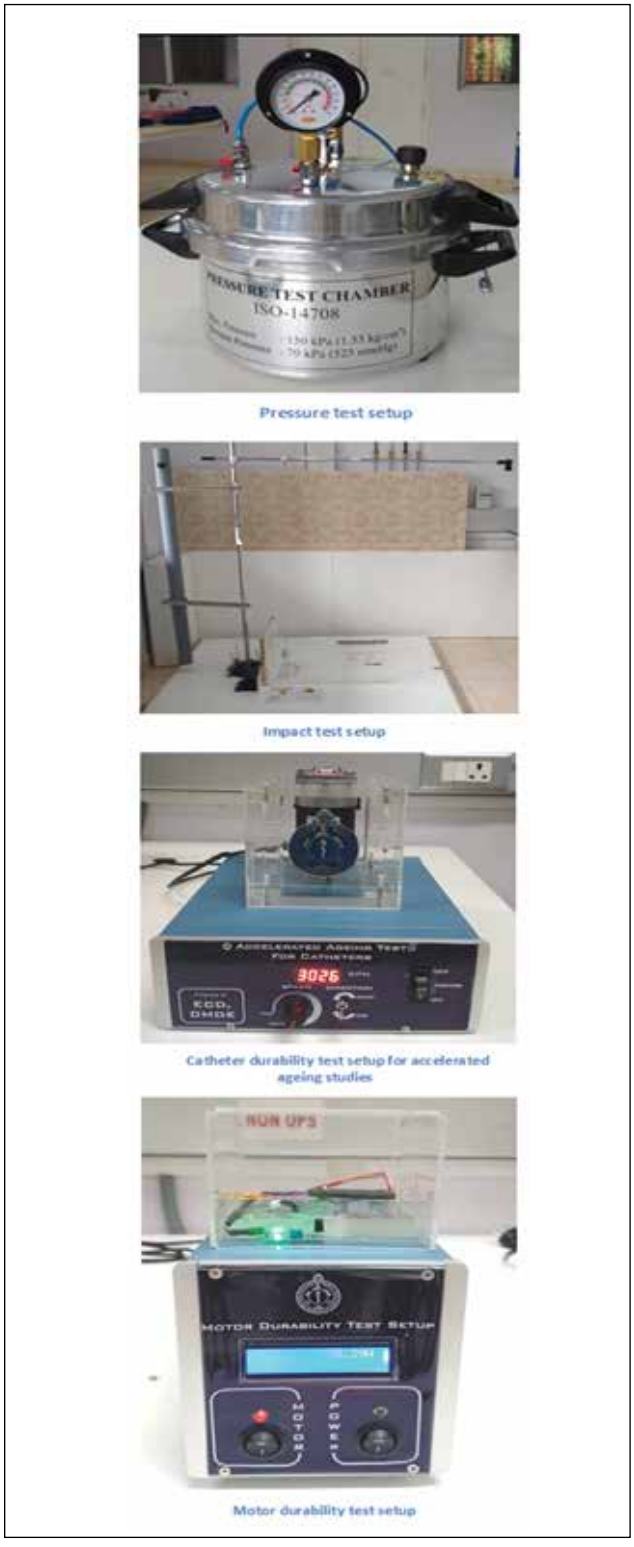


Figure 46. Test set-ups designed and fabricated for the evaluation of medical devices

Awards and Honours

1. Mr Sarath S Nair, Engineer E, won the SBAOI MAHE Young Scientist Award 2020 for the paper titled "Residual Drug volume detection in implantable micro infusion pump for targeted drug delivery using magnetic methods" at the International Conference on Biomedical Materials Innovation (ICBMI-2020).
2. Ms Amrutha C, Engineer C, was appointed as Nodal Officer for Regulatory Compliance Portal representing SCTIMST under the Department of Science and Technology, Government of India.
3. Ms Amrutha C, Engineer C, was selected Member of Standards Review Committee, Indian Pharmacopeia Commission.

DIVISION OF MEDICAL INSTRUMENTATION

The activities of the Division include technology development for: medical implants, transducers and bio-electrodes, bio-electrical impedance measurement techniques and novel diagnostic tools such as those required for artefact-free monitoring of breathing and early detection of various disorders. The Division's core research focuses on the development of highly sophisticated active implants such as deep brain stimulators, cardiac defibrillators, spinal cord stimulators and various kinds of sensors and electrodes like subdural and depth electrodes.

Developmental Activities

1. Deep Brain Stimulator System for Movement Disorders

Deep brain stimulation involves implanting electrodes within certain areas of brain. These electrodes produce electrical impulses that regulate abnormal impulses or the electrical impulses can affect certain cells and chemicals within the brain. The amount of stimulation in deep brain stimulation is controlled by a pacemaker-like device placed under the skin in upper chest. A wire that travels under the skin connects this device to the electrodes in the brain. Deep brain stimulation is used to treat a number of neurological conditions, such as essential tremor, Parkinson's disease and dystonia. Deep brain stimulation is also being studied as a treatment for epilepsy, cluster headaches, Tourette syndrome, chronic pain and major depression.

Typical device consists of following subsystems:

- Neurostimulator module
- Leads and electrodes
- Extension cables
- Programmer module

This project is being executed with Bhabha Atomic Research Centre (BARC) as co-development partner. The first sets of prototypes were being evaluated for safety and performance (Figure 47).

2. Automated Implantable Cardioverter Defibrillator

An Implantable Cardioverter Defibrillator (ICD) is a battery-powered pulse generator implanted in a pouch under the skin of chest or abdomen, often just below the collar bone that monitors heart rate. It uses batteries to send electric signals to a heart that's beating too slow, same as a pacemaker. It can also deliver an electric shock to help restore a normal heartbeat to a heart that's beating chaotically and much too fast.

An ICD monitors the heart's electrical activity using wires with electrodes on the end that are placed in specific areas of the heart. Wires or leads run from the pulse generator to positions on the surface of or inside the heart and can be installed through blood vessels, eliminating the need for open-heart surgery. The ICD responds to irregular life-threatening heart

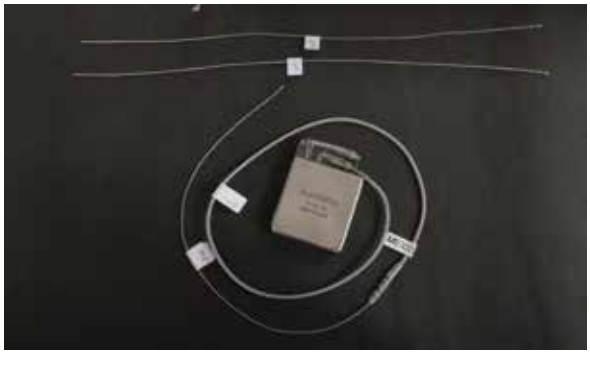


Figure 47. Deep Brain Stimulator System

rhythms from the lower chambers of the heart with either anti-tachycardia pacing (ATP) consisting of low energy impulses to promote a normal heartbeat, or shock therapy with high energy impulses, to prevent sudden cardiac arrest. This project is being executed with M/s Shree Pacetronix Ltd. as co-development partner. The first prototype of high voltage circuit and arrhythmia detection algorithm based on onset, stability, morphology was completed.

3. Intracranial Electrode

Intracranial electrodes are used during large craniotomies for localising the seizure-generating zones in brain. The epileptologist determines the optimum extent of coverage based on non-invasive localization studies and makes recommendations and requests about the grid and depth electrodes that are used. A period of inpatient extra-operative monitoring ensues in which the clinically important seizure pattern is observed and captured on video EEG. Direct brain mapping through grid stimulation is often performed, particularly if the area implicated in epileptogenesis is proximal to areas believed or known to be eloquent. Preclinical animal evaluations were underway. Design and development of a new kind of steering electrodes with feedback for deep brain stimulator applications was also ongoing.

4. Automated External Defibrillator

Automated external defibrillator is a medical device used to prevent sudden cardiac death. The device detects arrhythmia and provides appropriate therapy to restore the normal heart rate. The proposed AED consists of a supercapacitor, multifunction electrodes, charge storing capacitor and a microprocessor-based electrical circuit. The supercapacitor powers the entire device.The multifunctional electrodes analyse the ECG rhythm and detect any abnormalities in the heart rate. Once the detection is completed, the charging circuit charges the capacitor and the device provides biphasic shock to the patient.

New Initiatives

Development of Spinal Cord Stimulator for pain management (Funded by: TRC).

DIVISION OF POLYMERIC MEDICAL DEVICES

The Division of Polymeric Medical Devices focuses on the development of new polymers, polymeric formulations, composites and devices suitable for different biomedical applications. The Laboratory is equipped with facilities for compounding/mixing, moulding, electrospinning, static testing and dynamic mechanical analysis of polymeric materials and polymer synthesis. A new Facility for coating parylene on medical devices was installed during the year.

Developmental Activities

1. Skull base defect closure device

Minimally-invasive skull base surgery for removing pituitary tumours are performed via the intranasal route. During the procedure the surgeon drills the skull base bone to access the tumour site. This results in a defect in the skull base bone which needs to be sealed in order to prevent cerebrospinal fluid leakage. A flexible prototype device was developed for the closure of skull-base defect out of ethylene vinyl acetate-hydroxyapatite composite (Figure 48). By varying the hydroxyapatite content, the flexibility and rigidity of the composite material could be adjusted. The prototype device was foldable and regained its original shape when released. This allowed the insertion of the material through the narrow nasal corridor keeping it folded and finally deployed at the skull base. The device can be cut into desired shape by the surgeon during the procedure. The device has a rib that enables holding and manipulation of the device during the procedure using the surgical tools.

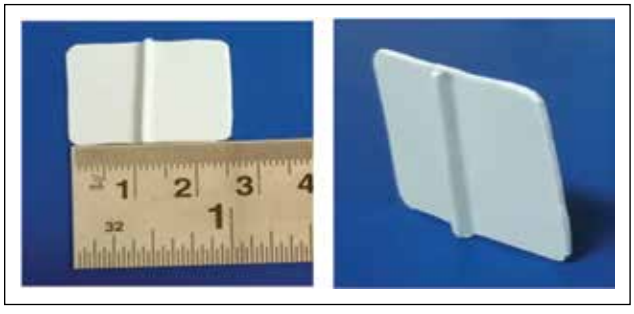


Figure 48. Skull base defect closure device made from ethylene vinyl acetate copolymer and hydroxyapatite

2. *Universal airway device for lung isolation*

In this Project, an endotracheal tube (ETT) was modified so that the improved product was capable of isolating lungs independently. The unique feature of this device is the provision of a left ventilating eye that allows selective isolation of left or right bronchus while using a bronchial blocker (Figure 49). The ventilating eye aids easy placement of the bronchial blocker and prevents its dislodgement after secure placement. The ETT of all sizes can be similarly modified to provide secure lung isolation while using bronchial blockers. A double lumen ETT has several disadvantages such as higher risks of tracheobronchial injuries, difficulty in placement in patients with difficult airway and non-availability for use in children. The Universal airway device having a single lumen can be used for one lung isolation with minimal risk of tracheobronchial injuries. It can be used for thoracic, vascular and cardiac surgeries and in critical care medicine for a variety of indications.

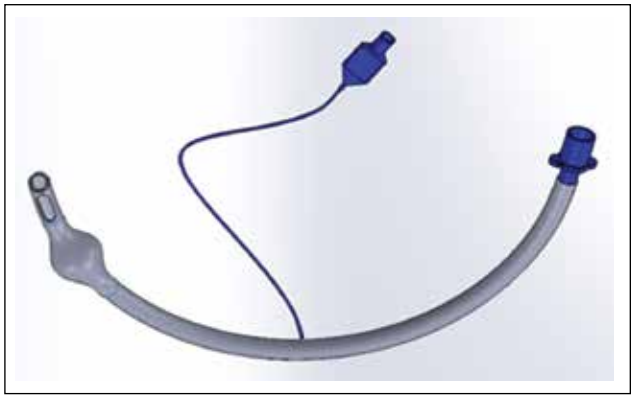


Figure 49. 3D model of right bronchotracheal tube

3. *Development of leukodepletion filter*

During the year a prototype device was developed and the pre-filter and final filter membranes used for fabricating the prototype device were tested for acute systemic toxicity and guinea pig maximization tests. ISO 10993 standards were followed for evaluating the filter membranes. The material passed both tests and project was completed during the year.

4. *Parylene coating for medical devices*

In this Programme, a Parylene Deposition System was installed in the laboratory and the preliminary coating studies on different metals and polymer substrates were ongoing.

5. *Development and evaluation of dural substitute*

In this Project, dural substitutes were prepared by electrospinning polycarbonate urethane. The toxicological evaluation of the electrospun membranes was completed. Implantation of the device was performed in rabbits. The histopathological evaluation of the retrieved material was underway.

6. *Development of radiopaque liquid embolic agent*

An injectable radiopaque liquid embolic composition free of metal particles was developed for treatment of arteriovenous malformations (AVM) in brain. Part of in vivo toxicological evaluation of the material was completed. Preclinical evaluation of the device in a pig model was ongoing. The material was injected into the rete mirabile of the animal and tested for radiopacity, injectability and flow behaviour under fluoroscopic conditions. The implantation period was 3 months. The performance of the material was evaluated by comparing with a commercial device as control. Overall performance of the material was found comparable to the control.

7. *Development of radiopaque polymeric microspheres for embolization therapy*

In this Programme, a radiopaque polymer was synthesized by grafting iodinated compound onto a bioinert polymer followed by conversion of the grafted polymer into microspheres by a special process. The process for preparing radiopaque microspheres was standardized and microspheres with good radiopacity were obtained. However, the microspheres showed mild toxicity in cell culture cytotoxicity studies. So, the process was modified by introducing additional purification steps.

8. *Design and fabrication of a head phantom for the dosimetric evaluation of radiotherapy treatment plans*

This is a collaborative programme between Regional Cancer Centre, Trivandrum and SCTIMST, funded by Kerala State Council for Science Technology and Environment. In this project, a polymer composite formulation with better computed tomography

number than the commercially available phantom was developed. Since the batch size of composite prepared in the laboratory facility was small, steps were being taken to scale-up the production process and to evaluate the composite formulation for reproducibility of results.

New Initiatives

1. A new research programme entitled, "Short-coir fiber polylactic acid biocomposite for orthotic assistive device" was initiated in connection with an open innovation challenge named, 'MaterialNEXT'. This was an event hosted by M/s Tata Steel Advanced Materials Research Centre, involving many teams with each team competing for a research award. Duration of the project was 2 months with project cost Rs 44880. The development work was in progress.
2. The Division opened a new Facility for moulding test samples out of polymer compositions. A Microinjection Moulding Machine of 12cc capacity is used for moulding samples for tensile tests, flexural tests, impact tests and water absorption studies. The Facility is now open for internal and external customers.
3. A Parylene Deposition System was installed in the Division which offers parylene coating services to researchers.

Testing and Evaluation

The Division is equipped with polymer processing and testing facilities. The processing facilities available are polymer compounding, microinjection moulding, compression moulding, parylene coating and electrospinning. Testing facilities include: mechanical testing using universal testing machine, dynamic mechanical analysis, impact testing and falling-ball micro-viscometer. These Facilities were extended to internal and external customers for their material processing and characterization.

The samples tested are summarized in the Table below:

Test	Number
Mechanical properties	998 sets of samples (278 external and 720 internal)
Viscosity measurements	60
Dynamic mechanical properties	23 samples (6 external and 17 internal)
Parylene coating	31
Microinjection moulding	228 specimens (78 external and 150 internal)

Training/Outreach Programmes

The DST-SCTIMST Summer Training Programme for SC/ST students was initiated from March 2021. About 10 students joined the institute in two batches and another 18 students would be admitted in subsequent batches. Training was offered to students who are studying or completed +2/UG/PG courses. Duration of the training was up to two months. They were offered scholarship from project funds received from the Scheduled Class Sub Plan (SCSP) and Tribal Sub Plan (TSP) Schemes of SEED Division, Department of Science and Technology, Government of India.

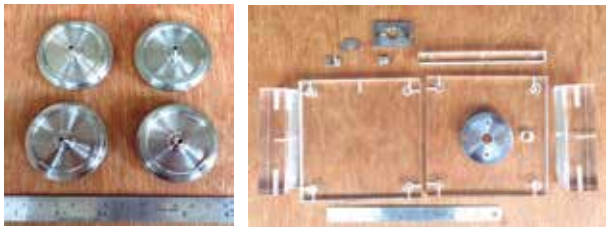
DIVISION OF PRECISION FABRICATION

The Division of Precision Fabrication provides service support to different scientific/technical laboratoriess and Hospital Wing of the Institute in fabricating dies, jigs, fixtures and machining of prototype components. These services are provided by utilizing the CNC and conventional machines available in the Division. Ferrous, non-ferrous and polymeric components are precisely fabricated for various research and TRC Projects of the Institute.

Activities

The important technical service activities carried out for various Projects are represented in Figure 50.

Major support was provided for TRC Projects such as paracorporeal left ventricular assist device, annuloplasty ring, bioprosthetic heart valve, implantable pulse generator, leukodepletion filter, microinfusion pump, intracranial electrodes and atrialseptal defect occluder. During the year, the Division executed nearly 101 work orders (61 major and 40 minor) related to fabrication, machining of test setups and prototypes for various projects. In addition, fabrication support was also provided to various COVID-19-related work (31 work orders) at the Institute.



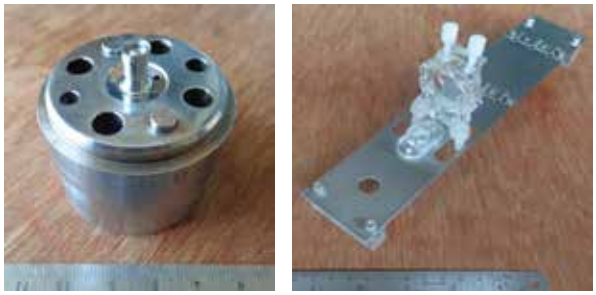
pLVAD pump bottom (left) and Components for testing catheter of microinfusion pump of ECD lab (right)

Aortic suction retractor components - Suction Tube and handle (left) and Annuloplasty ring holders (right)

Loads for connector assembly lead fixation testing fixture (left), Frame holder plate and ball holder for the fatigue-testing fixture (centre), Microfluidic device holder- Bottom and Top plate (right)

Components to test the performance of the micro infusion pump (left & centre) and Ball forming fixture (right)

UTM fixture for compression test of prosthetic foot (left), Marker Fixture - size 24 and size 26 (centre) and Thrust magnet holder and magnet holder caps for pLVAD (left)



Inner flap core for voice prosthesis (left) and Test fixture setup for hydrocephalus shunt (right)

Figure 50. Prototypes for various Projects

Staff

Faculty

Dr Roy Joseph, Scientist G and Head of the Department

Mr Muraleedharan C V, Scientist G (Senior Grade)

Mr D S Nagesh, Scientist G (Senior Grade)

Mr V Ramesh Babu, Engineer G

Dr P Ramesh, Scientist G

Mr Vinodkumar V, Engineer F

Dr Sujesh Sreedharan, Engineer F

Mr Ranjith G, Engineer E

Mr Sarath S Nair, Engineer E

Dr Manoj G, Scientist D

Dr Sivakumar K G V, Engineer D

Mr Sarath G, Engineer D

Mr Jithin Krishnan, Engineer C

Dr Gijo Raj, Scientist C

Mr Anoop Gopinathan, Engineer C

Mr Subhash N N, Engineer C

Mr Arvind Kumar Prajapati, Engineer C

Dr Chhavi Gupta, Engineer C

Mr Saurabh S Nair, Engineer C

Ms Amrutha C, Engineer C

Ms Neethu S, Engineer B

Technical

Mr Rajeev A, Senior Scientific Assistant

Ms Jasmin Joseph, Scientific Assistant - A

Mr Subhash Kumar M S, Technical Assistant - A

Ms Sreedevi V, Technical Assistant - A

Mr Biju Benjamin, Technical Assistant - A

Dr M Chandra Shekhar Nayak, Technical Assistant - A

Mr Reji Kumar S, Technical Assistant - A

Mr Prathyush M, Technical Assistant - A

Mr Jiji Kumar R S, Junior Technical Assistant - A

Mr Vijesh S S, Junior Technical Assistant - A

Mr Sinulal M V, Junior Technical Assistant - A

DEPARTMENT OF TECHNOLOGY AND QUALITY MANAGEMENT

The Department of Technology and Quality Management (DTQM) co-ordinates and manages transfer of technology, intellectual property management of various projects, management of quality system activities and accreditation (*COFRAC*, France, for testing and NABL, India, for calibrations), network/communication systems and engineering services in the BMT Wing Campus. The Construction Wing organises major civil/construction activities for the Campus. DTQM also includes Central Analytical Facility, an NABL-accredited Facility for characterisation of medical devices and materials.

The Department of Technology and Quality Management comprises the following Divisions:

1. Calibration Cell
2. Central Analytical Facility
3. Engineering Services including:
   - Network services
   - Electrical Maintenance
   - Water Supply
   - Air-conditioning (MRAC)
4. Quality Cell
5. Technology Business Division including

α Intellectual Property Cell

6. Customer Service Cell

CALIBRATION CELL

Calibration Cell (CAC) is an in-house facility to maintain traceability of measurement in reporting results at SCTIMST. Relevant calibration procedures are accredited by National Accreditation Board for Test and Calibrations (NABL). Measurement results are being made traceable to the SI units either through calibrations or with the use of Reference Materials (RM). CAC supports the testing labs in implementing quality control measures such as Inter-laboratory comparison and uncertainty estimation. CAC executes system validations for external customers on payment basis.

Calibration Cell is committed to establish traceability of measurement results with the use of reference standards traceable to national/international standards to satisfy the requirements of accreditation bodies.

Developmental Activities

Preparation and standardization of reference materials for biological evaluations

The increasing demand for safe medical devices has lead to the inevitable need for preclinical evaluation of the biomaterials and medical devices prior to the regulatory approval. Traceability to international standards is a requirement of accreditation bodies for global acceptance of test reports and evaluation results in qualifying any product or process in medical device development. However, traceability by accredited calibrations using reference standards cannot be achieved for qualitative characteristics, especially for biological evaluations based on ISO 10993 standards. In such cases, use of reference material (RM) has become an essential tool. Indigenous development of ready to use RMs can assure the availability of RM in a cost-effective manner in the country. A batch of 1000 numbers was prepared and used in the preclinical evaluation of products developed under Technical Research Centre Funding Scheme.

Testing and Evaluation

Mechanical, thermal and electro-technical calibrations carried out by Calibration Cell are accredited by NABL, India as per ISO 17025:2017. Mechanical calibration includes calibration of volumetric glassware, micropipettes, electronic balances, mass sets and rotational speed. Calibration of

Relative Humidity (RH) monitors, thermometers and temperature chambers like incubators are included in thermal calibrations.

Summary of calibrations and measurements performed during he year are summarized in the Table below:

Parameter	Number
Calibrations	508
Surface profile measurements	121

Research Programmes

Study projects were initiated with the following partners during the year:

1. M/s Pesticide testing Laboratory, Trivandrum
2. M/s Government Analyst Lab, Trivandrum
3. Rajiv Gandhi Centre for Biotechnology, Trivandrum

CENTRAL ANALYTICAL FACILITY

Central Analytical Facility (CAF) is the analytical service Division of BMT Wing equipped with facilities to carry out physicochemical evaluation of biomaterials and biomedical devices and offers analytical services to internal and external customers.

Activities

CAF hosts equipment such as: FT-IR Spectrophotometer, UV-Vis Spectrophotometer, Spectrofluorometer, Thermogravimetric Analyser, Differential Scanning Calorimeter, High Performance Liquid Chromatograph, Gel Permeation Chromatograph, Gas Chromatograph, Confocal Raman Microscope, Textural Analyser, Luminescent Image Analyser and Universal Testing Machine. In addition to the test services offered to customers, the Division supports various projects of the institute by providing technical advice and guidance. It also undertakes study mode projects sponsored by external and internal customers for the physicochemical characterisation of biomedical devices or materials. CAF assists M Phil, M Tech and PhD students in their lab modules or internships. The Division also supports academic activities of the institute by offering lab demonstrations during student or industrial visits and organising technical sessions.

In CAF, the testing activities are carried out under the quality management system as per the guidelines of ISO 17025. The laboratory maintains quality, confidentiality and impartiality in all of its testing activities. CAF is capable of performing most of the physicochemical analyses of materials outlined in the international standards for material evaluation. It is the only test service facility in Kerala accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL) for conducting residual ethylene oxide analysis of biomedical devices and materials. CAF also offers NABL accredited tests in the field of thermal analysis of materials. These tests include compositional analysis using thermogravimetry, determination of glass transition temperature, enthalpies of fusion and crystallisation using differential scanning calorimetry.

Research Programmes

Research programmes of CAF focus mainly on the development of analytical methods for the estimation of biologically relevant analytes. In addition to this, CAF is involved in the research programs of other divisions by providing analytical support in the characterisation of their materials.

Projects initiated during the year:

1. "Augmentation of Central Analytical Facility with tests on Personal Protective Equipment for medical use" (Funded by: TDF Scheme, SCTIMST, PI: Dr Renjith S, Co-I: Mr Willi Paul, Mentor: Dr Roy Joseph). The primary aim of the project is to develop and validate test methods for the quality evaluation of personal protective equipment according to relevant National and International standards. As part of the project, an apparatus was designed for synthetic blood penetration test.
2. "Organic-inorganic hybrid coatings with broad anti-microbial activity", a project under 'Material Next Event Season 2' sponsored by Tata Steel Ltd., was initiated in March 2021, with Dr Renjith S as Co-Investigator. In this project, hybrid antimicrobial coatings would be developed and coated over various substrates

such as glass, polymer and steel aiming to prevent pathogenic adhesion. This coating is expected to be useful in controlling many hospital-acquired infections.

Projects completed during the year:

1. "Release/Conjugation efficacy of zoledronic acid on nanoparticles". In this project, levels of zoledronic acid was estimated in samples using High Performance Liquid Chromatography
2. "Physicochemical evaluation of thermoresponsive polymeric samples". In this project, thermoresponsive polymeric films were analysed using FT-IR spectrophotometer, Gel Permeation Chromatography and Differential Scanning Calorimetry.

Testing and Evaluation

Physico-chemical properties of materials used in medical devices are characterised at the Analytical Facility on a routine basis. During the year, 1803 samples submitted by external and internal customers were analyzed at the CAF.

Awards and Honours

Mr Willi Paul, Scientific Officer, was elected Secretary, The Society for Biomaterials and Artificial Organs India (SBAOI) for a period of three years.

ENGINEERING SERVICES

The role of Division includes providing technical support for general maintenance of equipment and environment at various facilities, management of utility supply of power and water, maintenance of waste incinerator, and sewage systems of the campus. Electrical service maintains the 11 kV supply system and the diesel generator for power backup.

Activites

Major activities during the year include:

1. Third party Electrical Safety Audit in co-ordination with Electrical Safety Team Provided Engineering support for the product development activities during COVID-19 pandemic
2. Arranged Video Conferencing Facility for virtual meetings, COFRAC and NABL audits and conferences
3. Provided appropriate environmental conditions in Clean Room for COVID testing

QUALITY CELL

The Quality Cell is involved in implementation, maintenance and continual improvement of Quality Management System (QMS). In addition, the Quality Cell in engaged in ensuring that the facilities, equipment, personnel, methods, practices, records and its control are in conformance to the requirements of International Standard ISO 17025.

Activities

Quality Cell is involved in supporting all testing/ calibration laboratories as well as auxiliary support services/ sections.

Major activities of the Cell during the year:

1. COFRAC Surveillance Assessment

The surveillance assessment of COFRAC, France - external accreditation service provider for testing services based on ISO/IEC 17025:2017 was conducted online on 17-18 and 21-22 December 2020.

2. National Accreditation Board for Testing and Calibration Laboratories Assessment

- NABL pre-assessment for fresh accreditation of testing facilities at Central Analytical Facility was conducted online on 13 August 2020. Formal initial assessment was conducted online on 28-29 November 2020. The accreditation for three physico-chemical tests at Central Analytical Facility was granted by NABL which is valid from 4 January 2021 to 3 January 2023.
- NABL Desktop Surveillance for Calibration Cell was conducted during February 2021. NABL reviewed the documents submitted and recommended continuation of accreditation in accordance with ISO/IEC 17025:2017 as per the existing scope in the disciplines of electro-technical, mechanical and thermal calibration.

3. Management Reviews

- Management Review Committee meeting chaired by the Director, SCTIMST was held on 7 January 2021

- Two Technical Management Committee meetings chaired by Head BMT Wing were held on 24 June 2020 and 7 December 2020.

4. Internal Audits

Two internal audits were carried out: first internal audit (IABMT100.Y20) during 25 May to 3 June 2020 and second (IABMT200.Y20) during 16-23 November 2020. Corresponding post-audit meetings were conducted on 22 June 2020 and 3 December 2020, respectively.

5. Document initiated/revised

- A total of 3 system procedures and 176 work procedures were revised/ issued
- 81 Lab notebooks were issued during the period
- 89 Registers and Logbooks were prepared and issued to various laboratories/ Sections

6. Corrective Actions

Thirty corrective actions were generated during the year by different laboratories were verified and closed, except one (follow-up).

7. ISO 13485:2015 implementation

Identification of personnel from various Divisions, implementation of training, development of implementation plan and gap analysis of documents were completed. The required procedures and quality manual preparation was ongoing.

8. Training and participation

- Six personnel participated in online training for implementation of ISO 13485:2016 on 8-9 September 2020
- Three personnel participated in ISO 17025:2017 online Internal Auditor Training Course on 16-18 December 2020

9. Safety Audit

Safety audit with respect to biological, chemical, fire and radiation safety was conducted during 22-23 and 25-26 February 2021 and covered all the Divisions/ Sections of BMT Wing. Electrical safety audit was excluded from the safety audit as the same was conducted recently by a third party (M/s Ottotractions, Trivandrum).

TECHNOLOGY BUSINESS DIVISION (INCLUDING CUSTOMER SERVICE CELL and INTELLECTUAL PROPERTY RIGHTS CELL)

Technology Business Division focuses on the following activities of the Institute:

- Institute-industry interactions related to technology transfer and research project collaborations.
- Intellectual Property Rights like patent, design and trademark registration of Institute projects.
- Testing services and specific protocol-based study requests from the industry and academia for medical devices and biomaterials.
- Training, problem solving and consultancy activities of the Institute through the Industry Institute Partnership Cell.
- Internal research project funding of the Institute comprising of the Technology Development Fund Scheme, internal review of the project applications and also interim status reviews of projects.
- Outreach Programmes - giving exposure to students from different Institutions across India at the Institute on development of medical devices
- Discussions with Clinicians about projects aimed /under development

New Initiatives

Setting up of the Technology Transfer Office – project funded by NBM, BIRAC

The project submitted by Technology Business Division for setting up a Technology Transfer Office was sanctioned with a funding of Rs 9 Crore for 3 years. The project shall be implemented under SCTIMST-TIMed, the Technology Business Incubator of the Institute. The objective is to enhance academia-industry inter-linkages, strengthen bio-cluster ecosystem, provide increased opportunities for academia, start-ups, innovators and entrepreneurs to protect their intellectual property, translate knowledge into products and technologies and facilitate technology transfer activities.

Expression of Interest

Owing to the outbreak of the COVID-19 pandemic, the Institute identified solutions in terms of the diagnosis, prevention and care to curtail the disease burden. Several products were designed and prototyped quickly and expression of interest was called from industries to take it forward on fast track mode to scale up and manufacture with technical support from the Institute. Expression of Interest on different sets of COVID-19 related products were invited four times during the year.

New Technology Transfers

1. Technology transfer of Atrial Septal Defect closure device (Occluder) and Flow diverter stent to M/s Biorad Medisys, Pune on 14 January 2021 (Figure 51).
2. Technology transfer of pneumatic compression device and flowmeter to M/s Enproducts Pvt. Ltd., Kochi on 17 September 2020.
3. MoU signed with M/s Biogenix Inc. Pvt. Ltd. for the collaborative development of rapid detection kit for procalcitonin detection for sepsis and Chlamydia trachomatis on 19 March 2021.

Figure 51. Technology Transfer of Flow Diverter Stent and ASD Occluder to M/s.BioradMedisys. The agreement was signed by Dr K Jayakumar, Director, SCTIMST and Mr Jitendra M Hegde, Managing Director, BioradMedisysPvt. Ltd.

MoU

30 MoUs were signed with regard to the development of COVID-19 products:

1. Origin Diagnostics and Research, Karunagappally, Kerala - Real Time PCR kit
2. Wipro Enterprises Pvt. Ltd. (Through Wipro 3D Division, Bengaluru) - EBAS
3. Agappe Diagnostics Ltd., Kochi - Detection system for Corona virus using isothermal amplification
4. HMT Machine Tools Ltd., Kerala - Isolation pods
5. Origin Diagnostics and Research, Karunagappally, Kerala - Rapid kit for COVID-19
6. HMT Machine Tools Ltd, Kerala - Disinfection Gateway
7. IIT Palakkad - Co-development of automated workflow for point-of-care portable ultrasound that can be used in the care of patients with COVID-19
8. Agappe Diagnostics Ltd., Kochi - Rapid detection kit for corona virus standardized using antibodies from convalescent plasma sourced from COVID-19 patients
9. Debrique Creative Labs Pvt. Ltd., Chennai - 4-zone strategy for the design of mediCAB housing structures for the COVID-19 pandemic
10. HLL Lifecare Ltd., Kerala - (i) Disinfection Gateway (ii) Examination Booth (iii) Sample Collection Booth
11. Technopark Employees Co-Operative Hospital, Trivandrum - Sree Chitra Disinfection Gateway
12. Indian Railways, Trivandrum Division - Sree Chitra Disinfection Gateway (non-commercial, for in-house use)
13. HMG, Mumbai - (i) Sree Chitra Disinfection Gateway (ii) Examination Booth
14. JADRO Steel LLP, Kolkata - (i) Disinfection Gateway (ii) Examination Booth (iii) Sample Collection Booth
15. Sivapriya Exim Pvt. Ltd., Chennai - (i) Sree Chitra Disinfection Gateway, (ii) Examination Booth (iii) Sample Collection Booth

16. Agappe Diagnostics Ltd., Kochi - Rapid Viral RNA Isolation Kit (CHITRA Magna)
17. TVS Supply Chain Solution Ltd., Bengaluru - (i) Disinfection Gateway (ii) Examination Booth (iii) Sample Collection Booth
18. Indiahub E-Governance Pvt. Ltd., New Delhi - Disinfection Gateway
19. Agappe Diagnostics Ltd., Kochi - Rapid Viral RNA Isolation Kit for use in RT-PCR
20. Origin Diagnostics and Research, Karunagappally, Kerala - Polyurethane swab and Viral Transport Medium (VTM)
21. Vivesty Green Recyclers Pvt. Ltd., Kozhikode, Kerala - UV-based facemask disposal bin
22. Levram Lifesciences, Mumbai - Polyurethane swab and Viral Transport Medium (VTM)
23. Mallelil Industries, Kerala - Flocked nylon swab (oral and nasal)bfor sample collection during the testing of COVID-19.
24. PMG Equipments, Hyderabad - UV-based facemask disposal bin
25. VST Mobility Solutions, Kerala - UV-based facemask disposal bin
26. Sivapriya Exim Pvt. Ltd., Chennai – UV-based facemask disposal bin
27. Tata Sons Pvt. Ltd., Mumbai - RT LAMP-based test devices (i) ChitraGeneLAMP-N device and Nanotechnology-based RNA extraction kit for RT-PCR (ii) ChitraMagna RT-LAMP-based testing
28. Kerala State Drugs Pharmaceuticals Ltd. - (i) Disinfection Gateway (ii) UV-based facemask disposal bin (iii) Examination Booth (iv) Swab Collection Booth (v) lsolation Pod (vi) Innovative sanitizing technology (sanitizer bracelet)
29. Ultimate Moulds and Products, Thrissur - Viral Transport Medium
30. Eram Scientifics, TVPM - (i) Disinfection Gateway (ii) UV-based facemask disposal bin (iii) Examination Booth (iv) Swab Collection Booth

Intellectual Property Rights

Title	Numbers
Indian Patents Granted	15
Indian Patents Filed	44
Foreign Patents Granted	1
Foreign Patents Filed	19
Design Registrations	11
Trademark Registrations	7

EXHIBITIONS

1. India Healthcare Week 2020 with the theme "Redefining Healthcare Ecosystem", a virtual exhibition organised by Confederation of Indian Industry (CII) from 17-20 August 2020. This digital exposition was an opportunity to participate in the largest ever virtual healthcare event in India showcasing the technological advancements, new products and innovations. The Institute was represented by Mr Rajkrishna Rajan, Engineer E.
2. India International Science Festival (IISF) 2020, an annual event organised jointly by DST, DBT, MoES, DHF, and CSIR from the Government of India and Vijnana Bharati (VIBHA) from 22-25 December 2020 (held on virtual platform). The Institute was represented by: Drs Anilkumar P R, Vivek V Pillai, Manoj Komath, BijuSoman, Jayadevan E R, Arun Gopalakrishnan Remya N S, Manju S, Shiny Velayudhan, Gijo Raj, Subin Sukeshan and Renjith S; Engineers - Rajkrishnarajan, Vinod Kumar V, Sarath S Nair, Sajithlal M K, Suresh Kumar B, Mr Arvind Kumar Prajapati, Amrutha C, Saurabh S Nair, Jithin Krishnan and Neethu S.

CUSTOMER SERVICE CELL

Customer Service Cell co-ordinates the internal and external testing services and study projects for the evaluation of medical devices and biomaterials.

The summary of the testing services is given in the Table below:

Description	External			Internal		
	2018-19	2019-20	2020-21	2018-19	2019-20	2020-21
Number of work orders	*391*	*565*	*679*	*300*	*374*	*288*
Number of test materials	*735*	*978*	*1062*	*945*	*1030*	*1275*
Income (Rs)	*29,31,350*	*43,04,180*	*51,16,440*	*35,07,325*	*29,73,300*	*32,90,800*

Training/Outreach Programmes

1. The Industry Institute Partnership Cell conducted the following Workshops in virtual mode for the academia and medical device industry:
   - Writing proposals for scientific projects on 16 December 2020
   - Role of standards in medical device development - significance and application on 26 February 2021
   - Intellectual Property Rights and its significance on 29 January 2021
2. Competency Development Cell (CDC) organized four training programmes during the year (Figure 52). All these programmes were conducted strictly in line with COVID-19 guidelines. Details of the programmes conducted are given below:
   - Induction training for about 33 newly joined staff of BMT Wing on 1 October 2020. They were trained on quality management system, intellectual property rights, administrative procedures of SCTIMST, internet services, bio-safety, chemical safety, electrical safety and fire safety.
   - 'Origin Pro software (Origin Pro 2020)' - the latest version of Origin Pro software was demonstrated. Around 44 participants attended this half day long virtual training program conducted on 9 October 2020.
   - 'Quality assessment of analytical measurements' on 7 November 2020. The Resource persons for this training were Mr C V Muraleedharan, Associate Head, BMT Wing and Ms Leena Joseph, Section-in-Charge, Calibration Cell. Around 23 participants attended this training.
   - One-day programme on 'Government e-Marketplace' (GeM) held on 6 February 2021. This was organised for the benefit Staff of Stores & Purchase Division, students, and faculty members of the BMT Wing. Mr Manesh Mohan, Business Facilitator GeM, Trivandrum, was the resource person for this training programme. Around 35 participants attended this training.

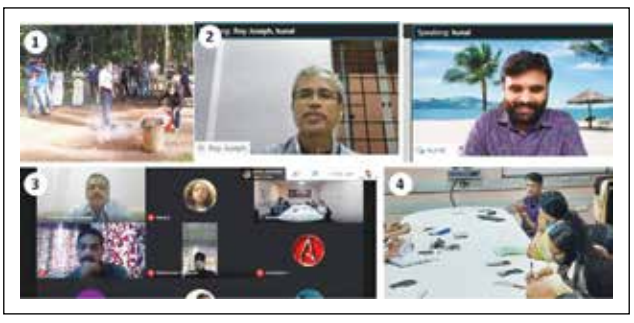


Figure 52. Four training programmes organised by the Competency Development Cell

Staff

Faculty

Mr S Balram, Scientist G and Head of the Department

Mr D S Nagesh, Scientist G (Senior Grade)

Dr Roy Joseph, Scientist G

Dr Ramesh P, Scientist G

Ms Leena Joseph, Scientist F

Dr Anugya Bhatt, Scientist F

Mr Vinodkumar V, Scientist F

Ms Sandhya C G, Engineer E

Mr Rajkrishna Rajan, Engineer E

Mr Sajithlal M K, Engineer E

Dr Arun Anirudhan V, Engineer D

Dr Renjith S, Scientist B

Technical

Dr Radhakumary C, Scientific Officer

Mr Willi Paul, Scientific Officer

Mr Arumugham V, Senior Scientific Assistant

Mr Rajesh R P, Senior Scientific Assistant

Mr Sreekanth S L, Senior Scientific Assistant

Mrs Nimi N, Scientific Assistant

Ms Asha Rani V, Technical Assistant (Instruments) - B

Mr Sajid A, Technical Assistant

Dr Sasikala T S, Technical Assistant

Mr Binu C P, Junior Engineer (MRAC)

Mr Sabu K S, Junior Engineer (Electrical)

Ms Deepa G K, Junior Engineer (Civil)

Mr Suresh N B, Junior Engineer (Civil)

Mr Sreejith L K, Junior Engineer (Instrumentation)

Mr Raju A S, Technical Assistant (Machine Operation)

Mr Krishna Prasad K, Technical Assistant (MRAC)

Mr Ranjith Kumar R, Technical Assistant (Electrical)

Mr Erlan Benanson, Technical Assistant (Electrical)

Mr Binu A U, Technical Assistant (Instruments) - A

Mr SajImon B, Junior Technical Assistant (Electrical)

Mr Selastin A J, Junior Technical Assistant (Electrical)

Mr Manu M H, Junior Technical Assistant (Electrical)

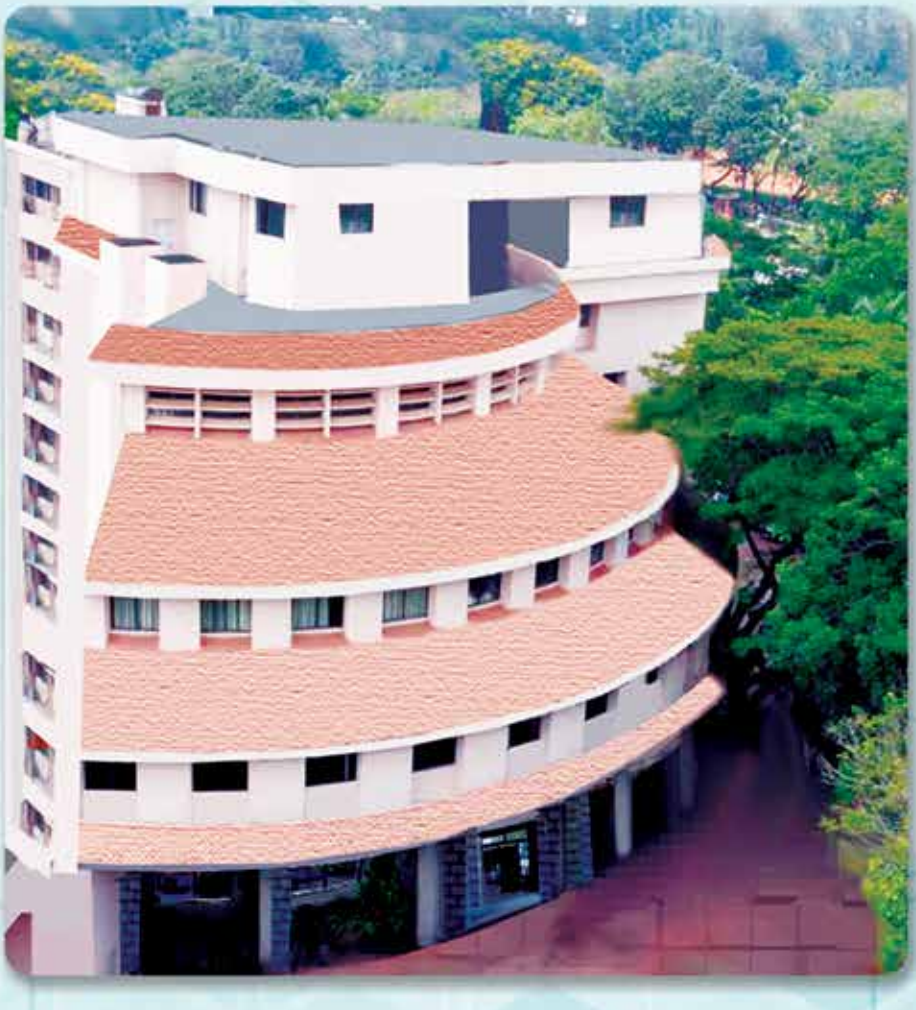
Mr Baiju S, Technician (Electrical)

Mr Babu A, Technician (Electrical)

Mr Latheesh Kumar S, Technician (Electrical)

Mr Santhosh Kumar R S, Technician (Electrical)

ACHUTHA MENON CENTRE FOR HEALTH SCIENCE STUDIES



ACHUTHA MENON CENTRE FOR HEALTH SCIENCE STUDIES

The Achutha Menon Centre for Health Science Studies (AMCHSS) is the Public Health Wing of the Institute. Since its inception in 1996, AMCHSS has been at the forefront of public health training and academic research in priority areas. It is one of the first Public Health Schools in India.

Activities

Teaching

Teaching Public Health and Allied Sciences are the main activity of AMCHSS. During the academic year 2020-21, 21 students enrolled for the two-year Master of Public Health (MPH) Programme. 19 students who joined the programme in 2019 continued their studies during this academic year. Two students also enrolled for the Diploma in Public Health (DPH) during the last academic year. 23 students graduated for the MPH degree during the academic year 2020-21.

Training

AMCHSS supported the research activities of SCTIMST by conducting short training programmes in Research Methodology. It also provided Consultancy in design of research studies and analysis of the data.

Research

The research initiatives of AMCHSS during the year were focused on the priority areas of non-communicable diseases, environmental health, tribal health, and health systems; that can influence health policies and programmes.The faculty are members of several committees in governmental and non-governmental agencies that are engaged in health.

New Research Initiatives

1. Team-based collaborative care model, facilitated by a mHealth enabled and trained nurse, for management of heart failure in India (TIME-HF)

PI: Dr Jeemon Panniyammakal (Funded by: DBT-Wellcome Trust India Alliance)

The impact of heart failure (HF) on human health is vast. It is associated with high mortality, frequent hospital readmissions and poor quality of life. Management requires frequent follow-up and attention to many health goals. Achievement of health goals is often sub-optimal. Optimal therapy, timely care for warning signs/symptoms and better adherence will improve patient survival and quality of life. It will require a team-based approach of engaging different cadres of health care providers, patients and their caregivers. Currently, there is paucity of hard evidence to support low-cost and resource-sensitive interventions to improve heart failure outcomes, and high-quality research is needed to resolve this problem. The proposed project directly builds on and expands findings from four ongoing Heart Failure Registries in India.

We propose a team-based Collaborative Care Model (CCM), facilitated by a trained nurse to rationalise the management of heart failure (HF). The patient-centred approach proposed in our study may improve uptake of guideline directed therapies, reduce hospital re-admissions and mortality. The specific aims are: Aim 1: To conduct stakeholder analyses to identify barriers and facilitators for implementing the CCM for HF management. Aim 2: To assess the effectiveness of the CCM in improving the number of days alive and out of hospital (DAOH) at two-year in comparison to 'usual care'. Aim 3: To inform the state-level scalability of the intervention model. The three design approaches include: Aim 1, formative qualitative research; Aim 2, a cluster randomized controlled trial; and Aim 3, cost-effectiveness and evaluative qualitative research.

We will use qualitative methods to develop the intervention strategy and understand acceptability, reach and impact of interventions. In the proposed cluster RCT, we will develop and test the effectiveness of a comprehensive intervention in 1,200 adult HF patients at 20 Units in India. Incremental Cost-Effectiveness Ratios (ICER) will be calculated from a health system and societal perspective. The project is likely to impact the practice of management of HF in low resource settings.

2. HPSR India Fellowship

Dr Rakhal Gaitonde was involved in the development of the HPSR Fellowship, which is a fellowship programme aimed at building a community of researchers who will not just conduct good research, but will lead the field both in the country and internationally. The Programme hopes to inspire these researchers to conduct research that is relevant for our country and use the evidence generated to change policies and practices. This Programme is not just a 'run of the mill' training programme; it is an intervention which hopes to 'transform' the health system in India. Dr Rakhal Gaitonde was involved in the overall designing, curriculum development and Module development and teaching of the Health Policy Module of the overall course.

In this Programme, AMCHSS was invited to be a part of the core group which includes Nossal Institute, Australia, Institute of Tropical Medicine, Antwerp, The George Institute, New Delhi and Institute of Public Health, Bengaluru. The overall program is hosted by Health Systems Transformation Portal (HSTP).

Ongoing Research Initiatives

1. Scaling up interventions to improve the control of hypertension and diabetes in partnership with the governments of Kerala and Tamil Nadu: Leveraging India's national non-communicable disease program

PI: Dr Jeemon Panniyammakal (Funded by: National Health and Medical Research Council, Australia)

This proposal will demonstrate, in the two Indian states of Kerala and Tamil Nadu, how low- and middle-income countries (LMICs) can achieve reach, adoption and sustainability of structured lifestyle modification (SLM) programmes to improve diabetes and hypertension outcomes. Our research will develop an evidence-based approach that better links and integrates prevention with disease management at both a community and systems level. Our approach will integrate with and strengthen both state governments' current efforts by building the capacity of the existing health workforce and supporting health systems strengthening. Our findings will also inform decision makers about: (1) How to allocate resources to different implementation strategies; (2) How to market the strategies and to whom; and (3) How much value the strategies will provide (return on investment). We will evaluate the implementation outcomes of a peer support programme and community mobilisation strategy to improve prevention and control of diabetes and hypertension (using RE-AIM framework and Theoretical framework of acceptability). The RE-AIM Framework will guide the planning and evaluation of our research in order to maximize the future public health benefits for India and other LMICs.

2. The long-term effects of a peer-led lifestyle intervention program on diabetes progression and cardiovascular risk: the Kerala Diabetes Prevention Program (K-DPP)

PI: Dr Jeemon Panniyammakal (Funded by: National Health and Medical Research Council, Australia)

The Kerala Diabetes Prevention Program (K-DPP) is one of the first peer-led structured lifestyle modification (SLM) programme for chronic disease prevention developed exclusively for people living in rural areas with limited resources, and minimum additional support. The K-DPP model resulted in a non-significant reduction in diabetes incidence at

2-year of follow-up. The current study is proposed to evaluate the effectiveness of K-DPP in terms of 7-year diabetes and cardiovascular risk related outcomes. We propose to conduct a 7-year follow-up evaluation of all original 1007 K-DPP study participants. The major objectives are as follows: (1) To understand the impact of a life style modification programme on cardiometabolic risk factors and preclinical changes in the microvasculature (retinal microvasculature and Albumin-to-Creatinine Ratio [ACR]), the reversibility of key CVD risk factors and the impact on predicted 10-year CVD risk, using the recently developed risk equation for Indians, Globorisk, (2) To undertake economic analysis to justify investments in CVD and related chronic prevention programs., and (3) To measure community engagement (CE) and programme sustainability of K-DPP.

3. Systems thinking approach to developing an integrated and patient-centred intervention model for multimorbidity care in primary care settings in India

PI: Dr Jeemon Panniyammakal (Funded by: Medical Research Council UK)

This proposal will use systems thinking approach and causal loop model to conceptualize how health systems manage patients with multi-morbidity in primary health care settings in India. Evidence will be sought from the literature by conducting a systematic review on benefits of existing interventions for patients with multi-morbidity in LMIC. An interdisciplinary research team of health system researchers, epidemiologists, and social scientists will conduct the study in two phases: (1) development of the intervention structure and causal loop modeling and (2) piloting of multi-level intervention for integrated management of multimorbidity. In the first phase, potential interventions will be identified and proposed to address gaps in the current system from patients, providers and health system perspectives. A causal loop modelling will be employed to identify feedback loops and evaluate impact of the potential interventions at the level of patients and care providers. We will also investigate ways in which the care for people with multiple chronic conditions can be organised and integrated within the community through community health workers. In the last phase (piloting), the causal loop analysis results will be linked to decision making on intervention implementation and evaluate the feasibility of the interventions.

4. Understanding disease clustering (Multi-morbidity) in the tribal population of Kerala

PI: Dr Jeemon Panniyammakal (Funded by: SCTIMST (Intra-mural), Government of India)

In this project, a cross-sectional community-based study will be conducted in three districts in Kerala (Malappuram, Wayanad and Trivandrum) to understand the pattern and distribution of multi-morbidity at individual, household and community level in the tribal population of Kerala. Further, we will explore the trajectories of common disease clusters across various age groups in the tribal population of Kerala. We will be able to develop a framework to understand multi-morbidity at the individual, family, and community level. Tackling multiple morbidities provide a greater understanding of the underlying biology, to map clusters of conditions and explore sequential and spatial relationships to identify key targets for interventions. The aim is to convert this into a cohort and follow-up them for a longer duration of time to understand the trajectories across different age groups.

5. Social, economic and health impact of industrial pollution in Dindigul district, Tamil Nadu

PI: Dr Srinivasan Kannan (Funded by: Indian Council of Social Science Research (ICSSR), Ministry of Human Resource Development, Government of India)

It is a study to understand the impact of industrialization on the rural environment and population health. The objective of the study is to study water contamination caused by tannery pollution and its effects on health, environment, and society in Dindigul district.

Specifically, the study will focus on the following: (1) Effects on livestock, agriculture, water and soil, (2) Long-term consequences of industrial pollution on the rural environment in terms of social structure, the land owning and other economic wellbeing in the areas surrounding the tanneries and (3) Specific consequences such as illnesses, deaths and other events in the villages (Figure 1).

6. Promoting engagement of scheduled tribes in health centre up-gradation in tribal areas: towards development of tribal packages in Family Health Centres under the Aardram Mission of the Government of Kerala.

PI: Dr Ravi Prasad Varma (Funded by: Department of Science and Technology -TSP)

The Aardram Mission of the Government of Kerala is an ambitious initiative for upgrading Primary Health Centres (PHCs) to Family Health Centres (FHCs) in the state in terms of better infrastructure and quality services. Health care needs of Scheduled Tribes (ST) population form a classical "triple burden" – severe malnutrition; communicable diseases like tuberculosis; and non-communicable diseases. The situation is complicated by increased levels of physical and mental disability, addictions and trauma (animal/snake bites). Existing supportive manpower (Tribal ASHA workers, tribal Anganwadi teachers, tribal promoters, literate persons from ST hamlets) can be utilised better in addressing health care needs of ST and fulfilling the Mission objectives. The Aardram Mission offers an opportunity of engaging with key ST stakeholders while developing FHCs in tribal areas – the proposed collaborative project (with State Health Systems Resource Centre, Kerala - SHSRCK) can help develop specific packages for service delivery to ST populations. In this context, the project aims to train members from ST community to foster engagement of ST in upgradation of PHCs in tribal areas as part of Aardram Mission of the Government of Kerala and to document good practices of quality improvement and service delivery to ST population in PHCs catering to ST population being upgraded as part of the Mission.

7. A worksite-based lifestyle program for reducing diabetes and cardiovascular disease in India

PI: Dr Jeemon Panniyammakal (Funded by: National Heart Lung and Blood Institute, USA)

In this Project, we will implement and evaluate the acceptability, delivery, effectiveness and cost-effectiveness of a worksite-based lifestyle improvement package in India. The study aims are: Aim 1: To measure the success of implementation and inform the scalability of this intervention programme by evaluating: (a) programme adoption by assessing participation and changes in weight and diet and physical activity behavior among lifestyle class participants, (b) fidelity to the programme by assessing activities of study-affiliated worksite staff, changes to the food options at the worksite canteen, management support for the programme and changes in the worksite environment, and (c) acceptability of the programme. Aim 2: To measure the effectiveness of the programme among participants by evaluating the change in number of individuals reaching two or more of cardiometabolic risk goals, namely reduction in blood pressure, triglycerides and HbA1c (the primary outcome), and through changes in secondary outcomes including rates of diabetes incidence and regression to normoglycemia. Aim 3: To measure the value and return on investment of the intervention for employers by assessing programme cost and cost-effectiveness and changes in staff productivity, absenteeism, health status and quality of life.

8. A family based randomized controlled trial of cardiovascular risk reduction in individuals with family history of premature coronary heart disease in India

PI: Dr Jeemon Panniyammakal (Funded by: DBT-Wellcome Trust India Alliance)

This proposal will use mixed methods (qualitative research, randomized control trial (RCT), and cost-effectiveness) to integrate cardiovascular risk management in families with positive history of premature CHD. The study aims are: Aim 1: To

identify barriers to implementing an integrated cardiovascular risk management programme in families of individuals with a positive history CHD. Aim 2: To assess the effectiveness of an integrated cardiovascular risk management strategy (consisting of screening for risk factors, lifestyle education and linkage to primary care for cardiovascular risk factor management) on risk factor clustering in families, and changes in blood pressure, lipids, glucose, smoking and physical activity. Aim 3: To estimate the scalability of the integrated cardiovascular risk reduction strategy in families of individuals with a positive history CHD for state- or nation-wide implementation. Scalability will be informed by cost-effectiveness and acceptability of the integrated cardiovascular risk reduction approach. A cluster randomized controlled trial in 1671 individuals from 750 families was the main component of this grant.

9. Mobile Telemedicine Project for Wayanad

PI: Dr Biju Soman (Funded by: Department of Science and Technology, Government. of India)

The three-year project was started in November 2017 with financial support from the Department of Science and Technology, Government of India to the tune of Rs 5.45 Crores under its tribal subcomponent plan. The Project explores the potential to use modern technologies like Telemedicine to improve secondary health care services in remote areas that tribal people inhabit. Wayanad district has the highest proportion of the tribal population in Kerala and is the only district coming under the list of aspirational districts in Kerala. We have deployed two Mobile Telemedicine Units in Wayanad and with its crew, including one medical officer, one staff nurse and a driver-cum-technician in each Unit. The Telemedicine Units had started services to all the 32 peripheral Centers, but the regular services got disrupted due to the Covid-19 pandemic situation. The facilities, including the staff, are helping the district authorities in pandemic containment activities.

We are currently working with C-DAC and the e-Health Kerala Project to streamline mobile telemedicine services with the state health system. This is very important as we should be positively handing the Units to the state system by the end of this year. We have got into a second MoU with C-DAC to facilitate these software changes and complete the Telemedicine Units pending fabrication work. We had made all arrangements to move the vehicles to the workshop at Kalamasseri, one at a time, so that there will not be any disruption of services, but extended lockdowns had hindered those efforts. In addition, the Health Technology Assessment (HTA) of the Project is still pending. The Project received a no-cost extension for one more year.

10. Efficient portable stand-alone vaccine refrigerator for rural application

PI: Dr Biju Soman (Funded by: Department of Science and Technology, Government. of India)

It is a two-year project with financial support from Department of Science and Technology, Government. of India to the tune of Rs 1.31 Crores. It was started in 2019 with a tripartite Memorandum of Agreement (MoA) with the Centre for Development of Advanced Computing (CDAC), Trivandrum, Indian Institute of Science (IISc), Bangalore and SCTIMST, Trivandrum. In this project, we aim to create two prototypes of portable refrigerators that can be used in rural areas for maintaining cold chain to safely transport vaccines and similar medicines by the field health workers. The aim is to replace the present-day vaccine carriers with these sophisticated electronic carriers that can keep the temperature for a longer duration, maintain an automatic log of the temperature readings and the number and length of openings of the device.

We have come up with the prototype, but the field testing could not be initiated due to the Covid-19 pandemic situation and frequent and extended lockdowns. Therefore, the funding agency has granted a no-cost extension for three more months.

11. The Regional Technical Resource Centre (RTRC) for Health Technology Assessment

PI: Dr Biju Soman (Funded by: Department of Health Research (DHR), Government of India)

The Regional Technical Resource Centre (RTRC) for Health Technology Assessment (HTA) was established in AMCHSS on 27 February 2018. The basic mandate vested in the Centre is to conduct HTA research for the needs specified by the DHR from time to time and to have a strong collaboration with the State Government to bring out the importance of HTA in the context of the overarching efforts of the government to achieve universal health coverage.

The initial project duration was three years, and the Department of Health Research had funded the project to the tune of Rs 143.5 Lakhs. The funding agency is impressed with our excellent work and promises to extend the Project for a longer duration.

Presently we are working on two HTAs, namely:

1. A HTA on available technologies for automatic detection of diabetic retinopathy from colour photographs of the fundus ("Nayanamritham")

2. A HTA on screening for critical congenital heart disease using pulse oximeter ("Hridyam")

12. National Environment Health Profile: a 20 city project which maps the relationship between air-pollution and health

PI: Dr Manju Nair (Funded by: Ministry of Environment, Forests and Climate Change, Government of India)

National Environment Health Profile (NEHP) is a twenty city multicentric study that aims to assess the effects of air pollution on health outcomes and to generate a model to predict the burden of health outcomes attributable to air pollution in India. The study involves an ecological longitudinal time series component, a cross sectional study and statistical modeling.

13. Delineating the role of DNA methylation in insulin resistance driven breast cancer development and progression

PI: Dr Srikant A (Funded by: Department of Biotechnology, Government of India)

Epigenetic mechanisms including DNA methylation play a crucial role in regulating gene expression without modification of the DNA sequence. Previous studies have reported associations between DNA methylation, breast cancer development and recurrence as well as between insulin resistance (IR) and altered global and site-specific DNA methylation. However, it is unclear how IR influences DNA methylation to modulate breast cancer risk. Furthermore, the mechanisms and pathways of IR driven DNA methylation changes in breast cancer development and progression remain unexplored. This Project explores the hypothesis that IR promotes breast cancer development and progression by DNA methylation-based reprogramming of genes. The proposed Project has the following specific aims: Aim 1: Conduct genome-wide DNA methylation profiling of IR and insulin sensitive (IS) cell lines to identify loci associated with breast cancer development and progression. Aim 2: Conduct genome-wide DNA methylation profiling of breast cancer tissue samples from IR and IS patients to identify progression associated loci. Aim 3: Targeted validation of DNA methylation sites associated with IR-driven breast cancer progression in surrogate tissues (whole blood and plasma) from breast cancer patients. Aim 4: Explore the functional relevance of DNA methylation differences associated with IR-driven breast cancer progression.

14. Primary Health Care preparedness and Local Self Government Institutions response in the context of COVID-19 in Kerala

PI: Dr Mala Ramanathan (Funded by: Learning Resource Allowance of PI)

This study is being undertaken in collaboration with the Director, Kerala Institute for Local Adminstration, Trissur.

This is a study to document the experiences of the Local Self Government Institutions (LSGIs) in terms of implementing the various responsibilities with respect to prevention, health promotion and mitigation of distress within their communities and the informational environment in which this happened. In addition, the study will also review the materials in the vernacular press in terms of available information on the COVID-19 pandemic and the emerging patterns of the nature and extent of information being provided.

The objective of this study is to provide policy inputs to LSGIs based on their collective experience.

Completed Projects

1. Effectiveness of drugs control and regulating mechanism of the Drugs Control Department in Kerala State
2. Availability, distribution and utilization of health care facilities in Kerala.
3. Non-Communicable disease risk factors among working population: An Institution based study in Kerala, India.

Membership in Taskforce Committees

1. Dr Rakhal Gaitonde: Member, Expert committee on COVID-19, Government of Kerala
2. Dr Rakhal Gaitonde: Member, National Task Force on COVID-19, Indian Council of Medical Research
3. Dr Rakhal Gaitonde: Member of the Public Health and Administration sub-group of the National Committee on Integration of Health constituted by the NITI AAYOG

Patent Application

An Indian Patent Application was filed for "Portable autonomous temperature-controlled medical cabinet" by Dr Biju Soman and colleagues (Subhash Joshi, Tharayparambil George, Rajiv Iyappan, Kiran Babu, Seena S Rajan, Jeysingh packiaraj K, Renji V Chacko, Vinod John, GSVL Narasimham).

Events Organized

1. AMC Seminar Series

The AMC Seminar Series is a periodic academic event with seminars held by invited national and international experts in public health. Dr Ravi Prasad Varma co-ordinated three AMC webinars:

- Dr Cherian Varghese Cross Cutting Lead for NCD and Special Initatives, Department of Noncommunicable Diseases, World Health Organization, Geneva on the topic "WHO global strategy to eliminate cervical cancer as a public health problem: an opportunity to make it a disease of the past"
- Dr Parvathi K. Iyer, Assistant Professor, Centre for Studies in Science, Technology and Innovation Policy, Central University of Gujarat, on the topic "Pharmaceuticals as 'Boundary Objects' and The Discourse of Drug Quality: Moving Beyond the Biomedical Model" on 7 January 2021
- Prof Chandni R, Professor and Head, Department of Emergency Medicine, Government Medical College, Kozhikode, on the topic "Genomics for clinical practice and public health in COVID-19" and Dr Vinod Scaria, Senior Scientist, CSIR Institute of Genomics and Integrative Biology, New Delhi, on the topic "What did we learn from the SARS-CoV-2 genomes from India" as part of the webinar on "SARS-CoV2 genome sequencing and its relevance to public health" on 20 January 2021.

2. Dr Ravi Prasad Varma delivered a radio talk on All India Radio on Micronutrient Malnutrition that was aired on 22 July 2020.
3. Dr Mala Ramanathan conducted a symposium on 'Explorations in qualitative research' with MPH student, Dr Durga Padmaja Praveena and PhD student Ms Sunu C Thomas.
4. Dr Mala Ramanathan developed Training module on 'Qualitative approaches for social innovation' for the TIMED fellows, BMT Wing,

SCTIMST, including, a two-hour training session on 'Learning to review the notes and identifying the needs using WEFT QDA'.

5. COVID-19-related activities

Dr Ravi Prasad Varma was instrumental in organizing the following Covid-19- related activities and one Radio talk:

- A webinar on Epidemiological basis of COVID-19 control strategies in English and Malayalam (along with Drs Jissa, Manju, Srikant, Rajalakshmi)
- Prepared podcasts in Malayalam for Kudumbashree Santhwanam workers and Lakshdweeep dialects (Mahal for Minicoy; Jasari – in separate dialects for Androth, Kalpeni and Kiltan) for frontline health workers of Lakshdweep
- Conducted training on infection control to staff of Department of Social Work, SCTIMST on COVID-19 on 19 April 2020
- Prepared daily reports (from April 2020 to November 2020) of high-risk districts and containment zones for COVID-19 epidemiological screening and triage of patients attending SCTIMST

Awards and Honours

1. Dr Jeemon Panniyammakal was awarded the Senior Clinical Fellowship from the DBT-Wellcome Trust-India Alliance (IA)
2. Dr Jeemon Panniyammakal was awarded a one-year Editorial Fellowship from the Annals of Family Medicine. He joined their editorial team as an Associate Editor. Annals of Family Medicine is rated as the number one family medicine journal and it is coordinated by the University of Michigan, USA.
3. Dr Gurpreet Singh, PhD scholar won the 1st Prize in the category of PhD. Awards for the paper entitled "Development and use of a reproducible framework for spatiotemporal climatic risk assessment and its association with the decadal trend of dengue in India" at the 48th Annual National Conference of Indian Association of Preventive & Social Medicine (IAPSMCON 2021), held at PGIMER, Chandigarh, from 19-21 March 2021.
4. Dr Arun Mitra, PhD scholar won the 1st Prize for the paper entitled "Data issues in administrative and survey data; an illustration during routine data of under-five malnutrition" at the IAPSM Young Leaders' National Conclave 2021, held at MGIMS, Sevagram, from 26-27 March 2021.
5. Dr Ranjana Ravindranath, PhD student was awarded the prestigious Health Policy Analyses Fellowship by The Alliance for Health Policy and Systems Research (the Alliance), an international partnership hosted by the World Health Organization.
6. Dr Jeemon Panniyammakal was awarded membership in the Research Foundation-Flanders (FWO) Review College. FWO is a public utility foundation based in Belgium and a reference for quality and reliable fundamental scientific research in the European region.

Faculty

Dr Sankara Sarma P, Professor and Head of the Department

Dr Mala Ramanathan, Professor

Dr Biju Soman, Professor

Dr Srinivasan K, Professor

Dr Rakhal Gaitonde, Professor

Dr Ravi Prasad Varma P, Associate Professor

Dr Jeemon Panniyammakal, Assistant Professor

Dr Srikant K, Assistant Professor

Dr Manju R. Nair, Scientist C

Dr Jissa V T, Scientist C

(A)

(B)

Figure 1. Project Investigator conducting training for research staff (A) and in-depth interview of village leaders in school (B)

DIVISION OF ACADEMIC AFFAIRS

DIVISION OF ACADEMIC AFFAIRS

The Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, continues to be a much sought-after destination for super speciality courses leading to DM or MCh Degrees in Cardiac and Neurosciences and post-graduate degree in Public Health. This is also one of the few institutions that offer Post-Doctoral Fellowship Programmes in subspeciality areas of Cardiac and Neurosciences. In addition, the Institute offers post-graduate and PhD courses in Medical, Biomedical and Health Sciences. Further, we have Diploma and PG Diploma courses in related areas.

Activities

Programs offered during 2020-21

Post-doctoral Programmes

1. DM Cardiology
2. DM Neurology
3. DM Neuroimaging and Interventional Neuroradiology
4. DM Cardiovascular Imaging and Vascular Interventional Radiology
5. DM Cardiothoracic and Vascular Anaesthesia
6. DM Neuroanaesthesia
7. MCh Cardiovascular and Thoracic Surgery
8. MCh Vascular Surgery
9. MCh Neurosurgery (after M S)
10. MCh Neurosurgery - 5-year course (after MBBS and 1-year Senior house surgency/ Residency in General Surgery)
11. Post-doctoral Certificate Course in Cardiothoracic and Vascular Anaesthesia
12. Post-doctoral Certificate Course in Neuroanaesthesia
13. Post-doctoral Certificate Course in Diagnostic Neuroradiology
14. Post-doctoral Certificate Course in Vascular Surgery
15. Post-doctoral Fellowship (Post DM/MCh/ DNB)

PhD/Master's Programmes

1. MD in Transfusion Medicine
2. Master of Public Health (MPH)
3. M Phil (Biomedical Technology)
4. PhD (Full-time) & (Part-time)

Diploma Programmes

1. Diploma in Public Health
2. Diploma in Cardiovascular and Thoracic Nursing
3. Diploma in Neuro Nursing
4. Diploma in Operation Theatre and Anaesthesia Technology
5. Diploma in Advanced Medical Imaging Technology

PG Diploma Programmes

1. Cardiac Laboratory Technology
2. Neuro-Technology
3. Medical Records Science
4. Clinical Perfusion
5. Blood Banking Technology

Advanced Certificate Programmes

1. Advanced Certificate Programme in Physiotherapy in Neurological Sciences
2. Advanced Certificate Programme in Physiotherapy in Cardiovascular Sciences

Other Programmes

Joint Programmes with other institutions (IIT Madras and CMC Vellore)

1. M Tech (Clinical Engineering)
2. PhD (Biomedical Devices and Technology)

Affiliated Programmes conducted at other Centres

A. National Institute of Epidemiology, Chennai

1. Master of Public Health (Epidemiology and Health Systems)

B. Christian Medical College, Vellore

1. MS Bioengineering
2. PhD in Bioengineering/Biomedical Sciences
3. Master of Public Health (MPH)

C. Indian Institute of Information Technology & Management - Kerala, Trivandrum

1. PhD (Imaging Sciences & Technology)

Indian Institute of Public Health, New Delhi

1. Master of Public Health
2. PhD (Health Sciences)

Admission Process

Admissions to various programmes of study is regulated by policy and procedures approved by the Academic Committee of the Institute from time to time. The Admission announcement is published all over India through advertisements in leading newspapers during the 1st week of September every year and in the Institute website. The annual selection process for admission to postdoctoral, doctoral, postgraduate and diploma programmes was carried out in the months of November and December. The selection for PhD (Fellowship holders), Master of Public Health and Diploma in Public Health was conducted in June 2020 and M Phil (Biomedical Technology) in July 2020.

The newly admitted students were welcomed at a function held on 8 January 2021 where the Director, Dean and various senior faculty members addressed them.

The Orientation Programme for the Senior Residents was conducted online from 22 February 2021 to 6 March 2021. The student community attended national and international conferences, and brought laurels to the Institute by winning best oral and poster presentation awards.

Number of students enrolled from 01.04.2020 to 31.03.2021

In total, 205 students joined in the academic year 2020-21. The details of the students/residents admitted to various academic programmes from April 2020 to March 2021 are summarized in the Table below:

Programme	Number of students
DM	23
MCh	12
PDF	13
PDCC	5
MD	1
MPH (SCTIMST)	21
MPH (IIPH, New Delhi)	50 (pending GB approval)
MPH (NIE, Chennai)	0
MPH (CMC, Vellore)	2
PhD (BMT/Hospital/AMCHSS)	19
M Tech	12
DPH	2
M Phil	6
MS Bioengineering	0
Diploma/PG Diploma/Certificate	39

The total strength of students on the rolls of the Institute (including the joint programmes and affiliated programmes) as on 31 March 2021 was 424.

Short-Term Training/Observership

The Institute provided short-term training/ observership to candidates sponsored by Government/Autonomous Institutions, Health Sector Organizations, Approved Medical/Dental/ Nursing/Engineering Colleges and other Paramedical Institutions. The training/observership was arranged in consultation with the respective Department/ Discipline. Observers from various institutions all over the country spent periods ranging from 15 days to 3 months in different Departments of the Institute. A total of 33 observers completed their observership at SCTIMST during the year.

Annual Convocation

The Annual Convocation Ceremony for the 36th batch of graduates was not conducted in 2020 due to COVID-19 pandemic. 176 students received their degrees/diplomas/ certificates during the year 2019-2020.

Degrees/Diplomas/Certificates Awarded during the year 2020-2021

In total, 191 students were eligible to receive degrees/ diplomas/certificates during the period 2020-2021.

Programme	Number
DM	20
MCh.	11
PDF	9
PDCC	5
MD	1
M Tech	0
DPH	1
MPH (SCTIMST)	23
MPH (IIPH, New Delhi)	43
MPH (CMC, Vellore)	10
MPH (NIE, Chennai)	10
PhD (BMT/Hospital/AMCHSS / IIITMK)	21
M Phil (SCTIMST)	4
MS Bioengineering	5
Diploma in Cardiovascular & Thoracic Nursing	7
Diploma in Neuro nursing	4
PG Diploma in Blood Banking Technology	2
PG Diploma in Clinical Perfusion	1
PG Diploma in Cardiac Laboratory Technology	3
PG Diploma in Medical Records Science	2
Diploma in Advanced Medical Imaging Technology	3
Diploma in Operation Theatre and Anaesthesia Technology	1
PG Diploma in Neuro Technology	4
ACP in Physiotherapy in Cardiovascular Sciences	1

National Science Day 2021

National Science Day 2021 was celebrated on 1 March 2021 at Biomedical Technology Wing (Figure 1). The theme of this year was "Future of STI: Impact on Education, Skills and Work". Sixty students from the Government Women's College, Thiruvananthapuram, attended the programme. Dr K Jayakumar, Hon'ble Director, SCTIMST presided over the function. The Chief Guest, Dr Rakesh K Mishra, Director of CSIR-Centre for Cellular and Molecular Biology, Hyderabad, delivered the Science Day message and explained the contributions made by the scientific community to the pandemic situation and how science is tackling COVID-19. As part of Science Day activities, Prof Harikrishnan S, Department of Cardiology, SCTIMST gave an introduction about Science Day to the students. He presented the road map of the various therapeutics used in the treatment of COVID-19 starting from the repurposing of drugs to the development of various vaccines. The Science Day Quiz Programme was conducted by Dr Renjith S, Scientist B, Central Analytical Facility, BMT Wing. Additionally, a Science Magic Show was performed by Dr Gijo Raj, Scientist C, Division of Polymeric

Medical Devices, BMT Wing. Finally, the participants visited different laboratories at BMT Wing to learn about their facilities and research activities.

Online Activities

During the year, examinations, thesis evaluations and answer sheet evaluations were conducted online

Figure 1. National Science Day Celebration

through dedicated and secure portals managed by the Computer Division of the Institute. All admission procedures were made online. This was made possible using the indigenously developed online software, 'Moodle'. The Institute now has the facility to conduct the entrance examination online through our indigenously developed software. Dissertation/thesis evaluation and answer sheet evaluations were made online through our indigenously developed software, 'Examinator'.

Progressive use of Hindi

The Institute complied with the provisions relating to the Official Language Act, Rules and instructions and directives of the Government of India. During the year, various competitions in Hindi like calligraphy, short story writing and essay writing were held for the employees. Hindi Fortnight/Hindi Day was observed (Figure 2). The Institute participated in the Town Official Language Implementation Committee (TOLIC) Meeting. 'Chitralekha', the in-house Hindi magazine was selected for the Rajbhasha Award under special category in 2019-2020 (Figure 3). Staff of the institute also participated in the TOLIC Rajbhasha competition and Ms Dimple Gopi, Librarian-cum-Documentation Officer, won the 2nd Prize in Essay Competition (Figure 3). SCTIMST organized quarterly Official Language Committee Meetings and submitted quarterly progress report to TOLIC and DST, Government of India. All the technical terminologies and 'Quote of the Day' were published in Hindi on the institute website and notice board for the awareness of the staff members. Hindi Cell organized training/Workshop on typing, noting and drafting in Hindi for the staff of the institute.

Figure 2. Conduct of Hindi Fortnight at the Institute

Figure 3. Dr Jayakumar K, Director, SCTIMST, Dr Santhosh Kumar B, Registrar SCTIMST and Mrs Dimple Gopi, Library-cum-documentation officer are receiving the memento/ certificate/award from V Rajarajan, Chief Postmaster

Faculty

Prof Jayakumar K, Director and Chairperson

Prof Ajit Kumar V K, Dean of Academic Affairs

Prof Prasanta Kumar Dash, Associate Dean (Student and Faculty Affairs)

Prof Kesavadas C, Associate Dean (Research and Publication Cell)

Prof Manikandan S, Associate Dean (Examinations and Curriculum)

Dr Mohanan P V, Associate Dean (PhD Program)

Prof Biju Soman, Associate Dean (Health Sciences)

Dr Santhosh Kumar B, Registrar

Ms Radha M, Deputy Registrar

Staff

Ms Chithra T S, Assistant Administrative Officer (Academic)

Mr Sarath Sam S S, Executive Assistant

Ms Smitha P M, Executive Assistant

NURSING EDUCATION

The Division co-ordinates the nursing-related educational programmes of the Institute.

Activities

During the year, 28 students, 17 Cardiovascular and Thoracic Nursing and 11 Neuro Nursing students were undergoing the speciality programme. Out of 17 students in the second year, 10 students graduated in December 2020.

Activities related to COVID-19

Training classes on use of face masks, donning and doffing of PPEs in Covid Care Areas, and steps of hand hygiene on one-to-one basis were organized for nurses and support staff including unit helpers and cleaning assistants. The COVID-19-related Questionnaire used to screen patients attending OPD, information on use of disinfectants and preparation of inpatient care areas and public places were translated to Malayalam language for easy uptake. Nursing students were also involved in the preparation of face shields during the pandemic period.

Other Activities

A Nurses' Day video was prepared by students to convey their gratitude to all nursing officers of the Institute.

Clinical Observership

One MSc Nursing student underwent clinical observership. Due to COVID-19 pandemic, no Observership was encouraged after March 2020.

Science Outreach Programme

Mrs Suja L Raj was the resource person for the talk "Nursing management- patient on mechanical ventilator" in the webinar titled "Critical care Nursing Trends, Essential Skills For Nurses to Succeed" organized by SUM Nursing College, Siksha O Anusandhan, Orissa on 25 June 2020.

Awards and Honours

Ms Jincy Mamachan, euro Nursing student won 2nd Prize for paper presentation at the 3rd Asian Congress of Neuronursing, Chennai on 12-13 December 2020.

Staff

Ms Suja Raj L, Lecturer in Nursing

LIBRARY, HOSPITAL WING

The Hospital Wing library has a collection of 16002 books and 15870 back volumes of journals. During the year, the library subscribed to 110 journals. Electronic access to the journals subscribed was activated and made available in both campuses.

Being part of National Knowledge Resource Consortium (NKRC), the library continued to get access to the full-text of selected journals from Elsevier, Wiley, Springer, Oxford University Press, American Chemical Society, Royal Society of Chemistry, Nature Publishing Group, Taylor & Francis and so on, databases of Web of Science and ASTM Standards.

The publications of our Institute from 1977 onwards were listed in the library website with an interface to search by date, department and author. The average impact factor of the journals in which the articles were published was also made available.

Staff

Ms Sudha T, Librarian-cum-Information Officer - A

Ms Dimple Gopi, Librarian-cum-Documentation Officer - A

Mr Jayamohan C S, Librarian-cum-Documentation Assistant - B

Ms Seema S, Librarian-cum-Documentation Assistant - B

LIBRARY, BMT WING

The library of the Biomedical Technology Wing has 11420 books, 6019 back volumes and subscribes to 51 journals. The library continued to subscribe to ASM Medical Materials Database, a comprehensive, peer-reviewed database providing a single relational resource to summarize scientific and engineering knowledge on implantable medical materials data to support surgical, cardiovascular, orthopaedic, and neurological medical device design developed by ASM International. The library has a good collection of standards and patents. The standards essential for the Quality Management System and R&D activities of BMT Wing were updated regularly.

The Document Archiving Cell forms part of the library and the Librarian-cum-Documentation Officer acts as the Document Archivist.

Staff

Mr Anil Kumar C, Senior Librarian-cum-Documentation Officer - A

Mr Joy Vithayathil, Senior Librarian-cum-Documentation Assistant - B

MEDICAL ILLUSTRATION

Medical Illustration focuses on clinical photography, event photography and audiovisual aid in connection with academic and medical research activities.

The Section documented/archived clinical images, operations, treatment procedures and patient progress during the stages of treatment with patient consent. These images were used for teaching, training, publication or research purposes. In addition, the Section undertook photography at institute functions, events and meetings; location photography, medico-legal photography and creative studio work. We also created figures, charts, posters, and other resources used for annual reports, scientific journals, teaching, research and development activities.

Audiovisual services such as web streaming, video conferencing and live broadcast services were also provided. Computer-based audiovisual equipment was used in clinical education, national and international conferences and seminars. In addition, Medical Illustration assisted the Computer Division for live video conferencing of meetings during the pandemic.

Staff

Mr Liji Kumar G, Scientific Officer

Mr Viji Kumar N, Projectionist

REPORT ON SCTIMST RESPONSE TO COVID-19

COVID-19, the novel corona virus continued to shake the world for the second consecutive year. Here, the entire SCTIMST Family came together to participate and contribute in this fight against COVID-19. The Institute, with its unique combination of Hospital, Biomedical Technology and Public Health Wings focused on multiple aspects that included patient care with strict COVID-19 protocol, COVID-19-oriented research and technology development and public health initiatives and awareness programmes.

The Institute also initiated vaccination for the staff in the months of February and March 2021 as per the Government guidelines.

The activities of the Institute related to the COVID-19 pandemic are compiled in this Section.

1. Technology Development

The Institute identified solutions in terms of the diagnosis, care and prevention to curtail the disease burden. The products were designed, prototyped, conducted limited validations and expression of interest were invited from industries to take them forward through the remaining validations, scale up and manufacture with technical support from the Institute. The Health Minister of Kerala and officials of Kerala State Drugs and Pharmaceuticals visited the Institute to discuss about taking the technologies forward.

♦ **The following technologies developed by the institute were commercialised:**

- **EBAS-Emergency Breathing Assist System**

  'AirBridge', the Wipro3D Chitra Emergency Breathing Assist System (EBAS) was launched by Dr V K .Saraswat, Hon'ble President of the Institute and Member, NITI Aayog, through video conferencing on 7 July 2020. The product was unveiled by Mr Pratik Kumar, CEO, Wipro Infrastructure Engineering and Executive Director, Wipro Enterprises and Ajay Parikh, Wipro Enterprises. Prof Asha Kishore, Director of the institute, gave an introduction about the device and its intended use in patients with moderate to severe breathing difficulty while awaiting mechanical ventilation.

- **Rapid Viral RNA Isolation kit – Chitra Magna**

  The commercial launch of Agappe Chitra Magna, a magnetic nanoparticle-based RNA extraction kit for use during testing for detection of COVID-19 was announced by Dr V K Saraswat, Hon'ble President of the Institute and Member, NITI Aayog, at a programme attended by Prof Ashutosh Sharma, Secretary, DST, Government of India, through video conference on 21 May 2020. The RNA extraction kit was developed by the Institute and manufactured by Agappe Diagnostics Ltd. It is the first indigenous magnetic nanoparticles-based extraction kit in the market and is different from the imported kits based on magnetic particle based- technologies.

- **Nylon flocked swabs - nasopharyngeal and oropharyngeal**

  The technology for Nylon flocked swabs, nasopharyngeal and oropharyngeal for COVID-19 testing was transferred to M/s Mallelil Industries. The Industrial partner obtained their manufacturing license soon after the technology transfer and is now successfully developing almost 1 lakh pieces per month at their Facility. The swabs are being sold to diagnostic labs both in Kerala and other states. They are available as sterile, ready-to-use devices with both the nasal and oropharyngeal swab variants.

- **UVC-based face mask disposal bin/ multipurpose bin**

  Bin-19 face mask disinfection bin and UV REPORT Spot multipurpose disinfector based on technology know how from the institute was launched by VST Mobility Ltd., Kochi on 8 June 2020. The two devices were formally launched by Ernakulam District Collector, S Suhas by installing a unit at his office, the administrative headquarters of the district.

- **Viral Transport Medium**

  The technology was transferred to three industries. M/s Origin Diagnostics and Research successfully launched the product and commercialised in India and exported to other countries.

- **Four-zone strategy for the design of mediCAB housing structures for COVID-19**

  The four-zone layout by the institute helps to separate the suspected, positive and critical patients. The deployable hospital is customisable and can be transported and deployed during emergency and disaster management. The four zones are: (1) Health workers zone (2) Suspected Zone (3) Ward for Positive patients (4) ICU. The design requirements for the negative pressure deployable units were derived from International Health Facility Guidelines (IHFG) and Guidelines for setting up ward and isolation facility by the Ministry of Health, Government of India. The institute signed a MoU with Modulus, a start-up in IIT Madras Research Park for a collaborative effort for developing deployable field hospital structures to combat COVID-19.

- Sample Collection Booth and Examination Booth

♦ **The technology was commercialised by M/s HLL Lifecare Ltd.**

- The following technologies developed by the Institute were transferred to industry:
- Infected secretion solidification system (Chitra Acylosorb) to M/s Romsons Scientific and Surgical Pvt. Ltd., Uttar Pradesh
- RT LAMP-based COVID testing device to M/s Tata Sons Pvt. Ltd., Mumbai and M/s Agappe Diagnostics Ltd., Kochi
- Isolation pods to M/s HMT Machine Tools Ltd., Kerala.
- UV-based facemask Disposal Bin, Examination Booth, Swab collection Booth, lsolation Pod and Innovative sanitizing technology (sanitizer bracelet) to M/s Kerala State Drugs Pharmaceuticals Ltd.

♦ **Low- cost Portable Ventilator**

The work on low-cost portable ventilator developed by the BMT Wing progressed:

- Clinical trial of Intubation Box prototype was initiated
- Clinical evaluation and design improvement of Helmet CPAP System was underway
- Hand-held capnography for pediatric intubations was launched for CHICU, CMICU and Pediatric Cath Labs.

♦ **MoU**

30 MoUs were signed with various industrial partners with regard to the development of COVID-19-related products.

♦ **ICMR designated Validation Centre**

The Institute was designated by ICMR as Validation Centre for COVID-19-related products. The Institute successfully completed evaluation of products such as

antimicrobial coating, surface disinfectant, UV-based devices from manufacturers across India.

2. MEDICAL SERVICES

The essential and emergency services of the Hospital Wing continued unhindered all through the pandemic.

♦ Patient Care

All the clinical departments started tele-consultations for patients in accordance with the prepared protocols. Standard operating procedures (SOP) were prepared by all departments involved in patient care and strictly followed to ensure uninterrupted services to the patients. Patients were issued advisories and certificates for obtaining COVID-19 vaccines.

♦ Infection Control

The hospital continuously monitored the progress on Infection control in managing the crisis on a dayto-day basis. Strict guidelines were followed with a stringent reporting mechanism. Team of experts in the hospital published manuals and guidelines related to COVID-19 which was updated from time to time and published to make it available to all concerned. The following COVID-related protocols were prepared, implemented and publicized for health care workers.

- Risk grading of patients, PPE Guidelines and protocols for Aerosol handling in operation theatres, Cath labs, Imaging suites and ICUs.
- Clinical protocol for management of patients in operation theatres and ICUs.
- Airway management protocols and guidelines on sterilization of airway and anaesthesia equipment in management of COVID-19 patients.
- Guidelines and protocols for transport of COVID-19 patients in the hospital and management protocols for various diagnostic procedures.

♦ Implementation of Digital Technology

- Remote access to MRI workstation was made available for assisting the MRI technicians and reducing patient contact.
- Review of images through PACS workstation by consultants and communications made through the digital route were encouraged to minimize contact. Remote image consultation was made available by implementing a VPN network.
- A separate logbook was maintained for portable X-ray machine's downtime (for decontamination and passive air exchange) for controlling the spread of COVID-19.
- UV lights were installed in the CT room to assist in disinfecting the room, if COVIDpositive patients or patients suspected to have COVID were imaged with CT.
- SMS service was created for informing the primary patient contact on daily updates of patients.
- Arranged video conferencing sessions for all Infection Control Team members and senior faculty with Director to monitor the progress of COVID-19 care in the hospital.
- A separate web page for COVID-19-related orders and guidelines issued by the Institute was created. This page was also updated with all government orders, circulars and hotspots.
- Software was developed to conduct patient consultation (with online payment) through the existing Electronic Medical Records (EMR) software as Video Consultation/ Telephone conversation with facility to send prescription as SMS link. In addition, a mobile app for video consultation was also implemented.
- New computing units having video conferencing feature were installed in outpatient departments.
- Established a Video Conference System based on Jitsi (meet.sctimst.ac.in) and a Virtual Classroom setup powered by Big blue button (vclass.sctimst.ac.in).
- "SCTIMST Examinator", a new online portal for the Division of Academic Affairs for collecting question papers online and evaluating answer sheets and thesis evaluation was implemented.
- Meetings convened by various departments and recruitments were made online. Modified

purchase and store modules were developed 182 SCTIMST Annual Report 2020-21 to mark the purchases and Store issues related to COVID-19.

♦ COVID Lab

The State Government had included this lab as one of its approved free testing facility in April 2020 and continued its work during the year. From 1 April 2020 to 31 March 2021, the Lab had performed RT-PCR for SARS CoV2 on 49410 samples from the State and 22148 from the Institute and issued Reports. In order to handle the increasing sample load, the BMT Wing COVID testing team was also involved in the testing process. They performed RT-PCR for SARS CoV2 on 3574 samples and reports were issued.

3. OUTREACH PROGRAMMES

The following programmes conducted by the Institute in connection with COVID-19 pandemic were covered by the media, both in Malayalam and English languages:

- Link between smoking and COVID 19
- Cardiovascular disease co-morbidity scare during the COVID-19
- Heart in the Time of COVID-19
- COVID-19 and elderly care
- COVID-19 and Lockdown: The divergent trajectory of interstate migrants
- Public health framework and its intersections with society while dealing with the pandemic
- Precautions during COVID-19
- Podcasts for the lay public on COVID-19
- Information leaflet on lockdown for womens' groups
- Obsessive compulsive hygiene, a Bioethics perspective

4. TEACHING AND TRAINING

All activities of the Division of Academic Affairs such as regular classes, training programmes, conduct of examination, evaluation of thesis, uploading and downloading question papers prepared by examiners, entrance and exit examinations, PhD Viva were carried out in online mode in the wake of the pandemic. This was facilitated by indigenous software developed by the Computer Division of the Institute.

5. COVID VACCINATION

The COVID-19 Vaccination Programme for staff, students, pensioners and dependents of the institute starting from 30 January 2021 as per Government guidelines.

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BOOK CHAPTERS

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EXTERNALLY-FUNDED RESEARCH PROJECTS (ONGOING)

Hospital Wing

Title of the Project	Principal Investigator	Funding Agency	Total Outlay (Rs in Lakhs)	Duration
Quantitative EEG and multi-model neuro imaging biomarkers of memory dysfunction in epilepsy	Dr Sanjeev V Thomas	D S T	66.42	3 years
Prospective study of patients undergoing micro neurosurgical procedures through a midline inter-hemispheric transcallosal approach	Dr Mathew Abraham	Chitra Alumni Educational and Research Foundation	8.76	3 years
Predictors of visual outcome and recurrence following surgical resection of medial sphenoid wing meningiomas	Dr Mathew Abraham	Chitra Alumni Educational and Research Foundation	4.00	3 years
ISCHEMIA: International Study of Comparative Health Effectiveness With Medical and Invasive Approaches	Dr Ajit Kumar V K	National Institutes of Health, USA & New York University School of Medicine	23.75	5 years
Tichval-2 Pilot Study TTK Chitra Titanium Heart Valve (Model –Tc2) Clinical Pilot Study	Dr Jayakumar K	TTK Health Care	102.00	5 years
Centre for Advanced Research and Excellence in Heart Failure - overall management of the Project	Dr Harikrishnan S	I C M R	50.43	5 years
Centre for Advanced Research and Excellence in Heart Failure - Biobank	Dr Harikrishnan S	I C M R	51.47	5 years

Centre for Advanced Research and Excellence in Heart Failure - NGS Genetics	Dr Harikrishnan S	I C M R	30.08	5 years
Centre for Advanced Research and Excellence in Heart Failure - National HF Database	Dr Harikrishnan S	I C M R	5.35	5 years
Centre for Advanced Research and Excellence in Heart Failure - Economic Impact	Dr Harikrishnan S	I C M R	19.02	5 years
Centre for Advanced Research and Excellence in Heart Failure – Quality of Life	Dr Harikrishnan S	I C M R	60.29	5 years
Centre for Advanced Research and Excellence in Heart Failure - NT proBNP Point-of-Care device development	Dr Harikrishnan S	I C M R	48.73	5 years
Centre for Advanced Research and Excellence in Heart Failure - Structured Physical Training	Dr Harikrishnan S	I C M R	16.07	5 years
Trivandrum Heart Failure Cohort	Dr Harikrishnan S	I C M R	17.84	5 years
National Heart Failure Registry	Dr Harikrishnan	I C M R	149.17	3 years
A resting state fMRI and Task-based fMRI	Dr Kesavadas C	G E Technology Centre	09.00	3 years
An automated lung ultrasound workflow for continuous monitoring and diagnostic assistance	Dr Kesavadas C	S E R B	5.94	2 years
Comprehensive and novel model for health care on geriatric pain conditions in India	Dr Subin Sukesan	Kusuma Trust, U K	£ 41000	5 years
Establishment of the India Stroke Clinical Trial Network (INSTRuCT)	Dr Sylaja P N	I C M R	54.35	4 years

Improving Stroke Care in India (IMPROVISE)	Dr Sylaja P N	N I H R, UK	£ 48382	4 years
Ayurvedic treatment in the rehabilitation of ischemic stroke patients in India: A Randomized Controlled Trial (RESTORE)	Dr Sylaja P N	I C M R	104.78	3 years
Improvement of secondary prevention in stroke survivors by a primary health care approach	Dr Sylaja P N	I C M R	7.27	3 years
HTA of National Stroke Care Registry Programme: Development of hospital based stroke registries in different regions of India	Dr Sylaja P N	I C M R	5.00	5 years
Improvis-ation (Improving stroke care in India – Advancing the INSTRuCT Operations and Network)	Dr Sylaja P N	N I H R, UK	14.30	1 year
Incidence, prevalence, risk analysis of dementia and basic research thereof	Dr Ramshekhar N Menon	DBT through NBRC	36.42	3 years
Genetics of complex pediatric epilepsy syndromes: Electro-clinico imaging based genotype-phenotype correlations in an Indian cohort	Dr Ramshekhar N Menon	I C M R	99.30	3 years
Real time assessment of shift of ICA during extended endoscopic skullbase surgery using intraoperative doppler and the role of tumour consistency in causing ICA displacement	Dr Prakash Nair	S E R B	18.64	3 years
Prospective single arm, multi-center, observational registry to further validate safety and efficacy of Ultimaster DES system in unselected patients representing everyday clinical practice	Dr Bijulal S	Terumo India Ltd.	11.74	18 months

Comprehensive Care Centre for Neurodevelopmental Disorders	Dr Soumya Sundaram	Federal Bank Hormis Memorial Foundation	219.00	5 years
Emotional Face Recognition: Understanding the underlying neural connectivity in high functioning adolescents with autism	Dr Soumya Sundaram	D S T	16.98	2 years
Exploring the human gut microbiome and metabolome in health and Parkinson's disease- a window to the gut microbiota brain axis alterations in Parkinson's disease	Dr Syam K	I C M R	5.77	3 years
Quantitative estimation of regional brain iron deposition- a potential biomarker for Parkinson`s disease and other neurodegenerative conditions causing atypical Parkinsonism	Dr Syam K	D B T	18.73	3 years
Enhancement of Research and Clinical resources of Movement Disorder Program under the Comprehensive Care Centre for Movement Disorder, SCTIMST	Dr Syam K	Dr T S Ravikumar Foundation, USA	16.77	5 years
Encoding of interhemispheric interactions in mirror dystonia: a window to the physiology of dystonia	Dr Divya K P	Dystonia Medical Foundation, USA	US $ 36000	4 years
Deciphering the genetic architecture of Parkinson`s disease in Indian population	Dr Divya K P	Michael J Fox Foundation, USA (US $ 46992 to SCTIMST)	US $ 299922	2 years
Genetic architecture of Parkinson's disease in India	Dr Divya K P	Michael J Fox Foundation, USA	375.00	3 years

Effect of combined visual-auditory-sensory stimulation using a structured protocol in hemineglect following right hemispheric ischemic stroke: a randomized controlled trial	Dr Sajith S	Centre for Disability Studies	4.00	18 months
Structural and functional imaging correlates of cognitive dysfunction in relapsing remitting multiple sclerosis	Dr Sruthi S Nair	D S T	32.15	3 years
Can cadiovascular patients with obstructive sleep apnea have adverse perioperative outcomes - A prospective study	Dr Sapna Erat Sreedharan	Resmed Foundation	3.80	2 years
Prevalence of atrial cardiopathy in cryptogenic strokes in comparison with strokes of known etiology – A prospective study	Dr Sapna Erat Sreedharan	I C M R	3.51	3 years
Dynamic modelling of α-synucleinopathy pathology using hiPSC-derived cerebral organoids for biomarkers and drug screening application	Dr Divya M S	National Centre for Biological Sciences	37.80	2 years
Molecular, clinicoradiologic and pathological characterization of oligodendrogliomas with CIC and FUBP1 mutations	Dr Deepti A N	S E R B	47.18	3 years
DNA methylation profiling of gangliogliomas and dysembryoplastic neuroepithelial tumors	Dr Rajalakshmi P	S E R B	50.38	3 years
An obligate role for Discoidin Domain Receptor 2 in cell cycle progression and apoptosis resistance in cardiac fibroblasts	Dr Neethu Mohan	D B T	39.87	3 years

Role of connexins in cardiac fibroblast phenotypic transformation and extra cellular matrix synthesis in cardiac diseases	Dr Neethu Mohan	I C M R	14.37	3 years
Regulation of progenitor cell function in heart by angiotensin	Dr Neethu Mohan	I C M R	19.73	3 years
Three dimensional printing in congenital heart disease	Dr Kapilamoorthy / Dr Kesavadas C	S E R B	38.12	3 years
Resting state functional magnetic resonance imaging and its cognitive correlates in patients with intracranial dural arteriovenous fistulas before and after interventional therapy	Dr Bejoy Thomas	D S T	22.68	3 years
Virtual reality-based solution for effective neuroanatomy teaching	Dr Kapilamoorthy / Dr Kesavadas C	S E R B	106.52	3 years
Development of portable low-cost disposable defibrillator for cardiac arrest management	Dr Manikandan S	D S T	12.95	2 years
General Anesthesia vs Sedation -Cognitive decline in elderly - A randomized controlled trial in patients with chronic subdural hematoma (GAS-CDE)	Dr Smita V	D S T	26.42	3 years
Transcriptional and translational regulation of periostin and its interaction with DDR2 in cardiac fibrosis	Ms Sruthi Radhakrishnan	D S T	19.44	3 years
A prospective cohort study on cerebrospinal fluid (CSF) diversion catheter related infections in a tertiary referral neurosurgical care center	Dr Dinoop K P	I C M R	12.29	2 years

Contemporary outcomes in cardiac channelopathies guided by genotype-based management	Dr Narayanan Namboodiri K K	I C M R	15.73	5 years
A randomized, multicentric, double-blind, placebo-controlled clinical trial of Nardostachys jatamansi and Withania somnifera formulation (SDA-217) as add-on therapy in patients of chronic insomnia	Dr Ashalatha Radhakrishnan	I C M R	38.91	3 years
Development of an artificial intelligence- based system for comprehensive cerebral arterial stroke imaging and prognostication	Dr Santhosh K	D B T	18.26	2 years
Effect and outcome determinants of right ventricular function in post-operative Tetralogy of Fallot: A retrospective descriptive	Dr Baiju S Dharan	I C M R	21.36	3 years
Identification and characterization of ubiquitin and SUMO modified exosomal proteins from Parkinson's disease patients' blood	Dr Madhusoodanan U K	I C M R	9.32	3 years
Prognostic value of circulating microRNAs in heart failure	Dr Sanjay G	I C M R	22.39	2 years

Biomedical Technology Wing

Title of the Project	Principal Investigator	Funding Agency	Total Outlay (Rs in Lakhs)	Duration
Detailed state model of CaMKII activation and auto-phoshorylation in the presence of NR2B and its behaviour in epileptic condtions	Dr Arun Anirudhan	KSCSTE	18.36	3 years
Defining the mechanobiology that leads to heterogeneity in muscle stem cells and its implication in regeneration	Dr Praveen K.S	SERB (Ramanujan fellow)	32.00	5 years
Programme support on translational research on biomaterials	Dr H K Varma, Dr Manoj Komath Dr A Sabareeswaran	DBT	47.05	5 years
Gold nanorod-based nanoprobe for cancer theranostics SERS and imaging therapy by PDT and PPT	Dr Jayasree R S	DBT	84.22	3 years
Differentiation of mesenchymal stem cells into chondrocytes by sustained delivery of miRNAs using chitosan hydrogel	Dr Prabha D Nair	SERB	76.97	3 years
Enteric coating and microencapsulation of antibodies	Dr Roy Joseph	DST	6.99	1 year
Blood-brain barrier permeable nanocarriers for diagnosis and therapy of neurodegenerative diseases	Dr Jayasree R S	DBT	94.98	3 years
MUSTER - musculoskeletal stem cells targeting	Dr Prabha D Nair	DBT	209.96	4 years
MUSTER - musculoskeletal stem cells targeting	Dr Harikrishna Varma	DBT	96.00	4 years

Preclinical evaluation and commercialisation of anti-snake venom (lgY), anti-hemotoxins and anti-neurotoxins	Dr Lissy K Krishnan	DST	247.99	2 years
Development of novel prototype mechanical clot retriever for the treatment of acute cerebral ischemic stroke	Dr Santhosh K	DST	15.09	2 years
To model the effect of mutations of HCN channels in neuronal excitability and impact of GABABR on GIRK and HCN mutation using neurons	Dr Arun Anirudhan	DBT	14.78	3 years
Development of indigenous voice prosthesis for rehabilitation of laryngectomies	Dr Roy Joseph, Mr Sujesh Sreedharan	KSCSTE- RCC, Trivandrum	4.37	3 years
A tissue-engineered skin substitute with localised hair follicle stem cells for hair follicles and sebaceous gland regeneration	Dr Babitha S	DST	29.41	3 years
Bioengineered construct with cardiac mesenchymal cells for myocardial repair	Dr Senthilkumar Muthuswamy	DBT (Ramalingaswamy Fellow)	88.00	5 years
Design and fabrication of a head phantom for dosimetric evaluation of radiotherapy treatment plan	Dr Roy Joseph	KSCSTE - RCC Trivandrum	29.34	3 years
Designing of 3D-printed cell-free biphasic matrices loaded with an admixture of biomolecules for enhanced progenitor cells recruitment and improved osteochondral regeneration	Dr Amrita Natarajan	ICMR (Fellowship)	3.51	3 years
Development of 'Human on-a-chip' device technology - A paradigm shift in biological evaluation and disease model	Dr P R Anilkumar Dr P V Mohanan	DST	311.83	3 years

Magneto-optic sensor for cardiac biomarker detection	Dr R S Jayasree	DST	7.46	2 years
Antimicrobial peptide loaded multifunctional 3D collagen scaffold for vascularised bone tissue regeneration	Dr P V Mohanan	DST	5.04	2 years
Extending benefits of biomedical science & technology to SC & ST communities through all level participatory engagement - ST components	Dr Roy Joseph	DST	301.43	3 years
Extending benefits of biomedical science & technology to SC & ST communities through all level participatory engagement - SC components	Dr Roy Joseph	DST	311.43	3 years
Stem cell-derived therapy for clinical management of lung damage in critically-ill corona viral pneumonia patients' exosome	Dr Naresh Kasoju	SERB	19.14	1 year
An easy and rapid detection platform for viral diseases from saliva: COVID-19 and beyond	Dr Jayasree R S	SERB	16.54	1 year
Development of P modified glass-ionomer cement to improve mechanical properties	Dr Manju S	SERB	24.14	2 years
Efficacy evaluation of 3D bioprinted liver constructs established from niche-specific bioink and stem cell-derived hepatocyte-like cells	Dr Anilkumar P R	SERB	47.41	3 years
Design and development of a micro dialysis set-up for cerebral applications	Dr Chhavi Gupta	DST	47.91	2.5 years

Achutha Menon Centre For Health Science Studies

Title of the Project	Principal Investigator	Funding Agency	Total Outlay (Rs in Lakhs)	Duration
Baseline surveillance of major risk factors of NCD in Kerala (KIRAN)	Dr Sankara Sarma	Government of Kerala	258.00	2 years
Resource Centre/HUB for conducting "Health Technology Assessment"	Dr Biju Soman	Department of Health Research, Government of India	81.57	5 years
National Environmental Health Profile	Dr Manju R Nair	Ministry of Environment, Forest & Climate change	52.67	3 years
Availability, distribution and utilization of health care facilities in Kerala	Dr Manju R Nair	Planning Board, Government of Kerala	9.00	2 years
Mobile Telemedicine Project for Waynad	Dr Biju Soman	D S T	564.00	3 years
A family based randomized controlled trial of cardiovascular risk reduction in individuals with family history of premature coronary heart disease in India	Dr Jeemon Panniyammakal	Wellcome Trust DBT India Alliance	226.67	5 years
The long-term effect of peer-led lifestyle intervention program on diabetes progression and cardiovascular risk: The Kerala Diabetes Prevention Program	Dr Jeemon Panniyammakal	National Health and Medical Research Council, Australia	144.00	3 years
Worksite-based lifestyle program for reducing diabetes and cardiovascular risk in India (India-Works)	Dr Jeemon Panniyammakal	Madras Diabetes Research Foundation/Emory University	64.43	3 years
Social, economic and health impact of industrial pollution in Dindigul district, Tamil Nadu	Dr Srinivasan K	Indian Council of Social Science Research	15.00	2 years

Delineating the role of DNA methylation in insulin resistance driven breast cancer development and progression	Dr Srikant A	D B T	42.50	5 years
Effectiveness of drugs control and regulating mechanism of the Drugs Control Department in Kerala State	Dr Ravi Prasad Varma	Planning Board, Government of Kerala	8.98	2 years
HPSR Fellowship India	Dr Rakhal Gaitonde	Forum for Health Systems Design and Transformation (HSTP)	5.83	5 years

Institute-Funded Projects (Ongoing)

Title of the Project	Principal Investigator	Funding Agency	Total Outlay (Rs in Lakhs)	Duration
Regulation of progenitor cell function in heart by Angiotensin II	Dr Neethu Mohan	SCTIMST (Seed Funding)	5.00	2 years
Intraoperative quantification of left ventricular volumes and ejection fraction by real-time three dimensional transesophageal echocardiography: Comparison with cardiac magnetic resonance imaging	Dr M S Saravana Babu	SCTIMST (Seed Funding)	3.75	2 years
Identification and characterization of neuronal derived curculating exosomal miRNA and protein cargoes in Parkinson's disease patients	Dr Madhusoodanan U K	SCTIMST (Seed Funding)	4.85	2 years
AGE modification of basement membrane: Implications in neurodegenerative disease	Dr Cibin	SCTIMST (Seed Funding)	5.00	2 years
Documenting cause of death among tribal population through automated verbal autopsy using Information and Communication Technology (ICT)	Dr Jissa V T	SCTIMST (ST Funds)	71.10	3 years

Institute-funded TDF Projects (Ongoing)

Title of the Project	Principal Investigator	Total Outlay (Rs in Lakhs)	Duration
Role of resting state functional magnetic resonance imaging in patients with intracranial dural arteriovenous fistula	Dr Bejoy Thomas	1.90	2 years
Assessment of carotid plaque vulnerability using 3T MRI and correlation with carotid endarterectomy	Dr Anoop A	0.75	2 years
Role of intravoxel incoherent motion imaging (IVIM) in post transarterial chemoembolisation (TACE) response evaluation of hepatocellular carcinoma (HCC)	Dr Jineesh	0.96	2 years
The role of biomarkers in predicting the risk of hemorrhagic transformation in acute ischemic stroke	Dr Sapna Erat Sreedhran	5.00	2 years
Development of Real Time RT-PCR assay for detection of SARS-CoV2	Dr Jyothi E K	2.75	1 year
Development and evaluation of air-borne infection control system for health care facilities	Mr Shaj Upendran	4.90	2 years
Development of a dural substitute with mucoadhesive and antibacterial properties	Dr P Ramesh	9.99	2 years
Design and development of a new kind of current steering electrodes with feedback for deep brain stimulator application	Mr Jithin Krishnan	5.00	2 years
Automated External Defibrillator (AED)	Ms Neethu	5.00	18 months
Design of novel polyaxial pedicle screws for thoracolumbar stabilisation	Mr Aravind Kumar Prajapathi	4.86	2 years
Development of a cost-effecive device for the isolation of autologous platelet rich plasma (PRP) for various therapeutic purposes	Dr Renjith P Nair	5.00	1 year
Reconstruction geometry optimization and methodology development using computational fluid dynamics evaluation for patient-specific vascular model acquired by MRI scanning	Mr Subhash S Nair	4.99	1 year

A suction-retractor device for aortic valve replacement in adult cardiac surgery	Dr Bineesh	4.5	3 years
Optimization of complete blood count haematology controls for use as internal quality controls in haematology analysers	Dr Anughya Bhatt	5.30	1 year
Alginate dialdehyde-gelatin as a post-surgical adhesion prevention material in thoracic surgery - A proof-of-concept study in swine models	Dr Sachin Shenoy	6.58	2 years
Indigenous bone graft expander for masquelet-induced membrane technique	Dr Lizymol P P	4.5	2 years
Developing decellularized porcine pericardium with enhanced strength for paediatric cardiovascular application	Dr Umashankar	7.5	3 years
Development of mucoadhesive bandages for the treatment of desquamative gingivitis	Dr Manju	5.10	2 years
Functional near infrared spectroscopy- based brain computer interface	Dr Sujesh Sreeedharan	4.83	1 years
Augmentation of Central Analytical Facility with tests on personal protective equipment for medical use	Dr Renjith S	3.00	1 years
Ceramic tile forms and tile support matrix-standardization and design considerations	Dr Francis Fernandez	6.50	1 years
Cavity conformable surgical space stent retractor (SSSR) design and proof- of-concept	Dr George C Vilanilam	5.00	1.5 years
Multi-layered wrap-knitted polyester in strengthening valve annulus after valve repair	Varghese T Panicker	6.76	2 years

Institute-funded TRC Projects (Ongoing)

Title of the Project	Principal Investigator	Total Outlay (Rupees in Lakhs)	Duration
Chitra AcryloSorb Respiratory Secretion Solidification System	Dr Manju S	4.30	2 months
Smart Assistive Breathing Device	Sarath S Nair	2.00	2 months
Digital Sanitization Systems	Sarath S Nair	2.00	2 months
Isolation Pods	Sarath G	2.00	2 months
Emergency Response Isolation Systems	Subhash N N	2.00	2 months
Ventilator Sharing Kit	Vinodkumar V	2.00	2 months
Examination Booth with UV disfection system as barrier between patient and doctor	Ramesh Babu V	2.00	2 months
Disinfection Gateway for entry points at offices, hospitals, apartments, etc	Jithin Krishnan	2.00	2 months
Antibody against ASPIKE protein to prevent COVID-19	Dr Anugya Bhatt	3.00	6 months
Rapid detection kit for IgG/IgM antibody	Dr Manoj G	4.00	6 months
Nylon Flocked Swabs (Nasopharyngeal and Oropharyngeal) for COVID-19 testing	Dr Lynda Velutheril Thomas	6.00	6 months
Oropharyngeal Sample Collection Kit	Dr Anugya Bhatt	6.00	6 months
Developing a point-of-care testing protocol based on RT-LAMP for fast detection of SARS-CoV-2	Dr Anoop Kumar T	20.00	6 months
Development of a cost-effective Ventilator	Nagesh D S	26.4	18 months
Development of a spinal cord stimulator for pain management	Jithin Krishnan	78.48	36 months
Development of rapid diagnostic kit for sepsis (procalitonin-based) and Chlamydia trachomatis	Dr Manoj G	40.61	24 months

Completed Projects
Hospital Wing & Achutha Menon Centre For Health Science Studies

Title of the Project	Principal Investigator	Funding Agency	Total Outlay (Rupees in Lakhs)	Duration
International Stroke Perfusion Imaging Registry (INSPIRE)	Dr Sylaja P N	University of Newcastle, Australia	07.36	3 years
Non-Communicable disease risk factors among working population: An institution- based study in Kerala, India	Dr G K Mini	P H F I	29.78	2 years
Desialylation-driven uptake of lipoprotein(a) to endothelial cells and monocytes / macrophages in diabetic cardiovascular patients: Is immune complex with natural antibodies a vehicle?	Dr Geetha M	S E R B	23.11	3 years
Meres 1 Trial : A prospective, multi centre, single arm, open label, pilot clinical study of Meres 100 sirolimus-eluting bioresorbable vascular scaffold system in the treatment of de novo native coronary artery lesions	Dr Ajit Kumar V K	Meril Life Science Pvt. Ltd.	6.79	3 years

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SCTIMST

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Prof M Madhusudanan
Head, Department of Neurology
Pushpagiri Medical College,Thiruvalla

Prof R Krishna Kumar
Department of Engineering Design
IIT Madras

Dr Kuruvilla Joseph
Senior Professor & Dean
Department of Chemistry
Indian Institute of Space Science and Technology
Thiruvananthapuram

Prof Anil Peethambaran
Head, Department of Neurosurgery
Government Medical College
Thiruvananthapuram

Prof Naresh Bhatnagar
Department of Mechanical Engineering
IIT Delhi

FINANCE COMMITTEE

Director (Chairperson)
SCTIMST

Prof Ashutosh Sharma
Secretary to Government of India
Department of Science & Technology
Technology Bhavan, New Mehrauli Road
New Delhi

Financial Advisor
Department of Science & Technology

Prof V P Mahadevan Pillai
Vice-Chancellor
University of Kerala
Thiruvananthapuram

Financial Advisor (Ex-officio Convener)
SCTIMST

RESEARCH COUNCIL

Prof P Balram (Chairman)
Former Director, IISc
Molecular Biophysics Unit
Indian Institute of Science
Bengaluru

Director
SCTIMST

Prof M S Ananth
Former Director, IIT Madras
Emeritus Research Fellow, Department of Chemical Engineering
CSIR - National Chemical Laboratory
IIT Madras

Prof G K Ananthasuresh
Department of Mechanical Engineering
Indian Institute of Science
Bengaluru

Shri Anil Kumar Anand
Director Technical
Microtrol Sterilisation Services Pvt. Ltd.
Mumbai

Shri Sasi P M
Director
International Centre for Free and Open Source Software (ICFOSS)
Thiruvananthapuram

Dr Balasubramanian Gopalan
Former CSO, Orchid Research Laboratories Limited
Scientific Advisor, Projects on Drug Discovery, Synthetic Chemistry & Process Research and in Crop Protection Chemicals
CSIR - Indian Institute of Chemical Technology
Hyderabad

Shri V Sashi Kumar
Managing Director, Phoenix Medical Systems (P) Ltd.
DP 42, SIDCO Industrial Estate
Chennai

Prof Vikram Jayaram
Chair, Division of Mechanical Sciences
Department of Materials Engineering
Indian Institute of Science
Bengaluru

Shri A V Ramani
Group Advisor (R&D)
TTK Group of Companies
Bengaluru

Dr Soma Guhathakurtha
Director
SynkroMax Biotech Pvt. Ltd.
Chennai

Dr Jyotsna Dhawan
Chief Scientist
Centre for Cellular & Molecular Biology
Hyderabad

Dr C N Ramchand
Chief Executive Officer
Saksin Lifesciences Pvt. Ltd.
Chennai

Dr K P Mohan Kumar
Director
Inter University Centre for Biomedical Research & Super Specialty Hospital
MG University Campus, Kottayam

Dr Manohar V Badiger
Senior Principal Scientist
Polymer Science and Engineering Division
CSIR - National Chemical Laboratory
Dr Homi Bhabha Road
Pune

Shri Ajay Pitre
Managing Partner
Pitre Business Ventures LLP
Pune

Shri Nandakumar S
Chief Executive Officer
Perfint Healthcare Pvt. Ltd.
Chennai

INSTITUTIONAL ETHICS COMMITTEE

Dr R V G Menon (Chairman)
Haritha, Kesavadev Road
Poojapura, Thiruvananthapuram

Prof Anandakumar A (Clinician)
Vice-principal & Head, Department of Neurology
Amrita School of Medicine
Ernakulam

Dr Christina George
Head, Department of Psychiatry
Dr Somervell Memorial CSI Medical College and Hospital
Karakonam PO, Thiruvananthapuram

Dr Kala Kesavan P (Basic Medical Scientist)
Professor & Head of Pharmacology
T D Medical College
Alapuzha

Dr Rema M N (Basic Medical Scientist)
Former DME & Head, Department of Pharmacology
Manjush, Puthupally Lane
Thiruvananthapuram

Dr S S Giri Sankar (Legal Expert)
Assistant Professor
Government Law College
Kochi

Dr Aneesh V Pillai (Legal Expert)
Assistant Professor, School of Legal Studies
Cochin University of Sciences and Technology
Kochi

Mr Satheesh Chandran (Social Scientist)
Secretary, SOMA India, Alwaye House,
DPI Junction, Thiruvananthapuram

Smt Sathi Nair
Retd. Chief Secretary
'Samtripthi' Devapalan Nagar
Peroorkada, Thiruvananthapuram

Dr P Manickam (Scientific Member)
Scientist E, ICMR-National Institute of Epidemiology (NIE)
R 127, 31'd Avenue, TNHB, Ayapakkam
Chennai

Dr K R S Krishnan (Scientific Member)
Retd. Director, Technical & Operation
HLL Life Care Limited, Poojappura
Thiruvananthapuram

Dr Harikrishnan S (Clinician – Alternate Member)
Professor, Department of Cardiology
SCTIMST

Dr Harikrishna Varma P R (Scientific Member)
Head, Biomedical Technology Wing
SCTIMST

Prof Mala Ramanathan (Member Secretary)
Achutha Menon Centre for Health Science Studies
SCTIMST

Ms Sreepriya C S (Co-ordinator)
Executive Secretary to the Director
SCTIMST

INSTITUTIONAL ANIMAL ETHICS COMMITTEE

Dr Prabha D Nair (Chairperson)
Scientist G (Senior Grade)
Division of Tissue Engineering and Regeneration Technology
Biomedical Technology Wing
SCTIMST

Dr P V Mohanan
Scientist G
Division of Toxicology
Biomedical Technology Wing
SCTIMST

Dr P R Umashankar
Scientist F
Division of In Vivo Models and Testing
Biomedical Technology Wing
SCTIMST

Dr V S Harikrishnan (Member Secretary)
Scientist E
Division of Laboratory Animal Science
Biomedical Technology Wing
SCTIMST

Dr K R Chandramohan Nair - CPCSEA, Main Nominee

Dr Madhavrao - Link Nominee

Dr Murali Krishna P - Scientist from outside the Institute

Dr Guruvayoorappan C, Socially-Aware Nominee

INSTITUTIONAL COMMITTEE FOR STEM CELL RESEARCH

Dr M Radhakrishna Pillai (Chairman)
Director, Rajiv Gandhi Centre for Biotechnology
Thycaud PO, Poojappura
Thiruvananthapuram

Prof Vikram Mathews (Vice-Chairman)
Clinical Haematology
Christian Medical College, Vellore
Tamil Nadu

Prof R V G Menon
Haritha, Poojapura
Thiruvananthapuram

Smt Sathi Nair
Retd. Chief Secretary
Samtripthi, Peroorkada
Thiruvananthapuram

Dr Sheila Balakrishnan
Additional Professor of Gynaecology & Head,
Fertility Unit
Government Medical College
Thiruvananthapuram

Dr Jackson James
Scientist-EII, Neuro-Stem Cell Biology Laboratory
Department of Neurobiology
Rajiv Gandhi Centre for Biotechnology
Thiruvananthapuram

Smt J Lalithambika IAS
Former Addl. Chief Secretary
Abhilash, Jawahar Nagar
Thiruvananthapuram

Shri Jaideep G Nair
Advocate
Anjali, Veera Bhadra Gardens
Thiruvananthapuram

Dr P Manickam
Scientist E, ICMR-National Institute of
Epidemiology (NIE)
R 127, 31'd Avenue, TNHB, Ayapakkam
Chennai

Dr Annie John
UGC Emeritus Professor
Department of Biochemistry
University of Kerala
Thiruvananthapuram

Shri Nemom V Sanjeev
Advocate & Notary
Nemom Chamber
Vanchiyoor PO
Thiruvananthapuram

Dr Neethu Mohan (Member Secretary)
Scientist D
Division of Cellular and Molecular Cardiology
SCTIMST

Ms Sreepriya C S (Co-ordinator)
Executive Secretary to the Director
SCTIMST

INSTITUTIONAL BIOSAFETY COMMITTEE

Shri C V Muraleedharan (Chairman)
Scientist G & Associate Head
Biomedical Technology Wing
SCTIMST

Prof Kavita Raja (Biosafety Officer)
Head, Department of Microbiology & Medical
Superintendent
SCTIMST

Dr K Madhavan Nampooothiri (DBT Nominee)
Principal Scientist (Biotechnology) & Head,
Microbial Processes and Technology, National
Institute of Interdisciplinary Science and Technology
(NIIST)
Thiruvananthapuram

Dr Abdul Jaleel
Scientist E-II, Proteomics Core Facility
Rajiv Gandhi Centre for Biotechnology
Thiruvananthapuram

Dr P Ramesh
Scientist G, Division of Polymeric Medical Devices
Biomedical Technology Wing, SCTIMST

Dr Sathyabhama
Scientist G
Department of Transfusion Medicine
SCTIMST

Dr G Srinivas
Scientist F & Acting Head
Department of Biochemistry
SCTIMST

Dr Anugya Bhatt
Scientist E, Thrombosis Research Unit
Biomedical Technology Wing
SCTIMST

Dr A Maya Nandkumar (Member Secretary)
Scientist G & Head, Department of Applied Biology
Biomedical Technology Wing, SCTIMST

TECHNOLOGY DEVELOPMENT COMMITTEE

Director (Chairperson)
SCTIMST

Dr Harikrishna Varma P R
Head, Biomedical Technology Wing
SCTIMST

Dr Roy Joseph
Scientist G & Head, Department of Medical Devices Engineering Biomedical Technology Wing
SCTIMST

Prof Harikrishnan S
Department of Cardiology
SCTIMST

Prof Bejoy Thomas
Department of Imaging Sciences and Interventional Radiology
SCTIMST

Dr Chitra Mandal
CSIR-Indian Institute of Chemical Biology
Raja S C Mullick Road, Kolkata

Dr Raghu Krishnapuram
Distinguished Member of Technical Staff
Robert Bosch Centre for Cyber-Physical Systems
Indian Institute of Science
Bengaluru

Prof Jayesh Bellare
Department of Chemical Engineering
IIT Bombay

Prof R Krishna Kumar
Head, Paediatric Cardiology
AIMS, Kochi

Shri V Sashi Kumar
Managing Director, Phoenix Medical Systems (P) Ltd.
DP 42, SIDCO Industrial Estate
Chennai

BUILDING COMMITTEE

Director (Chairperson)
SCTIMST

Dr Harikrishna Varma P R
Head, Biomedical Technology Wing
SCTIMST

Financial Advisor (Ex-officio Convener)
SCTIMST

Dr K P Sudheer
Executive Vice-President
Kerala State Council for Science, Technology & Environment
Sasthra Bhavan, Thiruvananthapuram

Shri S J Vijaya Das
Chief Project Examiner
Kerala Infrastructure Fund Board

SENIOR STAFF SELECTION COMMITTEE

Director (Chairman - Ex-Officio)
Head, Biomedical Technology Wing
Nominee of the Secretary, DST

An expert from outside the Institute nominated by the President
Scientist nominated by the President from among the members of the Institute
Senior academic staff of the Institute not below the rank of Professor/Scientist G/Engineer G

JUNIOR STAFF SELECTION COMMITTEE

Medical Superintendent
Head, Biomedical Technology Wing
A Representative of the Academic Wing of the Institute nominated by the Director
Three Members nominated by the President

SPECIAL RESERVATION CELL

Sri Kiran K V
Assistant Accounts Officer
F&A Division, SCTIMST

Sri Renu Remesan
Nursing Officer - B
SCTIMST

Sri Vinod D
Technical Assistant (Lab) - B
SCTIMST

INTERNAL COMPLAINTS COMMITTEE

Dr Prabha D Nair (Chairperson)
Scientist G (Senior Grade)
Division of Tissue Engineering and Regeneration Technology
Biomedical Technology Wing
SCTIMST

Dr Bismi Gopalakrishnan
Department of Law
University of Kerala

Dr Jayasree R S
Scientist F, Division of Biophotonics and Imaging
Biomedical Technology Wing, SCTIMST

Dr Jayadevan E R
Additional Professor
Department of Imaging Sciences and Interventional Radiology
SCTIMST

Dr Sanjay G
Additional Professor
Department of Cardiology
SCTIMST

Dr Sapna Erat Sreedharan
Additional Professor
Department of Neurology
SCTIMST

Dr Jissa V T
Scientist C, Achutha Menon Centre for Health Science Studies
SCTIMST

Nursing Superintendent
SCTIMST

PUBLIC GRIEVANCE COMMITTEE

Dr Harikrishna Varma P R
Head, Biomedical Technology Wing
SCTIMST

Prof Thomas Koshy
Department of Anaesthesiology
SCTIMST

Dr Maya Nandakumar
Scientist G & Head, Department of Applied Biology
Biomedical Technology Wing, SCTIMST

Prof Debasish Gupta
Head, Department of Transfusion Medicine
SCTIMST

Dr Jeemon P
Assistant Professor, Achutha Menon Centre for Health Science Studies
SCTIMST

Shri Vipin C G
Chief Accounts Officer
SCTIMST

Smt Sudha T
Librarian-cum-Information Officer
SCTIMST

Nursing Superintendent
SCTIMST

Smt Rosamma Manuel
Junior Scientific Officer (MSW)
SCTIMST

Administrative Officer Grade I
Hospital Wing, SCTIMST

EMPLOYEES GRIEVANCE COMMITTEE

Hospital Wing & Achutha Menon Centre for Health Science Studies

Prof K K Narayanan Namboodiri (Chairman)
Department of Cardiology
SCTIMST

Prof Srinivasan K
Achutha Menon Centre for Health Science Studies
SCTIMST

Dr Jayadevan E R
Additional Professor
Department of Imaging Sciences and Interventional Radiology
SCTIMST

Dr Prakash Nair
Associate Professor
Department of Neurosurgery
SCTIMST

Nursing Superintendent (Ex officio)
SCTIMST

Smt Sudha T
Librarian-cum-Information Officer
SCTIMST

Shri Binu Thomas
Senior Scientific Assistant
Department of Anaesthesiology
SCTIMST

Shri Shibu Raj R (Convenor))
Assistant Administrative Officer (P&A Division)
SCTIMST

Dr Satheesh Nair M (External Member)
Clinical Psychologist
Department of Health Services
Government of Kerala

Biomedical Technology Wing

Dr Manoj Komath (Chairman)
Scientist G & Head, Department of Biomaterial Science and Technology
SCTIMST

Shri Vinodkumar V
Engineer F, Division of Extracorporeal Devices
SCTIMST

Dr Jayasree R S
Scientist F, Division of Biophotonics and Imaging
Biomedical Technology Wing
SCTIMST

Shri Sajithlal M K
Engineer E, Network Service Cell
SCTIMST

Smt Sandhya C G
Engineer E, Technology Business Division
SCTIMST

Shri Arumugham V
Senior Scientific Assistant (Instruments)
Calibration Cell, Biomedical Technology Wing
SCTIMST

Administrative Officer (Convenor, ex officio)
Biomedical Technology Wing, SCTIMST

Dr Satheesh Nair M (External Member)
Clinical Psychologist
Department of Health Services
Government of Kerala

INTERNAL COMPLAINTS COMMITTEE ON SEXUAL HARASSMENT OF WOMEN IN THE WORKPLACE (PREVENTION, PROHIBITION AND REDRESSAL)

The Annual Report of the Internal Complaints Committee, SCTIMST, fulfils the requirements of Section 21(1) of the Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013.

1. Number of complaints of sexual harassment received during the year: 2
2. Number of complaints disposed of during the year: 2
3. Number of cases pending for more than 90 days: Nil
4. Number of Workshops or Awareness Programmes against sexual harassment organized: Nil

PROGRESS ON IMPLEMENTATION OF INTEGRITY PACT IN SCTIMST AS PER CENTRAL VIGILANCE COMMISSION REQUIREMENT

In the year 2007, the Central Vigilance Commission (CVC) vide Office Order dated 04-12-2007 recommended implementation of a concept called "Integrity Pact" (IP) in respect of all major procurements. The IP essentially envisages an agreement between the prospective vendors/bidders and the buyer committing the persons/officials of both the parties not to exercise any corrupt influence on any aspect of the Contract. The Integrity Pact, in respect of a particular Contract shall be operative from the date IP is signed by both the parties till the final completion of the Contract.

The Governing Body of SCTIMST vide, its resolution No.V.37 dated 03-03-2018 recommended to incorporate Integrity Pact, depending on the nature of procurements/contracts above a threshold value of Rupees One Crore. The IP is to be implemented through Independent External Monitors (IEM) appointed by the organization. IEM would review independently and objectively whether and to what extent parties have complied with their obligations under the Pact. The main role and responsibility of IEM is to resolve issues raised by an intending bidder regarding any aspect of the Tender which allegedly restricts competition or indicates bias towards some bidders.

Accordingly, SCTIMST had appointed Shri Sanjeev Behari IRS(Retd) and Shri Sharda Prasad IPS(Retd), both from Noida as Independent External Monitors for implementation of Integrity Pact at SCTIMST vide our Letter of Appointment dated 31-01-2019 for a period of 3 years. Both IEM were appointed as per the recommendation from CVC from their empanelled list. During the financial year 2019-20 the IEM visited SCTIMST four times during the months of May, August and October in 2019 and January 2020. The IEM had signed the Non-Disclosure Agreement with the Institute.

They had examined the interests of the Institute and signed the 'Absence of Conflict of Interest' declaration.

SCTIMST incorporated the Integrity Pact in open tenders with an estimated value of more than Rs 1 Crore floated during the financial years 2019-20 and 2020-21.

The following were some of the points discussed during the visit of IEM to SCTIMST:

1. Understand the working of the institute, its requirements, standards followed and rules and procedures followed during the Tender process
2. Discussed/Reviewed the information on Tenders awarded by the institute during the financial year

3. Reviewed the compliance and modifications in the system of the institute

4. Reviewed compliance with the post-tender instructions as issued by CVC

5. Reviewed the status on implementation of E-procurement

6. Discussed with Vigilance Officer of the institute regarding compliance with various requirements of CVC and submission of reports to CVC

7. Suggested improvements to be made in the procurement system in line with CVC guidelines from time to time

8. Conducted a Session on 'Integrity in Governance and Preventive Vigilance' to officers and staff of the institute as part of Vigilance Awareness Week

9. Examined the integrity in purchase process of major Tenders

RESERVATION AND OTHER WELFARE MEASURES FOR SCHEDULED CASTES/ SCHEDULED TRIBES/ OTHER BACKWARD CLASSES/ ECONOMICALLY WEAKER SECTIONS AND PERSONS WITH DISABILITIES

SCTIMST has been following, in letter and spirit, the Presidential Directives and other guidelines related to reservation/concession for Scheduled Castes/ Scheduled Tribes/Other Backward Classes/ Economically Weaker Sections issued by the Government of India from time to time. An adequate monitoring mechanism has been put in place in the Institute for sustained and effective compliance with the Reservation Policy. Rosters are maintained as per the directives and are regularly inspected by the Liaison Officer to ensure compliance. A Special Reservation Cell for SC/ST employees is functioning with five members, including an Officer. In order to monitor the implementation of reservation of students admitted to various academic programmes, a Student Reservation & Equal Opportunity Cell is also functioning. This Cell will address the grievances of candidates/students who belong to reservation categories on reservation-related matters and ensure measures to prevent any caste based discrimination in the Institute. Cell will also monitor and implement various scholarship (International/National/State/Others) opportunities to students belong to reservation categories.

The following were the major activities by the Institute for Scheduled Castes/ Scheduled Tribes/ Other Backward Classes/ Economically Weaker Sections and Persons with Disabilities:

1. Nominated Liaison Officer for SC/ST/PWD, Liaison Officer for OBC and Liaison Officer for EWS

2. Constitution of a five member Special Reservation Cell including one Officer-in-charge of the Cell.

3. Implementation of reservation in all temporary and project appointments above 45days.

4. Implemented reservation in Group A academic posts, laid down in the Central Educational Institutions (Reservation in Teacher' Cadre) Act, 2019 (10 of 2019) through regulation amendment vide Government of India Gazette notification.

5. Providing Fellowship for SC/ST students.

6. Free treatment for Scheduled Tribe patients utilizing the fund received from Government of Kerala. Till date Rs 115 Lakh was received from Government of Kerala under this scheme and a sum of Rs 90.51 Lakh was utilized for treatment of 1559 patients in IP and OP including reviews.

7. Institute provides telemedicine facility to the tribal population of Wayanad under the Mobile Telemedicine Project. This project uses innovative approaches to harness an existing sophisticated technology (Telemedicine) to improve access to secondary healthcare services in remote areas (a pressing public health need). Two mobile telemedicine units with a dedicated medical team (one MBBS doctor, one BSc Nurse and a driver-cum-technician) are available for this project. The mobile units visit the peripheral health centres on a fixed day and use the telemedicine facility to connect with the specialists. This facility has proven convenient, especially for the tribal people, who are reluctant to seek care from far off hospitals. The programme is funded by DST and done in collaboration with the Health Department of Kerala and the Centre for Development of Advanced Computing(C-DAC), Trivandrum.

8. AMCHSS has initiated two more tribal study projects from ST grant of the Institute tilted (1) Documenting cause of death among tribal population through automated verbal autopsy using Information and communication technology (ICT) and (2) Understanding disease clustering (Multi-morbidity) in the tribal population of Kerala.

STATEMENT OF ACCOUNTS
2020-21

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

BALANCE SHEET AS AT 31st March 2021

CORPUS/CAPITAL FUND AND LIABILITIES		2020-21	2019-20
		Rs.	Rs.
CAPITAL FUND	1	4826556824	3993230310
RESERVES & SURPLUS	2	244829294	242526805
EARMARKED ENDOWMENT FUNDS	3	877774200	853496857
SECURED LOANS & BORROWINGS, UNSECURED LOANS & BORROWINGS, DEFERRED CREDIT LIABILITIES	4,5,6	0	0
CURRENT LIABILITIES & PROVISIONS	7	537015338	719462202
TOTAL		6486175657	5808716173
ASSETS			
FIXED ASSETS	8	1751259011	1635762678
INVESTMENTS FROM EARMARKED ENDOWMENT FUNDS	9	640508212	731227132
INVESTMENTS-OTHERS	10	244829294	242526805
CURRENT ASSETS , LOANS, ADVANCES ETC	11	3849579139	3199199558
MISCELLANEOUS EXPENDITURE (TO THE EXTENT NOT WRITTEN OFF)			
TOTAL		6486175657	5808716173
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES & NOTES ON ACCOUNT	25		

Sd/-
Financial Adviser

Sd/-
Director

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR 2020-21

	Schedule	2020-21	2019-20
		[Rs.]	[Rs.]
INCOME		Rs.	Rs.
Income from Sales / Services	12	754916044	1188616696
Grants Received from Govt of India(Salary & General)	13	2650000000	1416606000
Fees/Subscription	14	16486501	15450906
Income from Investments }	15	18611077	20753549
Withdrawal from ERF }		0	0
Income from Royalty, Publication etc	16	7261992	1439767
Interest earned	17	35543373	35105209
Other Income	18	15803341	17131990
	Total	3498622328	2695104117
EXPENDITURE			
Establishment Expenses	20	2148546839	1854401640
Other Administrative Expenses	21	772665657	1056882434
Bank Charges	23	84447	1276137
Depreciation - Current Year		127482684	142920964
		3048779627	3055481174
Balance being Excess Expenditure over Income (-)/Excess income over expenditure(+)		449842701	-360377058
Add: Transfer to Special Reserve Account		6785866	5250964
BALANCE BEING DEFICIT CARRIED TO CAPITAL FUND		443056835	-365628021

Sd/-
Financial Adviser

Sd/-
Director

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULES

SCHEDULE 1 - CORPUS/CAPITAL FUND		2020-21	2019-20
	PARTICULARS	[Rs.]	[Rs.]
	Balance as at the beginning of the year	7037740954	6478338829
	Less Depreciation up to the end of the previous year	3044510646	2901589680
	Net balance at the beginning of the year	3993230308	3576749149
	Add: Plan Grants received from Government of India for creation of Capital Assets	450000000	844878000
	Add: Grants received under CSR scheme	1290000	4860301
	Less:Unutilized Grant-in-Aid ST-General	0	0
	Deduct: Balance of net expenditure transferred from the Income and Expenditure Account Or add excess of income over expenditure	443056835	365628021
	Less:Value of Assets Written off during the year	61020319	67629119
	DeductTransfer to BMT/Add Transfer from CHO	**0**	**0**
	BALANCE AS AT THE YEAR-END	4826556824	3993230310
SCHEDULE 2-RESERVES AND SURPLUS:			
	1. Capital Reserve:		
	As per last Account	--	--
	Addition during the year	--	--
	Less:Deduction during the year	--	--
	3. Special Reserves:		
	As per last Account	242526805	235362851
	Addition during the year (Current year transfer- Increase in provision)	2302489	7163954
	Less: Deductions during the year	0	0
	4. General Reserve:		
	As per last Account	--	--
	Addition during the year	--	--
	Less: Deductions during the year	--	--
	TOTAL	**244829294**	**242526805**

Sd/-
Financial Adviser

Sd/-
Director

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULE 3-EARMARKED/ENDOWMENT FUNDS		2020-21	2019-20
	a) Opening balance of the funds	853496857	865922085
	b) Additions to the funds:		
	i. Donations/grants	878884537	980189504
	ii. Income from Investments made on account of funds		
	iii. Other additions (Specify nature)	0	0
	TOTAL (a+b)	**1732381394**	**1846111589**
	c) Utilisation / Expenditure towards objective of funds		
	i. Capital Expenditure		
	- Fixed Assets	52084738	116523789
	- Others	0	0
	Total (Detailed Schedule Attached)	52084738	116523789
	ii. Revenue Expenditure		
	- Salaries, Wages and allowances etc.	66911520	78683502
	- Rent & Consumables etc.,	157582261	195404229
	- Other Administrative expenses	578028674	602003213
	Total	802522455	876090943
	TOTAL (c)		
	NET BALANCE AS AT THE YEAR-END (a+b+c)	**877774200**	**853496857**

Sd/-
Financial Adviser

Sd/-
Director

SCHEDULE 3-EARMARKED/ENDOWMENT FUNDS - AS ON 31.03.2021

PROJ #	NAME OF GRANTEE/PRINCIPAL INVESTIGATOR	FUND-WISE BREAK UP					
		OPENING BALANCE	ADDITIONS TO FUND		TOTAL		
			GRANTS	OTHER RECEIPTS		FIXED ASSETS	
	HOSPITAL PROJECTS		ADDITIONS TO FUND				
5000	PROJ-MISCELLANEOUS	11942902.72	0.00	5695705.71	17638608.43	0.00	
5040	DEVELOPING EXPERIMENTAL THERAUPEUTICALS	622041.70	0.00	0.00	622041.70	0.00	
5055	ROCKFELLER FOUNDATION,USA	686120.00	0.00	0.00	686120.00	0.00	
5078	PROJECT GRANT/DR MALA RAMANATHAN	5810.00	0.00	0.00	5810.00	0.00	
5094	KERALA STATE AIDS CONTROL SOCIETY	483814.02	275417.00	0.00	759231.02	0.00	
5100	AMC/MAC ARTHUR FOUNDATION/02-70546	46315.05	0.00	0.00	46315.05	0.00	
5108	EVAL.SUB-TYPES DEMENTIA/DR.MATHURA	15800.50	0.00	0.00	15800.50	0.00	
5119	STAKE HOLDER-PERCEPT/INST.REV BO	104492.73	0.00	0.00	104492.73	0.00	
5133	WHO FELLOWSHIP TRAINING CBICD	215059.00	0.00	0.00	215059.00	0.00	
5135	A 16-WEEK,DOUBLE BLIND/ASHA KISHORE	478033.39	0.00	0.00	478033.39	0.00	
5139	A 24 WEEK, MULTICENTER/DR. MATHURANATH	2602046.78	0.00	0.00	2602046.78	0.00	
5140	HARVARD SCHOOL OF PUBLIC HEALTH	91794.32	0.00	0.00	91794.32	0.00	
5142	BANKING FOR BETTER HEALTH-MEDISAVE	153911.36	0.00	0.00	153911.36	0.00	
5146	DEVELOPMENT OF SPECTROSCOPIC PROTOCOL	11026.00	0.00	0.00	11026.00	0.00	
5150	PROTOCOL 6002-INT 001	12096.60	0.00	150000.00	162096.60	0.00	
5153	DEV REF. MANUAL FOR PRIMARY	155802.00	0.00	0.00	155802.00	0.00	
5159	NCD RISK FACTOR SURVEILLANCE	71123.00	0.00	0.00	71123.00	0.00	
5161	DOSE RANGING STUDY:CGHR	1243052.00	0.00	0.00	1243052.00	0.00	
5168	PROJ/VERMEER STUDY	511714.00	0.00	0.00	511714.00	0.00	
5170	SAFETY OF E 2007 IN LEVODOPA	729601.50	0.00	0.00	729601.50	0.00	
5174	CHANGES IN SLEEP WAKEFULNESS-Dr.Mohanku.	49317.00	0.00	0.00	49317.00	0.00	

SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

Amount Rs.

UTILIZATION						TOTAL EXPENDITURE	NET BALANCE
CAPITAL EXPENDITURE		REVENUE EXPENDITURE					
OTHERS	TOTAL	SALARIES/ WAGES	RENT/ CONSUM ABLES	OTHER ADMN EXP	TOTAL		
		UTILIZATION					
0.00	0.00	0.00	0.00	13364123.17	13364123.17	13364123.17	4274485.26
0.00	0.00	0.00	35864.12	0.00	35864.12	35864.12	586177.58
0.00	0.00	0.00	0.00	0.00	0.00	0.00	686120.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5810.00
0.00	0.00	0.00	0.00	159854.12	159854.12	159854.12	599376.90
0.00	0.00	0.00	0.00	0.00	0.00	0.00	46315.05
0.00	0.00	0.00	0.00	0.00	0.00	0.00	15800.50
0.00	0.00	0.00	0.00	0.00	0.00	0.00	104492.73
0.00	0.00	0.00	0.00	0.00	0.00	0.00	215059.00
0.00	0.00	0.00	0.00	478033.39	478033.39	478033.39	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2602046.78
0.00	0.00	0.00	0.00	0.00	0.00	0.00	91794.32
0.00	0.00	0.00	0.00	0.00	0.00	0.00	153911.36
0.00	0.00	0.00	0.00	0.00	0.00	0.00	11026.00
0.00	0.00	0.00	0.00	50000.00	50000.00	50000.00	112096.60
0.00	0.00	0.00	0.00	0.00	0.00	0.00	155802.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	71123.00
0.00	0.00	0.00	0.00	1243052.00	1243052.00	1243052.00	0.00
0.00	0.00	0.00	0.00	511714.00	511714.00	511714.00	0.00
0.00	0.00	0.00	11680.00	717921.50	729601.50	729601.50	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	49317.00

5175	SURGICAL TRIAL IN LOBAR INTRACEREBRAL	39125.27	0.00	0.00	39125.27	0.00	
5176	WOMEN COMPONENT PLAN	0.00	0.00	0.00	0.00	0.00	
5180	COMMUNITY BASED INTRVEN-CV DIS	18308.00	0.00	0.00	18308.00	0.00	
5184	COMP HEALTH CARE PROJECT ST	2779112.00	0.00	0.00	2779112.00	0.00	
5190	PREVALENCE OF TYPE II DIABETES IN RURAL	42210.00	0.00	0.00	42210.00	0.00	
5192	TO PROVIDE INFRASTRUCTURE TO AMCHSS	145022.50	0.00	0.00	145022.50	0.00	
5193	SAFE MOTHERHOOD PROGRAMME	71796.00	0.00	0.00	71796.00	0.00	
5201	OPEN LABEL TRIAL IN PARKINSON	2527770.50	0.00	0.00	2527770.50	0.00	
5203	STUDY IN MRI - ISIR	26183.00	0.00	0.00	26183.00	0.00	
5207	BRAIN MRI STUDIES	0.00	0.00	0.00	0.00	0.00	
5209	MANAGEMENT - CORONARY EVENT	164611.00	0.00	0.00	164611.00	0.00	
5213	CREATION OF AMC FUND	17895418.92	0.00	888206.00	18783624.92	0.00	
5216	PROTOCOL SP921 A MULTICENTRE	879871.10	0.00	0.00	879871.10	0.00	
5226	ISOLATION, CHARACTERIZATION OF GLIOMAS	265709.00	0.00	0.00	265709.00	0.00	
5227	MONOTHERAPY/ ACTIVE CONTROL	173369.86	0.00	0.00	173369.86	0.00	
5232	CEREBELLUM AND CORTICAL	31438.00	0.00	0.00	31438.00	0.00	
5234	IMPROVING LOCALIZATION IN LESION NEGATIVE	-2860415.00	0.00	0.00	-2860415.00	0.00	
5237	KERALA DIABETES PREVENTION PROGRAM(K-DPP	26957.47	0.00	0.00	26957.47	0.00	
5238	IMPROVING LOCALIZATION IN LESION NEGA...	4884.00	0.00	0.00	4884.00	0.00	
5245	IMPROVING LOCALIZATION IN LESION N..	184938.00	0.00	0.00	184938.00	0.00	
5246	COMPREHENSIVE HEART FAILURE	100000.00	0.00	0.00	100000.00	0.00	
5247	A PHASE 3, 12-WEEK, DOUBLE BLIND, PLA...	1817731.85	0.00	0.00	1817731.85	0.00	
5248	A PHASE 3, DOUBLE BLIND, PLACEBO AND A..	1836908.73	0.00	0.00	1836908.73	0.00	
5249	CNRS-INDO-FRENCH PROJECT	2521.00	0.00	0.00	2521.00	0.00	
5252	INDO-US COLLABORATIVE STROKE	475753.00	0.00	0.00	475753.00	0.00	
5267	EVALUATION STUDY OF THE ASHA	190689.00	0.00	0.00	190689.00	0.00	
5273	INTERNATIONAL STROKE	39335.00	0.00	0.00	39335.00	0.00	
5275	ENCODING OF INTERHEMISPHERIC -	1071103.00	0.00	0.00	1071103.00	0.00	
5277	VASCULAR COGNITIVE IMPAIRMENT	39340.00	0.00	0.00	39340.00	0.00	

0.00	0.00	0.00	0.00	0.00	0.00	0.00	39125.27
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	18308.00
0.00	0.00	0.00	0.00	330338.00	330338.00	330338.00	2448774.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	42210.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	145022.50
0.00	0.00	0.00	0.00	0.00	0.00	0.00	71796.00
0.00	0.00	450141.00	180000.00	225385.00	855526.00	855526.00	1672244.50
0.00	0.00	0.00	0.00	0.00	0.00	0.00	26183.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	164611.00
0.00	0.00	0.00	0.00	5430.00	5430.00	5430.00	18778194.92
0.00	0.00	0.00	0.00	879871.10	879871.10	879871.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	265709.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	173369.86
0.00	0.00	0.00	0.00	31438.00	31438.00	31438.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2860415.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	26957.47
0.00	0.00	0.00	0.00	0.00	0.00	0.00	4884.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	184938.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	100000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1817731.85
0.00	0.00	0.00	0.00	167981.00	167981.00	167981.00	1668927.73
0.00	0.00	0.00	0.00	2521.00	2521.00	2521.00	0.00
0.00	0.00	0.00	447469.00	28284.00	475753.00	475753.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	190689.00
0.00	0.00	0.00	0.00	39335.00	39335.00	39335.00	0.00
0.00	0.00	217800.00	0.00	314.00	218114.00	218114.00	852989.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	39340.00

5279	FAMILY LED REHABILITATION AFTER STROKE..	25860.00	0.00	0.00	25860.00	0.00	
5284	INTERNATIONAL STUDY FOR COMPARATIVE	35496.00	10203.00	0.00	45699.00	0.00	
5289	MITOCHONDRIAL METABOLISM...	39726.11	0.00	0.00	39726.11	0.00	
5292	A RESTING STATE FMRI & TASK ..	2282.00	0.00	0.00	2282.00	0.00	
5293	DECIPHERING LRRK2 GENE	7076.50	0.00	0.00	7076.50	0.00	
5294	MTP/EC SERVICES OF WOMEN	227053.00	0.00	0.00	227053.00	0.00	
5296	ELECTROENCEPHALOGRAPHYWORKSHOP	25230.00	0.00	0.00	25230.00	0.00	
5297	THE HUMAN BRAIN MAPPING PROJ..	2962.74	0.00	0.00	2962.74	0.00	
5300	ANALYSING FUNCTIONAL NETWORKS	603761.00	0.00	0.00	603761.00	0.00	
5301	IN VITRO BETA AMYLOID UPTAKE	115730.35	0.00	0.00	115730.35	0.00	
5302	/DISABILITY STUDIES IN EPILEPSY	45407.00	0.00	0.00	45407.00	0.00	
5305	A FAMILY BASED RANDOMIZED	2201157.64	2461258.00	71163.00	4733578.64	159271.00	
5307	A RESTING FMRI	275752.00	0.00	0.00	275752.00	0.00	
5308	EPILEPSY CARE THROUGH SCHOOLS	261924.29	0.00	0.00	261924.29	0.00	
5310	KERALA DIABETES PREVENTION	1075067.25	0.00	0.00	1075067.25	0.00	
5313	EQUIPMENT FOR HEART FAILURE	1798467.35	0.00	115959.00	1914426.35	0.00	
5314	NON COMMUNICABLE DISEASES	1090168.55	0.00	0.00	1090168.55	0.00	
5315	PROSPECTIV SINGLE ARM MUL	933934.60	0.00	0.00	933934.60	0.00	
5317	MERES1 TRIAL A PROSPECTIVE	64965.00	0.00	0.00	64965.00	0.00	
5319	ENCORE	50532.00	0.00	0.00	50532.00	0.00	
5320	EFFECT OF YOGA ON MOTOR CORTEX PLAST	285649.00	0.00	0.00	285649.00	0.00	
5322	PREFRONTAL CORTEX	0.00	23388.00	0.00	23388.00	0.00	
5323	CHITRA DHWANI	35500.00	0.00	0.00	35500.00	0.00	
5325	DECIPHERING THE GENERIC	2349220.00	0.00	0.00	2349220.00	0.00	
5326	NEURO DEVELOPMENTAL DISORDERS	7090788.91	1859000.00	362800.00	9312588.91	62360	
5327	MOVEMENT DISORDER	1652215.00	0.00	0.00	1652215.00	0.00	
5329	E-DELIVERY FOR HEALTH CARE	7468243.88	0.00	0.00	7468243.88	0.00	
5332	HYPOXIA AND MINERALISATION	641.00	0.00	0.00	641.00	0.00	
5333	ELETROENCEPHALOGRAPHIC	204645.00	0	0.00	204645.00	0.00	

0.00	0.00	0.00	0.00	0.00	0.00	0.00	25860.00
0.00	0.00	0.00	5300.00	0.00	5300.00	5300.00	40399.00
0.00	0.00	0.00	19339.00	18155.11	37494.11	37494.11	2232.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2282.00
0.00	0.00	0.00	0.00	7076.50	7076.50	7076.50	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	227053.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	25230.00
0.00	0.00	0.00	0.00	0.74	0.74	0.74	2962.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	603761.00
0.00	0.00	0.00	75614.00	2902.00	78516.00	78516.00	37214.35
0.00	0.00	0.00	0.00	0.00	0.00	0.00	45407.00
0.00	159271.00	321318.00	0.00	1129919.00	1451237.00	1610508.00	3123070.64
0.00	0.00	0.00	0.00	0.00	0.00	0.00	275752.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	261924.29
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1075067.25
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1914426.35
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1090168.55
0.00	0.00	0.00	0.00	36474.75	36474.75	36474.75	897459.85
0.00	0.00	0.00	0.00	0.00	0.00	0.00	64965.00
0.00	0.00	0.00	0.00	10000.00	10000.00	10000.00	40532.00
0.00	0.00	77157.00	0.00	208492.00	285649.00	285649.00	0.00
0.00	0.00	0.00	0.00	23388.00	23388.00	23388.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	35500.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2349220.00
0.00	62360.00	838488.00	0.00	2716378.00	3554866.00	3617226.00	5695362.91
0.00	0.00	198875.00	0.00	0.00	198875.00	198875.00	1453340.00
0.00	0.00	0.00	0.00	58875.00	58875.00	58875.00	7409368.88
0.00	0.00	0.00	0.00	0.00	0.00	0.00	641.00
0.00	0.00	33154.00	0.00	75879.00	109033.00	109033.00	95612.00

5336	ESTABLISHMENT OF THE INDIAN STROKE CLINICAL TRIAL NETWORK (INSTRUCT)	248472.00	1349688.00	238950.00	1837110.00	0.00	
5337	SECONDARY PREVENTION BY STROKE	382180.00	549747.00	0.00	931927.00	0.00	
5338	ESTABLISHMENT OF A BIOREPOSITORY	26850.26	0.00	0.00	26850.26	0.00	
5339	ANTI EPILEPTIC DRUGS	20950.00	0.00	0.00	20950.00	0.00	
5340	STRUCTURAL AND FUNCTIONAL IMAGING	254878.01	0.00	0.00	254878.01	0.00	
5341	SLEEP APNEA	333751.75	0.00	0.00	333751.75	0.00	
5342	TRIVANDRUM HEART FAILURE	196246.00	516790.00	0.00	713036.00	0.00	
5343	BRAIN IRON DEPOSITION	464115.26	0.00	0.00	464115.26	0.00	
5344	IMPROVEMENT OF SECONDARY	14014.00	0.00	0.00	14014.00	0.00	
5345	MOBILE TELEMEDICINE PROJECT	34443930.98	0.00	0.00	34443930.98	0.00	
5346	DISEASE RISK FACTORS	551940.00	0.00	0.00	551940.00	0.00	
5347	UNDERSTANDING PHENOTYPES	325503.00	0.00	0.00	325503.00	0.00	
5348	PROSPECTIVE STUDY OF PATIENTS	417275.00	258000.00	120000.00	795275.00	0.00	
5349	FRACTIONAL FLOW REVERSE	60710.00	0.00	0.00	60710.00	0.00	
5350	ICMR-THSTI FORMS	106715.00	0.00	0.00	106715.00	0.00	
5354	WORKSITE BASED LIFESTYLE	1390885.00	1357047.00	0.00	2747932.00	0.00	
5355	REGIONAL TRC FOR HEALTH ASSESSMENT	1487232.00	3687132.00	0.00	5174364.00	0.00	
5356	AROGYAM NETWORK (KIRAN)	17134093.00	0.00	0.00	17134093.00	0.00	
6055	MOVEMENT DISORDER SURGERY	0.00			0.00	0.00	
5357	MOLECULAR, CLINICORADIOLOGIC AND PATHOLOGICAL CHARACTERIZATION OF OLIGODENDROGLIOMAS WITH CIC AND FUBP1 MUTATIONS (EMR/2016/005832)	1157872.05	0.00	0.00	1157872.05	0.00	
5358	AN OBLIGATE ROLE FOR DISCOIDIN DOMAIN RECEPTOR 2 IN CELL CYCLE PROGRESSION AND APOPTOSIS RESISTANCE IN CARDIAC FIBROBLASTS	606408.28	0.00	2124.00	608532.28	0.00	
5359	THREE DIMENSIONAL PRINTING IN CONGENITAL HEART DISEASE	433999.60	200000.00	0.00	633999.60	0.00	

0.00	0.00	1256689.00	0.00	12000.00	1268689.00	1268689.00	568421.00
0.00	0.00	0.00	2340.00	19996.00	22336.00	22336.00	909591.00
0.00	0.00	17342.00	0.00	9508.26	26850.26	26850.26	-0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	20950.00
0.00	0.00	115866.00	19600.00	119412.01	254878.01	254878.01	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	333751.75
0.00	0.00	372000.00	0.00	1669.00	373669.00	373669.00	339367.00
0.00	0.00	265608.00	39290.00	68769.00	373667.00	373667.00	90448.26
0.00	0.00	0.00	0.00	0.00	0.00	0.00	14014.00
0.00	0.00	3085419.00	0.00	2754133.00	5839552.00	5839552.00	28604378.98
0.00	0.00	0.00	0.00	551940.00	551940.00	551940.00	0.00
0.00	0.00	0.00	0.00	325503.00	325503.00	325503.00	0.00
0.00	0.00	604516.00	0.00	0.00	604516.00	604516.00	190759.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	60710.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	106715.00
0.00	0.00	0.00	0.00	4390.00	4390.00	4390.00	2743542.00
0.00	0.00	1970320	0.00	551329.00	2521649.00	2521649.00	2652715.00
0.00	0.00	1535260.00	0.00	789014.00	2324274.00	2324274.00	14809819.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	630154.93	0.00	630154.93	630154.93	527717.12
0.00	0.00	223688.00	178919.80	70732.00	473339.80	473339.80	135192.48
0.00	0.00	162360.00	0.00	24393.00	186753.00	186753.00	447246.60

5360	DESIALYLATION-DRIVEN UPTAKE OF LIPOPROTEIN(A) TO ENDOTHELIAL CELLS AND MONOCYTES / MACROPHAGES IN DIABETIC CARDIOVASCULAR PATIENTS: IS IMMUNE COMPLEX WITH NATURAL ANTIBODIES A VEHICLE?	315950.39	0.00	16983.00	332933.39	0.00	
5361	IMPROVING STROKE CARE IN INDIA (IMPROVISE)	2655084.56	1203198.00	0.00	3858282.56	79622.00	
5362	AYURVEDIC TREATMENT IN THE REHABILITATION OF ISCHEMIC STROKE PATIENTS IN INDIA: A RANDOMIZED CONTROLLED TRIAL (RESTORE)	4190262.00	2238638.00	0.00	6428900.00	0.00	
5363	NATIONAL HEART FAILURE REGISTRY	1014837.92	6217555.00	0.00	7232392.92	0.00	
5365	NATIONAL ENVIRONMENTAL HEALTH PROFILE	1394605.39	0.00	66635.00	1461240.39	0.00	
5368	VIRTUAL REALITY-BASED SOLUTION FOR EFFECTIVE NEUROANATOMY TEACHING	2072627.00	5700000.00	0.00	7772627.00	0.00	
5369	WORKSHOP ON BRAIN CONNECTIVITY ANALYSIS AND CONFERENCE ON BRAIN COMPUTER INTERFACE	85539.00	50000.00	0.00	135539.00	0.00	
5370	TRANSCRIPTIONAL AND TRANSLATIONAL REGULATION OF PERIOSTIN AND ITS INTERACTION WITH DDR2 IN CARDIAC FIBROSIS	16812.46	647833.00	0.00	664645.46	0.00	
5371	GENERAL ANESTHESIA VS SEDATION-COGNITIVE DECLINE IN ELDERLY – A RANDOMIZED CONTROLLED TRIAL IN PATIENTS WITH CHRONIC SUBDURAL HEMATOMA (GAS-CDE)	120204.48	800000.00	0.00	920204.48	0.00	
5373	ARCHITECTURE OF PARKINSON'S	16726281.19	0.00	0.00	16726281.19	889332	
5374	RISK ANALYSIS OF DEMENTIA	2891714.00	0.00	0.00	2891714.00	13597.50	
5375	CARE IN HEART FAILURE	1028878.00	2229728.00	0.00	3258606.00	0.00	
5376	CARE IN HEART FAILURE	2713688.27	940880.00	0.00	3654568.27	1575838	
5377	CARE IN HEART FAILURE	451791.80	2420250.00	0.00	2872041.80	0.00	
5378	CARE IN HEART FAILURE	400000.00	128750.00	0.00	528750.00	0.00	
5379	CARE IN HEART FAILURE	1647456.00	105000.00	0.00	1752456.00	0.00	
5380	CARE IN HEART FAILURE	500000.00	635000.00	0.00	1135000.00	0.00	
5381	CARE IN HEART FAILURE	0.00	3215800.00	0.00	3215800.00	0.00	
5382	CARE IN HEART FAILURE	0.00	2366524.00	0.00	2366524.00	0.00	
5383	VISUAL-AUDITORY	118689.00	0.00	0.00	118689.00	0.00	
5384	MAHATARI JATAN YOJANA	400000.00	0.00	0.00	400000.00	0.00	

0.00	0.00	35484.00	108652.79	188796.60	332933.39	332933.39	-0.00
0.00	79622.00	900000.00	3310.00	510886.00	1414196.00	1493818.00	2364464.56
0.00	0.00	811279.00	67840.00	1953936.00	2833055.00	2833055.00	3595845.00
0.00	0.00	775510.00	0.00	614737.00	1390247.00	1390247.00	5842145.92
0.00	0.00	372000.00	0.00	68188.00	440188.00	440188.00	1021052.39
0.00	0.00	403200.00	0.00	200000.00	603200.00	603200.00	7169427.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	135539.00
0.00	0.00	515160.00	1200.00	70008.00	586368.00	586368.00	78277.46
0.00	0.00	180000.00	0.00	80000.00	260000.00	260000.00	660204.48
0.00	889332.00	1109185.00	1069408.26	2441261.36	4619854.62	5509186.62	11217094.57
0.00	13597.50	1069045.00	0.00	20000.00	1089045.00	1102642.50	1789071.50
0.00	0.00	1811779.00	0.00	117316.00	1929095.00	1929095.00	1329511.00
0.00	1575838.00	262939.00	324466.26	73170.00	660575.26	2236413.26	1418155.01
0.00	0.00	0.00	239783.12	116250.00	356033.12	356033.12	2516008.68
0.00	0.00	0.00	0.00	39302.00	39302.00	39302.00	489448.00
0.00	0.00	0.00	0.00	129114.00	129114.00	129114.00	1623342.00
0.00	0.00	0.00	0.00	86820.00	86820.00	86820.00	1048180.00
0.00	0.00	0.00	0.00	94212.00	94212.00	94212.00	3121588.00
0.00	0.00	0.00	0.00	2366524.00	2366524.00	2366524.00	0.00
0.00	0.00	73742.00	0.00	0.00	73742.00	73742.00	44947.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	400000.00

5385	QUANTITATIVE EEG AND MULTI-MO	1003605.50	1200000.00	12743.00	2216348.50	154140.00	
5386	COMPREHENSIVE AND NOVEL MODEL	0.00	1253000.00	0.00	1253000.00	0.00	
5387	INDUSTRIAL POLLUTION	524080.00	0.00	0.00	524080.00	0.00	
5388	EFFICIENT PORTABLE STAND	117800.00	90500.00	1963.00	210263.00	0.00	
5389	PEDIATRIC EPILEPSY SYNDROME	1894440.00	4799533.00	0.00	6693973.00	94830.75	
5390	HUMAN GUT MICROBIOME	422882.00	0.00	0.00	422882.00	0.00	
5391	DISPOSABLE DEFIBRILLATOR	514640.00	450000.00	12009.00	976649.00	118321.00	
5392	DNA METHYLATION IN INSULIN	1050000.00	1050000.00	0.00	2100000.00	0.00	
5393	LIFESTYLE INTERVENTION	5341734.60	0.00	0.00	5341734.60	88200.00	
5394	SKULLBASE SURGERY	479937.00	300000.00	0.00	779937.00	346920.00	
5395	ROLE OF CONNEXINS	0.00	1437880.00	0.00	1437880.00	0.00	
5396	ATRIAL CARDIOPATHY	47500.00	0.00	0.00	47500.00	0.00	
5397	SYNUCLEINOPATHY PATHOLOGY	1768809.30	0.00	0.00	1768809.30	0.00	
5398	INTERVENTIONAL THERAPY	806400.00	0.00	0.00	806400.00	127245.76	
5399	STROKE CARE REGISTRY	477419.00	0.00	0.00	477419.00	0.00	
5400	VISUAL OUTCOME RECURRENCE	400000.00	0.00	0.00	400000.00	0.00	
5401	PREVENTION IN STROKE	1000000.00	0.00	0.00	1000000.00	0.00	
5402	CRANIOVERTEBRAL ANOMALIES	462000.00	0.00	0.00	462000.00	0.00	
5403	VIRTUAL AIRWAY ASSESSMENT	0.00	25000.00	0.00	25000.00	19999.00	
5404	EMOTIONAL FACE RECOGNITION	0.00	835170.00	0.00	835170.00	0.00	
5405	DNA METHYLATION PROFILING	0.00	1889413.00	0.00	1889413.00	0.00	
5406	MANPOWER FOR COVID 19 TESTING UNDER NHM	0.00	2012628.00	0.00	2012628.00	0.00	
5407	LUNG ULTRASOUND WORKFLOW	0.00	550000.00	0.00	550000.00	0.00	
5408	DRUGS CONTROL	0.00	898880.00	0.00	898880.00	0.00	
5410	CEREBROSPINAL FLUID	0.00	1229100.00	0.00	1229100.00	0.00	
5412	CARDIAC CHANNELOPATHIES	0.00	1573971.00	0.00	1573971.00	0.00	
5413	CHRONIC INSOMNIA	0.00	1288160.00	0.00	1288160.00	0.00	
5414	AVAILABILITY, DISTRIBUTION AND	0.00	720000.00	0.00	720000.00	0.00	
5415	ARTERIAL STROKE IMAGING	0.00	1413000.00	0.00	1413000.00	0.00	
5416	IMPROVIS-ATION (IMPROVING ST	0.00	1430000.00	0.00	1430000.00	0.00	
5417	REGULATION OF PROGENITOR CE	0.00	1973910.00	0.00	1973910.00	0.00	

0.00	154140.00	763200.00	35760.00	308500.40	1107460.40	1261600.40	954748.10
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1253000.00
0.00	0.00	300000.00	0.00	195751.00	495751.00	495751.00	28329.00
0.00	0.00	0.00	0.00	12792.00	12792.00	12792.00	197471.00
0.00	94830.75	958566.00	500000.00	16833.00	1475399.00	1570229.75	5123743.25
0.00	0.00	372000.00	0.00	44000.00	416000.00	416000.00	6882.00
0.00	118321.00	359600.00	0.00	20756.00	380356.00	498677.00	477972.00
0.00	0.00	0.00	677744.10	50000.00	727744.10	727744.10	1372255.90
0.00	88200.00	1176748.00	0.00	23785.00	1200533.00	1288733.00	4053001.60
0.00	346920.00	216000.00	80800.00	24149.00	320949.00	667869.00	112068.00
0.00	0.00	188828.00	378967.81	41880.00	609675.81	609675.81	828204.19
0.00	0.00	0.00	0.00	0.00	0.00	0.00	47500.00
0.00	0.00	406292.00	710144.37	0.00	1116436.37	1116436.37	652372.93
0.00	127245.76	281014.00	86340.00	9749.00	377103.00	504348.76	302051.24
0.00	0.00	300000.00	0.00	12163.00	312163.00	312163.00	165256.00
0.00	0.00	180667.00	0.00	120000.00	300667.00	300667.00	99333.00
0.00	0.00	0.00	0.00	1000000.00	1000000.00	1000000.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	462000.00
0.00	19999.00	0.00	0.00	0.00	0.00	19999.00	5001.00
0.00	0.00	115065	195731	65000.00	375796.00	375796.00	459374.00
0.00	0.00	92800.00	3476.00	125576.00	221852.00	221852.00	1667561.00
0.00	0.00	2012628.00	0.00	0.00	2012628.00	2012628.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	550000.00
0.00	0.00	0.00	0.00	719189.00	719189.00	719189.00	179691.00
0.00	0.00	61214.00	27300.00	48100.00	136614.00	136614.00	1092486.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1573971.00
0.00	0.00	27840.00	0.00	58960.00	86800.00	86800.00	1201360.00
0.00	0.00	0.00	0.00	83291.00	83291.00	83291.00	636709.00
0.00	0.00	0.00	0.00	40000.00	40000.00	40000.00	1373000.00
0.00	0.00	0.00	0.00	69924.00	69924.00	69924.00	1360076.00
0.00	0.00	0.00	0.00	56910.00	56910.00	56910.00	1917000.00

5419	HPSR FELLOWSHIP INDIA	0.00	583200.00	0.00	583200.00	0.00	
5420	TTK CHITRA	0.00	2000000.00	0.00	2000000.00	0.00	
5421	OUTCOME DETERMINANTS OF TOF	0.00	2136100.00	0.00	2136100.00	0.00	
5422	ATRIAL CARDIOPATHY	0.00	351230.00	0.00	351230.00	0.00	
5423	CHARACTERIZATION OF UBIQUITIN	0.00	932966.00	0.00	932966.00	0.00	
5427	PROGNOSTIC VALUE OF CIRCULATING MICRORNAS IN HEART FAILURE	0.00	2239467	0.00	2239467.00	0.00	
6077	TECHNICAL ADVISORY COMMITTEE	0.00	255068.00	0.00	255068.00	0.00	
6080	COMPREHENSIVE PAIN CLINIC	0.00	18750.00	0.00	18750.00	0.00	
6107	ROLE OF RESTING STATE FUNCTIONAL MRI IN PATIENTS WITH INTRACRANIAL DURAL ARTERIO VENOUS FISTULA	0.00	82505.00	0.00	82505.00	0.00	
6108	CEREBRAL HEMODYNAMIC	0.00	6370.00	0.00	6370.00	0.00	
6110	ROLE OF INTRAVOXEL INCOHERENT	0.00	24160.00	0.00	24160.00	0.00	
6111	REGULATION OF PROGENITOR CELL	0.00	209726.50	0.00	209726.50	0.00	
6112	INTRAOPERATIVE Quantification of Left Ventricular	0.00	2740.00	0.00	2740.00	0.00	
6114	AGE MODIFICATION	0.00	59964.40	0.00	59964.40	0.00	
6115	THE ROLE OF BIOMARKERS IN PR	0.00	476837.05	0.00	476837.05	0.00	
6118	AUTOMATED VERBAL AUTOPSY	0.00	68665.00	0.00	68665.00	0.00	
6121	REAL TIME RT-PCR ASSAY	0.00	14700.00	0.00	14700.00	0.00	
6122	AIR-BORNE INFECTION	0.00	35357.00	0.00	35357.00	0.00	
7101	ADVANCE TO P I	0.00	438748.00	0.00	438748.00	0.00	
6113	EXOSOMAL MIRNA	0	187284	0	187284.06	0	
7101	ADVANCE TO P I	0	0	1138960	1138960.00	0	
		191304711	77990809	8894201	278189721	3729677	

	OTHER PROJECTS						
1014	NEW PENSION SCHEME	8703584		147341811	156045395		
1301	EMPLOYEES PENSION FUND	212913291		416582735	629496026		
1075	PATIENT WELFARE FUND	11090677		1234489	12325166		
		0			0		

0.00	0.00	0.00	0.00	43200.00	43200.00	43200.00	540000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2000000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2136100.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	351230.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	932966.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2239467.00
0.00	0.00	255068.00	0.00	0.00	255068.00	255068.00	0.00
0.00	0.00	18750.00	0.00	0.00	18750.00	18750.00	0.00
0.00	0.00	0.00	82505.00	0.00	82505.00	82505.00	0.00
0.00	0.00	0.00	6370.00	0.00	6370.00	6370.00	0.00
0.00	0.00	0.00	24160.00	0.00	24160.00	24160.00	0.00
0.00	0.00	0.00	209726.50	0.00	209726.50	209726.50	0.00
0.00	0.00	0.00	2740.00	0.00	2740.00	2740.00	0.00
0.00	0.00	0.00	59964.40	0.00	59964.40	59964.40	0.00
0.00	0.00	0.00	476837.05	0.00	476837.05	476837.05	0.00
0.00	0.00	56840.00	0.00	11825.00	68665.00	68665.00	0.00
0.00	0.00	0.00	14700.00	0.00	14700.00	14700.00	0.00
0.00	0.00	35357.00	0.00	0.00	35357.00	35357.00	0.00
0.00	0.00	0.00	0.00	438748.00	438748.00	438748.00	0.00
0	0.00	0	187284	0	187284.06	187284	0.00
0	0.00	0	0	1138960	1138960.00	1138960	0.00
0	3729677	28243801	7220782	41776486	77241069	80970746	197218975

0	0			147719809	147719809	147719809	8325586
	0			303681243	303681243	303681243	325814783
	0			118892	118892	118892	12206274
	0					0	0

1078	DR. RICHARD A CASH & DR K MOHAN DAS AWARD	319962			319962		
1080	STAFF BENEVOLENT FUND	7753919		2048689	9802608		
1081	CONTINUUM - SPECIAL CME PUBLICATION FUND - Hospital	0			0		
1096	PEDIATRIC WELFARE FUND	0			0		
1099	CSR GRANT - REVENUE	9259704		3210000	12469704		
	TOTAL (B)	250041138	0	570417724	820458861	0	

	BMT PROJECTS						
PROJ #	**NAME OF GRANTEE/PRINCIPAL INVESTIGATOR**	**FUND-WISE BREAK UP**					
		OPENING BALANCE	**ADDITIONS TO FUND**		**TOTAL**		
			GRANTS	**OTHER RECEIPTS**		**FIXED ASSETS**	
	HOSPITAL PROJECTS		**ADDITIONS TO FUND**				
5000	PROJECT EXPENSE	25021640.57	0.00	90753459.79	115775100.36	0.00	
5057	DYNAMIC ORTHOPAEDIC PVT LTD, HYDROXY	6787.55	0.00	0.00	6787.55	0.00	
5089	DETEC & TREAT OF CANCER BY LASER	3959.00	0.00	0.00	3959.00	0.00	
7000	MISCELLENEOUS PROJECT	30944.09	0.00	0.00	30944.09	0.00	
7001	PRO;SAHAJANAND VASCU;DR.AURTHUR	78108.75	0.00	0.00	78108.75	0.00	
7002	DR.TOMS LABORATORY, DR. K.KRISHNAN	13876.00	0.00	0.00	13876.00	0.00	
7003	PROJ:D.S.T. DR.P.V. MOHANAN	2537.40	0.00	0.00	2537.40	0.00	
7004	PROJ:ATMRF:DR LISSY KRISHNAN	551.25	0.00	0.00	551.25	0.00	
7005	PROJECT:DYNAMIC ORTHOPAEDICS	13656.00	0.00	0.00	13656.00	0.00	
7006	PROJ: D.S.T. D.S.NAGESH	181074.00	0.00	0.00	181074.00	0.00	
7009	CHITOSAN BASED WOUND DRESSING	4761.75	0.00	0.00	4761.75	0.00	
7011	DST-FAB: CLINICALLY/SIG:SHAPE OF HEVA	213826.00	0.00	0.00	213826.00	0.00	
7014	AUROLAB,ARAVIND EYE HOSPITAL	13674.00	0.00	0.00	13674.00	0.00	
7015	TTK.HEALTHCARE.DEVELOPMENT OF VALV	39424.00	0.00	0.00	39424.00	0.00	

	0				0	0	319962
	0			969222	969222	969222	8833386
	0				0	0	0
	0				0	0	0
	0			4780179	4780179	4780179	7689525
0	0	0	0	457269345	457269345	457269345	363189516

UTILIZATION							
CAPITAL EXPENDITURE		**REVENUE EXPENDITURE**				**TOTAL EXPENDITURE**	**NET BALANCE**
OTHERS	**TOTAL**	**SALARIES/ WAGES**	**RENT/ CONSUM ABLES**	**OTHER ADMN EXP**	**TOTAL**		
		UTILIZATION					
0.00	0.00	0.00	113594713.9	0.00	113594713.87	113594713.87	2180386.49
0.00	0.00	0.00	0.00	0.00	0.00	0.00	6787.55
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3959.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	30944.09
0.00	0.00	0.00	0.00	0.00	0.00	0.00	78108.75
0.00	0.00	0.00	0.00	0.00	0.00	0.00	13876.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2537.40
0.00	0.00	0.00	0.00	0.00	0.00	0.00	551.25
0.00	0.00	0.00	0.00	0.00	0.00	0.00	13656.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	181074.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	4761.75
0.00	0.00	0.00	0.00	0.00	0.00	0.00	213826.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	13674.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	39424.00

7016	INDO-GERMAN COMMITTEE MEETING-DST	5407.00	0.00	0.00	5407.00	0.00	
7017	HINDUSTAN LATEX.EVALU:BLOOD BAG	23333.53	287100.00	0.00	310433.53	0.00	
7018	ALL INDIA COUNCIL FOR TECHNI:EDU:SH	761562	0.00	0	761562.00	0.00	
7019	DST.NIRANJAN	69847.00	0.00	0.00	69847.00	0.00	
7020	IFCPAR-DR.JAYAKRISHNAN	188.00	0.00	0.00	188.00	0.00	
7022	DST-LBFDPSBC-DR.SHARMA	79385.00	0.00	0.00	79385.00	0.00	
7023	DEV: HYDRO-CEPHALUS-HINDUSTAN LATEX	45510.00	0.00	0.00	45510.00	0.00	
7026	DEV.HEART VALVE-DST.MURALEE	2522.00	0.00	0.00	2522.00	0.00	
7029	DONERG/LIFE SCIENCE BOARD	6876.00	0.00	0.00	6876.00	0.00	
7031	DBT/DR P V MOHAN/DEV INVITROPYRO	79064.00	0.00	0.00	79064.00	0.00	
7032	DST. DR. ANNINE/BONE REGENERATION	29166.00	0.00	0.00	29166.00	0.00	
7033	BIOFUNCTIONAL EVALUATION DR. UMASANKER	72581.00	0.00	0.00	72581.00	0.00	
7034	DST. DR. NIRMALA RACHEL	14664.00	0.00	0.00	14664.00	0.00	
7035	DST-H.K.VARMA	95433.00	0.00	0.00	95433.00	0.00	
7037	INVIVO EVALUATION/ STED/DR. LISSY	6205.00	0.00	0.00	6205.00	0.00	
7039	JNC/ASR/DR. MOHANAN/STUDY OF ACCUTE…..	44684.00	0.00	0.00	44684.00	0.00	
7040	BIOMED/ C.V. MURALEEDHARAN	44000.00	0.00	0.00	44000.00	0.00	
7041	CSIR-GRANT-ASHA S MATHEW,PHD STUDENT	55973.00	0.00	0.00	55973.00	0.00	
7042	CSIR-GRANT-BERNADETTE K. MADATHIL,PHD	25870.00	0.00	0.00	25870.00	0.00	
7043	CSIR-GRANT-SAILAJA.G.S.SRF	9067.00	0.00	0.00	9067.00	0.00	
7044	LISI NO TRIAL TRIAL MERIND	21672.65	0.00	0.00	21672.65	0.00	
7045	NIRMALA RACHEL, CSIR	14063.00	0.00	0.00	14063.00	0.00	
7047	U.G.C. GRANT- RESEARCH FELLOW	300935.00	0.00	0.00	300935.00	0.00	
7048	CSIR GRANT- JOSENA JOSEPH	47473.00	0.00	0.00	47473.00	0.00	
7049	CSIR GRANT - MARY VARGHESE	35837.00	0.00	0.00	35837.00	0.00	
7050	INTEREST-PROJECT ACCOUNT	10204144.87	0.00	2759967	12964111.87	0.00	
7051	CSIR GRANT - MANITHA B NAIR	12062.00	0.00	0.00	12062.00	0.00	
7053	DR.SREENIVASAN/DEVEL.OF TEMP.RES.CO-OPLY	22619.00	0.00	0.00	22619.00	0.00	
7054	DST-DR.ANOOP-DIFF:EXPR:RAT BRAIN……	44434.00	0.00	0.00	44434.00	0.00	
7055	CSIR-NMITLI SCHEME-C.V.MURALEEDHARAN	756552.00	0.00	0.00	756552.00	0.00	

0.00	0.00	0.00	0.00	0.00	0.00	0.00	5407.00
0.00	0.00	0	202360	0.00	202360.00	202360.00	108073.53
0.00	0.00	0.00	0.00	0.00	0.00	0.00	761562.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	69847.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	188.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	79385.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	45510.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2522.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	6876.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	79064.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	29166.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	72581.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	14664.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	95433.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	6205.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	44684.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	44000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	55973.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	25870.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	9067.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	21672.65
0.00	0.00	0.00	0.00	0.00	0.00	0.00	14063.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	300935.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	47473.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	35837.00
0.00	0.00	0.00	1071622.65	0	1071622.65	1071622.65	11892489.22
0.00	0.00	0.00	0.00	0.00	0.00	0.00	12062.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	22619.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	44434.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	756552.00

7057	DST - PROJECT.DR.JAYABALAN	14471.00	0.00	0.00	14471.00	0.00	
7060	ICMR PROJECT/ SUDHAKAR MUTHALEE	124392.00	0.00	0.00	124392.00	0.00	
7062	DR. LIZY-SAHAJA:EVA "STENT"INVITRO…..	101675.00	0.00	0.00	101675.00	0.00	
7065	DR.T.V.KUMARI,DBT.BIOGENE	38659.00	0.00	0.00	38659.00	0.00	
7069	VSSC - PROJECT. D.S. NAGESH	153302.00	0.00	0.00	153302.00	0.00	
7071	STEC-PROJECT: DR.MAYA NANDKUMAR	375.00	0.00	0.00	375.00	0.00	
7072	SAHAJANAND MED.TECH. C.V.MURALIDHARAN	76292.00	0.00	0.00	76292.00	0.00	
7074	STUDY PROJECT: CLRI- DR.MOHAN	289303.00	0.00	0.00	289303.00	0.00	
7075	STUDY PROJECT - BIOSYNC SCI	11935.00	0.00	0.00	11935.00	0.00	
7076	ARROW INTERNATIONAL : DR.UMASHANKAR	399773.00	0.00	0.00	399773.00	0.00	
7080	DBT-DR.MAYA- TISSUE ENGINEERING HYBRID	10518.00	0.00	0.00	10518.00	0.00	
7081	USV LTD. MUMBAI - DR.MOHAN	88349.00	0.00	0.00	88349.00	0.00	
7082	INDO-US JOINT PROJECT	878.00	0.00	0.00	878.00	0.00	
7083	ARROW HAEMO DIALYSIS	30882.00	0.00	0.00	30882.00	0.00	
7085	DR.R.V.THAMPAN - CSIR	26381.00	0.00	0.00	26381.00	0.00	
7086	HORMONE RELEASING INTRA DEVICES	-86027.00	0.00	86027.00	0.00	0.00	
7087	CSIR - KALADHAR - BST	39103.00	0.00	0.00	39103.00	0.00	
7092	PROJ/7092/SEA FOOD	1993.00	0.00	0.00	1993.00	0.00	
7093	PROJ/7093/CSIR GRANT-LPA	50562.00	0.00	0.00	50562.00	0.00	
7095	PROJ/7095/CSIR GRANT-VIOLA.B.MORRIS	22072.00	0.00	0.00	22072.00	0.00	
7097	PROJ/7097/ACCELERATED AGEING	107003.27	0.00	0.00	107003.27	0.00	
7099	PROJ/7099/BCL	7011.00	0.00	0.00	7011.00	0.00	
7100	PROJ/7100/ITR PROGRAMME	4079.00	0.00	0.00	4079.00	0.00	
7101	PROJ/7101/CSIR/SONIA.T.A	2650.00	0.00	0.00	2650.00	0.00	
7103	PROJ/7103/CSIR/VIDYARAJ	5682.00	0.00	0.00	5682.00	0.00	
7105	PROJ/7105/CSIR/ARJUN NAMBOODIRI	26821.00	0.00	0.00	26821.00	0.00	
7107	PROJ/7107/CSIR/NEENA & 2 FELLOWS	34082.00	0.00	0.00	34082.00	0.00	
7108	PROJ/7108/CSIR/FRANCIS.B.FERNANDEZ	2154.00	0.00	0.00	2154.00	0.00	
7110	PROJ/7110/CSIR/DEEPA.R	10919.00	0.00	0.00	10919.00	0.00	
7111	PROJ/7111/CSIR/SHEEJA LIZA EASO	6353.00	0.00	0.00	6353.00	0.00	
7200	JOINT PROGRAME/M.TECH	464180	0.00	0.00	464180.00	0.00	

0.00	0.00	0.00	0.00	0.00	0.00	0.00	14471.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	124392.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	101675.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	38659.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	153302.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	375.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	76292.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	289303.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	11935.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	399773.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	10518.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	88349.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	878.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	30882.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	26381.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	39103.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1993.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	50562.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	22072.00
0.00	0.00	0.00	18004.00	0.00	18004.00	18004.00	88999.27
0.00	0.00	0.00	0.00	0.00	0.00	0.00	7011.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	4079.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2650.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5682.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	26821.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	34082.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2154.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	10919.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	6353.00
0.00	0.00	0.00	0	0.00	0.00	0.00	464180.00

7210	PROJ/7210/CSIR/SOMA DEY	1641.00	0.00	0.00	1641.00	0.00	
7220	COST OF ANIMAL FEED	3537265.97	0.00	587700.00	4124965.97	415123.95	
7230	PROJ/7230/CSIR/MANJU.S	12421.00	0.00	0.00	12421.00	0.00	
7250	PROJ/7250/CSIR/KIRAN.S.NAIR	15281.00	0.00	0.00	15281.00	0.00	
7260	PROJ/7260/ST0X083Y09/DR.P.V.MOHANAN	149985.00	0.00	0.00	149985.00	0.00	
7290	PROJ/7290/CSIR/RAKHI.A	19584.00	0.00	0.00	19584.00	0.00	
7330	Y.M.THASNEEM - UGC GRANT	7195.00	0.00	0.00	7195.00	0.00	
7370	VALIDATION OF ETO STERILSATION SYSTEM-	144405	0.00	205881	350286.00	0.00	
7375	ICMR PROJECT- MS. RENU RAMESH	32250.00	0.00	0.00	32250.00	0.00	
7385	CSIR GRANT - CAROLINE DIANA SHERLY	1321.73	0.00	0.00	1321.73	0.00	
7390	TOXICITY STUDY OF MATERIALS DR. P V MOHANAN	2062888	0.00	520000.00	2582888.00	0.00	
7395	RAISING ANTIBODIES IN RABBITS - DR V S HARIKRISH	633079.13	0.00	639812	1272891.13	0.00	
7400	CSIR GRANT :SHAIJU S NAZEER	3333.00	0.00	0.00	3333.00	0.00	
7402	PROOF OF CONCEPT STUDY - DR UMA SHANKAR	100747.00	0.00	0.00	100747.00	0.00	
7403	ICMR GRANT - PARVATHY R S	26967	0	0.00	26967.00	0.00	
7404	BIOFUNCTIONAL AND HISTILO - DR UMA SHANKAR	761369.00	0.00	0.00	761369.00	0.00	
7405	IN VITRO EVALUATION OF CELL- DR T V KUMAR	513742.91	0.00	131354.00	645096.91	0.00	
7406	CSIR GRANT - R ARATHI	6135.00	0.00	0.00	6135.00	0.00	
7407	TRSF MESENCHYMAL STEM CELL	1686.00	0.00	0.00	1686.00	0.00	
7409	SRUTHI PHD STUDENT UGC	9292.00	0.00	0.00	9292.00	0.00	
7411	DEV POLY ADHESIVE & POTT	206140.00	0.00	0.00	206140.00	0.00	
7412	REMYA K CSIR FELLOW	19900.00	0.00	0.00	19900.00	0.00	
7413	"PROJ/7413/ANTIMICROBIAL ACTIVITY"	89585.75	0.00	0.00	89585.75	0.00	
7414	"PROJ/7414/EFFECT OF NANOGRAPHENE MOUSE.."	34620.00	0.00	0.00	34620.00	0.00	
7415	"PROJ/7415/AXONAL GUIDANCE"	18450.00	0.00	0.00	18450.00	0.00	
7416	"PROJ/7416/PULMONARY FIBROSIS"	31023	0	0.00	31023.00	0.00	

0.00	0.00	0.00	0.00	0.00	0.00	0.00	1641.00
0.00	415123.95	0.00	264377.02	0.00	264377.02	679500.97	3445465.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	12421.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	15281.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	149985.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	19584.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	7195.00
0.00	0.00	104700.00	11400.00	0.00	116100.00	116100.00	234186.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	32250.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1321.73
0.00	0.00	518400.00	21723.00	0	540123.00	540123.00	2042765.00
0.00	0.00	0.00	77292	0.00	77292.00	77292.00	1195599.13
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3333.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	100747.00
0.00	0.00	0	4512.00	0.00	4512.00	4512.00	22455.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	761369.00
0.00	0.00	0.00	391938.33	0.00	391938.33	391938.33	253158.58
0.00	0.00	0.00	0.00	0.00	0.00	0.00	6135.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1686.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	9292.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	206140.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	19900.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	89585.75
0.00	0.00	0.00	0.00	0.00	0.00	0.00	34620.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	18450.00
0.00	0.00	0	0.00	0.00	0.00	0.00	31023.00

7417	"PROJ/7417/INVITRO & INVIVO EVALUATION"	89080	456585	0.00	545665.00	0.00	
7418	"PROJ/7418/THE NATURE OF FOREIGN BODY ..."	4746	350000.00	0.00	354746.00	0.00	
7419	PROJ/7419/DETERMINATION OF TOXICITY	52516.00	0.00	0.00	52516.00	0.00	
7421	PROJ/7421/FIBRIN BASED MATRIX	104713	0.00	0.00	104713.00	0.00	
7422	PROJ/7422/HISTOPATHOLOGICAL EVALUATION	687696.79	0.00	567845	1255541.79	0.00	
7423	PROJ/7423/TRACKING CARDIAC STEM	63872	0.00	0.00	63872.00	0.00	
7424	PROJ/7424/SYNAPTIC PROTEOME	24533.00	0.00	0.00	24533.00	0.00	
7425	PROJ/7425/BIOENGINEERED SKIN GRAFT FOR ...	736	175000.00	0.00	175736.00	0.00	
7426	PROJ/7426/POLYMERIC MICRO NEEDLES	114849.75	0	0.00	114849.75	0.00	
7427	PROJ/7427/ANIONIC POLYSACCHARIDE BASED .	3003.05	0.00	0	3003.05	0.00	
7428	PROJ/7428/BACTERIAL RESISTANCE	68836	548727	0.00	617563.00	0.00	
7429	PROJ/7429/BIORESORBABLE POLYMER MESH	101326.00	0.00	0.00	101326.00	0.00	
7430	PROJ/7430/TEST OF CRANIAL FIXATION	201070	0.00	0.00	201070.00	0.00	
7431	PROJ/7431/SHELL NACRE	0.00	507200	0.00	507200.00	0.00	
7432	PROJ/7432/CSIR CONTINGENCY GRANT	20000.00	0	0.00	20000.00	0.00	
7433	PROJ/7433/CSIR CONTINGENCY GRANT	20000.00	0	0.00	20000.00	0.00	
7434	PROJ/7434/CSIR CONTINGENCY GRANT	3766.00	0	0.00	3766.00	0.00	
7435	PROJ/7435/CSIR CONTINGENCY GRANT	20000.00	0.0	0.00	20000.00	0.00	
7436	PROJ/7436/CSIR CONTINGENCY GRANT	3603.00	0	0.00	3603.00	0.00	
7437	PROJ/7437/CSIR CONTINGENCY GRANT	16767.00	0	0.00	16767.00	0.00	
7438	PROJ/7438/SCTAC2010 DRUG FORMULATION	223237.43	0	0.00	223237.43	0.00	
7439	CSIR CONT.GRANT/MEDHASURENDRANATH	18871	0	0.00	18871.00	0.00	
7440	CSIR CONT.GRNAT/MANJULA P M	18356	0	0.00	18356.00	0.00	
7441	PROJ/7441/THERMORESPONSIVE POLYMERIC	0.00	49410	0.00	49410.00	0.00	
7442	PROJ/7442/RAPID PROTOTYPING FACILITY	0.00	50000	0.00	50000.00	0.00	
7443	PROJ/7443/MATRIX GEL(CHOLEGEL)	0.00	422667	0.00	422667.00	0.00	
7444	PROJ/7444/DIABETIC FOOT ULCER	0.00	148200	0.00	148200.00	0.00	
7445	PROJ/7445/RIGID KNEE BRACE	0.00	207000	0.00	207000.00	0.00	

0.00	0.00	498833.00	12867.00	0.00	511700.00	511700.00	33965.00
0.00	0.00	330000.00	24746	0.00	354746.00	354746.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	52516.00
0.00	0.00	40313.00	64400.00	0.00	104713.00	104713.00	0.00
0.00	0.00	0.00	188590.72	0.00	188590.72	188590.72	1066951.07
0.00	0.00	0.00	0	0.00	0.00	0.00	63872.00
0.00	0.00	0.00	9039.00	0.00	9039.00	9039.00	15494.00
0.00	0.00	165000.00	0.00	0.00	165000.00	165000.00	10736.00
0.00	0.00	0.00	77479.29	0.00	77479.29	77479.29	37370.46
0.00	0.00	0.00	0	0.00	0.00	0.00	3003.05
0.00	0.00	564687	10164.00	0.00	574851.00	574851.00	42712.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	101326.00
0.00	0.00	0.00	0.00	0	0.00	0.00	201070.00
0.00	0.00	487200.00	19400	0.00	506600.00	506600.00	600.00
0.00	0.00	0.00	1470	0.00	1470.00	1470.00	18530.00
0.00	0.00	0.00	0	0.00	0.00	0.00	20000.00
0.00	0.00	0.00	3000	0.00	3000.00	3000.00	766.00
0.00	0.00	0.00	4797	0.00	4797.00	4797.00	15203.00
0.00	0.00	0.00	3502	0.00	3502.00	3502.00	101.00
0.00	0.00	0.00	0	0.00	0.00	0.00	16767.00
0.00	0.00	0.00	91939.85	0.00	91939.85	91939.85	131297.58
0.00	0.00	0.00	0	0.00	0.00	0.00	18871.00
0.00	0.00	0.00	0	0.00	0.00	0.00	18356.00
0.00	0.00	0.00	0	0.00	0.00	0.00	49410.00
0.00	0.00	0.00	0	0.00	0.00	0.00	50000.00
0.00	0.00	391593.00	0	0.00	391593.00	391593.00	31074.00
0.00	0.00	59806.00	0	0.00	59806.00	59806.00	88394.00
0.00	0.00	104515.00	0	0.00	104515.00	104515.00	102485.00

7446	PROJ/7446/FAST RESORBING CERAMIC	0.00	561867	0.00	561867.00	0.00	
7447	PROJ/7447/BIOMINERAL BASED SELF-SETTING	0.00	561867	0.00	561867.00	0.00	
7448	PROJ/7448/STRUCTURAL PERFORMANCE ASSES..	0.00	141400	0.00	141400.00	0.00	
8004	PROJ/8004/PROGRAM SUPPORT & TISSUE	-278345.00	0.00	0.00	-278345.00	0.00	
8005	PROJ/8005/PROGRAM SUPPORT & TISSUE	-98722.00	0.00	0.00	-98722.00	0.00	
8006	PROJ/8006/BIOCONJUGATION NANO MAT.	139019.00	0.00	0.00	139019.00	0.00	
8008	PROJ/8008/CSIR GRANT-PADMAJA.P.NAMBI	12990.00	0.00	0.00	12990.00	0.00	
8009	PROJ/8009/DBT/DR.T.V.ANILKUMAR/DE…TISSUE	-310641.00	0.00	0.00	-310641.00	0.00	
8011	PROJ/8011/NANOFRONT/DR.NIRANJAN/ INTRAMAS	139900.00	0.00	0.00	139900.00	0.00	
8012	PROJ/8012/VSSC/DR.NIRANJAN/DESIGN STUDIES	2148623.00	0.00	0.00	2148623.00	0.00	
8015	PROJ/8015/DR.ANOOPKUMAR/PROGRAMME…	12581.00	0.00	0.00	12581.00	0.00	
8019	PROJ/8019/STEC/DR.P.RAMESH	82284.00	0.00	0.00	82284.00	0.00	
8020	PROJ/8020/CSIR/DR.LISSY KRISHNAN	19974.36	0.00	0.00	19974.36	0.00	
8021	PROJ/8021/ANGIOGENESIS EXP/ DR.UMASHANKAR	79036.00	0.00	0.00	79036.00	0.00	
8023	PROJ/8023/KSCSTE/DR.H.K.VARMA	76545.00	0.00	0.00	76545.00	0.00	
8024	PROJ/8024/IIT/DR.P.R.ANILKUMAR	2935.00	0.00	0.00	2935.00	0.00	
8026	PROJ/8026/	3339.00	0.00	0.00	3339.00	0.00	
8027	PROJ/8027/DR.P.V.MOHANAN	79732.00	0.00	0.00	79732.00	0.00	
8028	PROJ/8028/DR.DIKSHA PAINULY	22332.00	0.00	0.00	22332.00	0.00	
8031	PROJ/8031	-309053.00	0.00	0.00	-309053.00	0.00	
8032	PROJ/8032/O.S.N.NAIR	128471.00	0.00	0.00	128471.00	0.00	
8034	PROJ/8034/FLURO PASSI…DR.ROY JOSEPH	679576.1	0.00	0.00	679576.10	0.00	
8035	PROJ/EVALN OF SEWING RING-DR. UMASHANKAR	18801.00	0.00	0.00	18801.00	0.00	
8038	PROJ/DEV OF MISSION PROGRAM - DR.GSB	1182223.00	0.00	0.00	1182223.00	0.00	
8040	PROJ/SYNTHESIS OF OXIDE-DR.H.K.VARMA	1475.00	0.00	0.00	1475.00	0.00	
8041	PROJ/DEV OF NANO DEVICES DNA-DR.C.P.SHARMA	-6255.00	0.00	6255.00	0.00	0.00	
8046	PROJ/DIFF. OF ADULT PRO - DR.ASHA.S.MATHEW	739755.00	0.00	0.00	739755.00	0.00	

0.00	0.00	545200.00	0	0.00	545200.00	545200.00	16667.00
0.00	0.00	420332.00	0	0.00	420332.00	420332.00	141535.00
0.00	0.00	0.00	12000	0.00	12000.00	12000.00	129400.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	-278345.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	-98722.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	139019.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	12990.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	-310641.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	139900.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2148623.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	12581.00
0.00	0.00	0.00	0.00	82284.00	82284.00	82284.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	19974.36
0.00	0.00	0.00	0.00	0.00	0.00	0.00	79036.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	76545.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2935.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3339.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	79732.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	22332.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	-309053.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	128471.00
0.00	0.00	0.00	0.00	0	0.00	0.00	679576.10
0.00	0.00	0.00	0.00	0.00	0.00	0.00	18801.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1182223.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1475.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	739755.00

8049	PROJ/NEW VISION BIOMAT-DR.C.P.SHARMA	-44861.00	64387.00	0.00	19526.00	0.00	
8054	PROJ/MUSCULOSKELETAL STEM CELL/ DR.PDNAIR	0.21	0.00	0.00	0.21	0.00	
8055	MUSCULOSKELETAL STEM CELLS/ DR.H.K.VARMA	3.00	0.00	0.00	3.00	0.00	
8059	PROJ/CELL SHEET ENGG-DR.P.R.ANILKUMAR	108000.00	0.00	0.00	108000.00	0.00	
8062	PROJ/ACCELERATED AGEING../MR.C.V.MURALI	213728.00	0.00	0.00	213728.00	0.00	
8064	NONVIRAL GENE DELIVERY VECTORS- DR.REKHA	33801.00	0.00	0.00	33801.00	0.00	
8066	TO INVESTIGATE THE EFFECTS OF/ DR.GULIA	0.55	0.00	0.00	0.55	0.00	
8068	INSPIRE RESEARCH PROJECT -DR.BINDU.P.NAI R	3957.00	0.00	0.00	3957.00	0.00	
8069	PROJ/8069/STUDIES BIODEGRADABLE	1425.00	0.00	0.00	1425.00	0.00	
8070	PROJ/8070/PINSPIRE FACULTY AWARD-DR.SHIV	472880.65	0.00	0.00	472880.65	0.00	
8071	PROJ/8071/REGEN .OF INTERVERTEBRAL DISC	5840.00	0.00	0.00	5840.00	0.00	
8072	PROJ/8072/NANO CALCIUM PHOSPHATE	15412.10	0.00	0.00	15412.10	0.00	
8074	PRODUCTION OF NOVEL NANO INDO-UK DR.CP.S	303180.00	0.00	0.00	303180.00	0.00	
8077	HOME BASED VITAL SIGNS - DR.NIRANJAN.D.	204509.75	0.00	0.00	204509.75	0.00	
8079	DOSE RANGING STUDY FOR DES / DR.SABAREES	731710.00	0.00	0.00	731710.00	0.00	
8082	ASSESSMENT OF CERAMICCONSTRUCTS - FRANC	37118.00	0.00	0.00	37118.00	0.00	
8083	IN VITRO OSTEOARTHRITIC-DR.NEETHUMOHAN	8294.82	0.00	0.00	8294.82	0.00	
8085	PROJ/8085/ELECTROCHEMICALLY ASSISTED	40.00	0.00	0.00	40.00	0.00	
8086	PROJ/8086/GOLD NANORODS FOR THERAPY	18626.77	0.00	0.00	18626.77	0.00	
8087	PROJ/8087/CONTROLLED DELIVERY	26580.86	0.00	0.00	26580.86	0.00	
8088	PROJ/8088/CANCER TISSUE ENGINEERING A 3D	98.00	0.00	0.00	98.00	0.00	
8090	INSPIRE FELLOW PHD KEERTHI S JRF	28446	0	0.00	28446.00	0.00	
8094	ALTERNATE	902.02	0.00	0.00	902.02	0.00	
8095	DEV RAPID UTI DR. MAYA - DST	8173.15	0.00	0.00	8173.15	0.00	
8097	MULTIFUNCN - DBT SUNITHA PREM	223322.22	0.00	0.00	223322.22	0.00	
8098	HOW ACTIN FILAMENT STRUCTUDR RENU MOH	1129.00	0.00	0.00	1129.00	0.00	
8099	INSPIRE FELLOW RESHMA S	11021	0	0.00	11021.00	0.00	
8102	"ENGINEERING BIOMIMETIC…. NICHE TARA.S"	54224.75	0.00	0.00	54224.75	0.00	

0.00	0.00	0.00	0.00	6255.00	6255.00	6255.00	13271.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	108000.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	213728.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	33801.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3957.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1425.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	472880.65
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5840.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	15412.10
0.00	0.00	0.00	0.00	0.00	0.00	0.00	303180.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	204509.75
0.00	0.00	0.00	0.00	0.00	0.00	0.00	731710.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	37118.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	8294.82
0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	18626.77
0.00	0.00	0.00	0.00	0.00	0.00	0.00	26580.86
0.00	0.00	0.00	0.00	0.00	0.00	0.00	98.00
0.00	0.00	0	25000.00	0.00	25000.00	25000.00	3446.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	902.02
0.00	0.00	0.00	0.00	0.00	0.00	0.00	8173.15
0.00	0.00	0.00	0	0.00	0.00	0.00	223322.22
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1129.00
0.00	0.00	0.00	0.00	11021.00	11021.00	11021.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	54224.75

8106	PROJ/8106/MECHANISM OF ANGIOGENESIS	24150	0	0.00	24150.00	0.00	
8107	"PROJ/8107/DEFINING MECHANO -BIOLOGY TO HETEROGENEITY IN MUSCLE STEM -BIOLOGY"	832003.52	2300000	0.00	3132003.52	0.00	
8108	"PROJ/8108/DEVELOPMENT OF A DENTAL RESTORATIVE MATERIAL BASED ON INORGANIC HYBRID RESIN OF A DENTAL RES..."	44556.45	0.00	0.00	44556.45	0.00	
8110	"PROJ/8110/TO ALLEVIATE COGNITIVE DEFECTS"	6353.06	59542.00	0.00	65895.06	0.00	
8113	"PROJ/8113/TREATMENT OF BONE DEFECTS"	139800.00	0.00	0.00	139800.00	0.00	
8114	"PROJ/8114/NANO PARTICLES WITH CELLS"	135222.17	74236	0.00	209458.17	0.00	
8115	PROJ/8115/TECHNOLOGY RESEARCH CENTRE	169684562.18	0.00	12220370.00	181904932.18	6924552.54	
8116	"PROJ/8116/PROGRAM SUPPORT OF TRANSLATIONAL RESEARCH ON BIO MATERIALS FOR ORTHOPAEDICS AND DENTAL APPLICATIONS SUPPORT ON TRAN..."	750818.49	58000	0.00	808818.49	0.00	
8117	"PROJ/8117/GOLD NANOROD BASED TARGETED NANOPROBE FOR CANCER THERANOSTICS: DIAGNOSIS BY SURFACE ENHANCED RAMAN SCATTERING (SERS) AND FLUORESCENCE IMAGING AND THERAPY BY PDT AND PPT BASED TARGETED"	10371.19	0	0.00	10371.19	0.00	
8118	PROJ/8118/THE ROLE OF NMDA & DOPAMINE RECEPTORS IN SPINAL PAIN PATHWAYS	735480.25	0.00	46554.00	782034.25	0	
8119	PROJ/8119/DEVELOPMENT OF BIOMIMETIC STRONTIUM INCORPORATED NANOSTRUCTURED CERAMIC COATINGS ON CP-TITANIUM FOR ORTHOPAEDIC	0.49		0.00	0.49		
8122	PROJ/8122/DEV. OF CENTRIFUGAL BLOOD PUMP	1256920.36	0.00	0.00	1256920.36	0.00	
8123	PROJ/8123/DEV.OF LEFT VENTRICULAR DEVICE	3868819.09	0.00	0.00	3868819.09	1010615.55	
8124	PROJ/8124/DEV. OF AORTIC STENT GRAFT	6941109.86	799200.00	0.00	7740309.86	0.00	
8125	PROJ/8125/DEV. OF DEEP BRAIN STIMULATOR	5031269.64	900000.00	0.00	5931269.64	2000456.65	
8126	PROJ/8126/CARDIOVERTER DEFIBRILLATOR	13435599.44	0.00	0.00	13435599.44	210366.00	
8127	PROJ/8127/DEVELOPMENT OF LEUKODEPLETION	790962.99	429000.00	0.00	1219962.99	0.00	
8128	PROJ/8128/DEPT.OFANNULOPLASTY./MITRAL VALVE CORRECTION	4813319.80	0.00	0.00	4813319.80	0.00	

0.00	0.00	0.00	12000	0.00	12000.00	12000.00	12150.00
0.00	0.00	1476097.00	322538.00	100000.00	1898635.00	1898635.00	1233368.52
0.00	0.00	0.00	0.00	0.00	0.00	0.00	44556.45
0.00	0.00	0.00	0.00	65895.00	65895.00	65895.00	0.06
0.00	0.00	0.00	0.00	0.00	0.00	0.00	139800.00
0.00	0.00	103465.00	2360.00	0.00	105825.00	105825.00	103633.17
0.00	6924552.54	2665386.70	4999585.96	73281096.6	80946069.23	87870621.77	94034310.41
0.00	0.00	472629.00	62281.78	0.00	534910.78	534910.78	273907.71
0.00	0.00	0.00	0.00	0.00	0.00	0.00	10371.19
0.00	0.00	0.00	0.00	782034.00	782034.00	782034.00	0.25
0.00	0.00			0.00	0.00	0.00	0.49
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1256920.36
0.00	1010615.55	755745.00	232473.50	0.00	988218.50	1998834.05	1869985.04
0.00	0.00	1047672.00	207638.50	0.00	1255310.50	1255310.50	6484999.36
0.00	2000456.65	721872.00	141219.00	0.00	863091.00	2863547.65	3067721.99
0.00	210366.00	1308565.00	312993.00	0.00	1621558.00	1831924.00	11603675.44
0.00	0.00	458967.00	338474.13	0.00	797441.13	797441.13	422521.86
0.00	0.00	397161.00	20157.00	0.00	417318.00	417318.00	4396001.80

8129	PROJ/8129/DEVPT.OF BIOPROSTHETIC HEART VALVE	2015760.78	1969097.00	0.00	3984857.78	569070.00	
8130	"PROJ/8130/INTER VERTEBRAL SPACER"	352216.74	0.00	0.00	352216.74	0.00	
8131	PROJ/8131/BIOACTIVE MATERIAL PLATFORM	288896.56	0.00	0.00	288896.56	0.00	
8132	PROJ/8132/DEV. INTRACRANIAL ELECTRODES	231641.20	0.00	0.00	231641.20	0.00	
8133	PROJ/8133/OPTICAL PERIPHERAL NERVE	745239.84	0.00	0.00	745239.84	0.00	
8134	PROJ/8134/HYDROCEPHALUS SHUNT	7135922.00	60000.00	0.00	7195922.00	0.00	
8135	PROJ/8135/STANDARDIZATION OF ALBUMIN	1991515.90	0.00	0.00	1991515.90	99884.00	
8136	PROJ/8136/DEVELOPMENT OF NOVEL WOUND HEALING MATRIX COMPOSED OF HUMAN-FIBRIN	194536.73	0.00	0.00	194536.73	0.00	
8137	PROJ/8137/3D PRINTING OF SKIN TISSUE CONSTRUCTS FOR IN-VITRO TESTING & APPLICATIONS	8554851.15	0.00	0.00	8554851.15	3445799.63	
8138	PROJ/8138/DEVLPMT OF PLATFORM TECLGY IMPLATABLE MICRO INFUSION RECHRGING SYSTEM	5038145.47	0.00	0.00	5038145.47	382200.00	
8139	PROJ/8139/PARYLENE COATING FOR IMPLANTABLE MEDICAL DEVICES& DELIVERY SYSTEM	6578765.88	988000.00	0.00	7566765.88	6072145.00	
8140	PROJ/8140/REPAIR OF CARTILAGE INJURY	279957.32	0.00	0.00	279957.32	0.00	
8141	PROJ/8141/3D PRINTING OF LIVER TISSUE	4262596.39	0.00	0.00	4262596.39	49560.00	
8142	PROJ/8142/DEVELOPMENT OF ASSAY PLATFORM	272357.53	0.00	0.00	272357.53	0.00	
8143	PROJ/8143/POLYMERIC WOUND	353263.30	0.00	0.00	353263.30	0.00	
8144	PROJ/8144/WOUND HEALING MATRIX	387455.34	0.00	0.00	387455.34	0.00	
8145	PROJ/8145/LINT FREE ABSORBENT DRESSING	1504734.39	115200.00	0.00	1619934.39	390600.00	
8146	PROJ/8146/POINT OF CARE DETECTION	4583595.35	0.00	0.00	4583595.35	493700.20	
8147	PROJ/8147/POINT OF CARE DIAGNOSIS	1499157.13	0.00	0.00	1499157.13	389590.11	
8148	PROJ/8148/ALGINATE SCAFFOLD	1407218.14	0.00	0.00	1407218.14	277577.75	
8149	PROJ/8149/EVALUATION OF PLGC	92400.19	0.00	0.00	92400.19	0.00	
8150	PROJ/8150/DEV. OF OCCLUSION DEVICE	2371651.39	464400.00	0.00	2836051.39	82355.00	
8151	PROJ/8151/DEV.EMBOLIZATION DEVICE	846186.17	229600.00	0.00	1075786.17	0.00	
8152	PROJ/8152/DEVELOPMENT OF TITANIUM NITRATE COATED CORONARY STENT	3916902.15	847800.00	0.00	4764702.15	871500.00	
8153	PROJ/8153/CHARACTERISATION OF BACILLUS SPECIES-(MRSA)	4289345.90	0.00	0.00	4289345.90	1400647.00	

0.00	569070.00	1311967.00	480220.46	0.00	1792187.46	2361257.46	1623600.32
0.00	0.00	0.00	0.00	0.00	0.00	0.00	352216.74
0.00	0.00	0.00	0.00	0.00	0.00	0.00	288896.56
0.00	0.00	0.00	0.00	0.00	0.00	0.00	231641.20
0.00	0.00	94720.00	148871.03	0.00	243591.03	243591.03	501648.81
0.00	0.00	601956.00	164529.00	0.00	766485.00	766485.00	6429437.00
0.00	99884.00	0.00	183898.10	0.00	183898.10	283782.10	1707733.80
0.00	0.00	0.00	0.00	0.00	0.00	0.00	194536.73
0.00	3445799.63	434854.00	1452666.61	0.00	1887520.61	5333320.24	3221530.91
0.00	382200.00	1007445.00	882105.75	0.00	1889550.75	2271750.75	2766394.72
0.00	6072145.00	474000.00	260595.00	0.00	734595.00	6806740.00	760025.88
0.00	0.00	0.00	0.00	0.00	0.00	0.00	279957.32
0.00	49560.00	8100.00	1374363.50	0.00	1382463.50	1432023.50	2830572.89
0.00	0.00	0.00	20674.50	0.00	20674.50	20674.50	251683.03
0.00	0.00	0.00	0.00	0.00	0.00	0.00	353263.30
0.00	0.00	0.00	0.00	0.00	0.00	0.00	387455.34
0.00	390600.00	123458.00	112022.30	0.00	235480.30	626080.30	993854.09
0.00	493700.20	409200.00	300914.40	0.00	710114.40	1203814.60	3379780.75
0.00	389590.11	0.00	148251.97	0.00	148251.97	537842.08	961315.05
0.00	277577.75	0.00	403490.55	0.00	403490.55	681068.30	726149.84
0.00	0.00	0.00	0.00	0.00	0.00	0.00	92400.19
0.00	82355.00	630072.00	268658.65	0.00	898730.65	981085.65	1854965.74
0.00	0.00	239345.00	412575.24	0.00	651920.24	651920.24	423865.93
0.00	871500.00	580587.00	566844.50	0.00	1147431.50	2018931.50	2745770.65
0.00	1400647.00	53626.00	558567.38	0.00	612193.38	2012840.38	2276505.52

8154	PROJ/8154/DEPT.OF BIOMATERIAL SCIENCE &TECHNOLOGY	1198085.31	0.00	0.00	1198085.31	0.00	
8155	PROJ/8155/DEVPT.OF FLOW DIVERTER TREATMENT OF ANEURYSMS	5154302.38	874800.00	0.00	6029102.38	321431.00	
8156	PROJ/8156/RADIOPAQUE POLYMERIC MICROSPHERES OF EMBOLIZTION THERAPY	946064.30	0.00	0.00	946064.30	0.00	
8157	PROJ/8157/DEVLPMT OF PLRS & HIGH STAKE DECISION MKNG FROM CONCEPT PDT	850400.00	1800000.00	0.00	2650400.00	1780851.00	
8158	PROJ/8158/PRIMER TECHNOLOGY TNFR TECHNI CAL,MKT,FINICIAL,CL,REGLURTY INPUTS	608749.30	0.00	0.00	608749.30	9145.00	
8159	PROJ/8159/ITI INFRASTRUCTURE UPGRADTION PLAN	2777290.62	1145000.00	0.00	3922290.62	2328138.30	
8160	PROJ/8160/TOXICOLOGICAL EVALUATION	6193636.71	1400000.00	0.00	7593636.71	77815.50	
8161	PROJ/8161/LARGE ANIMAL EVALUATION	8359224.67	865626.00	0.00	9224850.67	665625.45	
8162	PROJ/8162/BLOOD COMPATIBILITY	1814959.68	0.00	0.00	1814959.68	225750.00	
8163	PROJ/8163/CYTOCOMPATIBILITY	1722103.47	0.00	0.00	1722103.47	198668.00	
8164	PROJ/8164/HISTOPATHOLOGICAL EVALUATION	2331852.67	5000.00	0.00	2336852.67	998048.75	
8165	PROJ/8165/MICROBIOLOGICAL EVALUATION	459320.93	50000.00	0.00	509320.93	0.00	
8166	PROJ/8166/ANALYTICAL CHARACTERISATION	1944382.00	35000.00	0.00	1979382.00	0.00	
8167	PROJ/8167/DESIGN & PROTOTYPING	2202588.68	250000.00	0.00	2452588.68	14536.00	
8168	PROJ/8168/DEVPT OF EQPT FOR PCKG VALIDATION	1926885.18	0.00	0.00	1926885.18	0.00	
8169	PROJ/8169/PREPARATION STD FOR BIOLOGICAL EVALUATION	2177861.70	0.00	0.00	2177861.70	298696.50	
8171	PROJ/8171/ENTERIC COATING & MICRO ENCAPSULATION OF ANTIBODIES	159157.76	90000.00	7603.00	256760.76	0.00	
8172	PROJ/8172/BIOACTIVE BONE CEMENT	616118.74	0.00	1849.00	617967.74	0.00	
8173	PROJ/8173/BLOOD DRAIN AREA TARGETED NANO CONSTRUCTS FOR DIAGNOSIS OF BRAIN DISEASES & DELIVERY OF THERAPUETICS INTO THE BRAIN	3463.23	0.00	0.00	3463.23	0.00	
8174	PROJ/8174/SCAFFOLDS BASED ON SELF-ASSEMBLING PEPTIDE DENDRIMERS AND RESORBABLE CALCIUM PHOSPHATES FOR ENDODONTIC TISSUE REGENERATION	221157.74	5258.00	0.00	226415.74	0.00	
8175	PROJ/8175/MUSTER- MUSCULOSKELETAL STEM CELL TARGETING	53348.53	2017807.00	231372	2302527.53	0.00	

0.00	0.00	57600.00	290874.19	0.00	348474.19	348474.19	849611.12
0.00	321431.00	942203.00	2193156.14	0.00	3135359.14	3456790.14	2572312.24
0.00	0.00	236439.00	107952.18	0.00	344391.18	344391.18	601673.12
0.00	1780851.00	360000.00	7609.00	0.00	367609.00	2148460.00	501940.00
0.00	9145.00	583604.30	16000.00	0.00	599604.30	608749.30	0.00
0.00	2328138.30	0.00	0.00	0.00	0.00	2328138.30	1594152.32
0.00	77815.50	761046.00	1429261.01	0.00	2190307.01	2268122.51	5325514.20
0.00	665625.45	331066.00	982353.37	0.00	1313419.37	1979044.82	7245805.85
0.00	225750.00	241149.00	929224.08	0.00	1170373.08	1396123.08	418836.60
0.00	198668.00	228000.00	682785.48	0.00	910785.48	1109453.48	612649.99
0.00	998048.75	444896.00	234672.40	0.00	679568.40	1677617.15	659235.52
0.00	0.00	248292.00	112706.59	0.00	360998.59	360998.59	148322.34
0.00	0.00	230400.00	742205.36	0.00	972605.36	972605.36	1006776.64
0.00	14536.00	823669.00	1144678.04	0.00	1968347.04	1982883.04	469705.64
0.00	0.00	0.00	35255.86	0.00	35255.86	35255.86	1891629.32
0.00	298696.50	8155.00	0.00	0.00	8155.00	306851.50	1871010.20
0.00	0.00	0.00	251822.36	0.00	251822.36	251822.36	4938.40
0.00	0.00	0.00	617967.74	0.00	617967.74	617967.74	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3463.23
0.00	0.00	0.00	226415.60	0.00	226415.60	226415.60	0.14
0.00	0.00	758400.00	373001.80	0.00	1131401.80	1131401.80	1171125.73

8176	PROJ/8176MUSTER- MUSCULOSKELETAL STEM CELL TARGETING	267519.18	884440.00	0.00	1151959.18	0.00	
8178	PROJ/8178/PRECLINICAL EVALUATION & COMMERCIALISATION ANTI SNAKE VENOM (IGY)	46376.9	0.00	8710.00	55086.90	0.00	
8179	PROJ/8179/DEVELOPMENT OF NOVEL PROTOTYPE MECHANICAL GLOT RETRIEVER FOR TREATMENT OF ACUTE CEREBRAL IS CHEMIC STROKE	356125.75	227100.00	74369.00	657594.75	0.00	
8180	PROJ/8180/TO MODEL THE EFFECT OF MUTATION OF HCN CHANNELS IN NEURONAL EXCITABILITY AND IMPACT OF GABABR ON GIRK AND HCN MUTATION USING NEURON	43768	0	1313	45081.00	0.00	
8181	PROJ/8181/DEVELOPMENT OF INDIGENOUS VOICE PROTHESIS FOR REHABILITATION OF LARYNGECTOMIES	95451.43	50000	204.00	145655.43	0.00	
8182	PROJ/8182/A TISSUE ENGINEERED SKIN SUBSTITUTE WITH LOCALISED HAIR FOLLICLE STEM CELLS FOR HAIR FOLLICLES AND SEBACEOUS GLAND REGENERATION	75027.04	1155000.00	0	1230027.04	0.00	
8183	PROJ/8183/BIO ENGINEERED CONSTRUCT WITH CARDIAC MESENCHYMAL CELLS FOR MYOCARDIAL REPAIR	92108.47	1827155	17150.65	1936414.12	0.00	
8184	PROJ/8184/FABRICATION OF A HEAD PHANTOM FOR DOSIMETRIC EVALUATION OF RADIOTHERAPHY TREATMENT PLANS	17200.66	200851.00	44.00	218095.66	0.00	
8185	PROJ/8185/BLOOD BRAIN BARRIER PERMEABLE NANOCARRIERS FOR DIAGNOSIS & THERAPY OF NEURO DEGENERATIVE DISEASES	3350883.9	0.00	0.00	3350883.90	3150.00	
8186	PROJ/8186/3D PRINTED CELL FREE BIPHASIC MATRICES LOADED WITH AN ADMIXTURE OF BIOMOLECULES FOR ENHANCED PROGENITOR CELL	226565	84533	0.00	311098.00	0.00	
8187	PROJ/8187/DEVELOPMENT OF HUMAN-ON-A-CHIP DEVICE TECHNOLOGY	15593958.2	3400000.00	859870.02	19853828.22	13601274.44	
8188	PROJ/8188/EXPERT ADVISORY GROUP	300622.00	0.00	0.00	300622.00	0.00	
8189	PROJ/8189/CARE IN HEART FAILURE NT PRO BNP POC DEVICE	739783.95	2366524	0.00	3106307.95	11356.8	
8190	PROJ/8190/MAGNETO-OPTIC SENSOR FOR CARDIAC BIOMARKER DETECTION.	229000.00	9826	0.00	238826.00	0	
8191	PROJ-8191:INDO-JAPAN-ANTI -MICROBIAL PEPTIDE(LL37) LOADED MULTIFUNCTIONAL	184654.00	179730	723.00	365107.00	0	

0.00	0.00	506831.00	0.00	0.00	506831.00	506831.00	645128.18
0.00	0.00	0	0.00	0.00	0.00	0.00	55086.90
0.00	0.00	0.00	224440.00	54774.00	279214.00	279214.00	378380.75
0.00	0.00	0.00	0.00	1313	1313.00	1313.00	43768.00
0.00	0.00	0.00	145655.00	0	145655.00	145655.00	0.43
0.00	0.00	1167952.00	0	0	1167952.00	1167952.00	62075.04
0.00	0.00	1522480.00	325897.57	0.00	1848377.57	1848377.57	88036.55
0.00	0.00	0.00	118133.98	20000.00	138133.98	138133.98	79961.68
0.00	3150.00	73200.00	229754.45	0.00	302954.45	306104.45	3044779.45
0.00	0.00	284200	0.00	0.00	284200.00	284200.00	26898.00
0.00	13601274.44	979200.00	1409284.47	458109.00	2846593.47	16447867.91	3405960.31
0.00	0.00	0.00	508.00	0.00	508.00	508.00	300114.00
0.00	11356.80	361603.00	467951.90	8114.00	837668.90	849025.70	2257282.25
0.00	0.00	0.00	69606.33	0.00	69606.33	69606.33	169219.67
0.00	0.00	0.00	113107	0.00	113107.00	113107.00	252000.00

8192	PROJ/8192/EXTENDING BENEFITS OF BIOMEDICAL SCIENCE &TECH TO ST COMPONENTS	0.00	11081120.00	126218.00	11207338.00	8999.86	
8193	PROJ/8193/EXTENDING BENEFITS OF BIOMEDICAL SCIENCE &TECH TO SC COMPONENTS	0.00	11281120.00	200552.00	11481672.00	9000.00	
8194	PROJ/8194/STEM CELL DERIVED EXOSOMETHERAPY FOR CLINICAL MGT OF LUNG DAMAGEIN CRITICALLY ILL CORONA VIRAL PNEUMONIA PATIENTS	0.00	1722650.00	0.00	1722650.00	8593.20	
8195	"PRO/8195/AN EASY & RAPID DETECTTION PLATFORM FOR VIRAL DISEASES FROM SALIVA"	0.00	1530000.00	0.00	1530000.00	0.00	
8196	"PROJ/8196/DEVPT OF MODIFIED GLASS IONOMER CEMENT TO IMPROVE MECHANICAL PROPERTIES"	0.00	1593500.00	0.00	1593500.00	0.00	
8197	"PROJ/8197/PURDUE UNIVERSITY OVERSEASES VISITING DOCTORAL FELLOWSHIP"	0.00	876000.00	0.00	876000.00	0.00	
8198	"PROJ/8198/EFFICACY EVALUATION OF 3D BIOPRINTED LIVER CONSTRUCTS ESTABLISHED FROM NICHE SPECIFIC BIOINIK & STEMCELL DERIVED HEPATOCYTE LIKE CELL"	0.00	1741720.00	0.00	1741720.00	0.00	
8199	PROJ/8199/DESIGN AND DEVPT OF A MICRO DIALYSIS SET-UP FOR CEREBRAL APPLICATIONS	0.00	2792050.00	0.00	2792050.00	0.00	
8220	PROJ/8220/SPINAL FIXATION SYSTEM FOR THORACOLUMBAR STABLIZATION	12802379.00	0.00	0.00	12802379.00	159096.00	
8221	PROJ/8221/DEVELOPMENT OF HIGH-STRENGTH TI-6AI-+4V CASTINGS FOR ORTHOPAEDIC IMPLANTS	5998988.00	0.00	0.00	5998988.00	763248.00	
8222	PROJ/8222/BIOCERAMIC CAGES WITH AXIALLY ALIGNED PORES AS A SUBSTITUTE FOR TRICORTICAL BONE GRAFT	1158437.24	0.00	0.00	1158437.24	0.00	
8223	PROJ/8223/CORNEAL EPITHELIAL CELL SHEET ENGINEERING:STANDARDIZATION & PRE-CLINICAL EVALUATION	1112000.00	3337000.00	0.00	4449000.00	24990.00	
8224	PROJ/8224/CHITRA ACRYLOSORB FLUID AND TECHNOLOGY"	0.00	433000.00	0.00	433000.00	99739.50	
8225	PROJ/8225/SMART ASSISTIVE BREATHING DEVICE"	0.00	200000.00	0.00	200000.00	0.00	
8226	PROJ/8226/DIGITAL SANITIZATION SYSTEMS"	0.00	200000.00	0.00	200000.00	0.00	
8227	PROJ/8227/ISOLATION PODS"	0.00	200000.00	0.00	200000.00	0.00	
8228	PROJ/8228/EMERGENCY RESPONSE ISOLATION SYSYEMS"	0.00	200000.00	0.00	200000.00	0.00	

0.00	8999.86	1446682.00	77964.57	226218.00	1750864.57	1759864.43	9447473.57
0.00	9000.00	2588654.00	37138.00	300552.00	2926344.00	2935344.00	8546328.00
0.00	8593.20	102193.00	53391.93	50000.00	205584.93	214178.13	1508471.87
0.00	0.00	106403.00	192069.44	122521.00	420993.44	420993.44	1109006.56
0.00	0.00	0.00	33300.00	89434.00	122734.00	122734.00	1470766.00
0.00	0.00	292000.00	0.00	0.00	292000.00	292000.00	584000.00
0.00	0.00	0.00	0.00	117000.00	117000.00	117000.00	1624720.00
0.00	0.00	0.00	0.00	200000.00	200000.00	200000.00	2592050.00
0.00	159096.00	577510.00	739191.20	0.00	1316701.20	1475797.20	11326581.80
0.00	763248.00	219408.00	203463.43	0.00	422871.43	1186119.43	4812868.57
0.00	0.00	230400.00	518927.47	0.00	749327.47	749327.47	409109.77
0.00	24990.00	204388.00	474786.27	0.00	679174.27	704164.27	3744835.73
0.00	99739.50	0.00	200731.01	0.00	200731.01	300470.51	132529.49
0.00	0.00	0.00	191284.20	0.00	191284.20	191284.20	8715.80
0.00	0.00	0.00	177339.09	0.00	177339.09	177339.09	22660.91
0.00	0.00	0.00	138728.00	0.00	138728.00	138728.00	61272.00
0.00	0.00	0.00	179579.02	0.00	179579.02	179579.02	20420.98

8229	PROJ/8229/VENTILATOR SHARING KIT"	0.00	200000.00	0.00	200000.00	0.00	
8230	PROJ/8230/EXAMINATION BOOTH WITH UV DISFECTION SYSTEM AS BARRIER B\W PATIENT AND DOCTOR"	0.00	200000.00	0.00	200000.00	0.00	
8231	PROJ/8231/DISINFECTION GATEWAY FOR ENTRY POINTS OF OFFICES,HOSPITALS,APARTMENTS,ETC	0.00	200000.00	0.00	200000.00	0.00	
8232	PROJ/8232/SPINAL CORD STIMULATOR	0.00	19718000.00	0.00	19718000.00	48315.00	
8233	PROJ/8233/RAPID DIAGNOSTIC KITS	0.00	10702000.00	0.00	10702000.00	0.00	
8234	PROJ/8234/ANTIBODY AGAINST ASPIKE PROTEIN TO PREVENT COVID 19"	0.00	300000.00	0.00	300000.00	0.00	
8235	PROJ/8235/RAPID DETECTION KIT FOR IGG/IGM ANTIBODY"	0.00	400000.00	0.00	400000.00	0.00	
8236	PROJ/8236/NYLON FLOCKED SWABS (NASOPHARYNGEAL AND OROPHARYNGEAL) FOR COVID 19 TESTING"	0.00	600000.00	0.00	600000.00	0.00	
8237	PROJ/8237/OROPHARYNGEAL SAMPLE COLLECTION KIT"	0.00	700000.00	0.00	700000.00	0.00	
8238	PROJ/8238/DEVELOPING A POINT OF CARE TESTING PROTOCOL BASED ON RT-LAMP FOR FAST DETECTION OF SARS-COV-2"	0.00	2250000.00	0.00	2250000.00	1250000.03	
8239	PROJ/8239/DEVELOPMENT OF A COST EFFECTIVE VENTILATOR"	0.00	2640000.00	0.00	2640000.00	148649.93	
	INTERNAL PROJECTS						
6216	PROJ/6216/EFFICACY OF HUMAN PROTEINS	0.00	0.00	3828	3828.00	0.00	
6217	PROJ/6217/BIOINKS FOR 3D BIO PRINTING	0.00	0.00	17820.82	17820.82	0.00	
6219	PROJ/6219/A METHOD OF CELL SEEDING	0.00	0.00	149642.7	149642.70	0.00	
6221	PROJ/6221/CIRCULATING TUMOR CELLS	0.00	0.00	272684.28	272684.28	0.00	
6223	PROJ/6223/DEVELOPMENT OF A DURAL SUB.	0.00	0.00	282680	282680.00	0.00	
6224	PROJ/6224/BIOCERAMIC EXTRUSIONS AND TOP.	0.00	0.00	214199.5	214199.50	214199.50	
6225	PROJ/6225/POST SURGICAL ADHESIONS	0.00	0.00	108072.25	108072.25	0.00	
6226	PROJ/6226/SKULL BASE BUTTRESS DEVICE	0.00	0.00	142850	142850.00	0.00	
6227	PROJ/6227/EMERGENCY BANDAGE	0.00	0.00	69000	69000.00	0.00	
6229	PROJ/6229/REVERSE SUCTION DEVICE	0.00	0.00	9831	9831.00	0.00	
6230	PROJ/6230/CAVITY CONFORMABLE SSSR	0.00	0.00	310258.5	310258.50	0.00	
6231	PROJ/6231/AIRWAY DEVICE	0.00	0.00	249841	249841.00	0.00	

0.00	0.00	0.00	160440.10	0.00	160440.10	160440.10	39559.90
0.00	0.00	0.00	0.00	0.00	0.00	0.00	200000.00
0.00	0.00	0.00	47620.00	0.00	47620.00	47620.00	152380.00
0.00	48315.00	287834.00	54103.00	0.00	341937.00	390252.00	19327748.00
0.00	0.00	263721.00	28664.74	0.00	292385.74	292385.74	10409614.26
0.00	0.00	0.00		0.00	0.00	0.00	300000.00
0.00	0.00	0.00	257117.84	0.00	257117.84	257117.84	142882.16
0.00	0.00	0.00		0.00	0.00	0.00	600000.00
0.00	0.00	0.00	425432.61	0.00	425432.61	425432.61	274567.39
0.00	1250000.03	0.00	0.00	920445.00	920445.00	2170445.03	79554.97
0.00	148649.93	168000.00	48186.00	0.00	216186.00	364835.93	2275164.07
0.00	0.00	0.00	3828.00	0.00	3828.00	3828.00	0.00
0.00	0.00	0.00	17820.82	0.00	17820.82	17820.82	0.00
0.00	0.00	4121.00	145521.70	0.00	149642.70	149642.70	0.00
0.00	0.00	143360.00	129324.28	0.00	272684.28	272684.28	0.00
0.00	0.00	0.00	282680.00	0.00	282680.00	282680.00	0.00
0.00	214199.50	0.00	0.00	0.00	0.00	214199.50	0.00
0.00	0.00	11917.00	96155.25	0.00	108072.25	108072.25	0.00
0.00	0.00	23172.00	119678.00	0.00	142850.00	142850.00	0.00
0.00	0.00	0.00	69000.00	0.00	69000.00	69000.00	0.00
0.00	0.00	9831.00	0.00	0.00	9831.00	9831.00	0.00
0.00	0.00	263290.00	46968.50	0.00	310258.50	310258.50	0.00
0.00	0.00	186948.00	62893.00	0.00	249841.00	249841.00	0.00

6232	PROJ/6232/STEERING ELECTRODES	0.00	0.00	13525	13525.00	0.00	
6233	PROJ/6233/EXTERNAL DEFIBRILLATOR	0.00	0.00	219259	219259.00	0.00	
6234	DSGNOF NOVEL POLY. PED.SCREW/A.PRAJAPATH	0.00	0.00	187455	187455.00	0.00	
6235	PROJ/6235/PLATELET RICH PLASMA	0.00	0.00	143153	143153.00	0.00	
6236	PROJ/6236/VASCULAR MODEL	0.00	0.00	217568	217568.00	0.00	
6237	PROJ/6237/SUCTION-RETRACTOR DEVICE	0.00	0.00	99000.8	99000.80	0.00	
6239	PROJ/6239/ALGINATE DIALDEHYDE	0.00	0.00	44580	44580.00	0.00	
6240	PROJ/6240/BONE GRAFT EXPANDER	0.00	0.00	2200	2200.00	0.00	
6241	PROJ/6241/PORCINE PERICARDIUM	0.00	0.00	16412.18	16412.18	0.00	
6242	PROJ/6242/MUCOADHESIVE BANDAGES	0.00	0.00	91799.61	91799.61	0.00	
6243	PROJ/6243/RS.5.10 LAKHS	0.00	0.00	183283.9	183283.90	0.00	
6244	PROJ/6244/AUGMENTAT. ANALYTICAL FACILITY	0.00	0.00	34347	34347.00	0.00	
6245	PROJ/6245/CERAMIC TILE FORMS	0.00	0.00	19560.1	19560.10	0.00	
6300	PROJ/6300/FIBROUS MESH SHEETS	0.00	0.00	101454.06	101454.06	0.00	
6301	PROJ/6301/KNITTED POLYESTER	0.00	0.00	475000	475000.00	0.00	
2622	OHF- FOR INNOVATIVE PROJECTS	1825008.72	0.00	0.00	1825008.72	0.00	
2621	IIPC FUND(INDUSTRY INSTITUTE PARTNERSHIP - BMT	260769	0.00	0.00	260769.00	0.00	
	Total (C)	412151008	107847295	113734508	633732812	48355061	

	GRAND TOTAL (A+B+C)	853496857	185838104	693046433	1732381394	52084738	

0.00	0.00	0.00	13525.00	0.00	13525.00	13525.00	0.00
0.00	0.00	174774.00	44485.00	0.00	219259.00	219259.00	0.00
0.00	0.00	103935.00	83520.00	0.00	187455.00	187455.00	0.00
0.00	0.00	133059.00	10094.00	0.00	143153.00	143153.00	0.00
0.00	0.00	217568.00	0.00	0.00	217568.00	217568.00	0.00
0.00	0.00	52839.00	46161.80	0.00	99000.80	99000.80	0.00
0.00	0.00	33600.00	10980.00	0.00	44580.00	44580.00	0.00
0.00	0.00	0.00	2200.00	0.00	2200.00	2200.00	0.00
0.00	0.00	0.00	16412.18	0.00	16412.18	16412.18	0.00
0.00	0.00	0.00	91799.61	0.00	91799.61	91799.61	0.00
0.00	0.00	64258.00	119025.90	0.00	183283.90	183283.90	0.00
0.00	0.00	0.00	34347.00	0.00	34347.00	34347.00	0.00
0.00	0.00	0.00	19560.10	0.00	19560.10	19560.10	0.00
0.00	0.00	0.00	101454.06	0.00	101454.06	101454.06	0.00
0.00	0.00	0.00	475000.00	0.00	475000.00	475000.00	0.00
0.00	0.00	0.00	0.00	1825008.72	1825008.72	1825008.72	0.00
0.00	0.00	0.00	0.00	260769.00	260769.00	260769.00	0.00
0	48355061	38667719	150361480	78982843	268012042	316367103	317365709

0	52084738	66911520	157582261	578028674	802522455	854607194	877774200

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULE 4-SECURED LOANS AND BORROWINGS:		2020-2021	2019-2020
	1. Central Government	--	--
	2. State Government (Specify)	--	--
	3. Financial Institutions	--	--
	a) Term Loans	--	--
	b) Interest accured and due	--	--
	4. Banks:	--	--
	a) Term Loans-Interest accured and due	--	--
	b)Other Loans(specify)- Interest accured and due-Over draft	--	--
	5. Other Institutions and Agencies	--	--
	6. Debentures and Bonds	--	--
	7. Others(Specify)	--	--
	Against OD facility- cheques issued	--	--
	TOTAL		

SCHEDULE 5-UNSECURED LOANS AND BORROWINGS		2020-2021	2019-2020
	1. Central Government	--	--
	2. State Government (Specify)	--	--
	3. Financial Institutions	--	--
	4. Banks:	--	--
	a) Term Loans	--	--
	b) Other Loans(specify)	--	--
	5. Other Institutions and Agencies	--	--
	6. Debentures and Bonds	--	--
	7. Fixed Deposits	--	--
	8. Others(Specify)	--	--
	TOTAL		

SCHEDULE 6-DEFERRED CREDIT LIABILITIES:		2020-2021	2019-2020
	a) Acceptances secured by hypothecation of capital equipment and other assets	--	--
	b) Others		
	TOTAL	--	--

Sd/-
Financial Adviser

Sd/-
Director

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULE 7-CURRENT LIABILITIES AND PROVISIONS		2020-2021	2019-2020
	A. CURRENT LIABILITIES		
	1. Acceptances		
	2. Sundry Creditors:		
	a) For Goods	262113510	234394790
	b) Others	0	0
	3. Advances Received	74082106	66220276
	4. Interest accured but not due on:	0	0
	a) Secured Loans / borrowings	0	0
	b) Unsecured Loans / borrowings	0	0
	5. Statutory Liabilities:	0	0
	a) Overdue		
	b) Others	4403980	5381621
	6. Other current Liabilities	189201375	410628264
	TOTAL(A)	**529800970**	**716624951**
	B.PROVISIONS		
	1. For Taxation	0	0
	2. Gratuity	0	0
	3. Accumulated Leave Encashment	0	0
	4. Trade Warranties/Claims	0	0
	5. Others(Specify) Audit fee	431640	537900
	Emergency Reserve Fund contribution	0	0
	Technology Development Fund contribution	6782728	2299351
	TOTAL(B)	**7214368**	**2837251**
	TOTAL(A+B)	**537015338**	**719462202**

Sd/-
Financial Adviser

Sd/-
Director

SCHEDULE 8- FIXED ASSETS

PARTICULARS	GROSS BLOCK			
	Cost/valuation as at the beginning of the year (01.04.2020)	Additions during the year 2020-21	Deductions during the year 2020-21	
A. FIXED ASSETS:				
1. LAND:				
a) Freehold	16894606	0	0	
b) Leasehold				
2.BUILDINGS:				
a) On Freehold Land *	47627608	0	0	
b) On Leasehold Land				
c) Ownership Flats/Premises				
d) Superstructures on Land not belonging to the entity	477182357	0		
3. A) PLANT MACHINERY & EQUIPMENT	3211849632	67644765	57939574	
B) Equipment - From Non Monetary grants	2	0	0	
4. VEHICLES	8546800	0		
5. FURNITURE,FIXTURES	93060564	505659	0	
6. OFFICE EQUIPMENT	1236622	0	0	
7. COMPUTER/ PERIPHERALS	9132746	0	24200	
8. ELECTRIC INSTALLATIONS	173068457	0	0	
9. LIBRARY BOOKS	223172534	4872594	0	
10. TUBEWELLS & W.SUPPLY	301965	0		
11. OTHER FIXED ASSETS				
A) OXYGEN CYLNDRS/GAS PLANT INST	2061682	128521		
B) KITCHEN/CANTEEN EQUIPMENTS	3751785	14995	0	
C) PAINTINGS	450216	0		
D) SURGICAL EQUIPMENTS	5226023	0	3056545	
Total for the year (Total -A)	4273563598	73166535	61020319	
Total for the previous year	4016528372	324664346	67629119	
Captial Work in Progress (B)	406709726	230832803	0	
Total for the year (A+B)	4680273324	303999338	61020319	
* Depreciation for item2(a) has been provided along with depreciation on 2(d)				

Sd/-
Financial Adviser

Sd/-
Director

	DEPRECIATION				NET BLOCK	
Cost/valuation at the year end (31.03.2021)	Depreciation as at the beginning of the year (01.04.2020)	Depr on items written off	During the year 2020-21	Total up to the year end (31.03.2021)	As at the end of current year end (31.03.2021)	As at the previous year end (31.03.2020)
16894606	0	0	0	0	16894606	16894606
47627608	0		0	0		
477182357	335670484	0	18913948	354584432	170225533	189139481
3221554823	2308396155	51480646	93215251	2401611407	819943416	903453478
2	1	0	0	1	1	1
8546800	7342389		180662	7523051	1023749	1204411
93566223	52551458	0	4101476	56652934	36913289	40509105
1236622	1081787		15483	1097270	139352	154835
9108546	8634706	18844	178230	8812936	295610	498040
173068457	111983024	0	6108543	118091567	54976891	61085433
228045128	209449759	0	7438148	216887907	11157221	13722775
301965	234460		6750	241210	60755	67505
2190203	1817510		149077	1966587	223616	244172
3766780	1775140	0	199164	1974304	1792476	1976645
450216	412072		3814	415886	34329	38144
2169478	5161702	3051623	-3027864	2133838	35640	64321
4285709813	3044510647	54551113	127482684	3171993332	1113716481	1229052952
4273563599	2901589682	40163071	136480238	2901589682	1229052952	1114938690
637542529	0	0	0	0	637542529	406709726
4923252342	3044510647	54551113	127482684	3171993332	1751259011	1635762678

Sd/-
Financial Adviser

Sd/-
Director

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULE 9 - INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS		2020-2021	2019-2020
	1. In Government Securities	47081032	47081032
	2. Other approved Securities	5685391	5685391
	3. Shares	0	0
	4. Debentures and Bonds	0	0
	5. Subsidiaries and Joint Ventures	0	0
	6. Others (to be specified)	0	0
	Pension & staff funds	146898446	145962696
	Project funds	440843343	532498013
	TOTAL	**640508212**	**731227132**
SCHEDULE 10-INVESTMENTS-OTHERS		**2020-2021**	**2019-2020**
	1. In Government Securities	--	--
	2. Other approved Securities	--	--
	3. Shares	--	--
	4. Debentures and Bonds	--	--
	5. Subsidiaries and Joint Ventures	--	--
	6. Others (to be specified) Sinking Fund Investments	150000000	150000000
	Technology Fund	94829294	92526805
	6. Others (to be specified)	--	--
	TOTAL	244829294	242526805
SCHEDULE 11-CURRENT ASSETS,LOANS,ADVANCES ETC		**2020-2021**	**2019-2020**
	A. CURRENT ASSETS		
	1. Inventories:		
	a) Stores and Spares	0	0
	b) Instruments & Loose Tools	0	0
	c) Stock-in trade		
	Store items	157635940	140051880
		0	0
	Stamps	18258	19329
	Medicine	16026116	16439845
	2. Sundry Debtors:	0	0
	a) Debts Outstanding for a period exceeding six months	30262021	194079650
	b) Others	296194991	275165216
	2.1 Income tax deducted at source	13995361	32733101

	3. Cash balances in hand(including cheques/ drafts and imprest)	1738986	776457
	4. Bank Balances:	0	0
	a) With Scheduled Banks:	0	0
	-On Current Account	2228279	1
	-On Deposit Accounts(L.C. margin & Commitment deposit)	1062485736	1195086595
	-On Savings Accounts	1273946513	114275256
	b) With non-Scheduled Banks:	0	0
	-On Current Account	0	0
	-On Deposit Accounts	0	0
	-On Savings Accounts	0	0
	5. Post-Office-Savings Accounts	0	0
	TOTAL(A)	2854532202	1968627330
	B.LOANS, ADVANCES AND OTHER ASSETS		
	1. Loans:		
	a) Staff	13104498	8193671
	b) Other Entities engaged in activities/ objectives similar to that of the Entity	0	0
	c) Other(specify)	0	0
	2. Advances and other amounts recoverable in cash or in kind or for value to be received:	0	0
	a) On Capital Account	746694076	777948794
	b) Prepayments	0	0
	c) Others	13965374	15449912
	3. Income Accured:	0	0
	a) On Investments from Earmarked/ endowment Funds	16029103	11198956
	b) On Investments-Others	0	0
	c) On Loans and Advances	0	0
	d) Others (Royalty)	539639	566648
	(includes income due unrealised)	0	0
	4. Claims Receivable	0	0
	From Govt of India on Grant in aid (7th CPC arrears)	**204714247**	**417214247**
	TOTAL(B)	**995046937**	**1230572228**
	TOTAL(A+B)	**3849579139**	**3199199558**
	Savings bank account includes Rs.15/- (GL code No.2410-Synd Bank vikas certificate)		

SCHEDULE 12- INCOME FROM SALES/SERVICES		2020-2021	2019-2020
	1. Income from Sales		
	a) Sale of Finished Goods	0	0
	b) Sale of Raw Material	0	0
	c) Sale of Scraps	0	0
	2. Income from Services		
	a) Labour and processing charges	0	0
	b) Professional/Consultancy Services	0	0
	c) Agency Commission and Brokerage	0	0
	d) Maintenance Services	0	0
	e) Others (Specify)	0	0
	From Hospital Services-Gross Income	748070638	1177777391
		0	0
	From Projects	2114081	6724953
	Testing & Facility charges received	4731325	4114352
	TOTAL	**754916044**	**1188616696**
SCHEDULE 13- GRANTS/SUBSIDIES		**2020-2021**	**2019-2020**
	(Irrevocable Grants & Subsidies Received)		
	1. Central Government (Salary & General)	2650000000	1416606000
	2. State Government(s)	0	0
	3. Government Agencies	0	0
	4. Institution/Welfare Bodies	0	0
	5. International Organisations	0	0
	6. Others(Specify)	0	0
	TOTAL	2650000000	1416606000
SCHEDULE 14-FEES/SUBSCRIPTIONS		**2020-2021**	**2019-2020**
	1. Entrance Fees	2366480	2053140
	2. Annual Fees/ Subscriptions	12235384	11096850
	3. Seminar/Program Fees	0	0
	4. Consultancy Fees	0	0
	5. Examination Fees and others	1884637	2300916
	TOTAL	**16486501**	**15450906**
SCHEDULE 15- INCOME FROM INVESTMENTS		**2020-2021**	**2019-2020**
	(Income on Invest.from Earmarked/Endowment Funds transferred to Funds)		
	1) Interest		
	a) On Govt. Securities	0	0

	b) Other Bonds/Debentures	0	0
	2) Dividends:		
	a) On Shares	0	0
	b) On Mutual Fund Securities	0	0
	3) Rents	0	0
	4) Others(Special Reserve Funds)1.Interest on Sinking Fund	17718455	19750795
	2.Withdrawal from Sinking Fund	0	0
	3.Interest on Technology Fund	892622	1002754
	TOTAL	**18611077**	**20753549**
SCHEDULE 16- INCOME FROM ROYALITY,PUBLICATION ETC		**2020-2021**	**2019-2020**
	1) Income from Royalty	7261992	1439767
	2) Income from Publications	0	0
	3)Others(Specify)	0	0
	TOTAL	**7261992**	**1439767**
SCHEDULE 17- INTEREST EARNED		**2020-2021**	**2019-2020**
	1) On Term Deposit		
	a) With Scheduled Banks	23961199	28611483
	b) With non-scheduled banks	0	0
	c) With Institutions	0	0
	d) Others	0	0
	2) On Savings Account	0	0
	a) With Scheduled Banks	10562890	6050502
	b) With non-scheduled banks	0	0
	c) Post Office Savings Account	0	0
	d) Others(accrued)	0	0
	3) On Loans	0	0
	a) Employees/Staff	1019284	443224
	b) Others	0	0
	4) Interest on Debtors and other Receivables	0	0
	TOTAL	**35543373**	**35105209**
SCHEDULE 18- OTHER INCOME		**2020-2021**	**2019-2020**
	1. Profit on Sale/disposal of Assets:		
	a) Owned assets	0	0
	b) Assets acquired out of grants, or received free of cost	0	0

	c) WIP written back from Repairs and Maintanance	0	0
	2. Rent	2075578	3002243
	3. Fees for Miscellaneous Services	0	0
	4. Miscellaneous Income Rent	10000	69200
	Other Income (including grant receivable from DST for 7th CPC	13717762	14781708
	Prior period income	0	-721161
	TOTAL	**15803341**	**17131990**
SCHEDULE 20-ESTABLISHMENT EXPENSES		**2020-2021**	**2019-2020**
	a) Salaries and Wages	1343690940	1112242094
	b) Allowances and Bonus	16190251	16296985
	c) Contribution to Provident Fund	0	0
	d) Contribution to other fund(specify)	0	0
	e) Staff Welfare Expenses	31708736	21193941
	f) Expenses on Employee's Retirement and Terminal Benefits	502272517	422462143
	g) Others(Specify) PG Training & Accademic payments	254684395	282206477
	TOTAL	**2148546839**	**1854401640**
SCHEDULES 21- ADMINISTRATIVE EXPENSES		**2020-2021**	**2019-2020**
	a) Purchases	545354083	750096625
	b) Concession to Poor patients/Labour and processing expenses	49163155	64396214
	c) Cartage and Carriage Inwards	238682	128011
	d) Electricity and power	55607991	57927882
	e) Water charges	4619677	8231352
	f) Insurance	2781590	1118301
	g) Repairs and maintenance	50699507	66667223
	h) Excise duty	0	0
	i) Rent,Rates and Taxes	208032	0
	j) Vehicles Running and Maintenance	711260	910393
	k) Postage,Telephone and Communication Charges	3918309	4246701
	l) Printing and Stationary	44526	31217
	m) Travelling and Conveyence Expenses	451050	3322642
	n) Expenses on Seminar/Workshop	240807	2069933
	o) Subscription Expenses	0	0
	p) Expenses on Fees	0	0
	q) Auditors Renumeration	931715	1872904
	r) Hospitality Expenses	0	0
	s) Professional Charges	0	0
	t) Provision for Bad and Doubtful Debts/Advances	0	0

	u) Irrecoverable Balances Written-off	0	0
	v) Packing Charges	0	0
	w) Freight and Forwarding Expenses	0	0
	x) Prior period expenses	22692477	43030333
	y) Distribution Expenses	0	0
	z) Advertisement and Publicity	1036277	3112041
	z1) Others(specify)	33966519	49720662
	TOTAL	**772665657**	**1056882434**
SCHEDULE 23-INTEREST		**2020-2021**	**2019-2020**
	a) On Fixed Loans		
	b) Bank Charges)	84447	1276137
	c) Others(specify)	0	0
	TOTAL	**84447**	**1276137**

Sd/-
Chief Financial Adviser

Sd/-
Director

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULE TO RECEIPTS & PAYMENTS ACCOUNTS FOR THE PERIOD FROM 01.04.2020 to 31.03.2021

	RECEIPTS	2020-21	2019-20		Payments	2020-21	2019-20
		Rs.	Rs.			Rs.	Rs.
I	Opening Balances			I	Expenses		
a)	Cash In Hand	776457	1260430				
b)	Bank Balances				a) Establishment expenses	2428086547	2452401624
	I) In Current Account	1	1		b) Administrative Expenses		
	ii)In deposit Account				For Purchases	14122975	18634976
	iii)Savings Account *	114275271	307869507		Other expenses	78384926	92157618
				II	Payments made against funds for various		
II	Grant Received				Projects		
	From Government of India				As Per schedule	150676284	117937737
	Under Object head - Creation of Capital assets	450000000	844878000				
	Under Object Head - Salary/General scheme	2650000000	1416606000	III	Investments & Deposits made		
					a) Out of Earmarked funds	141412711	111887223
					b) Out of own funds		
III	Receipts against Earmarked Funds						
				IV	Expenditure on Fixed Assets & Capital work		

	a) Earmarked funds	379812120	285369267		-in- progress		
	b)Own funds						
					a) Purchase of Fixed Assets	30466712	49334688
IV	Interest Received				b)Capital work-in-progress		
	a) On Bank deposits	29015906	33344235	V	Refund of Loans		
	b) Loans Advances etc	496104	200212				
	c) On NCMMR funds	0	0				
V	Receipts from services			VI	Finance Charges(Bank charges)	84364	1275168
	Receipts from Patient services	843413318	1040808951				
	Other receipts including Royalty	39272619	30890603	VII	Other Payments		
					To Funds/ Deposit- refunds	1297787987	1865915882
VI	Other receipts			VIII	Closing Balance		
	Grant received for Projects	89784909	110690375		a) Cash in hand	1738986	776457
	Refund of Deposits(LC Margin)				b) Bank Balances		
	Other receipts	822089594	752679064		I) In current Account	1	1
					iii) Savings Account *	1276174806	114275271
	Total	5418936300	4824596646		Total	5418936300	4824596646

Sd/-
Financial Adviser

Sd/-
Director

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

Provident Fund Account For The Year Ended 31-03-2021

Particulars	2020-21	2019-20
	[Rupees]	[Rupees]
LIABILITIES		
MEMBERS BALANCE	125801425	137113303
MEMBERS CREDITS [for march]	3643773	3660373
BALANCE DUE TO MEMBERS NOT IN SERVICE		
Under EPF scheme	7696198	7696198
,,GPF,,	532055	532055
PENSION FUND DUES	0	0
RESERVES&SURPLUS-INTEREST	232099697	223742250
TOTAL	369773148	372744179
ASSETS		
INVESTMENT AT COST	350253428	320014126
DUES TO PF ACCOUNT		
FROM INSTITUTE	3643773	3660373
FROM PF COMMISSIONER	0	0
INTEREST ACCRUED NOT DUE	5088040	34152770
BALANCE WITH BANKS		
SBT -GPF A/C	10787907	14916910
TOTAL	**369773148**	**372744179**

Sd/-
Financial Adviser

Sd/-
Director

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULES FORMING PART OF ACCOUNTS AS AT 31-03-2021

SCHEDULE 24- SIGNIFICANT ACCOUNTING POLICIES

1. ACCOUNTING CONVENTION

Financial Statements are prepared on the basis of historical cost convention and on accrual method of accounting except in the accounts not directly connected with the functioning of the Institute including Staff Benevolent Fund, Pension,etc.

2. INVENTORY VALUATION

Stores and spares including machinery spares are valued at cost.

3. INVESTMENTS

Investments including long term investments are carried at cost.

4. FIXED ASSETS

Fixed assets are stated at cost of acquisition inclusive of inward freight, duties and taxes incidental and direct expenses related to acquisition. Non monetary assets acquired free of cost are recorded at a nominal value ie. Re.1 (Rupee One).

5. DEPRECIATION

Depreciation is provided on reducing balance method at the rates specified by the Income Tax Act 1961. In respect of additions to fixed assets during the year depreciation is provided for full year. In case of condemnation of an asset, depreciation for the current year has not been provided and the accumulated depreciation for the previous years has been duly adjusted from the depreciation of the current year.

6. GOVERNMENT GRANTS/SUBSIDIES

Government Grant from Plan fund-Capital is treated as additions to Capital fund of Institute. Grants in respect of specific fixed assets acquired are shown as deduction from the cost of the related asset. Government Grants/subsidies are accounted on Grant release order basis, except grant in aid receivable for meeting arrears on account of 7th CPC.

7. FOREIGN CURRENCY TRANSACTIONS

Transactions denominated in foreign currency are accounted at exchange rate prevailing at the date of transactions.

8. RETIREMENT BENEFITS

Gratuity: From the year 2006, (with the implementation 6th Pay Commission report), the gratuity payments are treated as Institute expenses and accounted on actual payment basis.

Leave Salary: Leave encashment eligible at the time of retirement/reliving is treated as Institute expenses and accounted on actual payment basis.

Pension: From the year 2006, (with the implementation 6th Pay Commission report) 12% of the salary is transferred to the Pension Fund.

New Pension Scheme: In the case of employees who joined on or after 01.01.2004, 10% of the salary is deducted as employees subscription and equal contribution is being made by the Institute. The funds are remitted to NPS Trust Account maintained by GOI and subscription details forwarded to NSDL/CRA every month.

9. PROVIDENT FUND

Assets and Liabilities of General Provident Fund account were separated from Balance sheet of Institute and shown as separate statement. Interest is provided on the accumulations as per the rates prescribed by Central Government from time to time.

10. EMERGENCY RESERVE FUND

An amount equal to 7.50 percent of receipts from patient is to be transferred to a Fund for meeting unexpected requirements for Fixed assets subject to a maximum of Rs.50 Crore. It was decided to reduce the limit of ERF to Rs.15 crore and to utilize the remaining funds and the guideline of recouping these funds do not apply till further decision.

11. TECHNOLOGY DEVELOPMENT FUND

Receipts against technology developed by the Institute are transferred to the above fund and interest earned is utilized for meeting additional expenses on Improvement of technologies already developed.

12. OVER HEAD SCHEME

Overhead Funds scheme for Innovative Projects has been introduced from the year 2012-13. An amount of upto Rs.10 lakhs can be transferred to this account every year and utilised for innovative projects.

Sd/-	Sd/-
Financial Adviser	Director

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULE 25-CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS

1. CONTINGENT LIABILITIES

Rs. In lakhs

	2020-21	2019-20
Claims against the Institute not acknowledged as debts	NIL	NIL
Bank Guarantee given by Institute	45.96	45.96
Letters of credit opened on behalf of Institute	503.99	129.89
In respect of claims from parties for non- execution of orders	NIL	NIL

Service Tax :

" The office of the Commissioner of Central Excise and Customs vide order no: C.No.IV/16/152/2014 ST ADJ. Dated 08.06.2015 confirm demand of Service tax Rs.4.72 Lakhs under section 73(2) of the Finance Act 1994, being service tax short paid under the category "Technical Inspection and certification service" during the period 1.4.2009-31.03.2012 . Further impose a penalty of Rs 2.36 lakhs towards penalty under section 78 and Rs.0.05 lakhs for contravention of section 70 of the Act. In order to file appeal against the order, the institute paid Rs.0.35 lakhs towards deposit (i e 7.5% of demand confirmed)." During the year 2018-19, Institute received Order-In-Appeal dated 19.09.2018 issued by Commissioner (Appeals) rejecting the appeal filed by the Institute. Institute filed appeal before CESTAT, Bangalore against the above and remitted Rs.0.44 lakh as deposit under section 35F of CE Act.

Name of the Statute	Nature of Dues	Amount in Rs. in lakhs	Period to which the amount relates	Forum where dispute is pending.
Service Tax	Service tax and penalty	4.72	01/04/2009 to 31/03/2012	CESTAT, Bangalore.

2. UNEXPIRED CAPITAL COMMITMENTS

Rs. in lakh

	2020-21	2019-20
Estimated value of orders remaining to be executed on Capital Account	6641.46	118.73
Construction of New Hospital block (NHB)& Hospital Equipments & Facilities for NHB	3175.15	7111.98
Completion of Combination Devices Block	7539.87	2446.50

Ministry of Health and Family Welfare approved the construction of a new Hospital Block in the Institute at a cost of Rs.230 crore. The project is funded Jointly by Ministry of Health and Family Welfare - MoHFW (Rs.120crore) and Department of Science & Technology – DST (Rs.110 crore). Institute received Rs.110 crore from DST; out of which Rs. 70 crore was paid as advance to CPWD. CPWD received another Rs.31 crore directly from MoHFW.

Administrative approval and expenditure sanction was accorded for the completion of Combinational Devices Block (Originally called as Biology Block) at BMT wing vide BMT letter dated 21.05.2018. The work is being executed through CPWD.

Lease obligation for rentals for Plant & Machinery	NIL	NIL

3. CURRENT ASSETS, LOANS & ADVANCES

The aggregate amount shown in the Balance sheet for the Current assets, Loans and Advances, have the value, which is realisable in the ordinary course of business.

4. PROVISIONS

Provision for Income tax not made since there is no taxable income for Institute under Income tax Act 1961, during the year.

5. FOREIGN CURRENCY TRANSACTIONS:

Rs. in lakh

	2020-21	2019-20
5.1 Value of Imports Capital Goods (284.55+99.88) Stores Spare & Consumables (4.84+ 22.35)	683.46 49.36	384.43 27.19
5.2 Expenditure in foreign currency Travel Expenses	NIL	NIL
5.3 Earnings: Value of Exports	NIL	NIL

6. Current year Income, net of expenditure, under Institute Ethics Committee has been treated as income of the Institute amounting to **Rs.5.16 lakh** (previous year Rs.44.56 lakh).

7. Claim for Audit fees by C&AG amounting to **Rs.0.83 lakh** has been paid during the year. Provision for Audit fees has been made for current year amounting to **Rs.2.00 lakh**.

8. Accrued Interest on Investment amounting **Rs.160.29 lakh** (previous year Rs. 111.99 lakh) has been provided in the current year accounts.

9. As pointed out by C&AG, unutilized portion of Grant in Aid(ST General) is shown as current liability.

10. In order to release the pension dues as per the CCS pension rules, an additional amount of **Rs.4035.00 lakh** has been expended over and above the sanctioned 12% Institute contribution (amounting to **Rs.322.34 lakh**) to the Pension Fund.

11. Institute has done the actuarial valuation to ascertain the liability on account of Gratuity, Pension and Leave Encashment in respect of serving employees through an Actuary. As per their valuation report the liability is as follows

Present value of the past service gratuity	Rs. 4185.36 lakh
Present value of the pensionary liability for serving employees	Rs. 24400.00 lakh
Present value of the pensionary liability for Existing pensioners	Rs. 25502.15 lakh
Present value of the past service leave encashment	Rs. 2993.89 lakh

12. **(a)** Value of assets acquired from externally funded projects during the last three years has been identified as detailed below:-

FY 2017-18	Rs. 850.68 lakh
FY 2018-19	Rs. 940.31 lakh
FY 2019-20	Rs. 1165.23 lakh
FY 2020-21	Rs. 518.19 lakh

Since the cost of acquisition of these assets is nil, no depreciation has been charged on these assets.

(b) Value of non monetary assets acquired by the Institute is shown at nominal value of Re.1.

13. Technology Development Fund

An amount of Rs.23.02 lakh (previous year Rs. 71.64 lakh) was tansferred to Technology Development Fund. During the year Rs.43.19 lakh has been spent from Technology Development Fund.(Previous year Rs.53.33 lakh)

14. Overhead Fund Scheme

During the year an amount of Rs. NIL (previous year Rs.NIL) has been transferred to the Fund from the Overhead Charges collected from External Projects.

15. Funding of In house Projects to set off negative balance.

Administrative expenses include an amount of Rs.2.73 lakh (Previous year Rs.6.87 lakh) transferred to nullify the negative balances in the In house projects accounts.

16. Corpus fund for M Tech Clinical Engineering Program

As decided by the GB, an amount of Rs.16 lakh each is due to partner Institutes viz., CMC Vellore and IIT Madras for the year 2013-14 & 2014-15.

17. Corresponding figures for previous years have been regrouped, wherever necessary.

Schedules 1 to 25 annexed, form an integral part of the Balance Sheet as at 31-03-2021, and Income & Expenditure Account for the year ended on that date

Sd/-
Financial Adviser

Sd/-
Director

Separate Audit Report of the Comptroller & Auditor General of India on the Accounts of Sree Chitra Tlrunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram for the year ended 31 March 2021

1. We have audited the Balance Sheet of Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram as at 31 March 2021, the Income & Expenditure Account and the Receipts & Payment Account for the year ended on that date under Section 19(2) of the Comptroller & Auditor General's (Duties, Powers & Condition s of Service) Act, 1971 read with section 18(2) of the SCTIMST Act, 1980. These financial statements include the accounts of Bio-Medical Technology (BMT) wing of the SCTIMST. These financial statements are the responsibility of the SCTIMST's management. Our responsibility is to express an opinion on these financial statements based on our audit.

2. This Draft Separate Audit Report contains the comments of this office on the accounting treatment only with regard to classification, conformity with the best accounting practices, accounting standards and disclosure norms etc. Audit observations on financial transactions with regard to compliance with the Law, Rules & Regulations (Propriety and Regularity) and efficiency-cum-performance aspects etc. if any, are reported through Inspection Reports/ CAG's Audit Reports separately.

3. We have conducted our audit in accordance with auditing standards generally accepted in India. These standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatements. An audit includes examining, on a test basis, evidences supporting the amounts and disclosure in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of financial statements. We believe that our audit provides a reasonable basis for our opinion.

4. **Based on our audit, we report that:**

   I. We have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our audit.

   ii. The Balance Sheet, Income & Expenditure Account and Receipt & Payment Account dealt with by this report have been drawn up in the format approved by the Government of India, Ministry of Finance.

   iii. In our opinion, proper books of accounts and other relevant records have been maintained by the SCTIMST as required under Section 18(1) of SCTIMST Act, 1980 in so far as it appears from our examination of such books subject to observations made hereunder.

   iv. Based on our audit, we further report that:

(A) Balance Sheet

A1 Current liabilities and provisions (Schedule-7) of ₹53.70 crore As per Paragraph 8 of Schedule-24 Significant Accounting Policies of the annual accounts for the year 2020-21, retirement benefits are being accounted for on cash basis by SCTIMST. However, the institute has done the actuarial valuation for the year 2020-21 and the liability towards gratuity, pension and accumulated leave encashment were ₹41.85 crore, ₹499.02 crore and ₹29.94 crore respectively. Against the liability of ₹570.81crore as on 31 March 2021, SCTIMST has created provision of amounting to ₹32.58 crore only. This has resulted in understatement of Schedule-7: Current Liabilities and Provisions by ₹538.23 crore and understatement of establishment expenses.

A2 As per the notes and instructions contained in the approved Uniform Format of Accounts prescribed for central autonomous bodies, provisions were to be provided under Schedule- 7 - Current Liabilities and Provisions. SCTIMST paid ₹75.78 lakh in April/ May 2021 towards the annual maintenance charges (AMC) for the year 2020-21. It was however observed that Institute did not create provision for AMC during the year 2020-21. Thus, Schedule-7: Current Liabilities and Provisions understated and capital fund overstated by ₹75.758 lakh

(B) General

B1 Grant-in-aid

SCTIMST received an amount on ₹310 cr ore from DST. Out of this, Grants-in-aid towards Salary received from DST was ₹190 crore and Grant-in-aid towards General purpose received was ₹75 crore and the entire amount was spent. Grant-in-aid for creation of Capital Assets was with an opening balance of ₹60 crore and an amount of ₹45 crore grants was received during the financial year 2020-21, an amount of ₹30.40 crore was spent during the financial year and balance at the end of the year was ₹74.60 crore.

B2 General

As per Rule 233(ii) of GFR 2017, on completion of the projects or schemes, if the assets are allowed to be retained by the sponsoring institute/ organization, the implementing agency should include the assets at book value in their own accounts. As per Paragraph 12 of Schedule-25, value of assets acquired from on-going external projects from April 2014 to March 2021 was ₹43.25 crore. However, the value of assets procured towards the completed projects was not worked out and the consent of the sponsoring agencies not obtained to include the value of these assets in the institute accounts.

B3 As per approved uniform format of accounts, the Central Autonomous bodies are prescribed to follow accrual basis of accounting. In the accrual system of accounts, transactions are recorded in accounts at the time of transfer of goods and services. Audit scrutiny however revealed that the institute did not record its transactions at the time of transfer of goods and services. Further, Audit scrutiny revealed that the institute did not have its Creditors (Payable) ledger and Debtors (Receivable) ledger accounts required as prescribed under the Uniform format of accounts. Detailed ledger accounts which record the voucher level details of all outstanding transactions which would help the management to periodically pursue with the customers to adjust the outstanding transactions did not exist. As a result, the system of Debtors/ Creditors management was not effective as evident from the large outstanding amounts available in these accounts.

The institute may therefore disclose under its notes on accounts the accounting system pursued by the institute.

(C) Management letter

Deficiencies which have not been included in the Draft Separate Audit Report have been brought to the notice of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram through a Draft Management letter issued separately for remedial/ corrective action.

v) Subject to our observations in the preceding paragraphs, we report that the Balance Sheet, Income & Expenditure Account and Receipts & Payment Account dealt with by this report are in agreement with the books of accounts .

vi) In our opinion and to the best of our information and according to the explanations given to us, the said financial statements read together with the Accounting Policies and Notes on Accounts, subject to the significant matters stated above and other matters mentioned in Annexure to this Audit Report give a true and fair view in conformity with accounting principles generally accepted in India.

a. In so far as it relates to the Balance Sheet of the state of affairs of the Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram as at 31 March 2021; and

b. In so far as it relates to Income & Expenditure Account of the deficit for the year ended on that date.

For and on behalf of C & AG of India

Date:07/01/2022
Place : New Delhi

Director General of Audit
Environment and Scientific Departments

Reply to Separate Audit Report of the Comptroller & Auditor General of India on the Accounts of Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram for the year ended 31 March 2021.

Audit Para	Observation	Reply of the Institute
(A) Balance Sheet Al Current liabilities and provisions (Schedule-7) " 53.70 crore	As per Paragraph 8 of Schedule-24 Significant Accounting Policies of the annual accounts for the year 2020-21, retirement benefits are being accounted for on cash basis by SCTIMST. However, the institute has done the actuarial valuation for the year 2020-21 and the liability towards gratuity, pension and accumulated leave encashment were ₹41.85 crore, ₹499.02 crore and ₹29.94 crore respectively. Against the liability of, 570.81crore as on 31 March 2021, SCTIMST has created provision of amounting to ₹32.58 crore only. This has resulted in understatement of Schedule-7: Current Liabilities and Provisions by ₹538.23 crore and understatement of establishment expenses.	The liability in respect of Gratuity, Pension and Leave Encashment is disclosed in para 11 of Schedule No. 25-Notes on accounts. Detailed fund requirement based on the proposal submitted by the LIC of India for the creation of Pension fund has been forwarded to DST. It is understood that DST has taken up the matter with DoE for clearance & budget allocation.
A2 Current Liabilities and Provisions (Schedule 7) ₹75.758 lakh	As per the notes and instructions contained in the approved Uniform Format of Accounts prescribed for central autonomous bodies, provisions were to be provided under Schedule- 7 - Current Liabilities and Provisions. SCTIMST paid ₹75.78 lakh in April/ May 2021 towards the annual maintenance charges (AMC) for the year 2020-21. It was however observed that Institute did not create provision for AMC during the year 2020-21. Thus, Schedule-7: Current Liabilities and Provisions understate d and capital fund overstated by ₹75.758 lakh	It may be noted that creating provision for repairs and maintenance was not in practice at the Institute. However, suggestion from audit is noted for future guidance. There is a steady expense of ₹5 to ₹6 Cr under the head Repairs & maintenance at the Institute for past several years. The amount stated by the audit (for 2021-22) will be transferred to prior period expenses and can be verified during the next audit. Hence there is no understatement of current liabilities and over statement of capital fund.

(B) General B1 Grant- in- aid	SCTIMST received an amount of ₹310 cr ore from DST. Out of this, Grants-in-aid towards Salary received from DST was ₹190 crore and Grant-in-aid towards General purpose received was, ₹75 crore and the entire amount was spent. Grant-in-aid for creation of Capital Assets was with an opening balance of ₹60 crore and an amount of ₹45 crore grants was received during the financial year 2020-21, an amount of, ₹30.40 crore was spent during the financial year and balance at the end of the year was ₹74.60 crore.	Noted.
B2 General	As per Rule 233(ii) of GFR 2017, on completion of the projects or schemes, if the assets are allowed to be retained by the sponsoring institute/ organization, the implementing agency should include the assets at book value in their own accounts. As per Paragraph 12 of Schedule-25, value of assets acquired from on-going external projects from April 2014 to March 2021 was, ₹43.25 crore. However, the value of assets procured towards the completed projects was not worked out and the consent of the sponsoring agencies not obtained to include the value of these assets in the institute accounts.	Institute disclosed the value of assets acquired out of external projects in the Notes to Accounts (para 12 (a). These assets were acquired mainly out of funds received from GoI (DBT, DST for TRC & Meity etc.) and these projects are ongoing. Since the projects funded by external agencies are ongoing and final report is yet to be forwarded to respective funding agencies. Value of these assets may be included in the accounts of the Institute (Schedule-8) in the future years after due closure of projects. Based on the audit observation of the previous year, Institute has started the practice of obtaining consent letter from the concerned respective funding agencies as required in Rule 233 of GFR, 2017. Consent is yet to be received. Once the consent is received from the funding agencies, assets will be incorporated in the books of the institute.

B3 General	As per approved uniform format of accounts, the Central Autonomous bodies are prescribed to follow accrual basis of accounting. In the accrual system of accounts, transactions are recorded in accounts at the time of transfer of goods and services. Audit scrutiny however revealed that the institute did not record its transactions at the time of transfer of goods and services. Further, Audit scrutiny revealed that the institute did not have its Creditors (Payable) ledger and Debtors (Receivable) ledger accounts required as prescribed under the Uniform format of accounts. Detailed ledger accounts which record the voucher level details of all outstanding transactions which would help the management to periodically pursue with the customers to adjust the outstanding transactions did not exist. As a result, the system of Debtors/ Creditors management was not effective as evident from the large outstanding amounts available in these accounts. The institute may therefore disclose under its notes on accounts the accounting system pursued by the institute.	To take care of the Audit observation, Institute would consider the following:- **(a)** Institute will approach accounting software production houses like M/s. Tally Software Solutions Pvt. Ltd. to explore possibilities on whether their readymade software can accommodate multi functionalities of the Institute. This would help Institute to ascertain whether the software would support multiple functions/activities carried out which includes patient related activities such as Investigations (Lab, MRI, ECG, ECHO, Cath lab etc.) done at respective areas in Hospital block and link it to Accounts of the Institute. Inpatient billing record need to be available to operation theaters, ICUs and different wards to enable the smooth functioning of admission/discharge of patients. Besides Institute have Research and Academic divisions. Finance and accounting activities of these divisions also needs to be captured and accounted. **(b)** Institute have to hire and consultant who is an expert in Accounts and software to study the prevailing software program running at the Institute and suggest changes and improvements which would take care of the needs suggested by the Audit. Switching over to a new software and improvement in current one as suggested by the Audit requires time. However, audit observation is noted for future guidance.

(C) Management Letter	Deficiencies which have not been included in the Separate Audit Report have been brought to the notice of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram through a Management letter issued separately for remedial/corrective action.	The observations mentioned in the Management letter have been noted for future guidance as well as remedial/corrective action.

SCTIMST
www.sctimst.ac.in