



# Annual Report

## 2019 - 2020



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

Trivandrum, Kerala, India 695011



# SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY

TRIVANDRUM - 695 011, KERALA



## ANNUAL REPORT

2019-20

**Annual Report 2019-20**

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

I write this at a time of crisis seldom seen in recent history. As COVID-19 unleashes its sinister act, governments, institutions and individuals across the world are for once bound by a common intent to script an apt response to an invisible intruder. There is palpable fear that inaction and ineptitude at this time would lead to unprecedented loss of life and livelihood and grievously undermine all that has been assiduously built over time. As the scourge strikes unrelentingly, the message is loud and clear - the battle has to be won, sooner than later and at any cost.

For its part, Sree Chitra was quick to respond to the call of duty at a time of distress. It could not have been otherwise. A look at its history from the time of its inception to the present reveals an exceptional track record of creditable service in the vital realms of patient care, public health, and biomedical technology. The Institute is credited with the indigenous development of several technologies that have been transferred to industry and commercialized. As President of the Institute, it is a matter of profound personal pride for me that we have, amidst the encircling gloom, straddled these diverse domains and made important contributions to the nation's collective effort against the pandemic. Through an uncommon convergence of medical science and technology in the organization of the Institute, we present a model that is worthy of emulation.

Swiftly, the Institute tapped into its proven expertise in medical device development and brought forth several technologies that are an integral component of the arsenal against the affliction. These include the Emergency Breathing Assistance System, the Chitra GeneLamp-N test kit for Real-time LAMP test that is specific for the SARS-CoV2 N-gene and is awaiting validation, the RNA extraction kit using magnetic beads (Chitra Magna), Swabs made of locally-available material for sample collection, viral transportation medium, Chitra Acrylosorb for the safe management of infected respiratory secretion, isolation pods for transferring infected patients, single and double-chamber swab collection booth, UV-based disinfection gateway, and UV bins for safe disposal of used face masks, to cite a few. I gather that 24 patent applications have been filed and 26 MoUs signed for technology transfers and co-development of COVID-19-related products developed by the Institute, which is extraordinary by any reckoning. The Health Sciences Wing of the Institute sprang into action, contributing its expertise to national and regional task forces on research and healthcare delivery during the pandemic. The humanitarian activities engaged in by the employees unions of the Institute during the pandemic also deserve special mention.

These commendable achievements underscore an unmistakable message, which was aptly articulated by Prof Ashutosh Sharma, Secretary, Department of Science and Technology, Government of India, who noted 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."

I would hasten to add that Sree Chitra presents a quintessential example of institutional commitment to the lofty Vision of 'Atmanirbhar Bharat' that envisages a self-reliant India in the post-COVID world.

If the institution's performance in the grim context of the crisis has been highly commendable, its unswerving adherence to the cardinal principles that have guided it from the time of its humble origins was manifest even in the placid times that preceded the pandemic. True to the Kierkegaardian dictum that life has to be "lived forwards", Sree Chitra's journey has continued with renewed vigor and vitality in recent times. Going through this report, I note that about 33 research projects were initiated during the year that also witnessed 10 patents being granted for innovative technologies, in addition to 31 new patent applications and 13 design registrations being filed. A significant increase in the number of research publications should bring cheer and instil confidence to do even better. All of these speak of a vibrant work culture that is sensitive to its responsibilities.

That is not all. The hospital continued to offer high quality services in Cardiology, Neurology, Cardiac Surgery, Neurosurgery and Imaging Sciences and Interventional Radiology. Recently, many minimally-invasive procedures, as detailed in this Report, were introduced, which would add a new dimension to patient care at Sree Chitra. The commissioning of the Molecular Genetics and Neuroimmunology Unit for advanced diagnostics and research in the genetics of cardiac and neurological disorders, and the third-generation Cardiology (Electrophysiology) Cath Lab for Diagnostic and Interventional Electrophysiology are major milestones. I have no doubt that these new initiatives launched during the bygone year will profoundly impact the way we practise our exalted profession.

As we face the future, we can draw inspiration from the fact that the organisation has grown from a small medical centre into an Institute of National Importance, admirably serving the cause of national self-sufficiency in the realm of healthcare. But, we are at a critical moment in our history. The times ahead are likely to be very challenging, and unprecedented challenges call for unprecedented flexibility and adaptability. The world is wading through tough times, saddled with an all pervading sense of unease over the horrific onslaught of the pandemic on human life. Yet, it is deeply comforting that desperate situations like this tend to touch a responsive chord in people, bringing out the best in them, instilling a sense of shared purpose and nudging them to re-imagine their built-up beliefs about themselves and their world and re-conceive their future in tune with a new reality. Such are Nature's whimsical ways!

Today, as the world stands united in its fight against the pandemic, there are important takeaways from the experiences of institutions, big and small, that took heart to respond to the crisis. A dedicated team of competent professionals under an able and steadfast leadership can, within a short time, deliver results that a dreadful situation demands. Hurdles may arise even as one strives selflessly for the larger good of others but courage, tenacity, and importantly, unshakable faith in one's mission can ultimately overcome all odds, as we at Sree Chitra have amply demonstrated.

Riding the winds of change, let us plug into the new reality and surge ahead as an organization, tapping our diverse skills in the service of society. We have it in us to do it, and our fellow citizens will be so much the better for it.

I express my deepest appreciation for the Director, Head BMT, Dean, Medical Superintendent, doctors, engineers, scientists, nurses, the hospital staff and administrative officers who worked hard when it mattered most, with hardly any respite, and put in their very best to live through a veritable crisis.

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

V K SARASWAT



## 2019-20: Looking back

Prof Asha Kishore, Director, SCTIMST

This brief report is more than a chronicle of past performance. It is a tribute to all my colleagues who toiled tirelessly to tide over the travails of a perilous pandemic, and in doing so, rendered yeoman service to the sick who look up to the Institute for succour, especially at a time of deep distress.

As 2019 drew to a close, I looked forward to reporting an impressive story of accomplishments that would herald new ways of advancing our mission in the years to come. It was yet another year during which we had remained firmly embedded in an eclectic culture that blends the practice of modern medicine with technology development and public health initiatives. There was sufficient reason to rejoice as the year nodded to its fall, with no indication of an impending crisis. Sadly, before long, the euphoria over the robust performance of the Institute was eclipsed by the lengthening shadows of an ominous pandemic that cast a pall of gloom worldwide. There was an urgent need to tweak institutional priorities to meet the exigencies of an extraordinary situation. The wise dictum that “it is better to light a candle than curse the darkness” seemed more relevant than ever before.

Intensely aware of its obligations, and the canons of collaborative responsibility, the Institute was quick to respond to the clarion call of duty at an hour of adversity. It is said, and rightly so, that past performance provides impetus to individuals and institutions to take up challenges in times of need. The rapid strides made by the Institute in the recent past, in manifold domains relevant to its unique mandate, served to fuel expectations and place additional responsibilities upon its shoulders as COVID-19 struck unrelentingly. Buoyed by recent achievements and a growing confidence over its ability to deliver on promises, the Institute firmed up its resolve to adopt an integrated approach to the formidable challenge posed by the pandemic.

Without losing time, several important measures were initiated on multiple fronts, which included continuing medical and surgical Cardiology and Neurology clinical services, both in-patient and tele-consultations for non-emergent cases, testing for COVID-19 and functioning as a Mentor Institute for enhancing the national testing capacity for COVID-19, designing test and RNA extraction kits, and development of medical devices and technologies for immediate application in the treatment or prevention of disease contagion. New protocols were created for the testing and treatment of various disorders in the face of COVID-19, and several training sessions were conducted for the healthcare providers of the Institute. Various unions of employees did a commendable job during the total lockdown period, providing training to the public on personal protection and distributing food and clothes to relatives of poor patients for days on end in the state medical college campus.



To counter the pandemic comprehensively, the Biomedical Technology Wing harnessed its expertise and commenced fast-track R&D work on several pertinent technologies. More than innovation, the need of the hour was to ensure availability of devices and accessories that were indispensable for the management of the disease. Chitra Acrylosorb, the Emergency Breathing Assistance System, Viral Transport Medium, Oropharyngeal and nasopharyngeal swabs, Rapid SARS-CoV-2 antibody test kits, End-point and Real-time LAMP test using Chitra GeneLAMP-N kit, Chitra Magna-RNA isolation kit, deployable modular hospital, MEDICAB (with Modulus, an IIT Madras-based start-up), isolation pods for transferring infected patients, and single and double-chamber swab collection booth were developed and commercialized or are nearing completion at the time of this Report. It is extremely gratifying that all these products would be far less expensive and manufactured using locally-sourced materials. The R&D work at the Biomedical Technology Wing to combat COVID-19 led to 26 MoUs being signed, 24 patents being filed, designs being registered and technology transfer to industry being completed or initiated. This was team work at its best!

The Achutha Menon Centre for Health Science Studies was involved in supporting COVID-19-related activities of the Government of India and the Government of Kerala. Dr Rakhal Gaitonde, Professor at the Institute, served as Member of the ICMR National Task Force on COVID-19.

Amidst the inevitable turbulence of an emergent epidemic, there were voices of support and appreciation for the steps taken by the Institute to ensure the safety of the staff and innumerable patients who depend on the hospital. The Institute is grateful to the Hon'ble Union Minister of Health and Family Welfare, Dr Harsh Vardhan, the Hon'ble Chief Minister of Kerala, Shri Pinarayi Vijayan, the Hon'ble State Minister of Health and Social Welfare, Smt Shailaja Teacher, Dr V K Saraswat, Hon'ble President of the Institute, Hon'ble MP Dr Shashi Tharoor, Prof Ashutosh Sharma, Secretary, DST, and other officials of DST, Dr Rajan N Khobragade, Principal Secretary, Health & Family Welfare, Government of Kerala, officials of the State Health Department, the District Collector of Trivandrum, members of society and media and scores of others who extended enormous support and encouragement when it mattered most. I place on record my deepest gratitude to all our well-wishers.

It gives all of us immense happiness that Sree Chitra has been able to play its role well in the face of an unanticipated threat on an unprecedented scale. As the battle against COVID-19 continues, the institution would continue to engage with the epidemic with all the resources at its command. Its rich repertoire of experience and a treasure trove of goodwill shall be priceless assets in the days to come.

In the months preceding the pandemic, the Institute worked in unison to contribute toward major national missions, including the grand idea of "Make in India" that makes up the Institute's quintessential dream. Under the DST-supported Technical Research Centre for Biomedical Devices, as many as 41 mission mode R&D projects aimed at developing medical device technologies were underway during the year. Apart from these, many other projects were also initiated in order to develop, among others, high strength titanium castings for orthopaedic implants, spinal fixation system for thoracolumbar stabilisation, spinal cord stimulator for pain management and rapid diagnostic kits for sepsis and Chlamydia trachomatis using LAMP technology. The Technology Business Incubator or TIMed at the Institute was identified as a SPARSH Centre for implementing the Social Innovation Immersion Programme of the Biotechnology Industry Research Assistance Council (BIRAC), Department of Biotechnology, Government of India, for 3 years after a competitive review process. Many start-up firms incubating at TIMed received substantial support from multiple sources such as the Biotechnology Ignition Grant (BIG) Scheme of BIRAC, the NIDHI Seed Support Scheme of NSTEDB, DST, and Unicorn Ventures, a Venture Capital Firm.

Clinical activities during the year were focused on the treatment of complex heart diseases, interventional cardiology, pediatric congenital cardiac problems, cardiac electrophysiology, comprehensive heart failure care, cardiac and thoracic surgery, brain tumors, stroke, movement disorders, epilepsy, developmental brain

disorders, neuromuscular disorders, sleep disorders and pediatric neurology. The recent introduction of many minimally-invasive procedures represents a significant advance in patient care at Sree Chitra. These include new pacing modalities, fenestrated thoracic endovascular aortic repair for aortic arch aneurysm, hybrid procedures for congenital heart defects and percutaneous valve replacement, and stenting of the right ventricular outflow tract in select patients.

The year witnessed a substantial thrust toward infrastructure development with a view to propping up clinical services and research at the Institute. The setting up of the Molecular Genetics and Neuroimmunology Unit for advanced diagnostics and research was a significant milestone that would pave the way for genetic testing of cardiac and neurological disorders such as neuromuscular diseases, movement disorders, neurodevelopmental disorders, channelopathies, epilepsy syndromes, inherited metabolic diseases, and mitochondrial cytopathies. Supported by the Department of Science and Technology, the laboratory is equipped with state-of-the-art facilities to perform genetic tests using next-generation sequencing, Sanger sequencing and RT-PCR. A new In vivo evaluation facility for animal studies was set up to augment work on large experimental animals, which is the backbone of medical device development.

The Cardiology Cath Lab for Diagnostic and Interventional Electrophysiology was opened on 14 June 2019. This state-of-the-art Electrophysiology System, with advanced features, would augment the precision and efficacy of cardiac electrophysiological interventions and device implantations. The Division of Cardiac Electrophysiology and Pacing was selected as a Regional Centre for Genetic Evaluation of Cardiac Channelopathies by the Indian Council of Medical Research. The Centre would create a national level Registry to study the modes of presentation and demographics of patients with genetic cardiac arrhythmia syndromes and would undertake detailed genotyping of rare diseases based on new generation sequencing.

As in previous years, research and development activities maintained the momentum during the past year as well. There was a significant increase in the number of research publications to 279, which demonstrated that deep engagement with patient care and technology development did not deter the faculty from their academic pursuits. As many as 33 research projects were initiated during the year, of which 31 were funded by national agencies and 2 by international agencies. While 10 patents were granted, 31 patent applications and 13 design registrations were filed.

With predictable regularity, the Institute contributed to human resource development in diverse spheres during the year. We trained 17 PhD students, 116 research and technical personnel through DM, MCh, PDCC, PDE, and MD programs in Cardiac and Neuro Sciences, and 759 students through MPH, DPH and Diploma Courses, Projects, Apprenticeship and Observership programs. Notably, 134 candidates benefitted from affiliated programs with institutions like CMC-Vellore, NIE-Chennai, IIPH-Delhi and IIITM-K, Trivandrum. In addition, our Faculty guided 36 M Phil/MPH/M Tech projects. Apart from these structured courses, the Institute contributed to manpower generation through Workshops, Conferences, Training Programs, Popular Lectures, Awareness Camps, Seminars and Exhibitions, organised inside and outside the Institute.

Many important events were organized during the year, which helped showcase the performance of the Institute to the distinguished participants from across the world. The Annual Convocation of the 35th batch of graduates for the year 2019 was held on 18 May 2019. Dr VK Saraswat, Member, NITI Aayog, and Hon. President of the Institute, presided over the function. Prof Balram Bhargava, Secretary, Department of Health Research, Union Ministry of Health and Family Welfare, and Director General, Indian Council of Medical Research, was the Chief Guest and he delivered the convocation address. Dr E Sreedharan, Former IES Officer and MD, Delhi Metro, was the Guest of Honour. 176 graduates received their degrees during the Convocation. The 5th Annual Conference of the Movement Disorders Society of India was organized by the Comprehensive Care Centre for Movement Disorders from 31 Jan to 2 Feb 2020. There were 24 scientific sessions conducted by an eminent panel of faculty, including 9 international faculty

from leading research Centres in the United States, Canada, France and the United Kingdom and about 80 senior national faculty. More than 500 delegates from across India and the neighbouring SAARC countries attended the Conference. The Asia-Pacific Regional Committee of the International Brain Research Organization conducted 'Neuroscience School 2019' with the theme "Advanced techniques to explore the functions of normal and diseased brain" from 22 April to 6 May 2019.

The Institute won the National Intellectual Property Award 2019 in the category, "Top Indian R&D Institution/Organization for Patents and Commercialization" in recognition of its contribution to the harnessing of the country's intellectual capital and creation of an IP eco-system that boosts creativity and innovation. Mrs Sara Sherly George, Deputy Nursing Superintendent, received "The National Florence Nightingale Nurses Award 2019" while Professor Sanjeev V Thomas of the Department of Neurology was recipient of the "Ambassador for Epilepsy Award" at the 33rd International Epilepsy Congress in Bangkok. Professor Harikrishnan of the Department of Cardiology was awarded the Amrut Mody Unichem Prize by the Indian Council of Medical Research for Excellence in Research in the field of Cardiology and Heart Failure. Dr Harikrishnan also received the Excellence in Publication Award from the Society for Heart Failure and Transplantation. Dr Jeemon Panniyammakal of the Achutha Menon Centre for Health Science Studies was accepted into the World Heart Federation Emerging Leader Cohort, 2019. As many as 52 awards were won by students, faculty and staff in various national and international conferences. The Institute congratulates all of them who brought laurels.

The Institute received Rs 186.14 Crores as the total grant for 2019-20 from the Department of Science and Technology. A total of Rs 20.93 Crores was received as extramural funding from government agencies, non-governmental agencies and international agencies. In addition, a sum of Rs 40 Crores was obtained from the Ministry of Health and Family Welfare, Government of India, for procurement of equipment for the new hospital block being constructed under the PMSSY Scheme. We received Rs 8.29 Crores as funding for ad hoc research projects, which included Rs 5 Crores for the Technical Research Centre from DST. The total number of ongoing research projects funded by DST and SERB was 17, out of which 8 were initiated during 2019-20.

We are extremely grateful to the Government of India for its consistent support for all our activities. I place on record our immense gratitude to the President of the Institute, Dr V K Saraswat, for guiding us along as we strive to live up to what is expected of us as an institution that is committed to the alleviation of human suffering. We thank Prof Ashutosh Sharma, Secretary, Department of Science and Technology, for being a source of support at all times and for being appreciative of all our endeavours.

That is a brief account of a year that will be remembered for a long time. We are happy that we did not cower under the covers when faced with one of the gravest challenges that humanity has ever encountered. Instead, we chose to act as best as we could. I am aware that this report does not capture the totality of all that we accomplished together but I do believe that it points to an endearing fervour that fuels our journey forward. Our collective response to the pandemic, as outlined here, is an edifying example of intense and innate empathy. It has indicated in no uncertain terms that the inexorable passage of time has not dented or dampened our unswerving commitment to the core values that underlie our endeavour. Let us turn the lessons learnt into a firm foundation for our growth and evolution as an institution in the times to come.

ASHA KISHORE



## ..... Highlights of the Year .....

### INFRASTRUCTURE DEVELOPMENT

#### ◆ Molecular Genetics and Neuroimmunology Unit

The Molecular Genetics and Neuroimmunology Unit (MGNU) for advanced diagnostics and research, funded by the Department of Science and Technology, Government of India, was inaugurated by the Hon'ble President of the Institute, Dr V K Saraswat (through video conferencing), and the Director, Prof Asha Kishore, on 26 February 2020.

This Facility will be available to patients for genetic testing of cardiac and neurological disorders such as neuromuscular diseases (muscular dystrophies, hereditary neuropathies, myotonic syndromes), movement disorders (Parkinson's Disease, Huntington's Disease), neurodevelopmental disorders, channelopathies, epilepsy syndromes, inherited metabolic diseases, mitochondrial cytopathies, and for the identification of bacteria from body fluids. The Unit is equipped with advanced facilities to perform genetic tests using Next-generation sequencing, Sanger sequencing and Real-time Polymerase Chain Reaction (RT-PCR). The Next-generation sequencer (Illumina NextSeq550) was installed and standard run was completed. The RT-PCR machine (QuantStudio5) and Sanger sequencer (Genetic Analyzer 3500) were installed and training was completed. Sequencing tests were standardized and sequencing for 8 different gene mutations was performed. The RT-PCR machine was used for COVID-19 testing.

#### ◆ In Vivo Evaluation Facility

A new In Vivo Evaluation Facility for animal studies under the Division of In Vivo Models and Testing, Department of Applied Biology, was inaugurated by the Hon'ble President, Dr V K Saraswat (through video conferencing), and the Director, Prof Asha Kishore, on 12 March 2020. It is a state-of-the-art Facility for housing large experimental animals.

#### ◆ Central Analytical Facility

The Central Analytical Facility was strengthened by the addition of a UV-Visible Spectrophotometer (UV-Vis) and a Spectrofluorometer, using Technical Research Centre (DST-supported) Funds.

### CONTRIBUTIONS TOWARD NATIONAL MISSIONS

#### 1. “Make in India”

##### ◆ Transfer of Medical Device Technologies

The Emergency Breathing Assistance System (EBAS) developed at the Institute was transferred to Wipro Enterprises Pvt. Ltd. (through Wipro 3D Division), Bengaluru.

##### ◆ Collaborative Development





Real-time PCR kit, with Origin Diagnostics and Research, Karunagappally.

#### ◆ Technical Research Centre for Biomedical Devices (DST-supported)

- 41 mission mode R&D Projects aimed at developing medical device technologies were underway
- Six new projects were initiated:
  - i. Bioceramic cages for tricortical bone graft
  - ii. High strength titanium castings for orthopaedic implants
  - iii. Spinal fixation system for thoracolumbar stabilisation
  - iv. Corneal epithelial cell sheet engineering – validation and pre-clinical evaluation
  - v. Spinal cord stimulator for pain management
  - vi. Development of rapid diagnostic kits for sepsis and *Chlamydia trachomatis* using LAMP technology

#### ◆ Technology Business Incubator (TIMed)

- TIMed was selected as a SPARSH Centre for implementing the Social Innovation Immersion Programme of the Biotechnology Industry Research Assistance Council (BIRAC), Department of Biotechnology, Government of India, for 3 years after a competitive review process.
- M/s Alicorn Pvt. Ltd., a start-up incubating at TIMed was selected for funding under the coveted Biotechnology Ignition Grant (BIG) Scheme of BIRAC after a national competitive review process.
- M/s Sascan Meditech Pvt. Ltd., a start-up incubating at TIMed under NIDHI Seed Support Scheme of NSTEDB, DST, received CE approval for its Oral Scan Device and obtained ISO-13485:2016 Quality Management System certification from the British Standards Institute.
- M/s Sascan Meditech Pvt. Ltd., a start-up incubating at TIMed under the NIDHI Seed Support Scheme of NSTEDB, DST, attracted further investment from Unicorn Ventures, a Venture Capital Firm after a due diligence process.

## 2. “Skill India”

#### ◆ Industry-Institute Partnership Cell

- The Industry-Institute Partnership Cell (IIPC), which was set up as part of the Technical Research Centre Programme, conducted 7 Workshops, in collaboration with various departments of the Institute, for the benefit of participants from industry and academia.
- The IIPC conducted 3 Workshops for SC/ST candidates as a special call.

## 3. “Digital India”



- ◆ A Website for Right to Information (RTI) covering all concerned sections was launched.
- ◆ Websites for Technology Transfer of products and Industry-Institute Partnership Cell were launched.
- ◆ A new set-up was created for ISRO Telemedicine Service.
- 4. “Swachh Bharat”

The Swachhta Hi Seva Campaign 2019 was organized on the occasion of the 150th birth anniversary of Mahatma Gandhi. The theme for 2019 was “Plastic Waste Management”. As part of the Campaign, various activities like waste collection and cleaning drive, Waste Collection Day, and education on innovative plastic management methods, adopted by the Government of Kerala and the Government of India, were organized. Sri Shibu K Nair, Consultant, Zero Waste Systems, delivered a talk on “Beat the Plastic Pollution”.

## NETWORKING WITH OTHER INSTITUTIONS

- ◆ The Institute executed the following MoUs with government departments, institutions and industries to facilitate networking:
  - With M/s Eight Oaks Bio Pvt. Ltd., Ernakulum, for SCTAC 2010 (technology for an anti-cancer formulation)
  - With Origin Diagnostics and Research, Karunagappally, for Real-time PCR kit
  - With the Indian Council of Medical Research, National Centre for Disease Informatics and Research, Bengaluru, for the project titled “Development of Hospital- Based Stroke Registries in Different Regions of India (HBSR)”
  - With the Institute of Microbial Technology (CSIR-IMTECH), Chandigarh, on sharing of rare isolates and their identification

- ◆ **Expression of Interest**

To enhance Technology Transfer, an Expression of Interest was invited from the medical device industry and start-ups for different products.

## NEW INITIATIVES

- ◆ **Advanced Cardiology (Electrophysiology) Cath Lab**

The advanced 3rd generation Cardiology Cath Lab for Diagnostic and Interventional Electrophysiology was inaugurated by the Director, Prof Asha Kishore, on 14 June 2019. This state-of-the-art Electrophysiology System, with features such as electrophysiology navigation, integration with 3-dimensional mapping, CT-integration and reduced radiation exposure with online individual dose monitoring, augments the precision and efficacy of cardiac electrophysiological interventions and device implantations.



- ◆ The Division of Cardiac Electrophysiology and Pacing was selected as a Regional Centre for Genetic Evaluation of Cardiac Channelopathies by ICMR. The goals of the Centre are to: a) create a national level Registry to study the modes of presentation and demographics of patients with genetic cardiac arrhythmia syndromes, b) develop a genetic laboratory facility for detailed genotyping of these rare diseases based on next-generation sequencing, and c) develop a nodal centre in the country, comprising cardiologists, molecular and clinical geneticists, genetic clinic, and facility for genotyping and genetic counselling.

#### ◆ **Dialysis Unit**

The new Dialysis Unit was inaugurated by Shri Prasad K Panicker, Executive Director, Kochi Refinery, Bharat Petroleum Corporation Ltd. The Facility was made possible by a generous support of Rs 77.22 Lakhs from BPCL for the procurement of all essential equipment.

- ◆ An Indo-German Collaborative Research Proposal, led by the Comprehensive Care Centre for Movement Disorders, SCTIMST, and the University of Tuebingen, won the Michael J Fox Foundation Grant of USD 2.3 million. The project led by SCTIMST in India includes 16 other Indian Centres. This will be the first Genome-Wide Association Study (GWAS) on Parkinson's Disease in India, and one of the largest Genome-Wide Association Studies.
- ◆ The Department of Cardiovascular and Thoracic Surgery started the Minimal Access Cardiac Surgery Programme.
- ◆ The Department of Cardiovascular and Thoracic Surgery started the Congenital Heart Surgery Programme at the Government Medical College, Kozhikode, as per an MoU with the Government of Kerala.
- ◆ The Department of Imaging Sciences and Interventional Radiology performed new interventions such as the use of surpass streamline flow diverter for managing complex intracranial aneurysms, fenestrated TEVAR and branch fenestrated EVAR.
- ◆ The Institute initiated the necessary steps for the implementation of Ayushman Bharat - PMJAY- KASP.
- ◆ Code Grey System, an emergency response for occupational violence, was introduced in the Institute on 11 October 2019.

#### ◆ **Public Health Programmes**

7 Public Health-related Projects for a total outlay of Rs 13.5 Crores were initiated during the year.



## RESEARCH PROJECTS/PUBLICATIONS/PATENTS

### ◆ Number of Research Projects newly initiated during the year: 33

- Nationally-funded: 31
- Internationally-funded: 2

### ◆ Number of Research Publications: 279

### ◆ Patents

- Granted: 10 (Foreign = 1, Indian = 9)
- Applications Filed: 31 (Foreign = 3, Indian = 28)
- Design Registrations Filed: 13

## HUMAN RESOURCE DEVELOPMENT/TRAINING

### ◆ PhDs graduated: 17

### ◆ Research/Technical Manpower trained in DM/MCh/PDCC/PDF/MD in Cardiac and Neuro Sciences: 116

### ◆ Other Research/Technical Manpower trained in MPH/ DPH/ Diploma Courses/ Projects/ Apprenticeship/Observership: 759

### ◆ Manpower trained against affiliated programmes (CMC-Vellore, NIE-Chennai, IIPH-Delhi, IIITM-K, Trivandrum): 134

### ◆ M Phil/MPH/M Tech projects guided: 36

### ◆ 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 of the 35th batch of graduates for the year 2019 was held on 18 May 2019. Prof Balram Bhargava, Secretary, Department of Health Research, Union Ministry of Health and Family Welfare and Director General, Indian Council of Medical Research, was the Chief Guest and delivered the convocation address. Dr E Sreedharan, Former IES Officer and MD, Delhi Metro, was the Guest of Honour. Dr Vijay Kumar Saraswat, Member, NITI Aayog and President of the Institute, presided over the function. 176 graduates received their degrees during the Convocation.





◆ **International Brain Research Organization-Asia Pacific Regional Committee (IBRO-APRC) Neuroscience School 2019**

The Neuroscience School with the theme “Advanced techniques to explore the functions of normal and diseased brain” was conducted for the first time in Thiruvananthapuram from 22 April to 6 May 2019. Novel tools like optogenetics, imaging techniques in humans and other models, and regenerative strategies for neuronal replacement and repair were highlights of the School.

◆ **MDSICON-2020**

The 5th Annual Conference of the Movement Disorders Society of India (“MDSICON-2020”) was organized by the Comprehensive Care Centre for Movement Disorders from 31 Jan - 2 Feb 2020. The event was inaugurated by Sri Arif Mohammad Khan, Hon’ble Governor of Kerala. There were 24 scientific sessions conducted by an eminent panel of faculty, including 9 international faculty from leading research Centres in the United States, Canada, France and the United Kingdom and about 80 senior national faculty. More than 500 delegates from across India and the neighbouring SAARC countries attended the Conference.

◆ The 3rd P K Mohan Oration was organized on 19 October 2019 by the Department of Neurology. The orator was Prof Peter Sandercock, Emeritus Professor of Medical Neurology, University of Edinburgh, UK.

◆ The Annual National Conference of the Interventional Cardiology Council of Kerala was organized by the Department of Cardiology on 10-11 August 2019 at Trivandrum.

◆ The 16th Instructional Course and 11th Basic Sciences Course of the Neurological Society of India was organized by the Department of Neurosurgery on 4-5 May 2019 at the Institute.

◆ **NICE 2019** – Problem-Based Learning Discussions and Skill Enhancing Workshops on Neuroanesthesia and Cardiothoracic Anesthesia were organized by the Department of Anesthesiology on 28 April 2019 at the Institute.

◆ **CMID 2020** - Clinical Microbiology Diagnostics in Infectious Disease Syndromes, a 1-day CME, was organized by the Department in collaboration with the Academy of Clinical Microbiologists on 29 February 2020 at the Institute.

◆ The Institute participated in the India International Science Festival 2019, jointly organized by the Ministry of Science and Technology, Ministry of Earth Sciences and Vijnana Bharati from 5-8 September 2019 at Kolkata.

◆ The Institute participated under the Department of Science and Technology Pavilion in the Pride of India Expo at the 107th Indian Science Congress held at the GKV Campus Bangalore, Karnataka, from 3-7 January 2020. The event was the world’s largest Science Meet and was attended by more than 50,000 people. The DST pavilion was adjudged the “Most Innovative”.

◆ Dr Biju Soman organized and moderated an in-house discussion on the “Current Public Health Emergency of International Concern (PHEIC) on Wuhan Corona Virus (2019-nCoV)” at the Institute



on 1 February 2020.

- ◆ Dr Rakhal Gaitonde organized a Workshop on 'Use and value of HTA in decision making in Kerala State', for staff from the Department of Health and Medical Colleges on 27-28 November 2019 at the Institute. The resource persons were Prof Louis Neissen of LSTM and Denny John of the Campbell Collaborative.

### ◆ **Institute Open Day**

The Institute opened its doors to the general public on 6 March 2020 at the Biomedical Technology Wing. The programme was part of the outreach of the Institute to the general public. 1012 participants from 34 educational institutions (schools and colleges) who took part in the Open Day celebrations were exposed to the prototype of devices and finished models, and videos on clinical procedures and operation of various diagnostic instruments.

- ◆ **International Yoga Day 2019** was celebrated on 21 June 2019. Yoga training session by Dr Arun Thejaus K P, a colloquium on "Integration of Yoga in cardiac and neurologic conditions", and yoga and meditation classes were organized.

### ◆ **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. Hindi Fortnight/Hindi Day was observed, and Hindi Workshops and competitions for the employees were organized.

- ◆ **Vigilance Awareness Week 2019 and Rashtriya Ekta Diwas 2019 were observed with pledge taking ceremony.**

### ◆ **Events were organised in connection with:**

World Autism Awareness Day - 2 April 2019, World Multiple Sclerosis Day - 30 May 2019, World Blood Donor Day - 14 June 2019, National Voluntary Blood Donation Day - 1 October 2019, World Stroke Day - 29 October 2019, , International Epilepsy Day - 12 February 2020, National Science Day - 28 February 2020, World Sleep Day - 13 March 2020

- ◆ **Conferences attended by staff and students: 239**

- ◆ **Number of Conferences/Workshops organized by the Institute: 21**

## **AWARDS**

### ◆ **National Intellectual Property Award 2019**

The Institute won the National Intellectual Property Award 2019 in the category, "Top Indian R & D Institution/Organization for Patents and Commercialization". The award was received by the Director, Prof Asha Kishore, from Shri Ramesh Abhishek, Hon'ble Secretary, Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry, on 26 April 2019 at New Delhi. The Award, instituted by the National IP Office, Department of Industrial Policy and Ministry of Commerce, Government of India, recognizes and rewards individuals and enterprises for their creations and commercialization of IP that have contributed to harnessing the country's intellectual capital and



creating IP eco-system that boosts creativity and innovation.

◆ **National Florence Nightingale Nurses Award 2019**

Mrs Sara Sherly George, Deputy Nursing Superintendent, was awarded “The National Florence Nightingale Nurses Award 2019” by the National Press Council of India Charitable Trust and The News Papers Association of Karnataka on 27 July 2019 at the Bangalore Medical College & Research Institute.

◆ **Ambassador for Epilepsy Award**

Dr Sanjeev V Thomas, Professor (Senior Grade) and Head, Department of Neurology, was awarded the “Ambassador for Epilepsy Award” at the 33rd International Epilepsy Congress in June 2019 at Bangkok.

◆ **Amrut Mody Unichem Prize**

Dr Harikrishnan S, Professor, Department of Cardiology, was awarded the Amrut Mody Unichem Prize (2018) by the Indian Council of Medical Research for Excellence in Research in the field of Cardiology and Heart Failure.

◆ **Excellence in Publication Award**

Dr Harikrishnan S, Professor, Department of Cardiology, received the Excellence in Publication Award (2019) from SHFT - Society for Heart Failure and Transplantation on 23 August 2019 at Mumbai.

◆ **Emerging Leader, World Heart Federation 2019**

Dr Jeemon Panniyammakal, Assistant Professor, AMCHSS, “was accepted in the World Heart Federation Emerging Leader Cohort, 2019”.

◆ **Awards won by students, faculty and staff in conferences: 52**

## CSR FUNDS RECEIVED

- ◆ M/s Muthoot CSR contributed a sum of Rs 86.89 Lakhs toward the COVID-19 Scheme (including Plasma Therapy).
- ◆ M/s Tata Elxsi Ltd. contributed a sum of Rs 60 Lakhs for treatment of patients from financially weaker sections.
- ◆ The Bharat Petroleum Corporation Ltd., contributed a sum of Rs 48.60 Lakhs toward the establishment of a Dialysis Unit

## REVENUE GENERATED BY THE INSTITUTE

- ◆ Revenue generated by the Institute during the current financial year was Rs 120.37 Crores,



which was 65% 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 2019-20 was Rs 186.14 Crores (as against Rs. 196.74 Crores for 2018-19)
  - Revenue Grant: Rs 141.66
  - Capital Grant: Rs 44.48
- ◆ Total Extramural Funding received by the Institute from Government Agencies, Non-Governmental Agencies and International Agencies during 2019-20 : Rs 20.93 Crores
- ◆ DST and SERB Contribution
  - Funding for ad hoc Research Projects: Rs 8.29 Crores, which includes the 5 Crores for the Technical Research Centre from DST
  - In addition, a sum of Rs 40 Crores was received from the Ministry of Health and Family Welfare, Government of India, for procurement of equipment for the new Hospital Block being constructed under the PMSSY Scheme.
  - Total number of ongoing research projects funded by DST and SERB was 17, out of which 8 were initiated during 2019-20.

*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

- \* Multi-disciplinary technology development teams with clinical collaborations were set up for rapid technology development and fast tracking the technology transfer process, with emphasis on respiratory assist devices, screening and confirmatory diagnostic kits, and development of disinfection systems for prevention of COVID-19 transmission.
- \* Viral Transport Medium, Chitra Acrylosorb, Oropharyngeal and nasopharyngeal swabs, Rapid SARS-CoV-2 Test Kits (IgM/IgG Test Kit and Rapid SARS-CoV-2 antigen rapid test Kit), Chitra GeneLAMP-N device, Chitra Magna-RNA isolation kit, emergency ventilator, isolation pods for transferring infected patients, double-chamber swab collection booth, patient examination booth for contagious diseases, deployable hospital medicab, bubble helmet, single-chamber swab collection booth for contagious diseases, and so on, have already been developed or are nearing completion at the time of this Report.
- \* Achievements: In addition to the patents, MoUs and technology transfers listed in the preceding section, the R&D work at the Institute to combat the COVID-19 pandemic resulted in several MoUs being signed, patents being filed, designs being registered and the process of technology transfer to industry being completed or initiated at the time of this Report.

### ◆ Medical Services

- \* COVID-19 testing Laboratory

The ICMR-approved COVID-19 testing Facility was set up in March 2019 by the Departments of Microbiology and Biochemistry in the Hospital Wing of the Institute. 1200 samples were tested for SARS CoV-2 by RT-PCR in 3 weeks. The Laboratory was selected as Mentor Institute for SARS CoV-2 testing for Kerala, Lakshadweep, and Andaman and Nicobar.

- \* COVID Cell

The Institute COVID Cell was constituted in March 2019 as per the directions of the Kerala Government. The activities of the Cell included monitoring and co-ordinating surveillance, containment and preparedness activities, policy formulation, development of clinical protocols and training for medical and paramedical Staff.

- \* Development and implementation of the Infection Control Manual by the Department of Microbiology and Infection Control Team.
- \* The Institute applied for participation in the ICMR-sponsored 'Convalescent Plasma Clinical Trial'.
- \* Experts from the Departments of Cardiology, Neurology, Anaesthesia and Imaging Sciences and Interventional Radiology published manuals and guidelines related to COVID-19, which were made available on the Institute website.





### ◆ 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 the Government of Kerala.
- \* Dr Rakhal Gaitonde, Professor at the Institute, served as Member of the ICMR National Task Force on COVID-19.
- \* Drs Rakhal Gaitonde, Sankara Sarma, Biju Soman and Jissa V T, Faculty at the Institute, assisted the State Government in developing epidemiological and sero-prevalence studies in the State.



(A) Inauguration of Molecular Genetics and Neuroimmunology Unit by Dr V K Saraswat, Hon'ble President, SCTIMST (through video conferencing) (B) Prof Asha Kishore, Director, inaugurating the laboratory, (C) Lighting of the lamp and plaque unveiling by the Director on behalf of the Hon'ble President (D) Illumina NextSeq 550 (E) Sanger sequencer- ABI Genetic Analyzer 3500



*Inauguration of the In Vivo Evaluation Facility by Dr V K Saraswat, Hon'ble President, SCTIMST (through video conferencing). Prof Asha Kishore, Director, unveiled the plaque on behalf of the Hon'ble President.*





*Signing of MoU with M/s Eight Oaks Bio Pvt. Ltd., Ernakulum, for SCTAC 2010  
(technology for an anti-cancer formulation)*



*Inauguration of the Advanced Cardiology (Electrophysiology) Cath Lab by the  
Director, Prof Asha Kishore on 14 June 2019*



*Inauguration of the Dialysis Unit by Shri Prasad K Panicker, Executive Director, Kochi Refinery, Bharat Petroleum Corporation Ltd.*







*Annual Convocation of the 35th batch of graduates held on 18 May 2019*



*Swachhta Hi Seva Campaign 2019*





*International Brain Research Organization-Asia Pacific Regional Committee (IBRO-APRC) Neuroscience School 2019*



MDSICON 2020 (A) Inauguration by Sri Arif Mohammed Khan, Hon'ble Governor of Kerala (B) Eminent International Faculty





*Institute Open Day - Institute opened its doors to the general public on 6 March 2020 at the Biomedical Technology Wing*



*International Yoga Day 2019*





*73rd Independence Day Celebrations*



*71st Republic Day Celebration  
Illumination of the Institute from 25-29 January 2020*



*SCTIMST at the India International Science Festival 2019*



The Institute won the National Intellectual Property Award 2019 in the category, “Top Indian R & D Institution/ Organization for Patents and Commercialization”. Director, Prof Asha Kishore, received the award from Shri Ramesh Abhishek, Hon’ble Secretary, Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry on 26 April 2019 at New Delhi.



# HOSPITAL WING





# HOSPITAL ADMINISTRATION

## Activities

During the year, the Departments of Cardiology, Neurology, Cardiac Surgery, Neurosurgery and Imaging Sciences and Interventional Radiology registered 17258 new patients. There were 11451 patients admitted for surgical and interventional procedures. Outpatient Department Services registered 146518 patients for review in various Departments, including Specialty Clinics. The Institute provided free treatment to 1.82% of patients and subsidized treatment to 38.34% based on socio-economic background. Figures 1-7 show the annual statistics pertaining to hospital services during 2019-20.

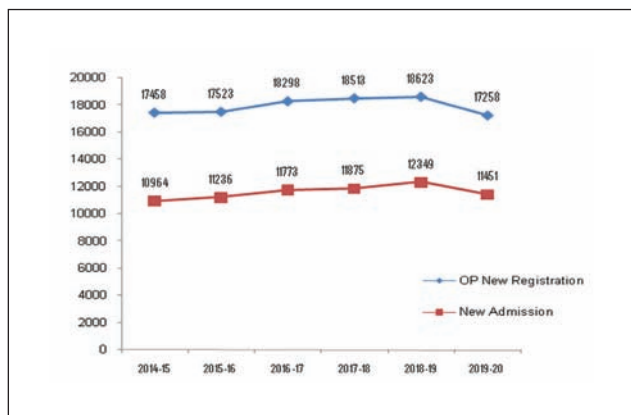


Figure 1. New Registrations and Admissions

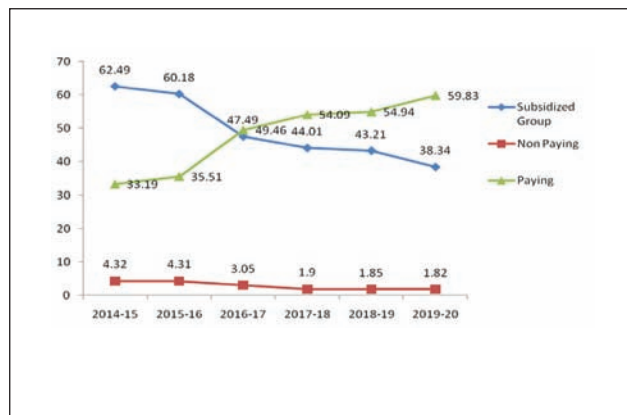


Figure 3. Paying, non-paying and subsidized treatment for inpatients



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

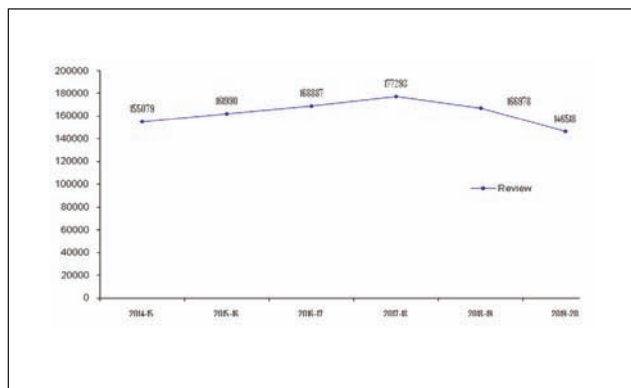


Figure 2. Review patients

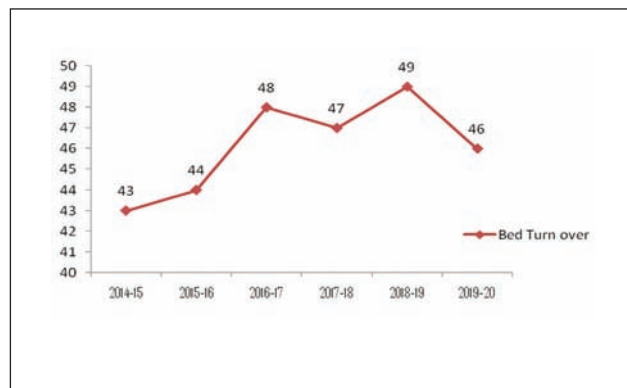


Figure 5. Bed Turnover



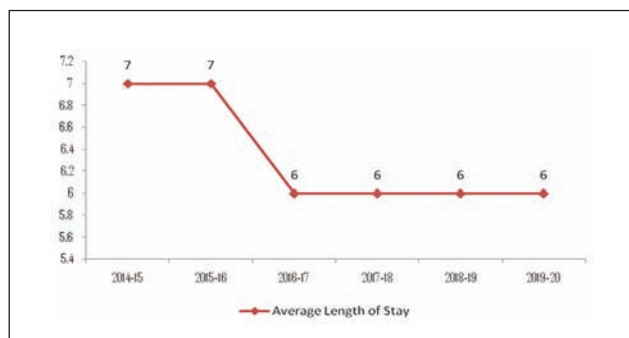


Figure 6. Average Length of Stay

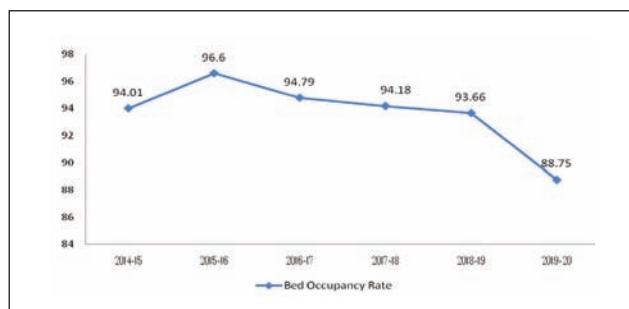


Figure 7. Bed Occupancy Rate

The number of patients who availed various financial schemes is summarized in the Table below:

Scheme	Number of Patients	
	IP	OP
RBSK	2113	16034
CGHS	0	0
Karunya	1196	0
CHIS PLUS	422	0
Thalolam	6057	0
Prime Minister's Relief Fund	0	0
Rashtriya Arogya Nidhi	123	0
PM Foundation	0	0
Sneha Santhwanam	0	8
<b>Total</b>	<b>9911</b>	<b>16042</b>

Other activities included:

### 1. Flood Relief Management by the Institute

During the 2019 floods in certain regions of Kerala, the Institute provided both medical and non-medical material relief to the flood victims. The staff of the Institute contributed clothes, medicines and other items needed in the flood relief camps.

### 2. The Hospital Management Committee was reconstituted on 26 April 2019 to oversee the patient care services in the Hospital.

### 3. The Institute revised the Socio-economic Classification System of patients. The new Socio-economic Classification System based on the criteria for identification of BPL families by Government of Kerala was implemented in the Hospital Wing on 1 December 2019.

### 4. Two Hospital Infection Control Committee (HICC) Meetings were conducted during the year. In addition, emergency HICC Meetings were also held to counter the Nipah virus outbreak (June 2019) and the COVID-19 pandemic (March 2020).

### 5. A Manual for infection control practices in the hospital was officially released on 15 October 2019.

### 6. The Institute introduced various precautionary measures to prevent COVID-19 pandemic.

### New Initiatives

### 1. The Institute initiated necessary steps for the implementation of Ayushman Bharat Scheme - Karunya Arogya Suraksha Paddhathi (KASP).

### 2. The e-portal for Electronic Maintenance of Records for the Code Blue Programme was activated on 12 July 2019.

### 3. Code Grey System for emergency response to occupational violence was introduced in the Institute on 11 October 2019.

### Events Organized

### 1. Inauguration of Voters Awareness Forum and live demonstration of Electronic Voting Machine and Voter Verifiable Paper Audit Trail was held on 6 April 2019.





2. SCT Premier League - Interdepartmental Cricket Tournament was held on 7 April 2019 as part of World Health Day celebrations at the Central Stadium, Trivandrum.
3. Basic Life Support (BLS) Training Programme for Nursing Personnel was conducted by the Code Blue Committee on 24- 25 April 2019.
4. MRI Safety Awareness Programme for the Staff of the Institute was conducted on 1 June 2019.
5. Health check-up for the female staff of the Institute was organized on 26 June 2019 in association with Snehta Women's Health Foundation.
6. The 2nd session of Yoga and Meditation classes for the staff was started on 20 July 2019.
7. Vigilance Awareness Week with the theme "Integrity - A way of life" was observed from 29 October to 2 November 2019.
8. Training Programmes on Ayushman Bharat-Karunya Arogya Suraksha Paddhati (KASP) for the Institute Staff were conducted by the State Agency, CHIAK, and the Insurer, Reliance on 17 January and 20 February 2020.

#### **Awards and Honours**

Ms Deepthi Bhaskar, Assistant Administrative Officer -A, secured the 1st rank in the LLB Examination conducted by the University of Kerala in July 2019.

#### **Staff**

##### **Hospital Administration**

Dr Kavita Raja, Medical Superintendent (till 15-03-2020)

Dr Sanjeev V Thomas (16-03-2020 onwards)

Dr Sathyabhama S, Associate Medical Superintendent

Dr Rahul D Nambiar, Administrative Medical Officer

Ms Priya P, Assistant Administrative Officer (OMS) - A

##### **Nursing Services**

Ms Sara Sherly George, Nursing Officer - A

Ms Nirmala M O, Deputy Nursing Superintendent - A

Ms Hepzibah Sella Rani J, Senior Nursing Supervisor  
Ms Chachiamma George, Senior Nursing Supervisor  
Ms Smitha A S, Assistant Nursing Superintendent - A

##### **Physical Medicine and Rehabilitation**

Dr Nitha J, Assistant Professor

##### **Central Sterile Services Department**

Ms Prasannakumari K, Senior Ward Sister

##### **Infection Control Unit & 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, (Junior scientific officer and In Charge OPD Services) and 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 Rosily Joseph, Chief Pharmacist

##### **Transport**

Mr Saji M S, Transport Supervisor



## MEDICAL RECORDS DEPARTMENT

Medical Records Department (MRD) is responsible for collecting and analyzing data and providing the right information to the right person at the right time. MRD plays an important role in Revenue Cycle Management as most of the requirements of Governmental and Non-Governmental Schemes and insurance claims are dependent on Medical Records. MRD handles a large volume of complex medical records requests for clinical and non-clinical activities, educational programmes and research.

### Activities

1. Documentation and updation of socio-economic and sociological data related to patients.
2. Processing patient registrations, admissions and maintenance of staggered appointment system.
3. Digitization of Medical Records and implementation of Electronic Medical Records. The Department worked towards increasing the adoption rate of Electronic Medical Records and reducing the burden of electronic documentation for clinicians with support from the Computer Division.
4. Quantitative and qualitative analysis of records and reporting of results.
5. ICD-coding and indexing of diseases and procedures and preservation of records.
6. Providing study materials and healthcare statistics for academic and research activities.
7. Generation and management of hospital statistics to administrators and Departmental Heads periodically.
8. Handling patient care-related correspondence and assisting tele-consultations.
9. Processing and issuance of various certificates, insurance claims and social security papers to patients.
10. Online reporting of overseas patients to Foreigner's Regional Registration Officer, and deaths to the Corporation of Thiruvananthapuram.

11. Printing, storage and supply of all Medical Records Forms.
12. Conducting academic programmes in Medical Records Science.

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

Activity	Number
New Registrations	17258
Admissions	11451
Reviews	146518
Bed Occupancy Rate	88.75%
Bed Turnover Rate	46 discharges/bed
Average length of stay	6 days
Records released for study/research	16270
Certificates processed/ issued	6038
Insurance claims processed	806
Records scanned and uploaded	59489
Electronic Medical Records processed	141369

### Geographic Distribution of Patients:

	Out Patient		In Patient	
Kerala	13596	78.78%	9298	80.00%
Tamil Nadu	2907	16.84%	1703	14.65%
Karnataka	36	0.21%	22	0.19%
Andhra Pradesh	42	0.24%	38	0.33%
Maharashtra	45	0.26%	33	0.28%
Other States	597	3.47%	507	4.36%
Outside India	35	0.20%	22	0.19%
<b>Total</b>	<b>17258</b>	<b>100%</b>	<b>11623</b>	<b>100%</b>



### New Initiatives

1. Switching from the earlier coding system to ICD-10CM for describing different illnesses and ailments. This will provide more information on the diagnosis and treatment.
2. Concurrent and retrospective review of medical records for conflicting, incomplete or non-specific provider records as part of improving clinical documentation practices.

### Staff

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

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 - A

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 Division provides essential services for patient management in the wards, operating theatres, outpatient departments and other supporting divisions of the Hospital Wing.

### Activities

The Division participated in the organization of many national and state level conferences during the year. The staff also actively participated in conferences to keep abreast of recent developments in their fields of interest. The staff members were also resource persons and faculty in regional and state-level conferences and training programmes.

The Division played an important role in community services by conducting health check camp in tribal settlement area in Idinjar with 32 participants. Groceries and clothes were distributed and health talk was delivered.

A team of nurses from the Paediatric Cardiac Surgery Department conducted 2 training sessions in Paediatric Cardiac Surgery ICU and OT at Calicut Medical College in September and October 2019.

### Events Organized

1. The State Level Nursing Conference on "Updates in Parkinson's Disease and Other Neurological Disorders" was conducted on 6 April 2019 at AMCHSS, SCTIMST.
2. The State level Neurosurgical Nursing Conference "COGNIZE-'19" was conducted on 23 November 2019 at SCTIMST.
3. The State Level Conference on "Comprehensive Nursing Management of Stroke" was held on 1 March 2020 at SCTIMST.
4. Continuing Medical Education (CME) on "Infection Prevention and Control (IPC) in a Superspecialty Setting – Facing the Future" was organized on 22 - 23 March 2019 at SCTIMST.

### Awards and Honours

1. Mrs Sara Sherly George, Deputy Nursing Superintendent, was awarded "The National Florence Nightingale Nurses Award 2019" by the National Press Council of India Charitable Trust and The News Papers Association of Karnataka on 27 July 2019 at Bangalore Medical College & Research Institute.
2. Shani S D won the 3rd prize for the essay on "The role of Nurses in improving patient care through clinical research" at the Global Health Network India competition.
3. Mrs Vijitha, Staff Nurse, secured the 1st rank in MSc Nursing Entrance Examination, Kerala.
4. Mrs Preena V won the 3rd prize for paper presentation at the VSICON 2019 26th Annual Conference of the Vascular Society of India from 16-20 October 2019 at Hyderabad. The Nursing Team from SCTIMST also won the Quiz Competition at the event.
5. Mr Ratheesh and Mrs Saji Gopinath won the 2nd prize in Quiz Competition in postgraduate and undergraduate categories, respectively, at the 40th Annual Meeting of Society of Indian Neuroscience Nurses (SINNCON-2019) held at Mumbai.

### Staff

Mrs Sara Sherly George, Nursing Superintendent

Mrs Nirmala M O, Deputy Nursing Superintendent

Mrs Chachiamma George, Assistant Nursing Superintendent

Mrs Hepzibah Sellarani J, Assistant Nursing Superintendent

Mrs Smitha A S, Assistant Nursing Superintendent





## DEPARTMENT OF ANAESTHESIOLOGY

The Department of Anaesthesiology has two Divisions: Division of Cardiothoracic and Vascular Anaesthesiology and Division of Neuroanaesthesia and Neuro Critical Care.

### DIVISION OF CARDIOTHORACIC VASCULAR ANAESTHESIOLOGY

#### Activities

##### *Clinical Activities*

The Division provides anaesthesia for cardiothoracic and vascular cases in 4 adult and 2 pediatric operating rooms, 3 catheterisation labs, 2 DSA labs, 2 MRI suites and 1 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 and regional nerve blocks, and highly effective intravenous and neuraxial pain relief practices.

By virtue of expertise in the field of perioperative care, the cardiac anesthesia team provided round-the-clock critical care services in various intensive care units of the hospital, namely, cardiac surgical ICU, congenital heart ICU and cardiac medical ICU.

The Division purchased two Anaesthesia Workstation Drager machines costing Rs 4264110 and a Flexible Intubating Video Endoscope costing Rs 1320000.

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

Location	Number of surgeries/ procedures
Adult cardiac surgery operation theatres	1383
Congenital heart surgery operation theatres	905
Cardiology catheterisation labs	680
Radiology: CT, MRI and DSA labs	169
Intensive Care Units	1246
<b>Total</b>	<b>4383</b>

##### *Academic Activities*

All working Saturdays were exclusively dedicated to well-structured departmental academic activities, which included introductory classes, symposiums/seminars, practise guidelines and pro-con sessions, systematic review and meta-analysis sessions, problem-based learning discussions, journal clubs and case presentations. Further, thesis and project details were also discussed. The faculty members delivered many invited lectures at various national conferences and Workshops. Five senior residents from AIIMS, Delhi, 1 postdoctoral fellow from AIIMS, Bhubaneswar, and 1 Consultant from United Arab Emirates visited the Division for training in adult and pediatric cardiac anaesthesia, intensive care and intraoperative echocardiography.

##### *Research Programmes*

Faculty and residents were actively involved in various research projects. They presented their research work at various national conferences.

The following Projects continued during the year:

- Comprehensive and novel integrated model for



health care solutions on chronic musculoskeletal non-malignant geriatric pain conditions and disability in India, PI - Dr Subin Sukesan (Funded by: Kusuma Trust)

- Intraoperative Quantification of Left Ventricular Volumes and Ejection Fraction by Real-Time Three-Dimensional Transesophageal Echocardiography: Comparison with Cardiac Magnetic Resonance Imaging, PI - Dr Saravana Babu (Funded by: TDF, SCTIMST)
- Universal airway device for selective lung isolation, PI - Dr Suneel P R (Funded by: TDF, SCTIMST)
- Comparison of different techniques for estimation of left ventricular volumes using intraoperative RT-3D-TEE- A prospective observational study, PI - Dr Shrinivas G
- Comparison of ultrasound-guided supraclavicular and axillary approaches to brachial plexus block for arm vascular surgery-A prospective, randomized, single blind, controlled trial, PI - Drs Shrinivas G & Rupa Sreedhar
- Monitoring pulmonary arterial pressure via transthoracic pulmonary arterial catheters in pediatric cardiac surgical patients: A single Centre experience, PI - Dr Shrinivas G
- Monitoring left atrial pressure via transthoracic route in pediatric cardiac surgical patients: A single center experience, PI - Dr Shrinivas G
- Comparison of hemodynamic parameters measured by thoracic electrical bioimpedance and transesophageal echocardiography in adult cardiac surgery patients, PI - Dr Shrinivas G
- Systemic oxygen delivery during cardiopulmonary bypass as a risk factor for prediction of cardiac surgery associated acute kidney injury PI - Dr Rupa Sreedhar

### New Initiatives

1. The 1-month external posting for senior residents was split into 2 weeks each in AIIMS, Delhi (to learn Robotic surgeries and Thoracic trauma) and the Institute of Heart- Lung Transplant and Mechanical Circulatory Support Service

at MGM Healthcare, Chennai (to learn Heart/ Lung transplants, LVAD and ECMO). The posting in Chennai was a new initiative approved by the Academic Committee.

2. The existing single report form for perioperative transesophageal echocardiography was revised into 2 separate report forms for adult and pediatric echocardiography.
3. Drafted protocols for patient management in operating rooms and ICU in COVID-19 scenario. This was widely circulated and used in many institutions across the country.
4. Developed the 'E posting software' with the help of the Computer Division for management of daily posting of Anaesthesia Technicians in operation theatres, Cath labs, MRI suites etc.
5. Preparatory in-house classes on mechanical ventilation to senior residents and Faculty of various specialties of SCTIMST were conducted by Drs Unnikrishnan K P, Suneel P R, Prasanta Kumar Dash, Thomas Koshy and final year Senior Residents. This was part of the preparedness for handling COVID-19 cases.
6. Preparatory classes for nurses of SCTIMST were conducted in anticipation of treating COVID-19 cases by Drs Suneel P R, Dr Prasanta Kumar Dash and Senior Residents. A mannequin and ventilator were used to demonstrate safe practices in intubation, endotracheal suctioning and tracheal extubation.

### Events Organized

1. NICE-2019: Problem-based Learning Discussions and 10 Skill Enhancing Workshops on Neuroanaesthesia and Cardiothoracic Anaesthesia were conducted on 28 April 2019 at the AMC Auditorium, SCTIMST.
2. ISA Trivandrum City Branch meetings were organized on 19 July, 4 October and 8 November 2019 by Dr Suneel P R at Hotel Horizon, Trivandrum.



### Awards and Honours

1. Dr Unnikrishnan K P, Professor, was awarded the Fellowship of American Society of Echocardiography by the American Society of Echocardiography in February 2020.
2. Dr Devarakonda V Bhargava, DM Cardiac Anaesthesia Senior Resident, was awarded the 'Dr Vijayalakshmi Kamat Award 2019' for the presentation titled 'Role of Transesophageal Echo in the intraoperative diagnosis of double outlet left ventricle and etiology of ventricular arrhythmia after surgical correction' at the 14th Annual Cardiac Anaesthesia Update from 9-10 November 2019 at Chennai.
3. The team of DM Cardiothoracic Vascular Anaesthesia senior residents won the following prizes at the 23rd Annual National Conference of IACTA from 7-9 February 2020 at Goa:
  - Drs Devarakonda V Bhargava and Mamatha Munaf won the 1st prize in Echocardiography Quiz
  - Drs Vasanth K and Murukendiaran G J won the 1st prize in the Mega Quiz
  - Dr Vasanth K won the 1st prize in the Video Flix competition

## DIVISION OF NEURO ANAESTHESIA AND NEURO CRITICAL CARE

### Activities

The Division is actively involved in various areas like patient care, academic, research and administrative activities of the Institute.

#### Clinical Activities

The patient care activities included care of neurologically ill patients during elective and emergency surgeries, perioperative management of patients in Cath labs for diagnostic and interventional procedures, and during CT and MRI.

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

Areas	Number
Neurosurgery	1582
Neuro Cathlab	245
MRI Procedures	385
Neuro ICU care-Neurosurgery	1500
Neuromedical, Stroke ICU	260
Radiology ICU	300
<b>Total</b>	<b>4272</b>

### Academic Activities

Academic activities included teaching and training of students undergoing DM and PDCC (Neuroanaesthesia), Diploma in Operation Theatre and Anaesthesia technology and nursing students. Teaching was done by didactic lectures, Pro and Con debates, Journal clubs, practical sessions and video conferencing. During the COVID-19 pandemic, academic activities were conducted through video conferencing while maintaining social distancing. In addition, interdepartmental academic programmes, spreading knowledge via conferences, seminars, Workshops as well as internet was actively undertaken by the staff and residents of the Division.

#### Research Programmes

Faculty and residents were also involved in clinical research (funded and non- funded) and biomedical device development. There was also active involvement in writing up projects and publishing in scientific journals.

The following Projects continued during the year:

1. Development of portable, low-cost disposable defibrillator for cardiac arrest management, PI - Dr Manikandan S (Funded by: DST)
2. Comparison of depth of anaesthesia indices (SNAP vs. Bispectral index) during desflurane general anaesthesia and awakening in patients undergoing interventional neuroradiology procedures, PI - Drs Ajay Prasad Hrishi & Unnikrishnan P (Funded by: SNAP)





3. General anesthesia vs sedation – cognitive decline in elderly - a randomised control study in patients with chronic SDH, PI - Drs Smita V & Manikandan S (Funded by: CSRI)
4. Cardiopulmonary and Cerebral resuscitation “Code Blue”, PI - Dr Ajay Prasad Hrishi (Funded by: TDF, SCTIMST)

#### *Product Development*

The following product development activities in collaboration with Biomedical Technology Wing continued during the year:

1. Development of portable, low-cost disposable defibrillator for cardiac arrest management, PI - Dr Manikandan S
2. Design and development of cerebral microdialysis device and methodology for estimation of cerebral metabolites, PI - Dr Ajay Prasad Hrishi (Funded by: TDF, SCTIMST)
3. Development of Ventilator for use in COVID-19 patients, Co-PI - Dr Manikandan S
4. Development of automatic gas blender for high flow oxygen therapy, Co-PI - Dr Manikandan S

#### **New Initiatives**

1. New Programmes: Preoperative transcranial doppler assessment of subarachnoid haemorrhage and stroke patients for surgery was started to help in intraoperative cerebral blood flow management.
2. Academic Programmes via video conferencing was initiated in the wake of COVID-19 pandemic.
3. Protocols for screening, evaluation and intraoperative management of COVID-19 patients was developed in the Department.

#### **Events Organized**

##### **1. NICE 2019: Problem Based Learning Discussions and Skill Enhancing Workshops on Neuroanesthesia and Cardiothoracic Anesthesia**

This 1-day Workshop was organized by the Department of Anesthesiology on 28 April 2019 at the AMC Auditorium, SCTIMST. It was attended by 100 delegates from various institutions across India. The Programme included 2 problem-based learning discussions on Neuro and Cardiac Anaesthesia, followed by full hands-on Workshop across 10 stations. The Workshop stations conducted were: lung isolation, airway and fibre-optic bronchoscopy, intracranial pressure monitoring, optic nerve sheath diameter, depth of anaesthesia monitoring, target controlled infusion devices, transcranial doppler, transthoracic echo, lung and vascular ultrasound and percutaneous tracheostomy (Figure 8). There was excellent feedback on the programme with suggestions for conducting similar Workshops in the coming years.

##### **2. Intraoperative Neuromonitoring Workshop**

The 16th Instructional and 10th Foundation Course of Neurological Society of India was conducted from 4-5 May 2019 at SCTIMST. Faculty members and residents of the Division conducted a 2-day Workshop on intraoperative neuromonitoring (Figure 9). The training programme was attended by over 100 neurosurgery trainees and 60 consultants from institutions across India.

##### **3. Amirtha Neuroanesthesia CME 2020**

Faculty from the Division conducted the Neuroanesthesia CME organized by Amirtha Institute of Medical Sciences on 8 February 2020 at Ernakulam. It was attended by about 250 anaesthetists from all over Kerala.



Figure 8. NICE 2019





Figure 9. Intraoperative Neuromonitoring Workshop

### Awards and Honours

1. Dr Soniya Biswas secured the 1st prize for the paper titled "Comparison of the effects of propofol and dexmedetomidine on motor evoked potentials in neurosurgery" at the AIIMS Neuroanesthesia Update from 19-20 October 2019 at AIIMS, New Delhi.
2. Dr Neeraja Ajayan received the V K Grower Best Paper Award for the presentation titled "Evaluation of haemodynamics and cardiac function before and after neurosurgery in patients with and without raised intracranial pressure: a pilot observational study with transthoracic echocardiography" at the 21st Annual Conference of the Indian Society of Neuroanaesthesiology and Critical Care - ISNACC 2020 in February 2020 at Chennai.
3. Drs Neeraja Ajayan and Shilpa Nagamoti Vilasrao won the 1st prize in Quiz competition at the 21st Annual Conference of the Indian Society of Neuroanaesthesiology and Critical Care - ISNACC 2020 in February 2020 at Chennai.





4. Dr Neeraja Ajayan won 2nd prize in Quiz competition at the Workshop on Neuromonitoring at the 21st Annual Conference of the Indian Society of Neuroanaesthesiology and Critical Care - ISNACC 2020 in February 2020 at Chennai.
5. Dr Keta D Thakkar won 3rd prize in Quiz competition at the 21st Annual Conference of the Indian Society of Neuroanaesthesiology and Critical Care - ISNACC 2020 in February 2020 at Chennai.
6. Dr Ajay Prasad Hrishi was awarded the European Diploma of Anesthesiology and Intensive Care on 24 September 2019 at Porto, Portugal.

#### **Staff**

#### **Faculty**

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

Dr Rupa Sreedhar, Professor (Senior Grade)

Dr Shrinivas V Gadhinglajkar, Professor

Dr Prasanta Kumar Dash, Professor

Dr Manikandan S, Professor

Dr P R Suneel, Professor

Dr K P Unnikrishnan, Professor

Dr Subin Sukesan, Associate Professor

Dr Smita V, Associate Professor

Dr Ajay Prasad Hrishi P, Associate Professor

Dr Unnikrishnan P, Assistant Professor

Dr Ranganatha Praveen, Assistant Professor

Dr Saravana Babu M S, 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

### Activities

#### Clinical Activities

The fully automated state-of-the-art equipment used in this service include: Dade-Behring/Siemens RXL, Aspen A1c HPLC Analyzer LD 500, Mindray 5-part Hematology analyzer-BC 5180 & 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 9,96,352 investigations during the year, which was marginally higher than the previous year. The investigations performed during the year are indicated in the Table below:

Investigations	Number
Arterial Blood Gas	19096
General Chemistry	454893
Hematology and Coagulation	375253
Clinical Pathology [CSF, Stools, Urine]	142789
Neurochemistry	73
Plasma Amino Acids	4248
<b>Total Investigations</b>	<b>996352</b>

#### Research Programmes

Three research laboratories supervised by faculty members continued to train 7 PhD students in various stages of their PhD Programme. This included seminars every Tuesday, mid-course comprehensive examinations and PhD thesis preparation.

#### **1. Impaired substrate-mediated cardiac mitochondrial complex I respiration with unaltered regulation of fatty acid metabolism and oxidative stress status in type 2 diabetic Asian Indians**

The cardiovascular complications associated with type 2 diabetes mellitus could be attributed to changes in myocardial mitochondrial metabolism. Though it is a known fact that permeabilized cardiac muscle fibres

as well as isolated mitochondria are metabolically compromised in Caucasian population, studies in myocardial mitochondrial function in Asian Indians are lacking. Thus, the objective of the study was to analyze if there is altered cardiac mitochondrial substrate utilization in diabetic Asian Indians. Mitochondrial substrate utilization was measured using high-resolution respirometry in isolated mitochondria prepared from right atrial appendage tissues of diabetic and non-diabetic subjects undergoing coronary artery bypass graft surgery. Western blotting and densitometric analysis were also performed to compare the levels of proteins involved in fatty acid metabolism and regulation. Mitochondrial oxygen consumption rate for fatty acid substrate was found to be decreased between diabetic and non-diabetic subjects. However, mitochondrial DNA copy number, levels of electron transport chain complex proteins and proteins involved in fatty acid metabolism and regulation remained unaltered. Decreased glutamate and unchanged pyruvate-mediated state 3 respiration was also observed in diabetic subjects. The study reported deranged cardiac mitochondrial fatty acid-mediated complex I respiration in type 2 diabetic Asian Indians with comparable levels of regulators of fatty acid oxidation as compared to non-diabetic myocardium (Figure 10). Altered glutamate-mediated mitochondrial respiration also pointed to altered mitochondrial complex I activity. The current study suggested that Asian Indian population also have altered cardiac mitochondrial substrate utilization similar to the previous reports in other ethnic populations

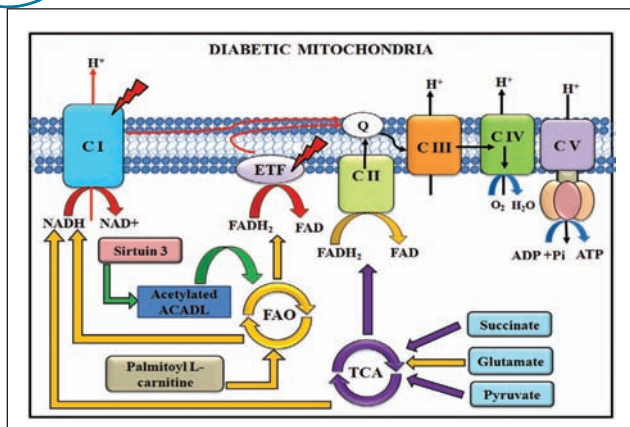


Figure 10. Deranged diabetic human mitochondrial respiration driven by palmitate and glutamate (orange arrows indicate possible alterations in fatty acid and glutamate metabolic pathways and complex II activity, red arrows indicate deranged activity of complex I and ETF; green arrows indicate unaltered activity/ levels)

## 2. No evidence of mitochondrial dysfunction in high glucose-treated glioma cells

Cancer cells rely more on glycolysis for their metabolic needs even in the presence of oxygen by maintaining oxidative phosphorylation at a low level as the glycolytic pathway provides the necessary intermediates needed for proliferating cells (Warburg effect). Although the glioma cell metabolism in normal glucose environment is much studied, the metabolic changes in high glucose condition remains unexplored. We examined the effects of hyperglycaemia on glioma cell line U251MG. It was observed that the longer the glioma cells remained under high glucose stress, the more aggressive their behaviour with increased proliferation and migration, along with less reliance on oxidative phosphorylation, but with no decline in mitochondrial efficiency (Figure 11).

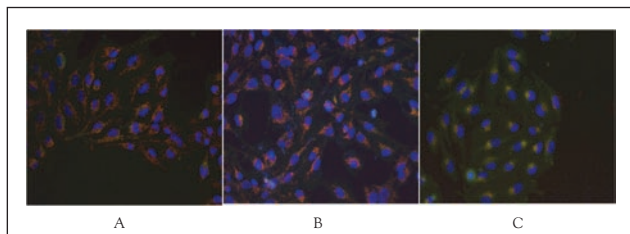


Figure 11. Fluorescence staining of U251 cells with JC1 dye to analyse mitochondrial membrane potential. JC1 accumulates in healthy mitochondria forming aggregates that give red fluorescence, while the dye localized in the

cytoplasm emits green fluorescence. The Control (A) and high glucose (B) show similar levels of red fluorescence, suggesting no decline in mitochondrial health in the high glucose state. Image C is the positive control (with uncoupler CCCP).

## 3. Chloroquine induces mitochondrial fragmentation and impairs its function in cardiomyoblasts

Cardiac cells rely considerably on autophagy and its impairment has enormous impact on muscle function. Pharmacological inhibitors of autophagy like chloroquine and its derivatives are used as anti-malarial and anti-cancer agents, and most recently, as potential treatment for COVID-19. However, the effect of chloroquine on cellular bioenergetics, particularly in muscle cells, remains unknown. Myocytes rely heavily on mitochondrial OXPHOS for their function and survival; and its impairment can lead to muscle damage. We investigated the mitotoxic effect of chloroquine in H9c2 cardiomyoblasts (Figures 12-14).

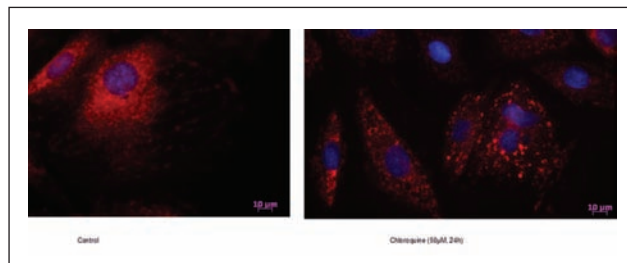


Figure 12. H9c2 cardiomyoblasts were stained with TMRM to analyze mitochondrial membrane potential after chloroquine treatment (50µM) for 24h. TMRM localizes in healthy mitochondria with good membrane potential giving red fluorescence. With chloroquine treatment TMRM staining showed decreased mitochondrial membrane potential.

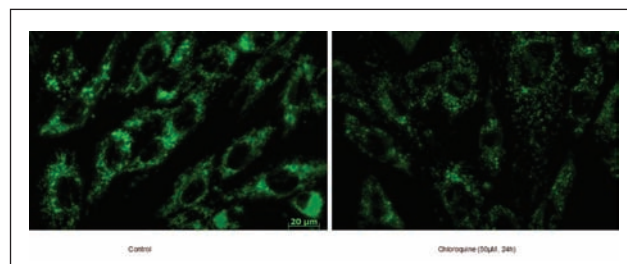


Figure 13. Fluorescent staining of mitochondria after 50µM of chloroquine treatment for 24h using Mitotracker Green dye. Mitotracker localizes in mitochondria giving fluorescence. With chloroquine treatment Mitotracker staining showed increased mitochondrial fragmentation.



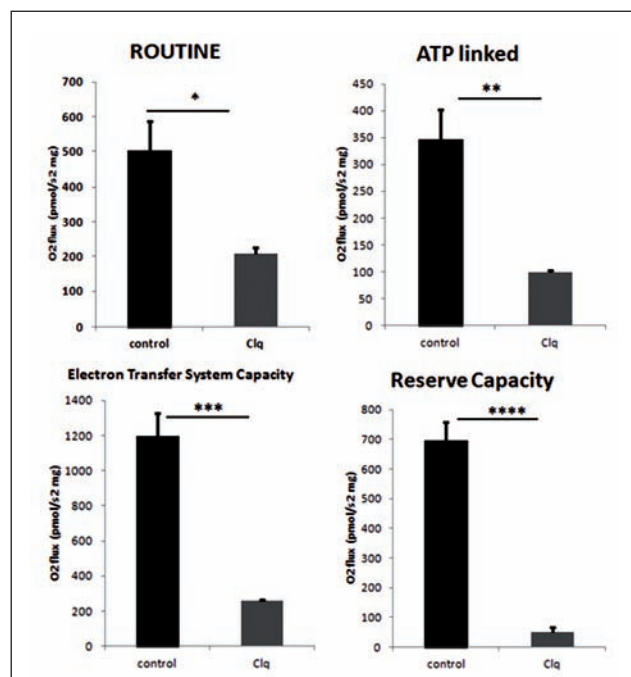


Figure 14. Intact cell bioenergetics decreased significantly with chloroquine treatment with a significant decline in coupling efficiency. This suggested accumulation of damaged mitochondria.

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

Exosomes, the membrane-encapsulated extracellular vesicles released from normal and diseased cells, carry functional proteins, RNA and metabolites. Evidence suggests that the miRNA and proteins in exosomes are involved in regulating the target cell functions and their dysregulated expression has been demonstrated in the initiation and progression of various diseases. The objective of the study is to identify dysregulated miRNA and proteins in neuronal-derived exosomes isolated from the plasma of Parkinson's Disease patients using next generation sequencing and mass spectrometry. The isolation of exosomes from the blood samples of control subjects using ultracentrifugation or commercially-available kits was standardized. The isolated exosomes were checked by Transmission Electron Microscopy and western blot. Exosome-specific antibodies CD63 (Merck-Millipore), Alix (Santa Cruz), TSG101 (Puregene) and HSP90 $\alpha$  (Puregene) were purchased and tested. The presence of brain-derived exosomes was confirmed by the presence of neuronal specific

marker, CD171 (L1CAM, Invitrogen). The isolation of CD171-positive (brain-derived) exosomes is ongoing.

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

Fully functional lysosomes are necessary to prevent age-associated neuronal protein accumulation, cell death and neurodegeneration. The susceptibility of a person with defective lysosomal function to neurodegenerative disease development or disease progression cannot be predicted by the existing biochemical assays or genetic testing. The objective of the study is to develop a simple, sensitive and specific assay for absolute quantification of lysosomal Glucocerebrosidase (GCase) activity in human blood cells. The assay will be validated using samples from: (a) Gaucher's disease patients with confirmed mutations in Glucocerebrosidase gene (GBA1) (b) Parkinson's Disease where an inverse correlation between GCase activity and  $\alpha$ -synuclein 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 population and possible predictor of their susceptibility to neurodegeneration.

#### 6. Genetic basis of inherited and acquired disorders

Studies were initiated to obtain the mutation spectra in Parkinson's Disease, cardiac channelopathies, cardiomyopathies, epileptic encephalopathies and pituitary adenomas in our population.

#### 7. Basement membrane modification and pericyte function

Advanced Glycation Endproducts (AGEs) are formed from non-enzymatic reaction of reactive carbohydrates with amino groups in proteins. This reaction produces stable end products in proteins with diverse chemical structures that are collectively known as AGEs. Although the role of AGEs in several neurodegenerative diseases has been reported, none of the studies has deliberated on the possible chance of basement membrane (BM) modification by AGEs. Pericytes have not attracted much attention in brain pathology for several years. The migratory property of pericytes due to decreased adhesion to BM has been



reported in diabetic retinopathy and in traumatic brain injury. However, how AGE-modification of BM affects brain pericytes is not known. Work on the role of AGE modification of basement membrane on brain pericyte adhesion, migration and proliferation, and the mechanisms in such changes continued. The effect of cytokines released by pericytes on AGE-modified BM was also studied.

8. Initiation of TARE project titled “Overcoming cancer drug resistance by targeting mitochondrial respiration” by Dr Mani Shankar Babu, Assistant Professor, University College, Trivandrum, under the mentorship of Dr Srinivasa Gopala on 11 November 2019.

#### *Academic activities*

#### **1. The following students successfully completed the PhD open defense:**

- Ms Karthi Raveendran on the thesis titled “Identification and characterization of endogenous glycoconjugates recognized by plasma anticarbohydrate antibodies” on 3 August 2019 (Guide: Prof Appukuttan P S).
- Ms Jessie John on the thesis titled “Modulation of tumor antigen-reactive anti-gal antibodies by lipoprotein(a) concentration and its effect on tumor susceptibility” on 11 October 2019 (Guide: Prof Appukuttan P S).
- Ms Nandini R J, on the thesis titled “Cellular and biochemical changes in type 2 Diabetes” on 16 March 2020 (Guide: Dr Srinivas Gopala).

#### **2. PhD thesis submission/colloquium:**

- Anand C R (PhD colloquium) titled “Nitric oxide-prodrug mediated molecular and bioenergetic alterations in cardiac and skeletal myoblasts in hyperglycaemia” on 21 August 2019 (Guide: Dr Srinivasa Gopala).
- Dhanya Krishnan submitted the PhD thesis titled “Shank associated RH domain interacting protein as a novel regulator of amyloid-beta mediated inflammation and phagocytosis in Alzheimer’s disease” on November 8, 2019 (Guide: Dr Srinivasa Gopala).

## **New Initiatives**

### **1. Genetics Laboratory**

The Molecular Genetics and Neuroimmunology Unit (MGNU) was inaugurated by the Hon’ble President, Dr V K Saraswat (via Skype) and the Director, Prof Asha Kishore, on 26 February 2020.

The RT-PCR machine (QuantStudio5) and Sanger sequencer (Genetic Analyser 3500) were installed and training completed. Sequencing tests were standardised and sequencing for 8 different gene mutations was performed. RT-PCR machine was used for COVID-19 testing (Figure 15).

Next Generation Sequencer (Illumina NextSeq550) was installed and standard run was completed (Figure 15).





Figure 15. Molecular Genetics laboratory and equipment. (A) Gel Documentation system, Covaris ultra Sonicator, Thermal cycler. (B) Illumina NextSeq550 (C) RT-PCR-QuantStudio5 and Sanger sequencer- Genetic Analyser 3500 (D) Molecular laboratory

## 2. COVID-19 testing laboratory

The Department was involved in establishing COVID-19 testing laboratory along with the Department of Microbiology. ICMR approved this facility and assigned the No. VRDL N114. Screening was started by collecting samples from Institute staff in quarantine. A total of 71 samples were tested as on 31 March 2020.

### Events Organized

1. One-day symposium on 'Targeting Metabolism in Non-Communicable Diseases' under the series of Biochemistry Talks was organized in Auditorium II, Hospital Wing, SCTIMST, on 2 August 2019 (Figure 16)

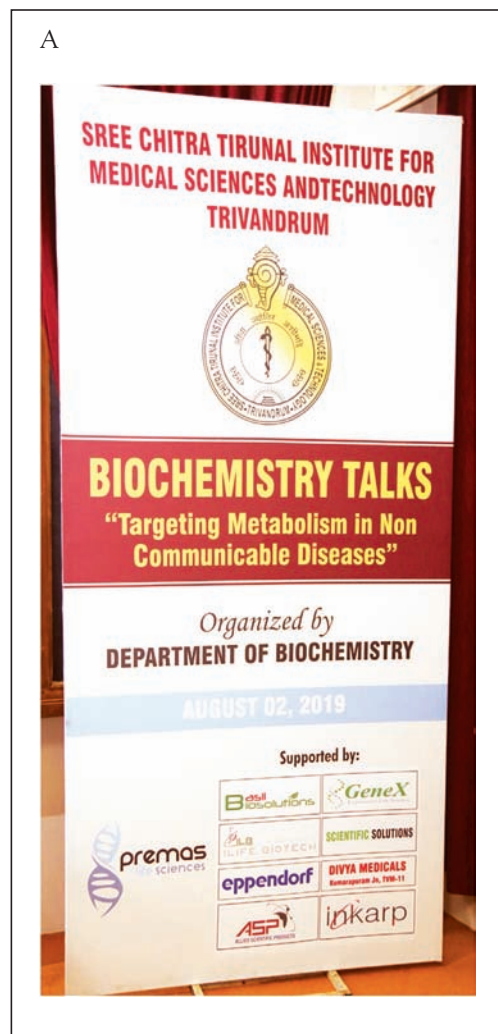






Figure 16. (A,B) Biochemistry Talks: Inauguration and lighting of the lamp by Prof Asha Kishore, Director, SCTIMST, in the presence of Dr Kavita Raja, Medical Superintendent, SCTIMST, Prof S Murthy Srinivasula, IISER, Trivandrum, Prof Manjunatha S, AIIMS, Hyderabad, Dr Abdul Jaleel K A, RGC B (C) Dr Srinivas G, Head, Biochemistry, delivering the welcome address (D) Participants of the Symposium





2. Prof Ram H Nagaraj, Professor of Ophthalmology and Pharmaceutical Sciences, University of Colorado, USA, delivered a lecture on 'Inflammation in Retinal Diseases' in Auditorium II, Hospital Wing, SCTIMST, on 10 December 2019 (Figure 17).



Figure 17 Lecture by Prof Ram H Nagaraj, Professor of Ophthalmology and Pharmaceutical Sciences, University of Colorado, USA

3. Prof Sreekumaran Nair, Professor of Medicine and Consultant in Endocrinology, Diabetes and Metabolism, Mayo Clinic, Rochester, USA, delivered a lecture on 'Consequences of Brain Insulin Resistance' in Auditorium II, Hospital Wing, SCTIMST, on 9 January 2020 (Figure 18).



Figure 18. Prof Sreekumaran Nair, Professor of Medicine and Consultant in Endocrinology, Diabetes and Metabolism, Mayo Clinic, Rochester, USA

4. Dr Rajesh C Das, Assistant Professor, Singapore University of Technology and Design delivered a talk on Studying Red Blood Cell Diseases in the Era of Technology & Design on 13 May 2019.
5. Dr Madhusoodanan U K was a Member of the Scientific Affairs Committee at the 39th Annual Conference of Indian Association for Cancer Research (IACR) organized by the Rajiv Gandhi Centre for Biotechnology from 5-7 February 2020 at Hotel Uday Samudra, Kovalam.
6. Dr Cibin T R was a Committee Member for organizing the colloquium on Integration of Yoga in Cardiac and Neurological Conditions as part of International Yoga Day 2019 on 24 June 2019 at the AMC Auditorium, SCTIMST.

### Awards and Honours

1. Dhanya Krishnan, PhD student, won Best Poster Award at the Symposium on Metabolism and Ageing on 16 July 2019, organized by the Department of Zoology, Mar Ivanios College, Trivandrum.
2. Dhanya Krishnan, PhD student, won the 2nd prize for her work in the Symposium on 'Targeting Metabolism in Non-Communicable Diseases' on 2 August 2019 at Auditorium II, Hospital Wing, SCTIMST.
3. Bhavya Bharathan, PhD student, won the 2nd prize for her work on 'Upregulation of MutT Homologue 1 in glioma: the defining role of isocitrate dehydrogenase and reactive oxygen species' in the symposium on 'Targeting Metabolism in Non-Communicable Diseases' on 2 August 2019 at Auditorium II, Hospital Wing, SCTIMST.
4. Ashok S, PhD student, won the 2nd prize for his Poster at the International Seminar on Recent Biochemical Approaches in Therapeutics (RBAT-VI) from 11-13 December 2019, organized by the Department of Biochemistry, University of Kerala.



## Staff

### Faculty

Dr Srinivas G, Scientist F and Acting Head of the Department

Dr Madhusoodanan U K, Assistant Professor

Dr Cibin T R, Assistant Professor

### Technical

Thomas T A, Scientific Officer (Lab)

Jayasree K K, Scientific Officer (Lab)

Dr Geetha M, Scientific Officer (Lab)

Vijayalekshmi L, Junior Technical Officer (Lab)

Radhakrishnan B, Junior Technical Officer (Lab)  
(until May 2019)

Sreenivas N C, Junior Technical Officer (Lab)

Sumitha KC, Technical Assistant (Lab) - B

Santhosh Kumar R, Technical Assistant (Lab) - B

Shreeja 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) - A

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 (since April 2019)

Mangalamma H R, Technical Assistant (Lab) - A  
(since November 2019)

Valsala B, Senior Unit Assistant

Shaji V, Unit Helper - A

Shamnad J, Cleaning Attendant - A



## DEPARTMENT OF CARDIOLOGY

The Department continues to offer state-of-the-art cardiac patient care services and is renowned for its academic and research programmes. The Department attracts applicants from all over India for its academic programmes - DM in Cardiology and Post-doctoral Fellowships in Adult Cardiology and Interventions, Cardiac Electrophysiology and Paediatric Cardiology. The Department also conducts post-graduate Diploma course in Cardiology Laboratory Technology. The Department continued to have one of the largest numbers of publications in scientific journals in the speciality across the country. During the year, the Department conducted several Workshops and initiated new research programmes. The sub-specialities - Adult Cardiology and Intervention, Electrophysiology and Paediatric Cardiology continued to set new benchmarks in patient care.

### Activities

#### ADULT CARDIOLOGY AND INTERVENTIONS

The Division performed around 800 coronary complex interventions such as left main interventions, rotational atherectomy and bypass graft interventions during the year. Coronary interventions were supplemented by state-of-the-art technologies like Intravascular Ultrasound (IVUS), Optical Coherence Tomography (OCT) and Fractional Flow Reserve (FFR) estimations when indicated. Additionally, Resting Flow Cycle Ratio (RFR) was initiated to assess the coronary flow reserve.

The other major specialized clinical service rendered by the Division was structural heart disease interventions. The Percutaneous Aortic Valve Programme received referrals from all major cardiac Centres in the state. Device closure of paravalvular leaks, congenital heart defects and acquired defects like ruptured sinus of Valsalva aneurysm, balloon dilatation and stenting of aortic coarctation were routinely performed. Patients with hypertrophic cardiomyopathy were referred for risk-stratification and comprehensive management by the Departments of Cardiology, Imaging Sciences and Interventional Radiology and Cardiac Surgery. The

Division performed large numbers of balloon mitral valvotomy with referrals from major cardiac Centres in South India for treatment of severe mitral stenosis in pregnancy by balloon valvotomy.

The interventions performed during the year are summarized in the Table below:

Procedure	Number
Coronary angioplasty (PCI)	647
Ad hoc - PCI	146
Coronary angiogram	975
Diagnostic cardiac catheterization	271
Balloon mitral valvotomy	64
Balloon aortic / pulmonary valvotomy	8
Transcatheter aortic valve implantation	5
ASD device closure	39
Device closure of other shunts, paravalvular leaks	10
Alcohol septal ablation	4
Other procedures	10

#### CARDIAC ELECTROPHYSIOLOGY

The Division is one of the leading Interventional Electrophysiology Centres in the country for management of cardiac arrhythmias and sudden cardiac death. The Division performed 350 ablations and electrophysiology procedures during the year, one of the largest in the country. In addition, 350 device implantations (including ICDs and cardiac resynchronization devices) were undertaken. Nearly 2000 patients were followed up in the Device Clinic. To aid complex ablation procedures, the Division continued using the 3D electro-anatomical mapping systems, CARTO 3 and Ensite Velocity. The Division conducted electro-anatomical ablation Workshops that were attended by Electrophysiologists from across the country.



The cardiac electrophysiology procedures performed during the year are summarized in the Table below:

Procedures	Number
3D electro-anatomical mapping and ablation	111
Atrial tachycardia, AF	26
Outflow tract ventricular tachycardia	31
Fascicular ventricular tachycardia	21
Scar-related ventricular tachycardia	20
Other ventricular tachycardia	13
Conventional Mapping and ablation	395
Ablation of SVT – AVNRT	118
Ablation of SVT – AVRT	71
Electrophysiological study	95
RFA	111
Device implantation	343
CRT	36
ICD	49
Pacemakers and others	258

## PAEDIATRIC CARDIOLOGY

The Division is an apex Centre for care of congenital heart diseases. Paediatric Cardiology, along with the Congenital Heart Surgery Division of Cardiac Surgery, serves as the Nodal Centre of the Hridayam Program of the Government of Kerala to support children with congenital heart diseases. The Division offered fetal echocardiography and follow up of high-risk fetuses with structural heart diseases and cardiac dysrhythmias. Device closure of atrial septal defects, ventricular septal defects, and patent arterial ducts with multi-modality imaging with minimal radiation exposure to the child were undertaken. Increased numbers of complex cardiac interventions such as implantation of BT shunt, right ventricular outflow tract stenting, closure of AV fistulae, juvenile balloon mitral valvotomy and angioplasty of the superior caval vein were performed. The Division worked in close collaboration with the Congenital Heart Surgery

Division of Cardiac Surgery for hybrid interventions, comprehensive postoperative care and long-term rehabilitation of children with complex congenital heart diseases.

The procedures performed in the Division during the year are summarized in the Table below:

Procedures	Number
Device closure of Atrial Septal Defect	166
Cardiac catheterization	129
Device closure of Patent Ductus Arteriosus	95
Balloon pulmonary valvotomy	39
Device closure of Ventricular Septal Defect	24
Patent Ductus Arteriosus stent implantation	24
Coarctation angioplasty / stent	16
Pulmonary artery angioplasty / stent	13
Balloon aortic valvotomy	11
Aorto-pulmonary collateral interventions	10
Balloon atrial septostomy	9
Others	16

### Research Programmes

The Department had ongoing extramural, intramural and industry-funded projects.

### Extramural Projects

The following extramural-funded projects were initiated/continued during the year:

1. National Centers of Advanced Research and Excellence (CARE) in Heart Failure, PI - Dr Harikrishnan S (Funded by: ICMR)

The Department of Cardiology was selected as one of the ten National Centres of Advanced Research and Excellence (CARE) in Heart Failure by ICMR, with a funding of Rs 5 Crores





in 2018-19.

During the second year of this project:

- activities to establish a National Heart Failure Biobank with state-of-the-art facilities continued
  - A genetic study on families with hypertrophic cardiomyopathy was initiated
  - A study on assessment of the economic impact of heart failure and quality of life at the national level progressed
2. The Division of Cardiac Electrophysiology 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, PI - Dr Narayanan Namboodiri K K (Funded by: ICMR)
  3. National Heart Failure Registry, PI - Dr Harikrishnan S (Funded by: ICMR)
  4. Trivandrum Heart Failure Cohort, PI - Dr Harikrishnan S (Funded by: ICMR)
  5. International Study of Comparative Health Effectiveness with Medical and Invasive Approaches, PI – Dr Ajit Kumar V K (Funded by: NHLBI, USA)
  6. Congenital heart disease for new-borns in Kerala (CHRONIK), PI - Dr Deepa S Kumar (Funded by: CSI Kerala)
  7. Trivandrum Congenital heart disease registry for newborns, PI - Dr Deepa S Kumar (Funded by: ICMR)
  8. Development of Advanced Holter Monitor with extended recording and episode detection, Co-PI – Dr Harikrishnan S (Funded by: IMPRINT Program, DST)
  9. 3D printing in congenital heart disease, Co-PI - Dr Deepa S Kumar (Funded by: DST-SERB)
  10. Effect and outcome determinants of right ventricular function in post-operative tetralogy of Fallot: A retrospective descriptive cohort study, Co-PI - Dr Deepa S Kumar (Funded by: ICMR)

11. Evaluation of intermediate-term cardiac and neurodevelopmental outcomes in children undergoing corrective arterial switch operation for complete transposition of great arteries, Co-PI - Dr Arun Gopalakrishnan (Funded by: NHM Kerala)

#### *Industry-sponsored Projects:*

1. Estimation study for reduction in transport of referral cases to tertiary hospitals by use of mobile-enabled telemedicine system in remote hospitals, PI - Dr Arun Gopalakrishnan (Funded by: Mobilexion Ltd.)
2. Prospective single arm multicenter observational registry to further validate safety and efficiency of the Ultimaster DES system, PI - Dr Bijulal S (Funded by: Terumo India Pvt. Ltd.)
3. Practical evaluation of Fractional Flow Reserve (FFR) and its associated alternate indices during routine clinical procedure pressure wire, PI - Dr Ajit Kumar V K (Funded by: St. Jude Medical India)
4. MyVal-1: A prospective multicentric single arm open label study of My ValTM, PI - Dr Ajit Kumar V K (Funded by: Meril Life Sciences)

#### *Completed Projects*

1. Influence of genetic polymorphisms in oral Vitamin K antagonist anticoagulation dose requirement in a South Indian population with prosthetic heart valves, PI - Dr Sanjay G (Funded by: Cardiological Society of India - Kerala Chapter)
2. Kerala Acute Heart Failure Registry, PI - Dr Sanjay G (Funded by: Cardiological Society of India - Kerala Chapter)
3. Pulmonary Hypertension Registry of Kerala, PI - Dr Harikrishnan S (Funded by: Cardiological Society of India - Kerala Chapter)
4. MACE Registry – Management of Acute Coronary Event Registry - First nationwide Registry of Acute Coronary Syndrome in India, Nodal Centre –SCTIMST, PI - Dr Harikrishnan S (Funded by: ICMR)



### Product Development

The following Medical Device Development projects in collaboration with BMT Wing and others continued:

1. A project for development of occlusion device for non-surgical closure of atrial septal defects was initiated by Dr Bijulal S in collaboration with the BMT Wing. The prototype of the device was developed by the Technical Research Centre for Biomedical Devices at the BMT Wing and was ready for animal studies.
2. A Titanium nitride-coated cobalt-chromium-based Coronary Stent System was under development by the BMT Wing under the guidance of Dr Harikrishnan S. The prototype of the developed stent platform demonstrated acceptable safety and performance indicators by in vitro tests.
3. A point-of-care device for estimating the biomarker, NT Pro-BNP, in patients with heart failure was under development by the BMT Wing under the guidance of Dr Harikrishnan S in collaboration with the Rajiv Gandhi Centre for Biotechnology as part of the CARE Program funded by ICMR.
4. The Department was part of the clinical evaluation of the indigenous TAVR system – MyvalTM, which was approved by the Drugs Controller General of India.
5. A Mobile App to monitor INR was developed under the guidance of Dr Harikrishnan S by Dr Jimmy Jose, NIT Calicut. The App was validated and ready for testing in patients.

### Events Organized

1. The Annual National Conference of the Interventional Cardiology Council of Kerala was organized by the Department on 10-11 August 2019 at Trivandrum. Dr Ajit Kumar V K was the Organizing Chairman and Dr Harikrishnan S was the Organizing Secretary.
2. 'Back to Basics 2020' - a simulator-based training programme on basics of cardiac interventions was conducted on 1- 2 February 2020 at SCTIMST. It was attended by 150 DM trainees and 50 Faculty

from all over India.

3. Congenital Heart Disease Awareness Week was organized from 7-14 February 2020 by the Department of Cardiology in collaboration with the Department of Cardiovascular and Thoracic Surgery.
4. A CME on Duct Dependent Congenital Heart Diseases in the newborn was organized on 14 February 2020 at SCTIMST by the Departments of Cardiology, Cardiovascular and Thoracic Surgery and Nursing Division.

### Awards and Honours

1. Dr Harikrishnan S was awarded the Amrut Mody Unichem Prize (2018) by the Indian Council of Medical Research for Excellence in Research in the field of Cardiology and Heart Failure. The award was conferred by Dr Harsh Vardhan, Hon'ble Minister of Health and Family Welfare, Science and Technology, Earth Sciences on 16 October 2019 at New Delhi.
2. Dr Harikrishnan S received the Excellence in Publication Award (2019) by SHFT - Society for Heart Failure and Transplantation on 23 August 2019 at Mumbai.
3. Dr Harikrishnan S was elected President of the Heart Failure Association of India in 2019.
4. Dr Harikrishnan S served as Associate Editor of the International Journal of Epidemiology (Oxford University Press).
5. Drs Ajitkumar V K and Harikrishnan S continued to serve in the Expert Group in Materiovigilance Program of the Indian Pharmacopoeia Commission.
6. Dr Krishnamoorthy K M was awarded the Golden Case Award at the 3rd National Heart Failure Conference in July 2019 at Kochi.
7. Dr Abhilash S P took up a Fellowship in Cardiac Electrophysiology at the Canberra Hospital, Australia, since August 2019.
8. Dr Deepa S Kumar received the Commonwealth Fellowship in "Interventional rehabilitation of RVOT and branch pulmonary arteries" - 1 May - 31 October 2019.



9. Dr Vijayan G, Senior Resident, secured the 1st prize in the Best Case Award category at the 26th Annual Conference of the Indian College of Cardiology at Kochi.
10. Dr Manish Ganwani, Senior Resident, secured the 3rd prize in the Best Case Award category at the 26th Annual Conference of the Indian College of Cardiology at Kochi.
11. Drs Vijayan G, Harikrishnan K N and Manish Ganwani, Senior Residents, won the 3rd prize in the Cardiology Quiz at the 26th Annual Conference of the Indian College of Cardiology at Kochi.
12. Dr Vijayan G, Senior Resident, secured the 1st prize in the Best Paper category at the Annual Conference of the Interventional Cardiology Council of Kerala, ICCCK 2019 at Kovalam, Trivandrum.
13. Drs Karthik R and Nandhini M, Senior Residents, secured the 1st prize in the Challenging Cases category at the 3rd National Heart Failure Conference of the Cardiological Society of India (CSI) at Kochi.
14. Dr Nandhini M, Senior Resident, received the Best Paper Award at the Summer Conference of the Cardiological Society of India (CSI) - Kerala Chapter at Calicut
15. Drs Harikrishnan K N and Vijayan G, Senior Residents, won the 1st prize in the Cardiology Quiz at the 3rd National Heart Failure Conference of the Cardiological Society of India (CSI) at Kochi.

## Staff

### Faculty

Dr Ajit Kumar V K, Professor (Senior Grade) and Head of the Department (until 31-08-2019)

Dr Sivasankaran S, Professor (Senior Grade) and Head of the Department (from 01-09-2019)

Dr Krishnamoorthy K M, Professor

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 (on study leave)

Dr Krishna Kumar M, Associate Professor

Dr Deepa S Kumar, Associate Professor

Dr Arun Gopalakrishnan, Assistant Professor

Dr Mukund A Prabhu, Assistant Professor

Dr Kartik Sambaturu, Assistant Professor

### Technical

Mr Suji K, 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 3 Divisions - Adult Cardiac, Paediatric Cardiac and Thoracic-Vascular. The Adult Cardiac Surgical Division performed complex cardiac surgeries along with minimally invasive procedures and complex valve repair procedures. The Division of Paediatric Cardiac Surgery continued its neonatal and infant complex surgical programmes. The Department initiated the Minimal Access Cardiac Surgery Programme during the year.

### Activities

1729 primary cardiovascular and thoracic surgeries and more than 300 follow-up minor procedures were performed during the year. This included 866 adult cardiac surgeries, 655 paediatric cardiac surgeries and 208 thoracic and vascular surgeries (Figure 19).

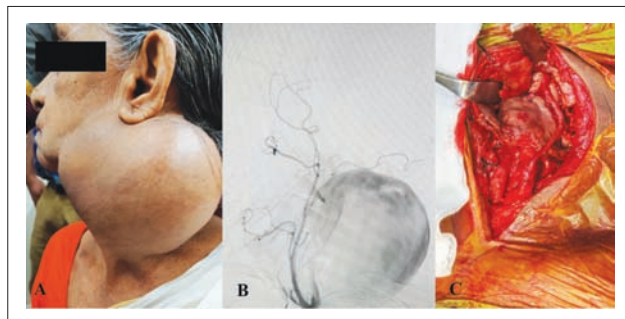


Figure 19. (A) 65 years old lady with large pulsatile swelling on the left side of the neck, (B) imaging suggestive of large internal carotid artery aneurysm, (C) aneurysm repaired with saphenous vein graft and patient recovered completely

The Division of Vascular Surgery performed 58 aortic aneurysm surgeries, including open and hybrid repair in 2019-20, the highest among the Vascular Centres in the country. The Department continued to regularly perform minimally invasive valve replacements (Figure 20) and completed over 100 homograft implantations.



Figure 20. Minimally invasive valve replacement

### Research Programmes

The Department had ongoing extramural, intramural and industry-funded projects.

#### Extramural Projects:

The following extramural-funded projects were initiated/continued during the year:

1. Effect and outcome determinants of right ventricular function in post-operative Tetralogy of Fallot: a retrospective descriptive cohort study. This will be the largest follow-up study of surgically-treated Tetralogy of Fallot patients in the world and aims to determine the factors influencing right ventricular function in the long-term so that optimal surgical strategies can be postulated, PI – Dr Baiju S Dharan (Funded by: ICMR).





2. Role of 3D printing in congenital heart disease, Co-PIs - Dr Baiju S Dharan & Dr Sabarinath Menon (Funded by: DST-SERB)

#### *Industry-sponsored*

1. Tichval 2 Pilot Study for TTK Chitra, PI - Dr Jayakumar K (Funded by: TTK)

#### *Completed Projects*

The Pilot Project on neurodevelopmental outcomes of arterial switch operation, funded by the National Health Mission (P5367), was the first study from the developing world on the assessment of neurodevelopmental outcome following correction of complex congenital heart disease. The study showed excellent cardiovascular outcomes and good functional quality of life. However, nearly one fourth of these children had some form of neurodevelopmental disorder, most of which were mild. PI - Dr Baiju S Dharan

#### *Product Development*

The following Medical Device Development Projects in collaboration with BMT Wing and others continued:

1. The 1st stage of the project on prevention of post-surgical adhesion using alginate dialdehyde-gelatin hydrogel was completed. The results from the small animal study were encouraging, and the project was extended for further assessment before use in patients to prevent surgical adhesions in staged cardiac surgery, PI - Dr Soumya Ramanan (Funded by: TDF, SCTIMST).
2. The project to develop a suction retractor device for aortic valve surgery that would aid in the visualisation of the valve during its repair or replacement continued, PI - Dr Bineesh K R (Funded by: TDF, SCTIMST).
3. Multi-layered warp-knitted polyester in strengthening valve annulus after valve repair, PI - Dr Varghese T Panicker (Funded by: TDF, SCTIMST).
4. Centrifugal blood pump with blood flow meter, PI - Dr Vivek Pillai (Funded by: TRC, SCTIMST)
5. Mitral annuloplasty system, PI - Dr Vivek Pillai (Funded by: TRC, SCTIMST)

6. Left Ventricular Assist Device, PI - Dr Jayakumar K (Funded by: TRC, SCTIMST)
7. Bioprosthetic heart valve, PI - Dr Jayakumar K (Funded by: TRC, SCTIMST). 3 animal trials were performed under the project during the year.
8. Reconstruction geometry optimization and methodology development using computational fluid dynamics evaluation for patient-specific vascular model acquired by MRI scanning, Co-PI: Dr Sudip Dutta Barua (Funded by: TDF, SCTIMST)
9. Initiated discussions with IIT, Palakkad to develop a high frequency ultrasound probe for intra-operative visualisation of epicardial coronaries. This would be helpful in intra-operative identification of the best place to suture a graft and also in re-operations where the course of the coronary arteries is not evident.

#### **New Initiatives**

1. The Department started Congenital Heart Surgery Programme at the Government Medical College, Kozhikode, as per MoU with the Government of Kerala. The team performed 21 complex congenital heart surgeries successfully during four visits.
2. Commencement of clinical trials for new generation Chitra valve (Tichval 2)
3. Minimal Access Cardiac Surgery (MICS) Programme was started.

#### **Events Organized**

1. The Department organized a CME on Congenital Heart Disease in May 2019 with faculty from Australia and UK.
2. Conducted a Workshop on Ozaki repair of aortic valve with Dr. Sivakumar Sivalingam from the National Heart Institute, Malaysia, on 27 September 2019.
3. Conducted a Workshop on Minimal Access Cardiac Surgery on 18 October 2019.

#### **Awards and Honours**

1. Dr Baiju S Dharan was Member of the Task Force for creating national guidelines for treatment of



congenital heart disease.

2. Dr Vivek V Pillai was appointed by MCI as an assessor for initiation of MCh CVTS Course at various medical colleges in India.

### **Staff**

### **Faculty**

Dr Baiju S Dharan, Professor and Head of the Department

Dr K Jayakumar, 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, Assistant Professor

Dr P Shivanesan, Assistant Professor

Dr.Renjith. S, Assistant Professor

### **Technical**

Ms Beegum Thaslim, Junior Scientific Officer

Ms Maya L, Perfusionist - B

Mr Sujith V M, Perfusionist - B

Mr Don Sebastian, Perfusionist - A

Mr Shanu P S, Perfusionist - A

Mr Rijesh S R, Perfusionist - A

Mr Sujesh S, Perfusionist - A

### **Transplant Co-ordinator**

Ms Beena B Pillai, Transplant Co-ordinator - A



## DIVISION OF CLINICAL ENGINEERING

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

### Activities

The Division ensured proper equipment management by promoting the use of standard-based approach that imparts 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 all staff of the Institute. DCE assessed the need for regular technical support of medical equipment and strategy for appropriate calibration, inspection, maintenance, and repair services.

Clinical Engineers in the role of 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, service equipment, 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 Section 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, pre-commissioning activities of 60kWp solar power plant in institute rooftop and electrical work in the up-gradation of MRI and CT.

During the year, the Division extended its service to the Institute by successfully managing more than 12000 work requests registered through the computerized complaint-management system. This included testing and certification of the newly- installed equipment, maintenance and repair of the existing equipment and infrastructure facilities and modification of electrical and air-conditioning systems. The Division also monitored and documented the activities of company service engineers that were executed during warranty and service contracts period.

The work requests managed are summarized in the Table below:

Subdivision	Complaints attended
Air Conditioning	928
Communication	725
Electrical	1897
Electronics	4915
Mechanical / Fitting	1822
Medical Gas Line	563
Office Equipment	68
<b>Total</b>	<b>10918</b>

### New Equipment Installations

Sl. No.	Equipment	Approximate Cost
1.	Philips EPIQ 7C Echocardiography System	Rs 10459770
2	Transcranial Doppler	Rs 1478400
3	Applied Biosystems 3500 Genetic Analyzer	Rs 8487376.41
4	Xtra Continuous Auto Transfusion System	Rs 2827440
5	Polaris 600/600 double dome OT light with accessories	Rs 1225917



6	Echocardiography System, highend portable, Philips CX50	Rs 7900000
7	8 Channel EMG/NCV/EP System	Rs 3260960
8	Illumina Next Seq 550 Next Gen Sequencer	Rs 17423715.92
9	Cath Lab System	Rs 36580368
10	Volista Surgical Light	Rs 2464000
11	Covaris M220 Focused-Ultrasonicator, for DNA shearing	Rs 1957234.59
12	Quant Studio 5 Real Time PCR System	Rs 1689763.59
13	Maxi Move Mobile Passive Lifter	Rs 2718045
14	Automated Motorized Combilizer	Rs 1205130
15	Curve Navigation Station - Mobile	Rs 26339943.39
16	Dell T5820 (Ris-Pacs Workstation)	Rs 314670.04
17	Bodytom 32 Slice CT Scanner	Rs 67191900
18	Anaesthesia Machine	Rs 3929040
19	G:Box Chemi XRQ Gel Documentation System	Rs 1053405
20	Terumo Blood Cell Separator	Rs 1811040
21	Movement Therapy Static Cycle	Rs 1032080
22	Hydrasys 2 Scan Iso Focussing	Rs 1993610
23	Air Handling Unit – 4 numbers	Rs 3192218.6
24	Bed for ICU use (fully motorized) - 21 numbers	Rs 1237782.24
25	DFM100 Defibrillator Biphasic / Monitor - 2 numbers	Rs 1176000

26	Intellivue MX550 Multiparameter Monitor - 2 numbers	Rs 1380000
27	Upright Freezer Cryocube F570	Rs 1278690
28	Dominant Flex Surgical Suction Pump	Rs 1347536.4
29	NVR CP-UNR-4K532R8-V2, Video Management	Rs 1690699.28
30	BK5000 Ultrasound ECHO Machine	Rs 5310747

### Research Programmes

The Division was involved in the following projects:

1. Development of portable low-cost disposable defibrillator for cardiac arrest management, Co-PI: Manoj G S (Funded by: DST)
2. Development of autonomic function monitor based on combined heart rate variability (HRV) & galvanic skin conductance, Co-PI: Manoj G S (Funded by: TDF, SCTIMST)

### Others

1. More than 14 students completed internship in the Division.
2. Faculty actively participated in the MTech Programme in Clinical Engineering.
3. Around 20 numbers of apprentices with BTech, Diploma and ITI qualifications were trained in the Biomedical, Electrical and Mechanical Divisions of DCE.
4. The Division was actively involved in the COVID19 preparedness and modified the wards, ICUs, AHUs, OTs, Imaging facilities (CT, ECHO room), and so on with infection control guidelines.
5. The Division provided technical support to many government institutions in Trivandrum, including RCC, Rajiv Gandhi Centre for Biotechnology, CDC, Kerala State Council for Science, Technology and Environment.





### New Initiatives

1. DCE was actively involved in the planning and designing 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 for the new hospital. The detailed layout of facilities like Modular OTs, X-Ray facility, Cath Lab, MRI, CT, ICU (main and step down), Pneumatic chute, wards, OPD, Speciality Labs, CSSD, dietary, laundry, and details of medical equipment and furniture were prepared for the proposed hospital block with the help of consultants and CPWD. Layout for managing patients and material movement was also prepared with the help of M/s. STAT hospital infection control.
2. Positive pressure air-conditioning systems with HEPA filters were installed in all operation theatres for better infection control.
3. New facilities like Genetics lab, 1.5 T MRI, new Cath Lab, were commissioned.
4. Installation of the new mobile CT was completed.
5. Completed all work related to 60KW solar power plant.
6. Initiated the work for replacing the old air compressor system.
7. Initiated the planning and tendering process of Liquid Oxygen System.
8. Prepared the technical specifications and started the tendering process for the procurement of 120 Crore worth medical equipment for the new hospital building.

### Events Organized

1. "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 16 Workshops, the details of which are provided below:

Title and theme of the event	Date and venue	Organizers/ Co-organizers
HEATS-42 - Portable Color Doppler	24 April 2019, Cardiology Department	DCE in association with Esaote India (NS) Ltd.
HEATS-43- Hydrasys 2 scan ISO Focussing	15 May 2019, Pathology Department	DCE in association with Trivitron Healthcare Pvt. Ltd.
HEATS-44- Bodytom 32 slice CT Scanner	30 May 2019, Neurosurgery Department	DCE in association with Schiller Healthcare India Pvt. Ltd.
HEATS-45- Anaesthesia Machine	01 June 2019, Paediatric OT	DCE in association with Drager Medical (India) Pvt. Ltd.
HEATS-46- Movement Therapy Static Cycle	25 June 2019, Physical Medicine & Rehabilitation Department	DCE in association with Hospimedica International Pvt. Ltd.
HEATS- 47- Philips HD5 Echocardiography System	18 July 2019, Cardiology Department	DCE in association with Philips India
HEATS- 48-Xtra Continuous Auto Transfusion System	03 August 2019, Department of CVTS	DCE in association with Medibright Associates
HEATS-49- Echocardiography System high end portable, Philips CX50	21 September 2019, Cardiology Department & CS ICU	DCE in association with Anamdev Engineers & Philips India



HEATS- 50- Quant Studio 5 Real Time PCR System	30 September 2019, Biochemistry	DCE in association with Invitrogen Bioservice India Ltd.
HEATS- 51- Training class on ventilator operation and maintenance arranged for nursing staff	03 December 2019, Auditorium-2	DCE in association with Getinge Healthcare
HEATS- 52- Curve Navigation Station-Mobile	04 December 2019, Neurosurgery Department	DCE in association with Champak Enterprises & Brain Lab
HEATS- 53- Maximove Mobile Passive Lifter	09 December 2019, Neurosurgery Ward & Neuro OT	DCE in association with Axis Healthcare
HEATS-54 - Cath Lab System	14 January 2020, Cardiology Department	DCE in association with Philips India
HEATS- 55- DFM100 Defibrillator Biphasic / Monitor	01 January 2020, Cardiac OT	DCE in association with Anamdev Engineers
HEATS- 56- Covaris M220 focused- ultrasonicator	30 January 2020, Biochemistry Department	DCE in association with Premas Life Sciences Pvt. Ltd.
HEATS- 57- OT light	14 February 2020, Paediatric OT	DCE in association with Champak Enterprises

- The Division conducted a Workshop on Air Circuit Breaker operation and maintenance in association with the OEM of ACB, M/s Larsen & Toubro (Figure 21).



Figure 21. Workshop on Air Circuit Breaker operation and maintenance



### Staff

Mr Shaj Upendran, Engineer F and Acting Head

Mr Manoj G S, Engineer C

Mr Anoop Jose, Engineer C

Mr Vishal V P, Engineer B

Mrs Neelima Muraleedharan, Engineer B

Mr Ganesh P, Assistant Engineer (Electrical)



## DIVISION OF CELLULAR AND MOLECULAR CARDIOLOGY

The Division of Cellular and Molecular Cardiology focuses on basic and translational research in the area of cardiovascular biology. The current focus is on key molecular regulators of myocardial tissue response to injury and remodelling that could be therapeutically targeted to prevent or delay the initiation and progression of heart failure. During the past year, the Division provided guidance to 4 PhD students and the Principal Investigator of a DST-supported project under the Women Scientists' Scheme (Wos-A). One student was awarded PhD during the year. The Division initiated collaborative research with other departments of the Institute and the collaboration with the Laboratory of Cardiovascular Science, NIA/NIH, USA, and the UCSD, USA, resulted in 2 major publications.

### Activities

#### *Research Activities*

The Division carried forward the ongoing work on molecular mechanisms underlying cardiac fibroblast growth. The ability to undergo phenotypic transformation into active myofibroblasts, proliferate and produce collagen is central to the role of cardiac fibroblasts in myocardial tissue response to injury. Further, unlike cardiac myocytes, cardiac fibroblasts are relatively resistant to pro-apoptotic stimuli that prevail in the injured myocardium and tend to persist in the infarct scar long after the healing response is completed, which leads to excessive collagen deposition and tissue fibrosis, compromising cardiac function. Exploration of mechanisms underlying these aspects of cardiac fibroblast biology is therefore of considerable scientific and clinical interest. Work done during 2018-19 had conclusively demonstrated the obligate role of Discoidin Domain Receptor 2 (DDR2), a collagen-specific receptor tyrosine kinase, in the phenotypic transformation of cardiac fibroblasts into myofibroblasts and in collagen gene expression in response to Angiotensin II, which is a potent regulator of cardiac fibroblast growth and function in a setting

of cardiac injury. The findings were published in the Journal of Biological Chemistry in early 2020.

During the year, the laboratory focused on the indispensable role of DDR2 in the relative resistance of cardiac fibroblasts to apoptosis and cell cycle progression in cardiac fibroblasts.

#### **1. DDR2 and apoptosis resistance**

Gene knockdown and over-expression approaches, electrophoretic mobility shift assay and promoter binding assay showed that DDR2 acts via ERK1/2 MAPK-activated SRF (Serum Response Factor) transcription factor to enhance the expression of anti-apoptotic cIAP2 in cardiac fibroblasts. Several lines of evidence also showed that Angiotensin II, produced in response to oxidative stress, induces cIAP2 expression in these cells to protect them against oxidative damage. The observations are important insofar as they explain how cardiac fibroblasts resist the hostile ambience of the injured myocardium, which promotes myocyte death, to play a role in wound healing in the short-term but persist in the infarct scar long healing, which is detrimental in the long-term.

#### **2. DDR2 and cell cycle progression**

DDR2 was found to act via ERK1/2 MAPK-activated SRF to transcriptionally up-regulate Skp2 that in turn facilitated post-translational degradation of p27, the cyclin-dependent kinase inhibitor that causes cell cycle arrest, to promote G1-S transition, as revealed by Rb phosphorylation, increased PCNA levels and flow cytometry. DDR2-dependent ERK1/2 MAPK activation also prevented FoxO3a binding to the p27 gene promoter, resulting in the transcriptional repression of p27 (Figure 22). Together, the data demonstrate conclusively for the first time that cardiac fibroblasts exploit a common regulatory mechanism involving DDR2-dependent activation of ERK1/2 MAPK and SRF to achieve co-ordinated regulation of cell survival and cell cycle progression, which would facilitate their critical function in the injured myocardium. Notably, DDR2 levels were found to



positively correlate with SRF, cIAP2 and PCNA levels in cardiac fibroblasts from Spontaneously Hypertensive Rats. These findings were accepted for publication in the American Journal of Physiology – Heart and Circulatory Physiology.

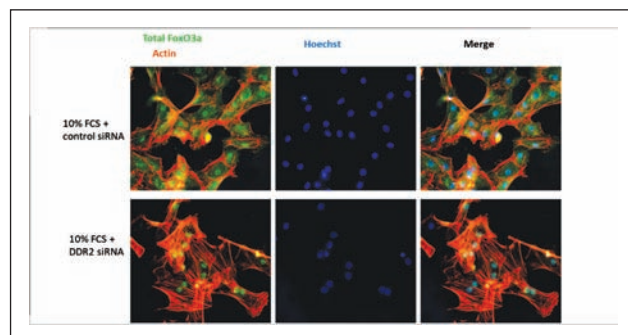


Figure 22. Immunocytochemistry for Total FoxO3a/actin. The Figure shows Total FoxO3a stained by Alexa 488 (Green) and Actin counterstained by phalloidin-rhodamine (Red). Nucleus is stained with Hoechst (Blue). DDR2 siRNA-treated cells show all nuclear staining for FoxO3a.

The following schematic representation (Figure 23) of the plausible molecular events that integrate multiple pathways under the regulatory control of DDR2 in cardiac fibroblasts, as delineated by this laboratory, indicates that DDR2 is a “master switch” that can profoundly impact myocardial tissue response to injury. Because of its predominant localization in fibroblasts in the heart, DDR2 holds promise as a drug target to control adverse myocardial remedial following cardiac injury.

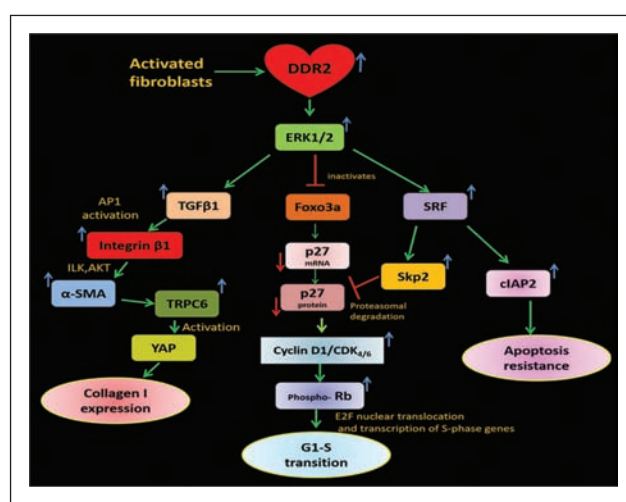


Figure 23. Schematic representation of plausible molecular events that integrate multiple pathways under the regulatory control of DDR2 in cardiac fibroblasts

3. Investigations carried out in collaboration with the NIH, USA, demonstrated the role of DDR2 in arterial fibrosis in a rhesus monkey model of metabolic syndrome and the results were published jointly.

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

Cardiovascular conditions such as cardiac fibrosis, cardiomyopathies and vascular fibrosis disturb the quantitative relationship between the cellular components and the extracellular matrix (ECM), compromising function. In this regard, it has been shown that periostin plays a critical role in cardiovascular tissue response to mechanical stress and injury. Surprisingly, the mechanisms by which periostin regulates the pathophysiological changes following injury, and how periostin itself is regulated in cardiac fibroblasts, are not adequately explored. Studies carried out in the laboratory during the year indicated elevated expression of periostin in response to Angiotensin II, a potent pro-fibrotic factor, in cardiac fibroblasts. Notably, preliminary investigations also pointed to the existence of a reciprocal regulatory relationship between DDR2 and periostin.

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

Conditions such as heart failure and atrial fibrillation, which are associated with altered activity of cardiac fibroblasts, are marked by significant variations in the distribution of the gap junction protein, connexin 43 (Cx43). Given the link between myocardial fibrosis and abnormalities in cardiac conduction, and the role of Cx43 in both of these, it is important to understand the role of Cx43 in the regulation of cardiac fibroblast function and cardiac fibrosis. Regulation of Cx43 in fibroblasts and Cx43-mediated regulation of collagen gene expression and microRNAs in cardiac fibroblasts remain largely unexplored despite the obvious importance of such mechanisms in fibroblast response to myocardial injury. Experiments were initiated during the year to explore whether Cx43 is under the regulatory control of DDR2 and is a key player in the DDR2-collagen axis in cardiac fibroblasts.



## **6. Regulation of progenitor cell function in the heart by Angiotensin II**

Angiotensin II, whose intracardiac levels are elevated following myocardial infarction, induces myocyte apoptosis and tissue fibrosis, and Angiotensin II inhibitors protect the injured heart. The laboratory continued to explore whether Angiotensin II induces cardiac progenitor cell apoptosis and impairs their cardioprotective paracrine function. The dose- and time-dependent effects of Angiotensin II on apoptotic status of c-kit positive cardiac progenitor cells were investigated during the year.

### **New Initiatives**

Dr Neethu Mohan initiated collaborative research with the Department of Pathology on the 'Role of connexins in cardiac fibroblast phenotypic transformation and extracellular matrix synthesis in cardiac diseases'.

### **Awards and Honours**

Dr Shivakumar was invited to deliver a talk at the Basic Cardiovascular Sciences Meeting of the

American Heart Association from July 29 to August 1 2019, in Boston, USA.

### **Staff**

#### **Faculty**

Dr K Shivakumar, Scientist G (Senior Grade) and Head of the Department (till 30-11-2019)

Dr Neethu Mohan, Scientist D and Acting Head (since 1-12-2019)

#### **Technical**

Ms Remani K, Junior Technical Officer (Laboratory)

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



## COMPUTER DIVISION

The Computer Division supports the functions of different Departments of the Institute.

### Activities

1. Maintenance of online softwares
2. Development of new Forms and Reports
3. Maintenance, updating and new development of the institutional Websites (Intranet, Internet)
4. Network monitoring, management, maintenance and new cabling work
5. Tuning and backup activities and maintenance of higher end Servers (18)
6. Tender publishing and online recruitment of staff and students
7. Updating and maintenance of all Portals such as Blood Donor, Vendor, Pension, CSC, Patient, DSpace, e-learning
8. OMR-based evaluation, form changes for recruitment (SSC,JSC), managing academic admissions
9. Report generation for Auditors, IT Committee and DST
10. Hardware and software maintenance of servers, storage, PCs, routers, switches, scanners, printers etc. with a remarkable uptime of 99.98% (Total 1625 devices)
11. Monitoring of Data Centre, management of Servers, storage and network
12. Data backup, maintenance of data, network security
13. Monitoring e-payment status
14. Monitoring of medical equipment integrated to EMR
15. Training for Apprentices, Staff and students
16. General help to staff and students on IT-related issues

### Research Programmes

Completed the Project - Develop a value-based e-delivery system for health care management and research, PI – Dr Geetha G (Funded by: Ministry of Electronics and Information Technology, Government of India)

### New Initiatives

1. Implemented LAN-based Surveillance System by connecting 30 cameras and 2 NVR. Installed 2 viewing stations for Security Officer and Assistant Security Officer.
2. Implemented Web-based Picture Archival System (PACS) with integration to Electronic Medical Records
3. Launched the software for recording the Cardiology Device Therapy Data in the Pacemaker Clinic with online view in Electronic Medical Records
4. Launched RTI website covering all concerned sections in detail
5. Launched websites for Technology Transfer of Products and Industry - Institute Partnership Cell
6. Implemented ICD-10 for coding medical diagnosis
7. Launched Student Portal for all students
8. Implemented software for Code Blue monitoring
9. Configured SAN switches for BMT Wing storage connectivity
10. Configured new domain controllers for user authentication
11. Developed software for Pulse Wave volume measurement and a Java app for assessing writer's cramp disease
12. Implemented e-tender for procurement in Pharmacy
13. Implemented software for Radiology Badge monitoring with SMS option



14. Implemented the new income group patient classification and emergency patient care system
15. Developed software for Hospital Queue Management System
16. Implemented Toughbook 7, rugged portable tablets for patient care
17. Created a new set-up for ISRO Telemedicine Service
18. Launched website for publishing activities related to COVID-19

#### **Awards and Honours**

Dr Geetha G was selected to the Board of Studies, Computational Biology and Bioinformatics, University of Kerala for 3 years from January 2020.

#### **Events Organized**

The Computer Division, in collaboration with the Division of Academic Affairs and SPSS India, organized a training session on SPSS Statistical

Package on 20 July 2019.

#### **Staff**

Dr Geetha G, Scientist G

Mr Suresh Kumar B, Engineer E

Mr Rejith L R, Programmer - B

Mr Saji K S, Programmer - A

Mr Manoj M, Technical Assistant (Computer Programmer) - B

Mr Anish R, Technical Assistant (Computer Programmer) - B

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

Ms Haseena L, Technical Assistant (Computer Programmer) - A





## DEPARTMENT OF IMAGING SCIENCES AND INTERVENTIONAL RADIOLOGY

The Department of Imaging Sciences and Interventional Radiology (IS&IR) offers diagnostic and interventional procedures in neurological and cardiovascular diseases. Diagnostic services include Magnetic Resonance Imaging (MRI 1.5 and 3T), Computed Tomography, ultrasound and X-ray studies. Interventional Radiology Facility of the Department is involved in the management of peripheral and neurovascular minimally invasive procedures. It is equipped with biplane and single plane DSA systems for neuro and non-neuro interventional procedures. The Neuro Intervention Centre (NIC) and the General Medical Ward are the inpatient management facilities under IS&IR. The Neuro Intervention Centre was started in 2012 as a dedicated ICU facility for managing patients with neuro vascular disorders. Strict quality management practices and multidisciplinary approach have contributed significantly to improving patient management and helped keep morbidity and mortality consistently below 1% (0.4% in 2019-20).

### Activities

#### Clinical Activities

The statistics for the Department during the year are summarized in the Table below and in Figures 24-29.

Procedure	Number
MRI	4941
CT	5064
Ultrasound	4142
X-Ray	35188

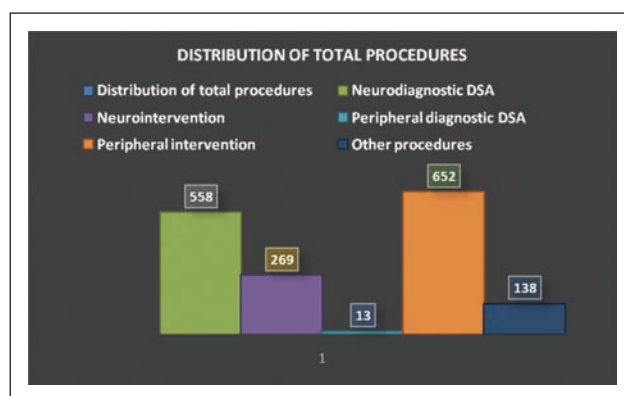


Figure 24. Distribution of total procedures in 2019-20

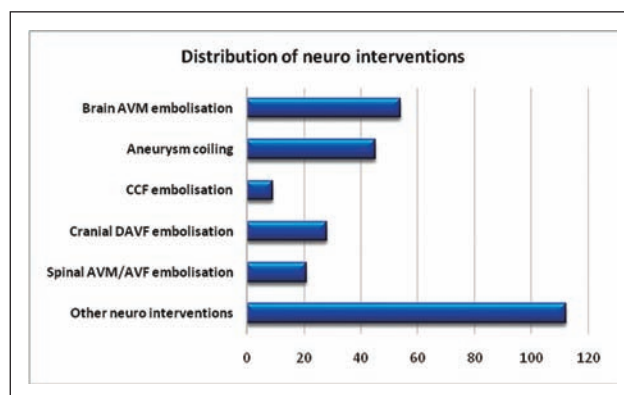


Figure 25. Distribution of neuro-intervention procedures in 2019-20

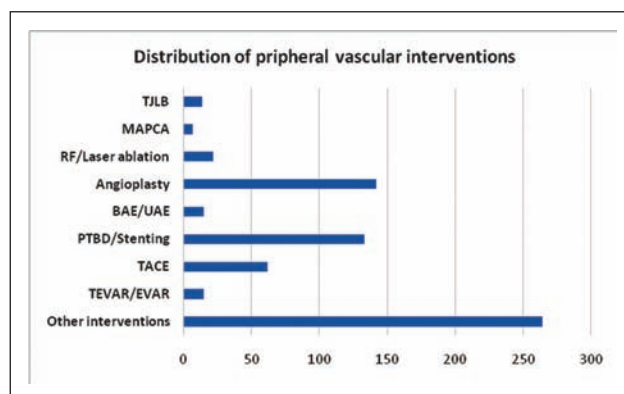


Figure 26. Distribution of peripheral vascular procedures in 2019-20

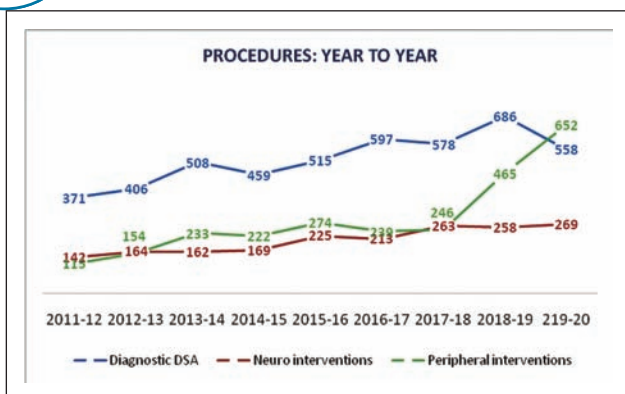


Figure 27. Trend of procedures in the Department from 2011-12 to 2019-20

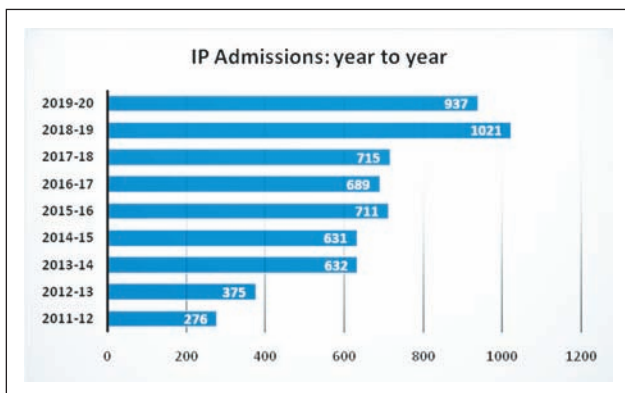


Figure 28. Inpatient admissions in the Department from 2011-12 to 2019-20

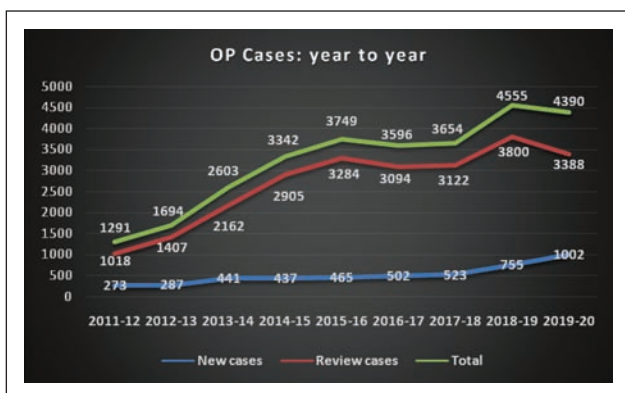


Figure 29. Trend of outpatient visits in the Department from 2011-12 to 2019-20

The Department upgraded Siemens 1.5T MRI to Avanto 1.5T MRI at a cost of 7.883 Crores (Figure 30).



Figure 30. Avanto 1.5T MRI

### Research Programmes

The Department had several ongoing extramural, intramural and industry-funded projects.

### Extramural Projects

The following extramural-funded projects continued:

1. Virtual reality-based solution for effective neuroanatomy teaching, PI – Dr Kesavadas C (Funded by: DST-SERB)
2. 3D printing in congenital heart diseases (Figure 31), PI - Dr Anoop A (Funded by: DST-SERB)
3. 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 (Funded by: CSIR-DST)

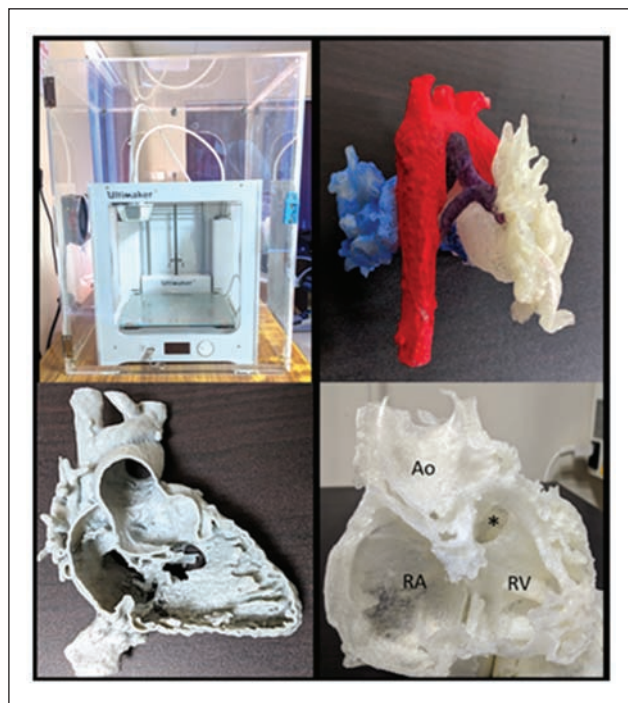


Figure 31. 3D printing in congenital heart diseases

### Product Development

The following Medical Device Development projects in collaboration with BMT Wing continued:

1. Role of resting state functional magnetic resonance imaging in intracranial dural arteriovenous fistula patients, PI - Dr Bejoy Thomas (Funded by: TDF, SCTIMST)
2. Development of a prototype Flow Diversion Intracranial Stent for the treatment of complex intracranial aneurysms, PI - Dr Santhosh K (Funded by: TDF, SCTIMST)
3. Development of novel prototype Mechanical Clot Retriever for the treatment of acute cerebral ischemic stroke, PI - Dr Santhosh K (Funded by: DBT)
4. Radiopaque liquid embolization device by chemical grafting of iodinated compounds onto the ethylene vinyl alcohol co-polymer, PI - Dr Jayadevan E R (Funded by: TRC, SCTIMST)
5. Development of Aortic Stent Graft for treatment of thoracic aortic aneurysms, PI - Dr Jayadevan E R (Funded by: TRC, SCTIMST)
6. Assessment of carotid plaque vulnerability

using 3T MRI & correlation with carotid endarterectomy, PI - Dr Anoop A (Funded by: TDF, SCTIMST)

7. CEUS in diabetic peripheral arterial disease, PI - Dr Anoop A (Funded by: TDF, SCTIMST)
8. Role of IVIM in HCC, PI - Dr Jineesh, (Funded by: TDF, SCTIMST)

### Research Projects in collaboration with other institutions

Dr C Kesavadas, Professor, had research collaboration with the following academic institutions:

1. National Institute of Technology, Surathkal, Karnataka, Collaborator: Dr Jeny Rajan

Topic: Automatic detection and quantification of Focal Cortical Dysplasia regions from Magnetic Resonance brain images using machine learning techniques Machine learning for cortical dysplasia (Funded by: DST)

2. IIITMK, Trivandrum, Collaborator: Dr Joseph Paul

Topic: Quantitative Evaluation of BOLD Changes with Accelerated SWAN imaging: Implications to Filtering and Reconstruction (Funded by: ICMR)

3. BITS- Pilani, Hyderabad, Collaborator: Dr Venkateswaran Rajagopalan

Topic: MRI-based non-invasive quantitative biomarker for early diagnosis and prognosis of brain tumor (Funded by: DBT)

### New Initiatives

1. New procedures performed in Neuro intervention:

- Surpass streamline flow diverter used for managing complex intra cranial aneurysm

2. New procedures performed in peripheral intervention:

- Fenestrated TEVAR (Figure 32)
- Branch fenestrated EVAR (Figure 33)
- Percutaneous treatment of endoleak by direct sac puncture
- Prostatic artery embolization for benign



prostatic hyperplasia (Figure 34)

- AV Fistula – declotting
- Total pedal arch arterial reconstruction
- Emergency Direct portosystemic shunt
- Thoracic duct embolization for chylous pleural effusion (Figure 35)

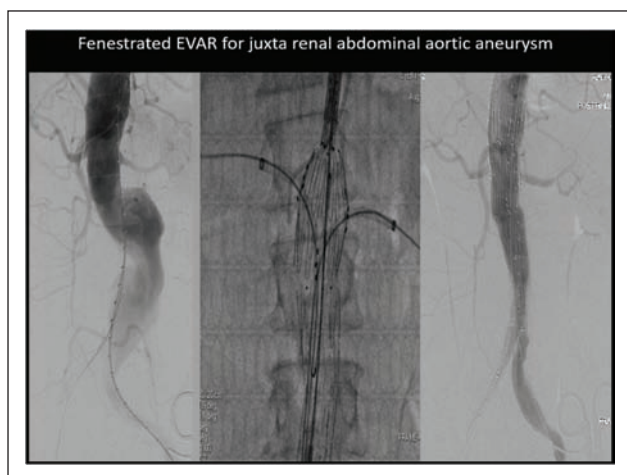


Figure 32. Fenestrated TEVAR

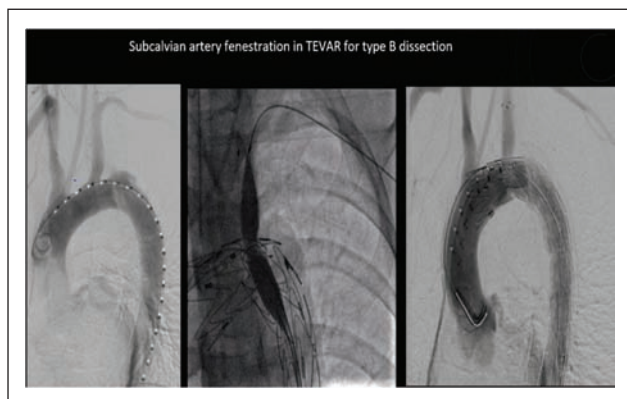


Figure 33. Branch fenestrated EVAR

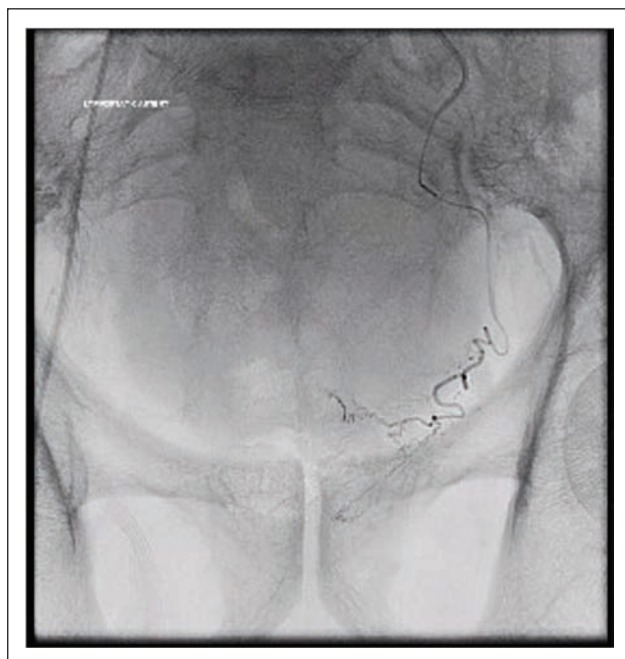


Figure 34. Prostatic artery embolization for benign prostatic hyperplasia

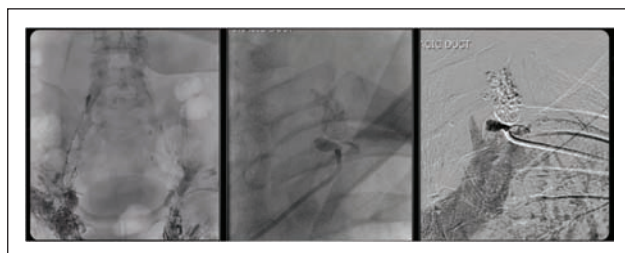


Figure 35. Thoracic duct embolization for chylous pleural effusion

## Events Organized

### FLAIR - 2019

Focussed Learning - Advanced Imaging in Radiology, a 2-day CME was conducted on 25-26 May 2019 at the AMC Auditorium, SCTIMST.

## Awards and Honours

1. Dr Bursupalle Mahesh Reddy, Senior Resident, received the Cum Laudae Award for the poster titled "Single ventricle heart in congenital heart disease- what a radiologist should know" at ECR 2020, Austria.





2. Dr Santha Kumar, Senior Resident, won the 2nd prize for the presentation titled “Imaging genomics of Tubulinopathies and ASL-PET correlation in epilepsy” at ISNR 2019, New Delhi.
3. Dr Sabarish S S, Senior Resident, won the 1st prize in Neuroradiology Grand Quiz at ABCNR 2019, CMC Vellore.

### **Staff**

### **Faculty**

Dr C Kesavadas, Professor and Head of the Department

Dr Bejoy Thomas, Professor

Dr T R Kapilamoorthy, Professor (Ad Hoc)

Dr E R Jayadevan, Additional Professor

Dr Santhosh Kannath, Additional Professor

Dr A Anoop, Assistant Professor

Dr Jineesh V, Assistant Professor

### **Technical**

Ms Githakumari V, Junior Scientific Officer

Mr Alex Jose D, Senior Technical Assistant

Ms Sheebakumari R, Senior Technical Assistant

Mr Johnson C, Senior Technical Assistant

Mr Krishna Kumar, Technical Assistant - B

Mr Vikas N, Technical Assistant - B

Mr Mahesh P S, Technical Assistant - B

Mr Joyi K, Technical Assistant - B

Ms Sandhya V, Technical Assistant - B

## DEPARTMENT OF MICROBIOLOGY

The Department is involved in:

1. Providing accurate and quick reports on all specimens sent to the Laboratory
2. Providing clinical microbiology service, one component of which is antibiotic stewardship
3. Outbreak investigation and containment using microbiological methods
4. Maintaining the viral culture facility
5. Training MD and MSc Microbiology students as observers and as Apprentice trainees, respectively
6. Liaising with Hospital Infection Control Unit
7. Enhancing and supporting research activities of all Wings of the institute

### Activities

#### Clinical Activities

#### 1. Bacteriology and Mycology

A total of 8286 samples were received. There were 11 cases of infective endocarditis, with 1 unusual organism - *Dermococcus nishinomyaensis*. There were 76 fungal isolates, of which 73 were *Candida* species, including 1 infective endocarditis. The most common was *Candida tropicalis* followed by *C. albicans* and *C. parapsilosis*. Three mould fungi were isolated, *Cladophialophora bantiana* from brain abscess, *Scedosporium* species from sphenoidal sinusitis and *Rhizopus arrhizus* from oculorhinocerebral zygomycosis. There were 3 cases of salmonellosis with 2 cases of *Salmonella paratyphi A* and 1 of *Salmonella tennessee*, confirmed at CRI Kasauli. The interesting isolates are illustrated in Figures 36-42.

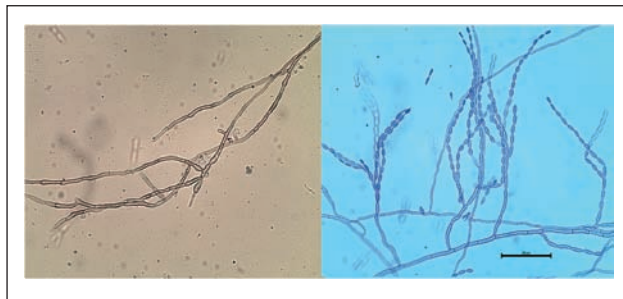


Figure 36. Brain abscess due to *Cladophialophora bantiana*

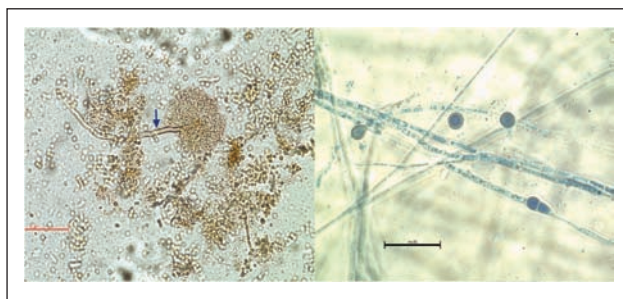


Figure 37. Sphenoidal sinusitis due to *Scedosporium apiospermum*



Figure 38. Oculorhinocerebral zygomycosis due to *Rhizopus arrhizus*

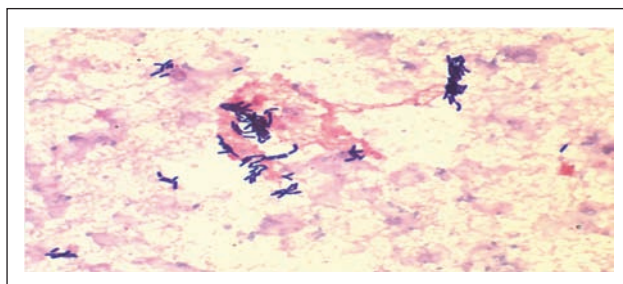


Figure 39. Septicaemia due to *Listeria monocytogenes* in a DVR patient

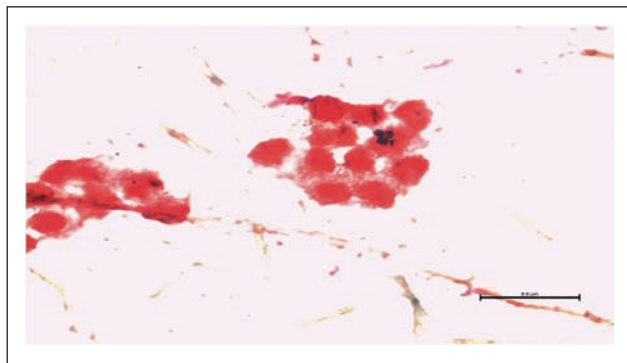


Figure 40. Emptyema due to *Corynebacterium striatum*

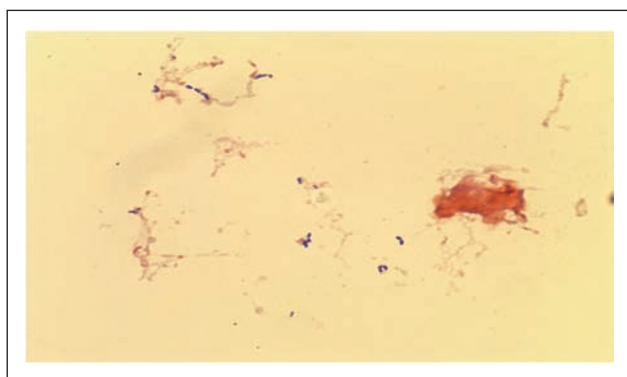


Figure 41. Brain abscess caused by *Streptococcus anginosus*

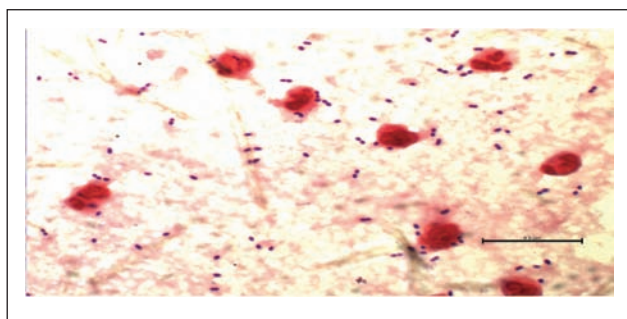


Figure 42. Pyogenic meningitis caused by *Streptococcus pneumoniae*

## 2. Mycobacteriology

158 samples were processed with no isolates. RNTCP took over molecular diagnosis of tuberculosis countrywide. Dr Dinoop was identified as the nodal officer for the Institute and all samples were sent to the RNTCP laboratory in the Medical College,

Trivandrum. However, mycobacterial culture continued to be performed with conventional Lowenstein-Jensen Medium.

## 3. Serology

Nephelometer (Agappe Diagnostics) installed in 2016 continued to be used for providing rapid results for ASO, CRP, RF, C3 and C4. Total samples received during the year were: RF - 935, ASO - 270, CRP - 2223, TPHA - 241, RPR - 19, Widal - 4, Brucella - 9, Malaria - 8, C3&C4 - 1.

## 4. Viral serology

Automated VIDAS (Enzyme Linked Immunofluorescent Assay) and ARCHITECT-Abbott diagnostics (Chemiluminescence Linked ImmunoAssay) combined were utilized to provide rapid results for HIV, HBsAg, HCV, TFT and Procalcitonin. Syphilis was also included for automated analysis in the ARCHITECT machine. Hepatitis B antibody titre was measured for the health care personnel to assess their immune protection levels post-vaccination and after health care accidents like needle stick injuries using ARCHITECT systems. Total samples processed during the year were: HIV - 10629, HBsAg - 10633, HCV - 10642, TFT - 21956 and Procalcitonin - 1914. Various rapid card tests like Tridot were also used for confirmation and emergency purposes.

## 5. Parasitology

A case of hydatid disease involving the occipital lobe caused by *Echinococcus multilocularis* (Figure 43) and a case of *Enterobius vermicularis* infection (Figure 44) in a patient with AIDP were diagnosed.

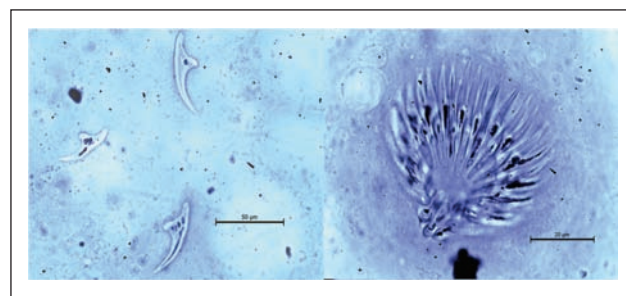


Figure 43. Hydatid disease of occipital lobe caused by *Echinococcus multilocularis*

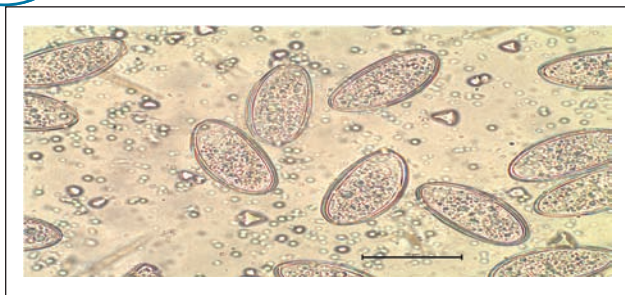


Figure 44. *Enterobius vermicularis* infection in a patient with AIDP

## 6. Molecular Diagnostics

Samples were received from SCTIMST, MCH, RCC, KIMS, SUT, Gokulam Medical College, Holy Cross, Kottiyam and Cosmopolitan Hospitals

- BioFire Film Array Multiplex PCR System  
82 tests were performed using 3 different panels: Respiratory (n=49), Meningitis/Encephalitis (n=26) and Blood culture ID (n=6). CE-IVD-approved standard PCR tests for: viral encephalitis (n=78) and tropical fever agents (n=21) using respective panels.
- TB PCR: 30 samples were tested of which none was positive for *Mycobacterium tuberculosis* complex.
- Brucella PCR- 3 samples were tested of which none was positive.

## 7. Homograft Valve Bank

34 valves were harvested during the year and 24 homografts (10 aortic and 14 pulmonary) were implanted.

### Research Programmes

1. A prospective cohort study on cerebrospinal fluid (CSF) diversion catheter-related infections in a tertiary referral neurosurgical care centre, PI - Dr Dinoop K P (Funded by: ICMR)
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: Seed Fund, SCTIMST)

3. A prospective cohort study on Infective Endocarditis (IE) - microbiological profile and clinical outcomes, PI - Dr Kavita Raja
4. Prosthetic valve endocarditis: A 10-year single-centre retrospective cross-sectional study from a tertiary cardiac referral hospital, PI - Dr Dinoop K P
5. A retrospective study on cerebrospinal fluid (CSF) diversion catheter-related infections – Experience from a tertiary referral neurosurgical centre, PI - Dr Dinoop K P
6. Projects in collaboration with the In Vitro Diagnostic Group in BMT Wing:
  - Development of a Rapid Technique for Identification and Characterization of Clinical *Acinetobacter baumannii* Isolates by Raman spectroscopy, PI - Dr Jyoti E K
  - Rapid Diagnostic Kit for SARS-CoV-2 Detection, Patent filed, Co-investigators: Drs Jyoti E K & Dinoop K P (Funded by: MPLAD)
  - Development of antigen-based assay kit for SARS-CoV2, Patent filed, Co-investigators: Drs Jyoti E K & Dinoop K P (Funded by: MPLAD)
  - Point-of-care detection of human papilloma virus using loop-mediated amplification of DNA, Co-investigator: Dr Jyoti E K (Funded by: TRC, SCTIMST)

### Memorandum of Understanding

An MoU was signed with the Institute of Microbial Technology (CSIR-IMTECH), Chandigarh, on sharing of rare isolates and their identification on 20 May 2019 (Figure 45). Drs Kavita Raja and Jyothi E K visited the Institute for signing the MoU.





Figure 45. Signing of MoU with Institute of Microbial Technology, Chandigarh

### New Initiatives

1. The Department joined the Kerala Antimicrobial Resistance State Action Plan on 6 May 2019
2. The Department joined the EQAS for Bacteriology and Serology with IAMM and Mycology with PGIMER, Chandigarh
3. The Department initiated a class on infection control for technical staff of operation theatres and Cath Labs in September 2019
4. As part of collaborative activities with BMT Wing, Dr Jyothi and Dr Dinoop joined the In Vitro Diagnostics group at BMT Wing
5. The Department started SARS CoV-2 testing on 24 March 2020 after receiving approval from ICMR, with the active support and participation of the Department of Biochemistry, and data entry

support from the Departments of Transfusion Medicine and Pathology. Until 31 March 2020, 71 samples were tested, of which 2 were positive.

6. The Department was selected as Mentor Institute for SARS CoV-2 testing for Kerala, Lakshadweep, and Andaman and Nicobar.

### Events Organized

1. Clinical Microbiology diagnostics in infectious disease syndromes (CMID 2020), a 1-day CME was organized by the Department in collaboration with the Academy of Clinical Microbiologists on 29 February 2020 at the AMC Auditorium, SCTIMST. The CME was attended by faculty and residents from all Medical Colleges within Kerala and a few from outside Kerala (Figure 46).





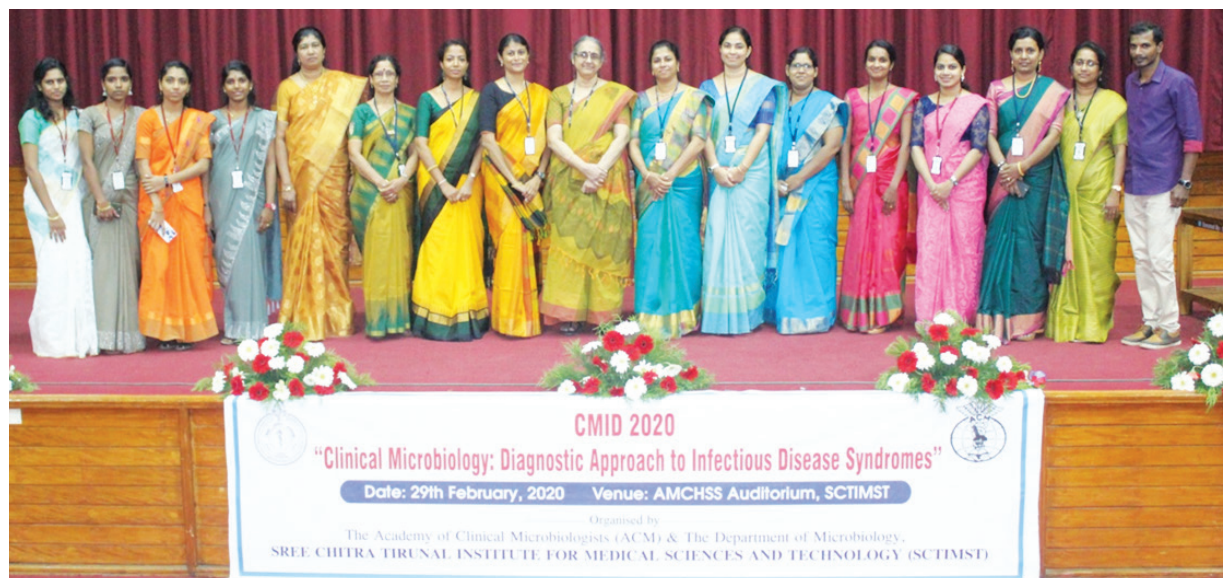


Figure 46. CME on Clinical Microbiology diagnostics in infectious disease syndromes (CMID 2020)



2. The “Global Handwashing Week” with the release of Hospital Infection Control Manual was organized by the Department in collaboration with the Hospital Infection Control Unit from 9-15 October 2019. A class was taken for the students of the Government Medical College High School, Kumarapuram, on spread of infectious diseases (Figure 47).



Figure 47. Global Handwashing Week

### Awards and Honours

Dr Kavita Raja was selected as a CSC Alumni Advisory Panel Member by the Commonwealth Scholarship Commission on 2 September 2019.

### 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 G S, Scientific Assistant

Ms Reeba Rani D C, Technical Assistant (Lab) - B

Ms Cinta Rose, Technical Assistant (Lab) - A

Ms Smitha M, Technical Assistant (Lab) - B

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





## 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 and weekly Speciality Clinics for review of patients under different Subsections.

During the year, a total of 23099 outpatients were seen in General Neurology, which included 16899 reviews and 6200 new registrations, and 16732 patients were seen in Speciality Clinics. The inpatient number was 3379, bed strength was 60 and the bed occupancy rate was 100%. There were 10 mortalities with a mortality rate of 0.30% 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 of Neurology during the year are summarized under the individual Sections.

### Events Organized

1. The 3rd P K Mohan Oration was organized on 19 October 2019 by the Department. The orator was Prof Peter Sandercock, Emeritus Professor of Medical Neurology, University of Edinburgh, UK.
2. Dr Jalesh Panicker, Consultant in Urology, National Hospital for Neurology and Neurosurgery and UCL Institute for Neurology, London, visited the Department on 17 August 2018 and gave a talk on 'A neurological approach to unexplained urogenital symptoms'.
3. The Departments of Neurology and IS&IR jointly organized a talk on 'Unifying Models and Theories of Human Brain Function and

Dysfunction' by Dr Vinod Menon, Professor of Psychiatry and Behavioural Sciences and Director, Stanford Cognitive and Systems Neurosciences Laboratory, Stanford University, California, on 19 August 2019.

4. The book 'Disability: An overview in the context of Rights of Persons with Disability (RPwD) Act' was released by Smt K K Shailaja, Hon'ble Minister, Social Justice Department, Government of Kerala, on 24 July 2019. The Department had contributed 3 chapters in the book.

### Awards and Honours

1. Prof Sanjeev V Thomas was awarded the 'Ambassador for Epilepsy Award' at the 33rd International Epilepsy Congress in Bangkok in June 2019.
2. Dr Ramshekhar N Menon received the Asian Oceanian Epileptology Award by the Epilepsy Society Australia for Observership at the Royal Children's Hospital Melbourne from April-June 2019.
3. Dr Ramshekhar N Menon was awarded the Commonwealth Medical Fellowship by the British Commonwealth Scholarship Commission. Dr Menon completed the Fellowship in Pediatric Epilepsy at the Great Ormond Street Hospital for Children, London, UK, between December 2019 and May 2020.
4. Dr Soumya Sundaram started the Indian Council of Medical Research and Department of Health Research (ICMR-DHR) Fellowship for Senior Biomedical Scientist at the University of New South Wales, Sydney, Australia, on 26 February 2020.
5. Dr Poornima Narayanan Nambiyar, Senior Resident, was awarded a travel bursary for poster presentation titled: 'EEG as a prognostic marker in autoimmune encephalitis' at the 33rd



International Epilepsy Congress in Bangkok.

6. Dr Harikrishnan R, Senior Resident, secured the 1st prize for his presentation titled: 'Visual field defects and their impact on quality of life after anterior temporal lobectomy for MTLE' at ECON 2020 from 17-19 January, Ahmedabad.
7. Drs Udit Saraf and Soumya V S, Senior Residents, won the 2nd prize in the 'Emerging Brain Quiz' conducted in Medical College, Trivandrum, on 10 November 2019.
8. Dr Vaibhav Tandon, Senior Resident, won the 1st prize and Drs Mohan Sumedha Maturu and Naveen Kumar P won 2nd prize at the 6th Stroke Summer School from 6- 8 September 2019 in Bengaluru.

## NEUROLOGY INTENSIVE CARE UNIT

### Activities

The distribution of cases in the Neurology ICU during the year is summarized in the Table below and Figure 48:

Neurological condition	Number
Status epilepticus	17
Super refractory Status epilepticus	6
Myasthenia gravis	8
Meningitis	13
• Chronic Tubercular	7
• Pyogenic	4
• Aseptic	0
• Carcinomatous	0
• Chronic non-infective	2
Acute strokes including intracranial bleed	19
Cerebral venous sinus thrombosis	2
Central nervous system demyelination	38

Motor neuron disease	1
Guillain-Barre syndrome	17
Chronic inflammatory demyelinating polyradiculoneuropathy	11
Viral encephalitis	4
Autoimmune encephalitis	23
Rasmussen's encephalitis	3
Parkinson's Disease	4
Metabolic encephalopathy	8
Others	41
CNS tumours	6
<b>Total</b>	<b>221</b>
<b>Mortality</b>	<b>10 (4.5%)</b>

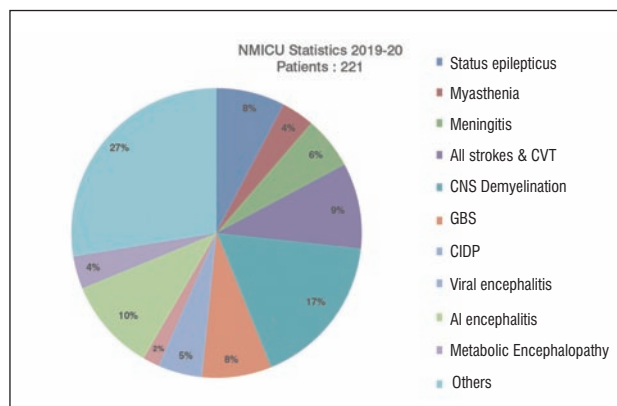


Figure 48. Neurology ICU Statistics

Among various neurological conditions, CNS demyelination was the leading cause for admission to the NMICU (17% of the total admissions). Number of patients with demyelinating illnesses (CNS and PNS) and autoimmune encephalitis recorded an increase over previous years.

Mortality remained less than 5% (4.4 % during 2019-20) for the 3rd consecutive year. Out of the 10 patients who expired, 2 had tubercular meningitis, 1 each with pyogenic meningitis, autoimmune encephalitis, CNS demyelination, GBS, metabolic encephalopathy, status epilepticus, intracranial bleed and invasive rhinocerebral-mucormycosis.



Compared to the preceding year, there was a reduction in the number of patients (221 Vs 302) as shown in the Table below and Figure 49.

Neurological condition	2016-17	2017-18	2018-19	2019-20
Status epilepticus	26	44	49	17
Super refractory	11	6	6	6
Myasthenia gravis	7	18	6	8
Meningitis	19	24	16	13
<i>Chronic Tubercular</i>	10	11	7	7
<i>Pyogenic</i>	2	3	5	4
<i>Aseptic</i>	2	3	0	0
<i>Carcinomatous</i>	3	3	1	0
<i>Chronic non-infective</i>	2	4	1	2
Acute strokes including intracranial bleed	8	22	29	19
Cerebral venous sinus thrombosis	4	2	4	2
Central nervous system demyelination	13	25	27	38
Motor neuron disease	3	3	4	1
Guillain-Barre syndrome	3	15	18	17
Chronic inflammatory demyelinating polyradiculoneuropathy	3	4	5	11
Viral encephalitis	1	8	4	4
Autoimmune encephalitis	5	13	13	23
Rasmussen's encephalitis	3	2	6	3
CJD	1	3	1	4
Metabolic encephalopathy	17	25	11	8
Others	21	77	103	47
Total	145	291	302	221
Mortality	10 (6.9%)	7 (2.4%)	15 (5%)	10 (4.5%)

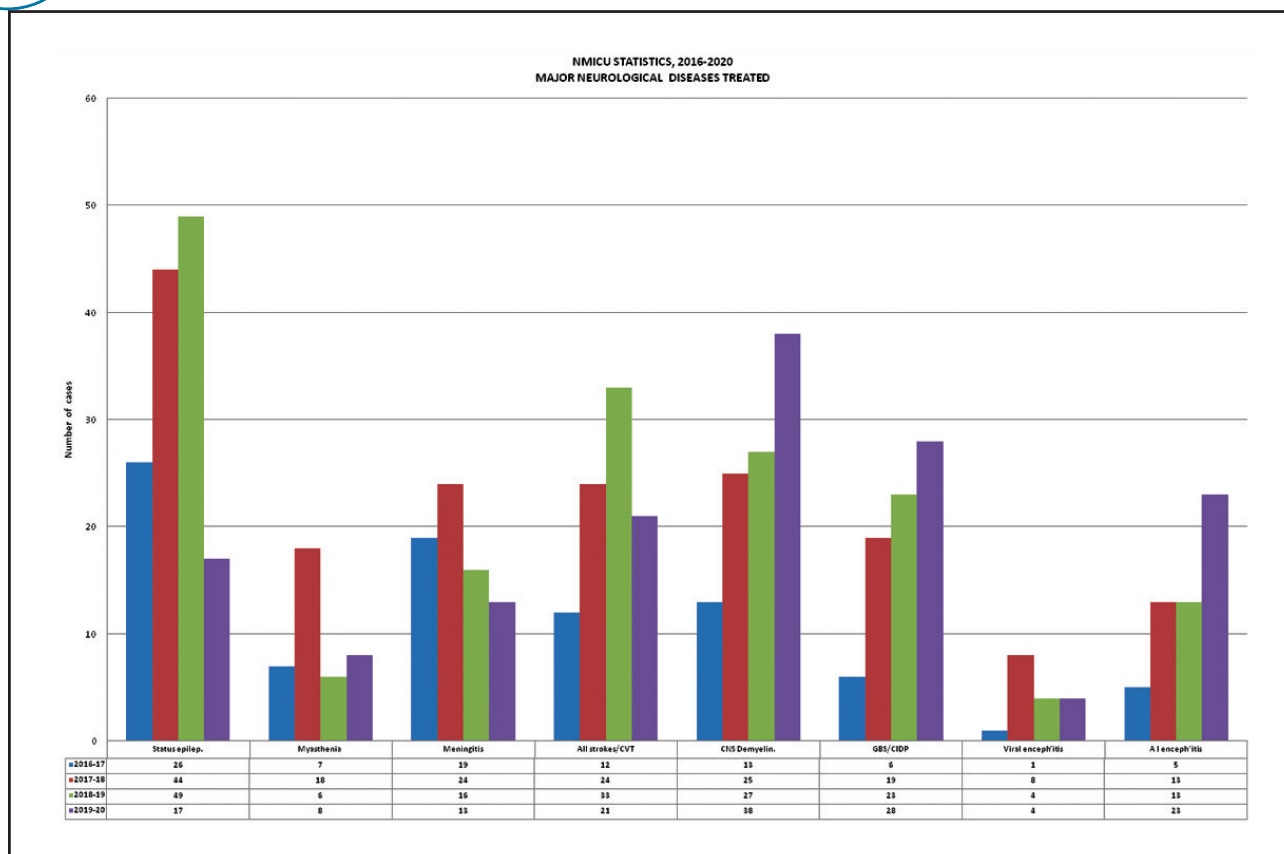


Figure 49. Major neurological diseases treated in Neurology ICU

### Special procedures

Plasma exchanges (PLEX) were given for 36 patients, Rituximab administration for 26 patients and IV IgG for 21 patients. These were in addition to other routine procedures like muscle biopsy, lumbar punctures and mini-tracheostomies.

### New Initiatives

1. Initiated NMICU Infection Registry
2. Neurocritical Care Patient Management Conference (PMC) was undertaken to discuss management issues in patients with multisystem involvement and/or other medical complications.

### COGNITION & 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, MCI dementia - stroke and childhood developmental disorders. The CBNS conducts a Memory and Neurobehavioral Disorders Clinic every week. It also provides advice and technical support to the Alzheimer's & Related Disorders Society of India (ARDSI), a voluntary organization that helps dementia patients and caregivers. The Section also carries out clinical and basic science research in the fields of Dementia, Cognition and Behaviour.





## Activities

The annual activities of the Section are summarized in the Table below:

Activity	Number
Speech and Language evaluations	2298
Speech therapy	348
Audiometric evaluations	314
Neuropsychological testing	892
IQ assessments	95
Counselling Sessions	346
Memory & Neurobehavioral Clinic attendance	564

Comprehensive assessment of patients with cognitive problems admitted to the Institute and counselling of caregivers of patients with dementia along with psychosocial support were done. Further, research activities on structural and functional neuroimaging in dementias and development and validation of neuropsychological batteries were carried out. 25 students from the National Institute of Speech & Hearing, Trivandrum, completed 1 month internship in the Section.

## Research Programmes

1. Dementia Science Program (A multicentric initiative sponsored by the Department of Biotechnology and National Brain Research Centre to phenotype and map incidence prevalence of dementia in India along with risk factors)
2. Biochemical and functional investigation of dorsolateral prefrontal cortex in mild cognitive impairment using functional Magnetic Resonance Spectroscopy and functional Magnetic Resonance Imaging, Co-PI - Dr Ramshekhar N Menon (Funded by: DST-SERB)
3. A resting state fMRI and task-based fMRI study: Optimization, language lateralization, memory lateralization and connectivity in normal subjects versus patients with epilepsy, Co-PI - Dr Ramshekhar N Menon (Funded by: DBT)

4. In vitro beta-amyloid uptake by peripheral blood macrophages: predictor for progression of mild cognitive impairment to Alzheimer's Disease, Co-PI - Dr Ramshekhar N Menon (Funded by: ICMR)
5. Effect of yoga on neuropsychological functions and brain connectivity networks in mild cognitive impairment and cognitively normal subjects
6. Development and validation of a comprehensive clinical and neuropsychological battery for use in the Indian context for patients with vascular cognitive impairment
7. Non-Linear analysis of EEG signals of patients with Alzheimer's Disease
8. The human brain mapping project a resting state fMRI study of healthy controls and patients with mild cognitive impairment (MCI) & degenerative dementia of the Alzheimer's type (AD)
9. Learning of novel object name pairs in persons with epilepsy
10. Control-based validation of neuropsychological test batteries for material-specific memory impairment in patients with medically refractory temporal lobe epilepsy due to hippocampal sclerosis.
11. Validation of ICMR Neurocognitive test battery in 5 Indian languages sponsored by the Indian Council for Medical Research

## New Initiatives

1. Cognitive retraining in MCI and early dementia: Retraining battery validated as part of SATYAM project, now a routine service offered by the Memory and Neurobehavioural Clinic
2. Validation and publication of the ICMR Neurocognitive test battery
3. Development and validation of face-name paired associate learning tests and famous faces recognition test for diagnosis of MCI and early dementia



### Events Organized

1. 23<sup>rd</sup> National Conference on Alzheimer's and related disorders was organized by the CNBC, SCTIMST, in association with ARDSI and KSSM on 15-17 November 2019. National faculties from SCTIMST, NIMHANS and AISH, Mysore, participated in this programme. More than 300 delegates attended the conference and more than 30 scientific papers were presented. Dr Ramshekhkar N Menon was the Organizing Secretary of this conference.

### Awards and Honours

1. Ms Manju Mohan P was awarded the 1st prize for poster presentation at the 23rd National Conference of Alzheimer's and Related Disorders Society of India (ARDSI) held at Trivandrum from 15-17 November 2019.
2. Ms Manju Mohan P successfully completed Masters of Arts in Psychology from the Indira Gandhi National Open University in August 2019.
3. Ms Manju Mohan P was awarded Doctoral degree in Speech Language Pathology from the University of Mysore in February 2020.
4. Ms Manju Mohan P was certified as Oral Placement Therapy Level 1 and Level 2 Practitioner and Ms Vipina V P was certified as Oral Placement therapy Level 1 Practitioner in May 2019.
5. Ms Vipina V P and Ms Manju Mohan P were certified as PROMPT-trained Speech Language Pathologists by the PROMPT Institute in June 2019 and January 2020, respectively.
6. Ms Sushama S R was certified as an Applied Behaviour Analyst by CDMRP under Dr Geetha Srikanth in 2019.

### COMPREHENSIVE CARE CENTRE FOR MOVEMENT DISORDERS

The Comprehensive Care Centre for Movement Disorders (CCCMD) at SCTIMST is involved in clinical care, teaching and training, and research

within the neurological sub-speciality of Movement Disorders. The Centre provides comprehensive medical and surgical care to patients affected with various movement disorders (which include conditions like Parkinson's Disease and other tremor disorders, dystonia, chorea and so on), trains neurologists from various parts of India in state-of-the art management of movement disorders, conducts DM Neurology and Post-doctoral Fellowship Programmes in Movement Disorders, and is actively involved in the PhD Programme, focusing on basic biomedical and clinical research.

### Activities

During the year, CCCMD was involved in externally-funded national and international research projects. Two students continued their PhD programme and 2 Post-doctoral Fellows in Movement Disorders completed their training. Two neurologists and 1 PhD student joined the courses offered by CCCMD during the year. Two multicentre collaborative projects (one of them with international collaboration) were approved and initiated during the year. Five articles were published in scientific journals, and scientific presentations were made in several international and national conferences by the faculty of the Centre. Dr Sabine Meunier, Researcher from Pitié-Salpêtrière Hospital, Paris, France, visited the Centre for collaborative research. Two projects based on non-invasive brain stimulation were completed. The analysis of the Michel J Fox Foundation- funded study – CAGE-PD (cataloguing the genetic architecture of PD) continued. The Centre also organized a 3-day international scientific conference (the 5th Annual Conference of the Movement Disorders Society of India) in which 9 renowned international and about 80 national faculty who are senior experts in the field of Movement Disorders attended, along with about 500 delegates from all over India and nearby SAARC countries.

The clinical activities of CCCMD included the weekly Movement Disorders Review Clinic, Botulinum Toxin Injection Clinic and the Movement Disorders Surgical Programme. The Motor Physiology Lab under the CCCMD conducted electrophysiological



investigations in patients with Movement Disorders apart from TMS-based research studies. The Motor Physiology Lab conducted about 110 sessions of electrophysiological studies.

About 630 patients with various Movement Disorders were referred to the CCCMD from all over India and were freshly registered during the year. In addition, the Movement Disorders Review Clinic had about 2850 review consultation visits. Seventy-five patients sought consultation through the e-consultation system. About 430 botulinum toxin injection sessions were undertaken in the fortnightly Botulinum Toxin Injection Clinic. 25 deep brain stimulation and related surgical procedures were performed. About 65 deep brain stimulation programming sessions were done on patients on follow-up.

#### *Research Programmes*

1. A research project funded by the SATYAM Program of the DST, exploring the physiological basis of the salutary effects of Yoga on the neural control of movements, was completed during the year and data analysis was completed too. This study also aimed to examine the beneficial effects of Yoga on patients with PD (Figure 50).
2. An ICMR-funded study on the longitudinal follow-up of cognitive functions in patients with PD is ongoing.
3. An ongoing project funded by the Department of Biotechnology, Government of India, examines whether estimation of iron levels in various parts of the brain by MRI-based techniques can differentiate Parkinson's Disease from other neurological disorders with a similar clinical picture ("Atypical Parkinsonisms") (Figure 51).
4. The Centre conducted many internally-funded/non-funded projects as well:
  - A transcranial magnetic stimulation-based study, which examined the relationship between cerebellum and the loss of depotentiation of motor cortex synapses that occur in dyskinetic PD patients, was completed, analysed and submitted for publication.
  - Resting state functional and effective connectivity changes in cerebellum-basal ganglia interconnecting network in Parkinson's Disease and pathophysiological and therapeutic implications – is an ongoing study that explores the connections between cerebellum and basal ganglia structures (Figure 52).
  - Other ongoing studies explored various clinical aspects of Movement Disorders: the relationship between apraxia of eye lid opening and DBS, the cognitive outcome of DBS surgery, kinematics of writing abnormality in patients with Writer's cramp (a task-specific dystonia) and so on.
5. The research projects completed in the previous years resulted in 5 original research publications in high-impact journals.

#### *Product Development*

The CCCMD, collaborating with the Biomedical Technology Wing of the Institute and external collaborators, is engaged in the development of a low cost and efficient Deep Brain Stimulation system for Movement Disorders. The project reached the stage of completion of the first version of the prototype and functional validation in the laboratory.

#### **New Initiatives**

1. An Indo-German collaboration of CCCMD with the University of Tuebingen won the Michael J Fox Foundation grant of USD 2.3 million. The 3-year project is led by SCTIMST in India and includes 16 other Indian Centres. This study will be the largest genome-wide association study and the 1st in Indian population and is aimed at identification of the genetic risk factors of Parkinson's Disease in 10000 patients with Parkinson's Disease and an equal number of healthy volunteers. The recruitment of various Centres was initiated during the year.
2. A second collaborative study, titled "Exploring the human gut microbiome, metabolome and alpha-synuclein in health and Parkinson's

Disease (PD) – a window to the gut microbiota-brain axis alterations in PD” that received funding from the Indian Council of Medical Research - was initiated and recruitment of patients progressed. The proposal aims to explore the variations in the gut flora of patients with PD compared to healthy volunteers and examine how these variations could impact the pathogenesis of PD. Gut dysbiosis is currently a research hot-spot in PD. The Cochin University of Science and Technology (CUSAT) is the collaborator for the study and the expertise for bacterial metagenomics and bio-informatics will be provided by CUSAT.

### Events Organized

The Comprehensive Care Centre for Movement Disorders organized the 5th Annual Conference of the Movement Disorders Society of India (“MDSICON-2020”) from 31 January – 2 February 2020. This 3-day scientific conference was attended by more than 500 delegates (Neurologists, Neurosurgeons, teaching faculty in various Medical Colleges, post-graduate trainees in Neurology and Neurosurgery, researchers and PhD students) from across India and the neighbouring SAARC countries. The conference had 24 scientific sessions (plenary as well as parallel sessions) composed of didactic lectures, live Workshops, demonstration of latest technology, discussion of clinical cases, presentation of original research results as platform and poster sessions, award paper presentations and panel discussions. The scientific sessions were handled by an eminent panel of faculty, including 9 international faculty - senior scientists and clinicians from leading research Centres in United States, Canada, France and the United Kingdom and about 80 senior national faculty. The 3-day event was inaugurated by Sri Arif Mohammad Khan, Hon’ble Governor of Kerala.

### Awards and Honours

Dr Syam Krishnan was awarded the International Parkinson and Movement Disorder Society Travel Grant Award to attend the International Congress of Parkinson’s Disease and Movement Disorders at Nice, France, in September 2019.



Figure 50. Yoga training for healthy volunteers on International Yoga Day conducted by the research team of the SATYAM project

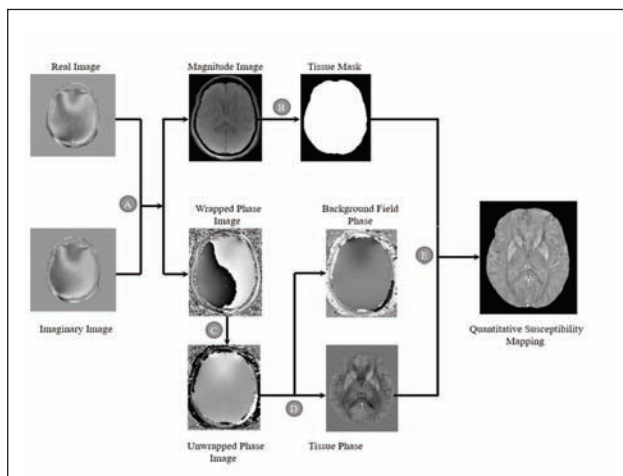


Figure 51. Protocol for “quantitative susceptibility mapping” on magnetic resonance images from patients to differentiate various Parkinsonian disorders by quantitatively estimating the iron content of certain areas in the brain (basal ganglia)

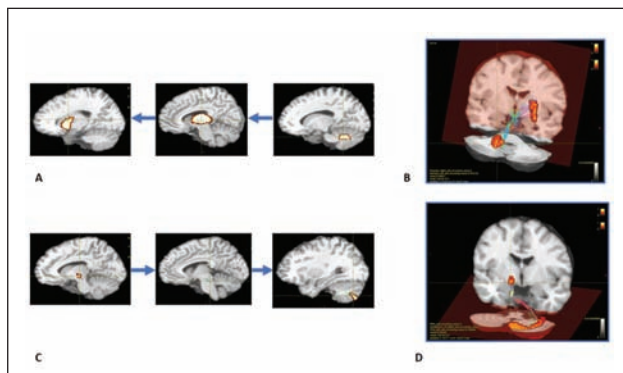


Figure 52. 2D and 3D visualization of Diffusion-Tensor Imaging Tractography results for cerebellum-basal ganglia interconnecting network





## COMPREHENSIVE CENTRE FOR SLEEP DISORDERS

The Comprehensive Centre for Sleep Disorders, a subsection of the Department of Neurology, is engaged mainly in the clinical care of patients with sleep disorders on an outpatient basis, performing diagnostic studies and prescribing treatment like CPAP titration. In addition, the Centre is also engaged in clinical research on sleep disorders in the patients.

### Activities

Sleep Outpatient Clinics are conducted on Thursday afternoon, where new and review patients are seen, investigations are planned and treatment initiated, and Inter-departmental consultations from Cardiology and Surgical specialties are attended. A 2-bedded Sleep Laboratory is functional with facilities for performing diagnostic polysomnography, CPAP titration and multiple sleep latency tests.

The clinical services delivered during the year are summarized in the Table below:

Activity	Number
Sleep Outpatient Clinic attendance	296
Polysomnography – diagnostic	70
CPAP titration studies	17
Multiple sleep latency test	5
IQ assessments	95
Counselling Sessions	346
Memory & Neurobehavioral Clinic attendance	564

### Research Programmes

One extramural-funded study titled: “Can OSA affect perioperative outcomes in patients undergoing cardiovascular surgery?”, initiated in August 2017 in collaboration with the Departments of Anaesthesiology and CVTS, was completed in August 2019.

## Events Organized

The Centre organized awareness activities centred around the theme “Better Sleep, Better Health, Better Planet” on World Sleep Day 2020 on 13 March, which included poster and essay competitions for students from 5 schools in Trivandrum City. In addition, an educational booklet on common sleep problems and sleep hygiene was prepared for release.

## 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 neurologist, neurosurgeon, vascular surgeon, interventional radiologists, cardiologists and neuroanaesthetists. Comprehensive rehabilitation to stroke survivors is provided 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.

### Activities

The Stroke Clinic is conducted every Friday where the stroke survivors are reviewed and followed up. As part of secondary prevention, the team is committed to providing education regarding the symptoms and risk factors of stroke and the importance of medical adherence for the patient as well as the primary care givers. There is a patient management conference every Friday by a multidisciplinary team that includes neurologists, neurosurgeon, vascular surgeon, cardiologist and interventional radiologists. The team discusses the most challenging cases and takes decisions based on consensus regarding the treatment plan for the patient.



Routine clinical activities are summarized in the Table below:

Areas / Procedures	Number
Stroke Clinic attendance	3024
Stroke unit admissions	436
Carotid endarterectomy	37
Carotid stenting	12
IV thrombolysis	25
Mechanical thrombectomy	40
Moyamoya revascularization	21
Decompressive hemicraniectomy	14
Hematoma evacuation	5
Cerebellar decompression	3

#### Research Programmes

##### 1. Secondary Prevention by Structured Semi-Interactive Stroke Prevention Package in India Study (SPRINT Study)

The 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, PI – Dr P N Sylaja (Funded by: ICMR)

##### 2. Improving Stroke Care in India (IMPROVISE)

The 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 the Stroke Unit. It is a multicentre study including CMC Ludhiana, AIIMS Delhi, and SCTIMST.

##### 3. A project titled “Understanding phenotypes in Moyamoya disease by resequencing 17q25ter region - An imaging genomics approach study” was completed in July 2019. One scientific paper was published and another manuscript is in the process of submission (Funded by: Wellcome Trust DBT)

##### 4. A randomised controlled trial (RESTORE) Ayurvedic treatment in the rehabilitation of ischemic stroke patients in India

The study was initiated in November 2018. SCTIMST is the national co-ordinating Centre for this project. It is a multicentre study including CMC Ludhiana, AIMS Kochi, and SCTIMST.

#### Memorandum of Understanding

A MoU was signed between the Indian Council of Medical Research, National Centre for Disease Informatics and Research, Bengaluru, and Sree Chitra Tirunal Institute for Medical Sciences and Technology for the project titled “Development of Hospital-Based Stroke Registries in Different Regions of India (HBSR)”.

Dr Murugan S Nair, Neurologist from General Hospital, Trivandrum, and Dr Krishnapriya S K, Neurologist from General Hospital, Kollam, were observers in the Unit for 3 weeks in June 2019 since Stroke Units have been started in district hospitals.

#### New Initiatives

1. A 40-minute training video was prepared for physiotherapists on stroke rehabilitation. This video was released on 30 May 2019 by Smt K K Shailaja Teacher, Hon'ble Minister of Health and Social Welfare, in the presence of Sri Rajeev Sadanandan, Additional Chief Secretary, Health and Family Welfare, Government of Kerala. This video is included in the World Stroke Academy training sessions of the World Stroke Organization.
2. Another 40-minute training video on stroke for community health workers was prepared to equip the health workers with information on stroke and care of stroke survivor.

#### Events Organized

1. A State level Nursing Conference on Stroke Care was organized on 1 March 2020 at the AMCHSS Auditorium, SCTIMST. 350 nurses working in Stroke Units in 14 districts under the Directorate of Health Services, Government of Kerala, and private hospitals across Kerala attended the conference.



2. Many activities were organized on World Stroke Day on 29 October 2019:

- Social media activities including this year's theme of the World Stroke Day "Stroke is preventable, don't be the one" through Facebook.
- A 1-day conference on stroke for primary care physicians was organized on 29 October 2019 at the AMCHSS Auditorium, SCTIMST, in association with the Directorate of Health Services, Government of Kerala. About 100 physicians from Trivandrum and Kollam districts working in PHC, CHC and Taluk hospitals attended the programme.
- A banner prepared on the theme of the World Stroke Day was released by Smt K K Shailaja Teacher, Hon'ble Minister of Health and Social Welfare, and the banner was placed in all the taluk and district hospitals of Kerala.

3. As part of the IMPROVISE (Improving stroke care in India) Project, stroke patient- and carer-focused meetings were organized for identifying the problems faced by stroke survivors and their caregivers. The aim was to find ways of tackling the problems of patients and carers, and evolve strategies for improving stroke care by caregiver training. Dr Liz Lightbody and Ms Alison McLoughlin from the University of Central Lancashire, UK, participated in the meeting. They provided training to staff nurses in the Stroke ICU on neurological and physiological monitoring of stroke patients.

### Awards and Honours

Dr P N Sylaja was selected as Co-chair from India for the Mechanical Thrombectomy 2020 global alliance.

### NEUROMUSCULAR AND MULTIPLE SCLEROSIS DIVISION

The Division caters to 2 broad groups of disorders: (a) Neuromuscular disorders that include anterior horn cell diseases, neuropathies, inflammatory myopathies, and 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

The Neuromuscular Clinic functions on every Tuesday. In 2019-20, the Clinic recorded 1710 patient visits. A Patient Management Conference focussing on rehabilitation of patients with significant physical disability was organized in the afternoon of all Tuesdays. The session was attended by Neurology consultants and residents, Physiatrist, speech therapist, occupational therapist, and medical social worker.

The Multiple Sclerosis (MS) Clinic functions on the second Tuesday of every month and specifically addresses the disease modifying therapy, rehabilitation needs and social problems in multiple sclerosis and related demyelinating diseases. In the year 2019-20, 75 patient visits were made in the MS Clinic.

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

Study	Number
Nerve conduction studies	1237
Electromyography	695
Repetitive nerve stimulation	125
Single fibre EMG	18
Visual evoked potential	335
Brainstem auditory evoked potential	100
Somatosensory evoked potential	93

The faculty participated in several national and international conferences.

Dr Sruthi S Nair gave a radio talk in All India Radio on the topic 'Multiple Sclerosis – causes, treatment and prevention', which was aired on 21 October 2019. A brief account of multiple sclerosis was also aired through FM radio on the occasion of World Multiple Sclerosis Day on 30 May 2019.

#### Research Programmes

1. The 3-year project titled 'Structural and functional correlates of cognitive dysfunction in multiple sclerosis', funded by the Cognitive Science Research Initiative (CSRI) of the Department of Science and Technology, which was initiated in June 2017, continued to recruit patients and controls for neuropsychological testing and multimodality MRI. Interim analysis of the project was presented at the Group Monitoring Committee meeting of the CSRI on 1 October 2019.
2. Newly-initiated intramural projects included 'Clinical studies on phenotypic patterns of amyotrophic lateral sclerosis and profile of juvenile myasthenia gravis'.

#### New Initiatives

1. The Neurorehabilitation Meeting was restructured to specifically cater to paediatric neuromuscular disorders with focus on care of Duchenne Muscular Dystrophy and Spinal Muscular Atrophy with substantial inputs from the Department of Physical Medicine and Rehabilitation. Systematic evaluation of physical disability and multidisciplinary care were initiated.
2. The Division collaborated with the Kerala Social Security Mission, Government of Kerala, to derive a state-wide project for the management of persons with multiple sclerosis.

#### Events Organized

1. **World Multiple Sclerosis Day Programme 2019**  
A patient outreach programme was organized for persons with multiple sclerosis and their families on 19 May 2019 (Figure 53). The Chief Guest for the occasion was Dr Mohammed Asheel, Executive Director, Kerala Social Security Mission, and other speakers were Prof Muralidharan Nair and Dr Nitha J. The programme was attended by 45 invitees.



Figure 53. Participants in the World Multiple Sclerosis Day 2019 Programme





Figure 54. Parent interaction programme for Duchenne Muscular Dystrophy conducted on 4 August 2019

## 2. **Standard of Care in Duchenne Muscular Dystrophy**

A parent interaction programme was conducted by the Neuromuscular and Pediatric Neurology subsections of the Department on 4 August 2019 in the Government Guest House, Thycad (Figure 54). The programme was attended by about 90 parents of children with Duchenne Muscular Dystrophy and featured talks on the various aspects of care of Duchenne Muscular Dystrophy, including cardiac, pulmonary, endocrine, rehabilitation needs, genetic counselling and emerging therapies.

## 3. **Patient Outreach Programme, 'Mindfulness in multiple sclerosis'**

was conducted by Dr Krishnan (Associate Professor of Psychiatry) and Ms Lekshmy K (Psychologist and mindfulness researcher) on 8 February 2020 in Swasthy Hall, SCTIMST.

## Awards and Honours

Dr Sruthi S Nair was awarded the 2019 International Scholarship by the North American Chapter of the

International Federation of Clinical Neurophysiology in the AANEM Annual meeting in Austin, Texas, USA, on 17 October 2019.

## PAEDIATRIC NEUROLOGY DIVISION

The Division has a separate Comprehensive Care Centre for Neurodevelopmental Disorders (CCCND) for management of children with various neurodevelopmental disorders like autism, attention deficit hyperactivity disorders and cerebral palsy and has completed 2 years of functioning. A Speciality Clinic for autism and other similar disorders is conducted every 1st and 3rd Saturday. Comprehensive management of children diagnosed with autism spectrum disorder and other neurodevelopmental disorders is offered through the Clinic. Clinical services for the management of various neurological disorders in children are conducted as outpatient and inpatient services. The Staff of CCCND also conduct an outpatient clinic every week at the National Institute of Speech and Hearing, Trivandrum, for children with autism. The faculty delivered talks on various aspects of autism spectrum disorder at CADDRE- The Autism School and also on All India Radio.



## Activites

218 paediatric neurology admissions and 928 new cases were registered at the CCCND during the year. The distribution of cases is shown in the Table below. 152 cases were seen in the Autism Clinic out of which 70 were new cases.

Cases	Number
Autism Spectrum Disorder	115
Intellectual developmental disorder	234
Social communication disorder	88
Motor disorders	389
Learning disorder	102

### Research Programmes

1. Clinical, electrophysiological, radiological and etiological profile of children with autism spectrum disorder
2. Validation of the Malayalam translation of broad autism phenotype questionnaire and assessment of the autistic traits in parents of children with autism spectrum disorder
3. Autism spectrum disorders: Barriers in implementing home training programmes

### New initiatives

A protocol-based rehabilitation management for Duchene Muscular Dystrophy was implemented in Paediatric Neurology. A detailed psychosocial assessment and counselling was also instituted at CCCND after the recruitment of Medical Social Worker.

### Events organized

1. A Parent Outreach Programme titled 'Let's Join Hands Together' was held on 2 April 2019 on World Autism Awareness Day (Figure 55).

Parents of children with autism were invited to attend a session by Dr Tomy David C S (Psychiatrist). The aim of the session was to help parents identify support systems from within themselves. The programme was attended by 17 children and their families.



Figure 55. Parent Outreach Programme on Autism Day

2. A 2-day Workshop on 'Applied Behavioral Analysis and Red flags in Autism' was conducted on 31 August -1 September 2019 (Figure 56). Ms Gita Srikant (Founder Director of WeCAN, the 1st ABA Center in Chennai for children affected by Autism Spectrum Disorder) and Ms Swati Narayan (Chief Operating Officer at ProACT Behavioral Services) were the speakers at the Workshop. A total of 30 delegates participated in the Workshop.
3. A talk on 'Neurobiology of ADHD' by Dr Valsamma Eapen, Professor and Chair of Infant, Child and Adolescent Psychiatry, University of New South Wales, and Head of the Academic Unit of Child Psychiatry, South West Sydney, was organized on 21 January 2020 (Figure 57).



Figure 56. Workshop on Applied Behavioral Analysis and Red flags in Autism



Figure 57. Talk on Neurobiology of ADHD

## 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 neighbouring 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: (1) to provide comprehensive medical, surgical, psychosocial and occupational care for patients with epilepsy with 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) to address issues pertaining to women with epilepsy under the subsection of Kerala Registry for Epilepsy in Pregnancy (KREP).

### Activities

The Centre conducts 2 Speciality Clinics in a week and patients are admitted for diagnosis and pre-surgical evaluation. Two epilepsy surgeries are conducted every week.

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

Activity	Number
Video EEG monitoring	1249
Intracranial monitoring	5
Epilepsy surgery	100
Intraoperative electrocorticogram	70
WADA test	5
Epilepsy clinic attendance	8090





### *Product Development*

The development of intracranial electrode in collaboration with BMT Wing continued. The prototype was ready and awaited animal safety testing.

### **Events Organized**

International Epilepsy Day was observed on 12 February 2020. Multiple competitions were conducted for children with epilepsy. Malayalam playback singer, Sri G Venugopal, was the Chief Guest. Prizes were distributed to the winners of the competition. Prof Sanjeev V Thomas, Prof Ashalatha R, Prof Mathew Abraham and Dr Ajith Cherian gave talks on epilepsy. Around 300 people attended the programme.

### **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, Additional 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

2019-20 was a year of consolidation as well as achievement for the Department of Neurosurgery, which continued its pursuit of excellence. During the move forward, the Mission of the Department remained unchanged - to provide world-class neurosurgical care, advance neurosurgical knowledge through research and innovation and ensure the best academic environment for neurosurgical education.

### Activities

The Department had significant increase in the number of patients seeking surgical care during the year with most of them requiring meticulous evaluation and complex procedures. The goals of the Department included: dedication to providing technically advanced and timely surgical care to patients, commitment to the education of Residents and Post-doctoral Fellows, and clinical research with emphasis on device development. The Department also offered training in the form of observership to many Residents from other institutions in India. Faculty and Residents actively represented the Institute in various international and national conferences and Workshops. Significant research work was performed within the department and as collaborative inter-departmental TRC- and TDF-funded projects, and as part of the PhD Programme.

### Clinical Activities

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 coordinated manner, 5 days a week.. A total of 1517 surgeries were performed during this period, most of which were complex procedures of various sub-specialities of neurosurgery. During academic inter-departmental meetings on working Saturdays, meticulous planning of the surgical strategy for patients who were awaiting surgery was done along with inter-departmental neuroradiology discussions.

### Research Programmes

#### The following research projects continued:

1. A prospective observational study of patients undergoing microneurosurgical procedures through a interhemispheric transcallosal approach, PI - Dr Mathew Abraham (Funded by: CAREF)
2. A prospective observational study of outcomes of different transcranial approaches for craniopharyngiomas, PI - Dr Mathew Abraham (Funded by: CAREF)
3. Predictors of visual outcome and recurrence following surgical resection of Medial Sphenoid Wing Meningioma, PI - Dr Mathew Abraham (Funded by: CAREF)
4. Evaluation of fibrous mesh sheets as scaffolds for increasing the area of neovascularisation in Moyamoya disease, PI - Dr Jayanand Sudhir (Funded by: TDF, SCTIMST)
5. Development of skull base buttress device for the closure of osteodural defect, PI - Dr Prakash Nair (Funded by: TDF, SCTIMST)
6. Reverse suction and suction arrester, PI - Dr Tobin George (Funded by: TDF, SCTIMST)

#### The following research projects were newly initiated:

1. Craniovertebral junction anomalies: clinical and radiological outcome evaluation after surgical intervention, PI - Dr Krishnakumar K K (Funded by: CAREF)
2. Real-time assessment of shift of ICA during extended endoscopic skull base surgery using intraoperative doppler and the role of tumour consistency in causing ICA displacement, PI - Dr Prakash Nair (Funded by: DST-SERB).
3. Cavity conformable surgical space stent retractor - Design and Proof-of-Concept, PI - Dr George



Vilanilam (Funded by: TDF, SCTIMST)

### *Product Development*

The Department was involved in the following Medical Device Development projects in collaboration with the BMT Wing:

1. Development of cavity conformable surgical space stent retractor
2. Development of novel pedicle screws for thoracolumbar fixation

The following major equipment were purchased during the year:

1. BODYTOM portable CT scanner costing Rs 6.91 Crores
2. Curve: 2 Brain Lab neuronavigation costing Rs 2.52 Crores
3. BK5000 intra-operative Ultrasound worth Rs 50.8 Lakhs
4. MAXIMOVE patient hoist device costing Rs 27.18 Lakhs

### **New Initiatives**

With the introduction of portable intra-operative CT scanner machine in the Neurosurgery Department, the level of safety in surgery and excellence in patient care witnessed a significant leap – protocols ensuring imaging of patients after surgical procedures led to detection of any adverse events in the least possible time, paving the way for immediate intervention and enhanced patient safety.

### **Events Organized**

The Department organized the 16th Instructional Course and 11th Basic Sciences Course of the

Neurological Society of India on 4-5 May 2019 at SCTIMST. The Courses focussed on in-depth training of Neurosurgery Residents from all over the country in all aspects of Neurosurgery and its sub-specialities. Dr Mathew Abraham was the Organizing Chairman, Dr George Vilanilam was the Organizing Secretary and Dr Ganesh D was the Treasurer for this event.

### **Awards and Honours**

1. Dr Mathew Abraham was appointed by the Government of Kerala as Member of the Expert Committee for deciding the parameters and protocols for brain death and the Committee report was accepted by the Government in April 2019.
2. Dr Easwer H V received a testimonial from Mr Rajeevan Sadanandan, Additional Chief Secretary, Department of Health and Family Welfare, Government of Kerala, for his contributions to the Deceased Donor Organ Donation Programme, Government of Kerala.
3. Dr George Vilanilam was appointed Mentor for the Epilepsy Surgery Program, training Workshop resource person, performing epilepsy surgeries at the National Epilepsy Centre, Colombo, Sri Lanka in September 2019.
4. Dr George Vilanilam was selected for the International League Against Epilepsy (ILAE) Leadership Development Program from 21-26 June 2019 at Bangkok.
5. Dr Jayanand Sudhir won the Best Paper Award for the presentation titled “Surgical outcome of Moyamoya disease in children” at INDPNCON 2020 in February at Kolkata.
6. Dr Jayanand Sudhir won the Best Paper Award for the presentation titled “Entangled: difficulties in microvascular anastomosis” at Vascular Neurosurgery Update 2019 in SGPGI, Lucknow.
7. Dr Jayanand Sudhir was appointed Member of National Advisory Committee for 6th National



Symposium on Shock Waves NSSW-2020 from 26-28 February 2020 at IIT Madras.

8. Dr Ganesh Divakar was selected for the national level NSI Educational Course on spinal deformity and peripheral nerve surgeries on 27-28 July 2019 at Guwahati, Assam.
9. Dr Ganesh Divakar was selected Member of Advisory Board on the status of programmable shunt products in current clinical practice and current treatment options and unmet medical needs in hydrocephalus: Neurocritical Care on 24 November 2019 at New Delhi.

#### Staff

#### Faculty

Dr Mathew Abraham, Professor and Head of the Department

Dr Easwer H V, 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)



## 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, and 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	1118
Cardiovascular & thoracic biopsies	364
Muscle biopsies	53
Frozen sections	449
Cytology	144
Paraffin blocks	5477
Immunohistochemistry	4865
Immunopathology	6530

Electrophoresis Unit costing 20 Lakhs was purchased for the detection of oligoclonal bands in CSF and serum.

### 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 a-synucleinopathy 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

Four immunology tests were introduced during the year:

- Indirect immunofluorescence tests for: ANA, dsDNA and Aquaporin 4 - MOG
- Test for detection of oligoclonal bands in CSF and serum

### Events Organized

1. The Department organized a short CME on Autoimmunity and Neurology in collaboration with CPC Diagnostics at SCTIMST on 30 November 2019.
2. The Department participated in the "Open Day" conducted as part of the National Science Day 2020 celebration at the Institute on 6 March 2020 at the Biomedical Technology Wing. Dr Rajalakshmi P was part of the Organizing Committee. The Department displayed normal and pathological specimens of human heart and brain. A poster on "Brain-fun-facts" was also presented.

### Staff

#### Faculty

Dr Deepti A N, Associate Professor and Acting Head  
Dr Rajalakshmi P, Assistant Professor  
Dr Divya Mundackal Sivaraman, Scientist C

#### Technical

Ms Sushama Kumari P, Scientific Officer (Lab)  
Mr James T, Junior Scientific Officer  
Ms Neena Issac, Technical Assistant (Lab) - A  
Ms Resmi S R, Technical Assistant (Lab) - A



## PAIN CLINIC

The Comprehensive Multidisciplinary Pain Clinic functions on patient management decisions arrived at by the Pain Clinician Team from various specialty departments of the Institute.

### Activities

The Clinic offers highly skilled interventional procedures as indicated below (Figure 58):

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



Figure 58. Procedures performed at Pain Clinic

During the year, 1642 patients were registered in the Clinic and 859 patients were catered to in the Clinic and Intervention suites, the details of which are provided in the Table below:

Activity/Procedure	Number
Direct outside and hospital referrals	4
Review and direct in-house referrals	701
Regenerative autologous PRP prolotherapy interventions	134
Major interventions (Gasserian ganglion radiofrequency ablation)	12
Minor interventions (Trigger point and musculoskeletal infiltrations)	5
Rehab and physiotherapy Interventions	3
<b>Total</b>	<b>859</b>

The Clinic offered outpatient services on Fridays. Major interventions were performed in the Digital Subtraction Angiography-Radiology Cath Lab and minor interventions were performed in the outpatient procedure room/observation room.

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

### Research Programmes

1. 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, for: Development of stance control knee ankle foot orthosis (SCKAFO) for knee instability management and A/F Bio-inspired total foot pressure off-loading device for diabetic foot ulcer management in geriatric population, in collaboration with TynorOrthotics Pvt. Ltd. (Tynor).



2. The Faculty of the Clinic were part of the new research initiative and technology transfer for 'Biological fluids component separator and mechanism thereof'. A Patent Design Registration was filed for the same.
3. Pre-clinical studies for regenerative therapies in pain with osteoarthritis continued in collaboration with Dr Prabha D Nair, Division of Tissue Engineering and Regeneration Technologies, BMT Wing.
4. Basic sciences 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. A patent was filed for the same.
5. Drs Subin Sukesan and Nitha J were co-investigators in the study "Home-based Therapeutic exercises for Pain - Adherence, and Barriers" by Ms Arunima Sunil Kumar Bindhurani (Student in Advanced Certificate Programmes in Physiotherapy in Neurological Sciences).

### **New Initiatives**

The Clinic initiated specialized geriatric care for patients above 60 years with chronic musculoskeletal non-cancerous pain conditions, with funding from Kusuma Trust, UK. The administrative clearance procedures from the Institute and DST were underway.

### **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



# DEPARTMENT OF TRANSFUSION MEDICINE

## Activities

During the year 2019-20, 6646 blood units were collected entirely from voluntary blood donors, out of which 5511 units were collected from outdoor blood donation camps and 1135 units from in-house collection. 185 outdoor blood donation camps were held during the year from which 5511 units were collected. A total of 11123 units of blood were cross-matched (10512 units for in-house patients and 611 units for outside patients) of which 7706 units were transfused (7095 for in-house patients and 611 for outside patients). 34736 blood groupings were performed on patients (32167 for in-house patients and 2569 for outside patients). 6646 units of blood collected were processed into various blood components: 6550 units of packed red cells, 6401 units of fresh frozen plasma, 1785 units of platelets and 1575 units of fresh plasma. 16 single donor platelets were prepared by the apheresis method. 185 units of platelet-rich plasma were prepared for the Pain Clinic under the Regenerative Medicine Programme. 18 therapeutic plasma exchanges performed at the Neurology ICU for neurological conditions were supported by Residents and faculty of the Department. 172 platelet-rich plasma therapies were performed jointly with the Pain Clinic.

## Research Programmes

1. Cross-sectional study to evaluate electronic gadget usage and sleep quality of blood donors
2. A comparative study of the performance of red cell leucofilters used in the Department
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)

## New Initiatives

1. The Department carried out Nucleic Acid Amplification Testing on all donated blood units, which significantly increased blood safety.
2. Fully automated immunohematology equipment

was installed in the Department for carrying out blood grouping, antibody screening and cross-matching.

3. Platelet-Rich Plasma Therapy was undertaken as a regular treatment modality jointly with the Pain Clinic of SCTIMST.

## Events Organized

1. World Blood Donor Day was celebrated on 14 June 2019. Blood donation camps were organized in the Department. Painting competition on Voluntary Blood Donation was conducted in several schools of Trivandrum and prizes were awarded.
2. A cricket match was conducted between blood donors belonging to 4 blood groups and the winners were felicitated during National Voluntary Blood Donation Day.
3. National Voluntary Blood Donation Day was celebrated on 1 October 2019. On the occasion, regular voluntary blood donors and voluntary blood donation camp organizers were felicitated.
4. The Department conducted the Refresher Training Programme for Blood Bank Medical Officers of Kerala from 23-25 October 2019.
5. A 1-day CME on 'Nucleic Acid Amplification Testing- Impact on Blood Safety' was organized by the Department on 29 April 2019.

## Awards and Honours

1. Dr Debasish Gupta was entrusted, as an Executive Member of the Indian Pharmacopoeia Commission, Ministry of Health and Family Welfare, Government of India, to write a complete Monograph on Blood Components, which was completed and submitted to the Government of India.
2. Dr Debasish Gupta, as Chairperson of the Committee on Developing National Reference Standards of Blood Grouping Antisera by the National Institute of Biologicals, Ministry of Health and Family Welfare, Government of India, attended and chaired 3 meetings during the year.



3. Dr Debasish Gupta was elected President of the Indian Society of Transfusion Medicine for a term of 3 years.
4. Dr Debasish Gupta was the Resource Person for the CME Programme on Hemovigilance by Manipal Hospital, Bengaluru, and Children Hospital, Mumbai.
5. Dr Debasish Gupta was the Resource Person for the 2-day National Training Programme for medical doctors organized by the Hemovigilance Programme of India, Ministry of Health and Family Welfare, Government of India.
6. Dr Amita won the 1st prize for free paper at the ISBTI Kerala Chapter in August 2019.
7. Dr Amita R was nominated Member of the Executive Committee of the Kerala State Chapter of Indian Society of Blood Transfusion and Immunohematology (ISBTI) for a term of 3 years.
8. Dr Amita R won the 2nd prize in Hindi calligraphy competition conducted at SCTIMST as part of Hindi Fortnight Celebrations in September 2019.
9. Media Presentations by Dr Amita R:
  - TV show on “Voluntary Blood Donation” on Mangalam TV on 14 June 2019, World Blood Donor Day
  - Talk on Apheresis on Big FM, on 21 September 2019, in connection with World Apheresis Awareness Day and National Voluntary Blood Donation Day
  - Talk on “Tests done on donated blood units in Blood Bank” on Ananthapuri FM on 1 December 2019, World AIDS Day
  - Three-part weekly talk series on “Females and Blood donation” on Ananthapuri FM
10. Drs Anila Mani and Sreethu Chand, Junior Residents, won the 2nd prize in quiz competition at the 44th National conference of ISBTI.
11. Drs Anila Mani and Sreethu Chand, Junior Residents, won the 2nd prize in quiz competition at the ISBTI - Kerala Chapter.

#### Staff

#### Faculty

Dr Debasish Gupta, Professor and Head of the Department  
Dr S Sathyabhama, Scientist G  
Dr R Raj Bharath, Associate Professor  
Dr Amita R, Assistant Professor

#### Technical

Ms Sheela Devi K S, Scientific Officer  
Ms Girija C, Nursing Officer - D  
Ms Sindhu P N, Scientific Officer  
Ms Baby Saritha G, Junior Technical Officer  
Mr Sivakumar S, Junior Technical Officer  
Mr Sunil K P, Technical Assistant - B  
Ms Jyothi M, Senior Technical Assistant  
Mr George Paul Taliyath, Medical Social Worker - A  
Ms Renjini M, Technical Assistant - B  
Ms Sindhu M S, Technical Assistant - B  
Ms Manju K Nair, Technical Assistant - B  
Ms Preethy Prakash, Technical Assistant - B  
Ms Geetha S, Unit Helper - B



# 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 Pharmacopoeia (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, which resulted in a number of technologies. The Department is working on cutting edge research areas like 3D-bioprinting, regenerative technologies, stem cell therapy, research in memory and learning, sleep research, material-cell microbial interactions, biomaterial-tissue interactions and laboratory animal models.

The Department of Applied Biology comprises the Divisions of:

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

### DIVISION OF EXPERIMENTAL PATHOLOGY

The Laboratory is unique in the country as a COFRAC-accredited laboratory with facilities to undertake routine and also a wide range of specialized techniques for the evaluation of biocompatibility of various materials as per International standards and pre-clinical evaluation of medical devices as per approved protocols. The Division is engaged in the histological evaluation of samples from internal and

external customers.

### Product Development

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 a wound healing matrix. This technology was transferred to M/s Alicorn Medical Pvt. Ltd. The Company is an incubatee at SCTIMST TiMed and is licensed to manufacture Class D biomedical device for testing purpose by the Central Drugs Standard Control Organisation (CDSCO).

### Research Programmes

1. Testing the potential of cholecyst-derived scaffold for cardiac application.
2. Preparing the cholecyst-derived material as powder and gel and for use in hybrid scaffold products for applications like hernia repair.
3. Rabbit implantation study to evaluate osseous integration of dental implants developed under DBT Translational Research Program on Biomaterials for Orthopaedic and Dental Applications. Histopathological evaluation of the newly designed implant showed good osseointegration and new bone formation around the implants (Figure 1).
4. Gross and histopathological evaluation for following medical devices under development:
  - Alginate scaffold with recombinant growth for enhanced wound healing
  - Biodegradable PLGC-fibrin hemostatic graft for skin regeneration
  - Calcium phosphate porous ceramic beads loaded with antibiotic



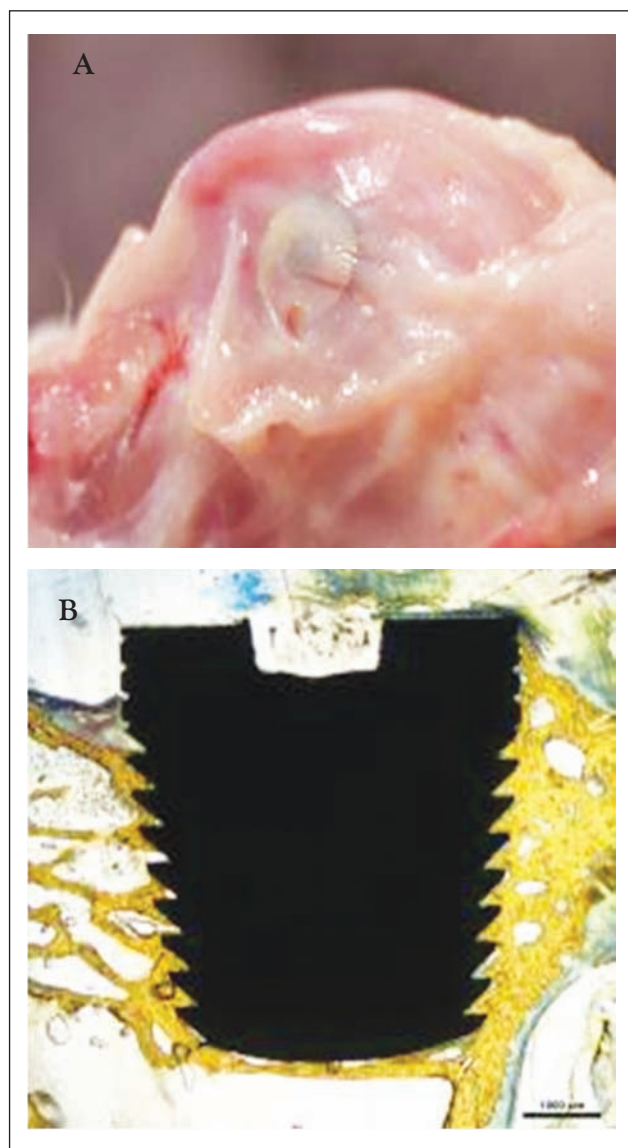


Figure 1. Osseointegration study on titanium dental implant (A) Implant in femoral condyle 12 weeks post implantation. (B) Histology of the site with Ti implant bone interface, proving osseointegration

## Testing and Evaluation

At the Histopathology Laboratory, a total of 446 tissue specimens were received, which included muscle, subcutaneous tissue with implant, penile and vaginal tissue and bone with implant for biocompatibility evaluation as per ISO 10993-6 and 10. Preclinical evaluation specimens such as pig mandible with

bone graft, rat calvarial bone with implant, dura substitute, dental sockets, rabbit knee joint tissues, rat heart infarct model and skin wound healing studies were also received. 46 test reports that included accredited and non-accredited test reports and necropsy reports were issued during the year. Internal audit was successfully completed. The Laboratory has maintained the quality system for the past 17 years and has successfully retained COFRAC accreditation for intramuscular, subcutaneous and bone implantation tests and mucosal irritation tests.

## DIVISION OF LABORATORY ANIMAL SCIENCE

The Division of Laboratory Animal Science (DLAS) facilitates research and testing using small laboratory animals by imparting care, welfare and management of small laboratory rodents and rabbits. The Division is CPCSEA-registered and the activities are carried out as per the standard ISO 10993, on the quality platform ISO/IEC 17025 accredited by COFRAC. The primary mandate of DLAS is to breed stock and supply good quality small laboratory animals for testing and research. DLAS has a state-of-the-art experimental animal facility with Individually Ventilated Cages (IVC) System and changing stations. The Division takes part in device development projects and delivers animal models for proof-of-concept studies. In addition, the Division also carries out special training for budding researchers in small laboratory animal handling, ethics and technicalities of small laboratory animal welfare assessments.

The Division takes care of the Institutional Animal Ethics Committee (IAEC) and executes the process of obtaining sanctions for animal experimentation for the Institute, in compliance with CPCSEA stipulations. DLAS conducted 3 IAEC Meetings (15 May 2019, 17 July 2019 and 21 January 2020) and approved B-Form applications to perform animal studies in the Institute.



## Research Programmes

The Division supplied animals for in vivo evaluation of biomaterials and devices under the following Projects:

1. Optical peripheral nerve stimulator
2. Chitosan/alginate-based antioxidant polymeric wound dressings for controlled antibiotic delivery
3. Alginate scaffold with recombinant growth factors for enhanced wound healing
4. Preclinical evaluation of wound dressings in diabetic model
5. Bioengineered skin graft for chronic wounds using 3-D hybrid scaffold composed of silk fibroin, fibrin and amnion
6. Curcumin-albumin conjugate, a novel anti-inflammatory drug formulation for treatment of osteoarthritis – study in rabbits
7. Evaluation of the bioavailability and efficacy of human protein as delivery vehicle of curcumin in animal models - Pharmacokinetics in rats
8. Preclinical evaluation of anti-snake venom (IgY) - Immunization with snake venom in poultry, evaluation of ED50 in mice and pharmacokinetics of IgY-study in rats
9. Spinal cord injury model
10. Oral Insulin Delivery System

## Testing and Evaluation

The Division supplied: 134 Rabbits, 669 Rats, 890 Mice and 85 Guinea pigs for research and testing during the year.

## Training

1. The Division conducted a 1-day Conference on “Severity classification and harm-benefit analysis in animal experimentation” on 18 February 2020 at SCTIMST. It was funded by the Laboratory Animal Scientists Association, India. Dr Klas Abelson, Associate Professor, Department of Experimental Medicine, University of Copenhagen, led the sessions. There were about 50 participants including Scientists, Veterinarians, CPCSEA nominees, MSc, MVSc

and PhD students.

2. Special training was organised for 6 candidates from the Government Medical College, Alappuzha, on 5-6 April 2019. The topics were small laboratory animal handling, ethics and technicalities of small laboratory animal welfare assessment.

## DIVISION OF MICROBIAL TECHNOLOGY

The Division is unique in that it focuses on studying infections associated with the use of medical devices, understanding bacterial biofilms and their immune evasion mechanisms and tests such as bioburden analysis, in vitro genotoxicity assay and sterility test as part of product release studies. The Division is an accredited Test Facility for medical devices and materials and conducts microbiological evaluations for researchers and industrial customers.

As nanotechnology has gained prominence and its use in health care delivery is being explored, the Division started exploring the role of nanoparticles in microbial infections and immune modulations. The Division is also interested in developing newer in vitro diagnostics and treatments, specifically in the area of antimicrobial resistance and is working on ‘targeted antibiotics’ as a solution for misuse and overuse of antibiotics.

## Product Development

1. *Rapid diagnostic kit for urinary tract infection - Rapidogram* was transferred to industry and the process of multicentric trials for CDSCO approval was ongoing.

2. *Development of Universal Transport Medium*

Universal Transport Medium (UTM) is a critical component in diagnosis of viral diseases and plays a critical role in keeping the virus intact and viable, and at the same time prevents overgrowth of the natural and other bacterial flora from the site of sample collection. Thus, UTM maintains the viability of the viruses and facilitates isolation of viral DNA/ RNA for



diagnosis and culture. This product was modified for the current COVID-19 pandemic as swab collection medium.

## Research Programmes

### 1. Antibacterial compound from *Bacillus safensis* against Methicillin-resistant *Staphylococcus aureus*

Developing target-specific antibiotics would prevent overuse and misuse of antibiotics. With this goal, *Bacillus safensis* was isolated by sampling air and showed antibacterial activity specifically against Methicillin-resistant *Staphylococcus aureus* (MRSA) (Figure 2) and, to a limited extent, towards *Staphylococcus aureus*. *Bacillus safensis* was purified and the pure culture was submitted to Microbial Repository at NCCS Pune. Media standardisation and optimisation of production conditions for antibacterial production was carried out and large scale production was initiated in the fermentor. Characterisation of the antibacterial compound showed that the molecule had unique properties like temperature stability and high salt tolerance.



Figure 2. Kirby bauer disc diffusion assay for antimicrobial activity of cell-free supernatant at various time intervals against MRSA

### 2. Immunomodulation by *Pseudomonas* biofilms

An intact barrier protects lung tissues from invading pathogens. In this study, Electrical Cell-Substrate Impedance Sensing (ECIS) was used to study the changes in barrier integrity during infection with *Pseudomonas*. It was observed that, during the early stages of infection (as early as 2 hours post-infection), *Pseudomonas* disrupted the barrier integrity. Pro-inflammatory cytokine expression was assessed by RT-PCR and ELISA-based quantification. An increase in TNF1 expression was observed in cells infected with biofilms of *Pseudomonas*. The planktonic forms of *Pseudomonas* induced IL-8, iNOS and (TNF1) gene expression in A549 and THP1 cells and their co-cultures.

Morphological changes in A549 cells, monocytes (THP1) and their co-cultures were assessed by acridine orange and propidium iodide to understand the mechanism of cell death. The biofilm-infected cells showed hallmark features of both apoptosis and necrosis. Like apoptotic cells, the biofilm-infected cells showed cellular blebbing. The cells also appeared to have lost membrane integrity, which is typically observed in necrotic cells (Figure 3). Nuclear changes in infected cells were analysed by Hoechst 33342 staining. Nuclear fragmentation, with an intact nuclear membrane, was observed in cells infected with biofilms of *Pseudomonas*.

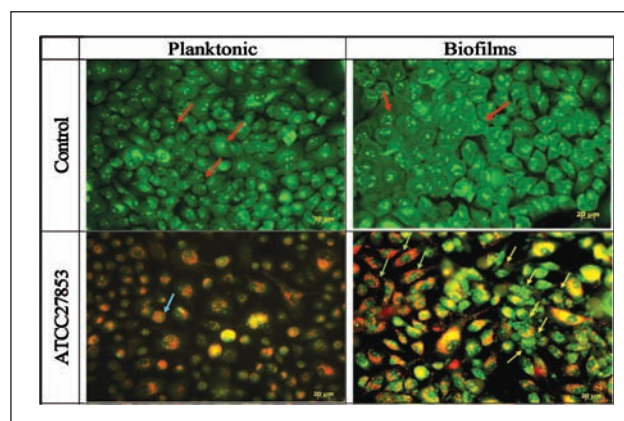


Figure 3. Acridine orange and propidium iodide staining of A549 cells infected with *Pseudomonas* planktonic and biofilm forms. Biofilm-infected cells show blebbing (yellow arrows) and loss of membrane integrity (green arrows)



### 3. Nanoparticles as inducers of pulmonary fibrosis

Pulmonary fibrosis is a chronic lung disease characterized pathologically by excessive accumulation of extracellular matrix and remodelling of lung architecture. Due to rapid development of the nanotechnology industry in the last decade, nanoparticles are omnipresent in our everyday life. Many nanomaterials have been engineered for medical purposes, including theranostics. On the other hand, nanoparticles, as foreign material in human bodies, are reported to have potential adverse effects on the lung. Exposure to airborne particles contributes to many chronic pulmonary diseases. Small-sized particles, especially nanosized particles, have unrestricted access to most areas of the lung. Understanding the mechanisms of fibrotic responses induced by nanoparticles using in vitro systems was a major objective of this study. For this, along with traditional cell culture systems, Electrical Cell-Substrate Impedance Sensing (ECIS) was used to understand the changes. Tight junctions of alveolar epithelial cells (AECs) are integral to the maintenance of the AEC barrier integrity. Fibrotic lung diseases involve AECs as a target of injury and driver of ongoing pathological processes. Here, alveolar epithelial barrier integrity was measured using ECIS. In addition, the effect of carbon black nanoparticle, a common component of air pollution, was studied using ECIS. Exposure of A549 to varying concentrations of carbon nanoparticles induced a change in impedance, a clear indicator of change in tight junction integrity (Figure 4). Cytokine expression and signalling, molecular mechanism of apoptosis and role of epithelial-mesenchymal transition in induction of fibrosis were also investigated.

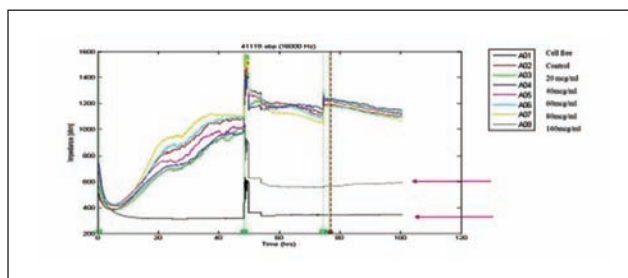


Figure 4. Impedance change in A549 monolayer exposed to varying concentrations of carbon black indicating of change in tight junction integrity

### Testing and Evaluation

For supporting medical device development, the Division offers a number of tests to the medical devices industry and to researchers within the Institute. The Division maintains a Class 10000 Facility for performance of sterility test and full-fledged Microbiology and Tissue Culture Laboratories working on ISO 17025 Platform. It is also involved with health monitoring of small and large experimental animals to ensure high quality animals for experimental purposes, biocompatibility assessments and pre-clinical studies.

A total of 98 test requests with 242 samples were handled during the year. The tests conducted were (number of samples in brackets): Sterility test (40), Genotoxicity test- Bacterial reverse mutation assay (2), Bioburden analysis (2), Microbiological monitoring of controlled environment (103), Microbiological analysis of water (48), Spore Viability Test (3), Anti-microbial activity testing - agar diffusion method (4) and Growth promotion test for microbiological media (40).

### COVID-19 testing

Responding to the national call in combating COVID-19 pandemic and teaming up with ICMR-approved COVID Testing Laboratory at the Hospital Wing, the BMT Wing COVID testing team was constituted with faculty, staff and students from all Divisions of the Department of Applied Biology. They were trained in the complex task of testing of clinical samples for the n-COVID-19 virus.

### DIVISION OF MOLECULAR MEDICINE

The current research interest of the Division is in understanding the functional alterations in the brain due to interactome and connectome modifications. These studies are being carried out in the *Caenorhabditis elegans* model. We have developed various experimental paradigms like imprinting and olfactory learning in this model to see how targeted neurons alter functionally.

## Product Development

### 1. Growth factor-incorporated biological scaffold for enhanced wound healing

The Programme aims to develop cost-effective bandages with growth factors for chronic skin wounds. Growth factors allow the wounds to heal faster, and TGF- $\alpha$  and VEGF are two growth factors that have a critical role in the wound healing process. These growth factors were incorporated into a bio-scaffold to augment the healing process. They were expressed as functional peptides to increase the stability and bioactivity levels. Preclinical results showed that a combination of these growth factors had a significant effect on the healing of chronic skin wounds.

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

A modified LAMP reaction was developed for faster detection of pulmonary tuberculosis. The assay was cost-effective and could be performed within one hour with minimum expertise in 20 patient samples at a time. More than 1500 cases were tested and the LAMP test demonstrated a sensitivity and specificity of 93% and 95%, respectively, in comparison with qPCR. A national level field trial was planned after receiving the approval of ICMR.

## Research Programmes

### 1. Interactome and connectome alterations in the brain during physiological and pathological conditions

Learning and memory are fundamental functions of the brain. Though it is known that neuronal plasticity has a role in this pathway, the exact mechanism by which neurons record and recall memory is not clear. *Caenorhabditis elegans* (*C.elegans*), a nematode model with limited, but well-defined nervous system, was used to elucidate the neuronal connectome involved in conditional learning paradigm, especially in olfactory learning. One of the critical observations was that the base levels of neurotransmitters, especially dopamine, tyramine, insulin and glutamate,

were critical in the development of behaviour patterns in this organism. A series of genetic mutants were analysed to further ascertain how alterations in the receptors of these neurotransmitters affected the learning paradigm in specific neurons involved in olfactory signal recognition. The learning deficiency could be linked to epigenetic factors that were critical to the development of proper circuits during early development. In the olfactory learning pathway, a series of receptors were demonstrated to have a critical role at various stages. Besides, dopamine neuron degeneration was found to have a significant impact on learning in *C.elegans* (Figures 5 and 6).

To further probe how neurodegenerative diseases like Alzheimer's Disease and Parkinson's Disease (PD) affected the memory pathway, mutant worms expressing human alpha-synuclein and beta-amyloid in nerve cells were used. As in PD patients, worms expressing human alpha-synuclein in their dopamine neurons showed neurodegeneration as the organism aged. Moreover, dopamine neurons were found to be more sensitive to metallic salts and developed degeneration.

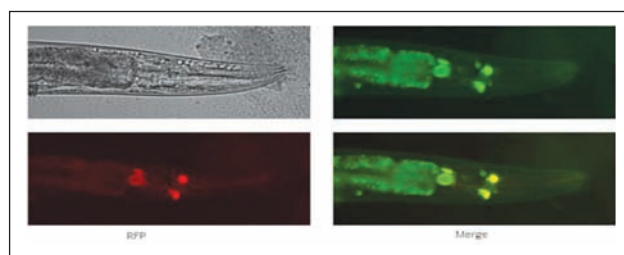


Figure 5. Transgenic worm expressing GCaMP-6, a calcium sensor, in dopamine neurons. RFP was used as a co-marker for transgenic construction.

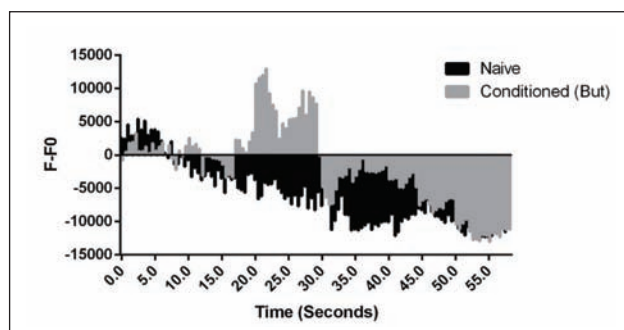


Figure 6. GCaMP-6 expression profiling during memory recalling in dopamine neuron after conditioning to Butanone (But).





## DIVISION OF SLEEP RESEARCH

The Division conducts studies to understand the neural mechanisms involved in sleep regulation and undertakes translational research in the emerging aspects of sleep medicine for improving human health. The Laboratory is equipped with state-of-the-art equipment and technology to conduct sleep research.

The current research explores the role of sleep in developmental programming for ontogenetic organization of heart rhythms via autonomic balance and tuning with sleep-wakefulness and cognitive development using insomnia model in rodents. The effects of controlled sleep deprivation in dams during pregnancy on offspring were studied by monitoring the heart rate variability and sleep and emotional-cognitive behaviour immediately after birth and until adolescence. The free moving offsprings were monitored for the electrophysiological parameters - EEG (for electrical activity of brain) and EMG (for muscle activity) and heart rate variability. Maternal sleep deprivation suppressed the development of parasympathetic component of the autonomic system in infants and disturbed autonomic balance for heart rhythms in relation to sleep stages. The Laboratory also aimed to identify suitable inflammatory markers for acute and chronic sleep deprivation. Research outputs from the Division were published in international journals and presented at various international meetings. The Division provided extensive training to students in techniques to study sleep and cognition in free moving animals.

### Research Programmes

The Division is one of the few Laboratories at the National and International levels that work towards identifying the role of sleep during pregnancy in shaping cognition in offspring, which is a novel area of research. The sleep and cognitive studies conducted illustrated distinct variations in circadian patterns of non-rapid eye movement (NREM) sleep and delta power in maternal sleep from pregnancy to nursing period. Evaluation of neonatal sleep of pups born to the

REM sleep-deprived mother provided important clues for understanding the role of sleep during pregnancy. The sleep-wake patterns in neonates born to the sleep-challenged dams displayed not only immature networks but also pointed to reduced parasympathetic development for heart rate during initial days of birth. These findings were novel and indicated that excessively disturbed sleep may be a risk factor for an optimal development of autonomic regulation of heart rate. Deficiency in parasympathetic balance during early postnatal period might interfere with the development of regulatory mechanisms by the autonomic nervous system during this early window.

The Division is also engaged in finding solutions for prevention and management of hyperactivity and impulsive disorders in children. Our previous work had demonstrated that sleep deprivation during the third trimester of pregnancy had serious consequences on the cognitive development of the offspring. Sleep deprivation during pregnancy produced hyperactivity, emotional deficits and increased risk-taking behaviour during the entire peri-adolescence period. In addition, efforts to find a safe herbal substitute for management of insomnia during pregnancy continued.

### Training and Education

1. Neuroscience School 2019 with the theme "Advanced techniques to explore the functions of normal and diseased brain", sponsored by the International Brain Research Organization-Asia Pacific Regional Committee (IBRO-APRC), was organised by the Department from 22 April - 6 May 2019 at SCTIMST. The School introduced novel tools like optogenetics, imaging techniques in humans and animal models, and regenerative strategies for neuronal replacement and repair. A special session on Neuroethics was conducted. The technical lectures were followed by demonstration and hands-on sessions.
2. The Division was engaged in the popularization of Sleep Science research by organizing events like World Sleep Day and talks.





## DIVISION OF TISSUE CULTURE

The Division offers in vitro cytotoxicity testing of biomaterials and devices performed under the quality platform on cultured mammalian cells to internal and external customers. Three basic tests done on ISO17025 platform are accredited by COFRAC, France. The Division also offers cytocompatibility tests that involve analysis of cell-material interaction through a variety of tests like cell adhesion, cell proliferation, MTT assay, cellular uptake of particles, IC50, osteogenic potential of biomaterials, wound healing assay and DNA repair assay. The Division is involved in research and technology development in the area of cell and regenerative technologies. Research areas include cell technologies, biofabrication, 3D bioprinting, cell-material interaction, stem cells and scaffolds for tissue engineering and in vitro tissue models.

### Product Development

#### Major Programmes

##### *1. 3D-bioprinting of liver tissue constructs for in vitro hepatotoxicity testing*

The Division initiated the Three Dimensional (3D) Bioprinting and Biofabrication Programme for development of liver construct as the part of Institute's Core Research Programme. A novel bioink based on modified gelatine was developed, aiming at the functional maintenance of liver constructs. Parenchymal liver constructs were 3D bioprinted based on a computer-aided design model and liver-specific functionality was assessed. Rat and human primary hepatocytes were used for the biofabrication of liver constructs. The in vitro-developed construct was functional and responded to drugs in a dose-dependent manner. These miniature functional liver constructs can be used as: an in vitro hepatotoxicity test system to screen drugs, an alternative for in vivo animal testing and a prediction system for clinical evaluation of drugs. The comparison of this in vitro test system against the gold standard in vivo animal testing was underway.

##### *2. Corneal epithelial cell sheet engineering*

The Project was funded by the Department of Science and Technology through the TRC Scheme of the Institute. The damaged corneal tissues are treated by transplantation using donated cornea. However, worldwide demand for healthy donor corneas has exceeded the supply. To meet the demand, bioengineered corneal tissues was developed using thermoresponsive polymer-based cell sheet engineering strategy. A novel thermoresponsive polymer known as glycidylmethacrylate-conjugated Poly(N-isopropylacrylamide) (NGMA) was developed and its efficacy in regenerating damaged cornea was demonstrated in rabbit model. The synthesis of NGMA, characterization of cell sheets and the efficacy was evaluated as per the requirements of regulatory approval for clinical translation. The preclinical evaluation of the cell sheets will be performed in limbal stem cell-deficient animal models.

##### *3. Development of a novel device and a method of cell seeding for the establishment of an in vitro co-culture system*

Cell-cell interaction studies in vitro can give a lot of information on organization of cells in tissues and their functional characteristics. Two or more different types of cells are co-cultured together with direct or indirect contact. Currently, there are no specialized tools that allow direct contact co-culture system. A novel device was developed at the Division for the establishment of an in vitro co-cultured tissue construct that can potentially be used: to understand fundamental cell biology, as a toxicological testing model or as an artificial tissue for therapeutic applications. A polymeric scaffold with bio-inspired structure was prepared by electrospinning of regenerated silk fibroin that served as a substrate for the cells to attach and grow. A device was also designed and fabricated to hold the substrate and to co-culture different cell types. The tool was used to develop co-cultured tissue constructs with epithelial keratinocytes (HaCaT) and subcutaneous connective tissue fibroblasts (L929) (Figure 7).

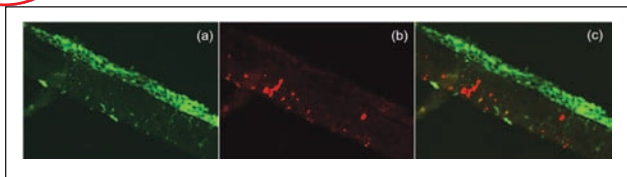


Figure 7. Differentially stained HaCaT and L929 cells when seeded and co-cultured on electrospun RSF scaffold, clipped onto the cell culture insert, led to successful formation of native tissue architecture including epithelisation by (A) keratinocytes (green) and (B) infiltration by fibroblasts (red) cells (C: merged).

## Collaborative Programmes

### 1. 3D Bioprinting of skin tissue constructs for in vitro testing and applications

Skin is the largest organ and is the primary defence mechanism of our body. Under the 3D Bioprinting Core Programme, the Division collaborates with the Division of Thrombosis Research to formulate novel bioinks and develop skin substitutes. Modified alginate and gelatin were supplemented with bioactive cocktail for feasibility of skin tissue bioprinting.

### 2. Bioceramic cages with axially-aligned pores as a substitute for tricortical bone graft

Long bone fracture, complicated by delayed or non-union of bones, is currently managed by surgical interventions using autologous bone graft. Mostly, a secondary surgery is inevitable during such surgical treatment. Synthetic scaffolds have been considered to avoid secondary surgery, but the host bone to graft interaction and the strength of the scaffold has to be improved. A novel synthetic scaffold with improved tissue-material interaction was developed and studies on cell-material interaction continued.

## Research Programmes

### 1. Biofabrication of liver constructs by 3D Bioprinting

One of the major research programmes at the Division is the biofabrication of liver construct by 3D Bioprinting. In order to attain functional performance

of constructs at the organ level, the entire concept of 3D bioprinting of liver was categorized at different levels and studied. Bioink that had the specific property to retain tissue functions was developed and evaluated. Liver construct using primary rat and human hepatocytes was developed and functional evaluation was performed.

Three-dimensional (3D) bioprinting is one of the emerging technologies in the field of regenerative medicine that helps in creating tissue constructs mimicking the natural physiological conditions of tissues and it could alleviate organ failure or replacement issues. 3D bioprinting has emerged as a promising technology to fabricate tissue structures with high precision and fidelity.

### 2. Pre-clinical evaluation of photo-protective bioink

The main element in the 3D bioprinting process is bioink. GelMA (Gelatin methacrylamide), a modified form of gelatin, is one of the widely used bioinks. GelMA crosslinks with UV at a safe wavelength range. However, the free radical initiated might affect cell viability. Hence, a new formulation of GelMA-based bioink with photoprotective property was devised. Biological evaluation by direct contact and test on extract as per ISO 10993-5 and the cell viability by MTT assay confirmed that GelMA was non-cytotoxic to cells. The photoprotective effect of the bioink formulation was also confirmed by assessing the intracellular free radicals. Scaling up of GelMA synthesis was ongoing and different batches of GelMA were synthesized and evaluated for crosslinking efficiency and cytotoxicity.

### 3. Organoid bioprinting of functional liver construct engineering

The functional performance of liver is attributed to its physiological cellular organization. To attain rapid organization in the bioprinted construct, a new approach of partially organized cell clusters was used for 3D bioprinting. This allowed fabrication of histomimetic tissue construct. Hepatic organoids were first developed using microvalve-based bioprinting

of hepatocytes. In order to generate a large number of spheroids, a culture chamber was designed and fabricated in-house. Hepatocellular carcinoma cell line (HepG2) and primary rat hepatocytes were used to generate the microtissues (Figure 8). The microtissues were viable and secreted optimum levels of albumin and urea. The microtissues also exhibited insulin-stimulated glucose uptake. Histomorphological analysis of the microtissues showed hepatic plate-like reorganization of cells. Immunohistochemical analysis revealed expression of hepatocyte polarisation markers MRP2 (biliary canalicular transport protein) and ZO1 (tight junction protein) within the microtissues. The microtissues were subsequently 3D bioprinted using GelMA.

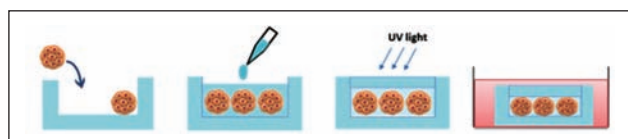


Figure 8. Use of microtissue for generation of histomimetic tissue construct. Spheroids are entrapped within GelMA (blue) and allowed to organize in culture medium (pink).

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

An ECM-derived tissue-specific bioink was developed for 3D bioprinting of functional liver construct for transplantation. As collagen is the basic component of tissues, it is a suitable base component in bioinks. However, collagen is not soluble in physiological condition and cannot be crosslinked easily. Hence, collagen-based bioink was developed by functionalizing it for crosslinking. The degree of functionalization, crosslinking efficiency and in vitro cytotoxicity were evaluated. The modified collagen was found to be printable.

#### 5. Defining the regulatory role of HSP70 in myoblast differentiation

Heat shock proteins are essential in maintaining the overall health of cardiac cells. Cardiac cells are exposed to extensive mechanical and oxidative stress, which results in damage to proteins. Chaperone

machinery proteins such as the HSP70-90 complex help in the removal of misfunctional proteins and play a cardioprotective role. Inhibition of HSP70 in cells could be deleterious to cardiac cells. In order to understand and evaluate the role of HSP70, commercially available human cardiomyocytes were treated with a HSP70 chemical inhibitor. This led to decreased ROS levels and cytoskeletal markers such as myogenin, myoD and sarcomeric myosin heavy chain. Other HSP70-related proteins such as HIF-1 also showed a decrease post-inhibition. A detailed investigation of molecular mechanisms involved showed that the AKT pathway, JNK pathway and p38 MAPK were perturbed by the inhibition of HSP70. Thus, interaction of HSP70 with various signalling molecules helps in maintenance of the cardiomyocytes. This study demonstrated that HSP70 was essential for maintenance and proliferation of human cardiomyocytes.

#### 6. Bioengineered construct with cardiac mesenchymal cells for myocardial repair

Heart failure is a major cause of death worldwide for which cell therapy is a potential option. 3D scaffolds were developed by the Division by modifying type I collagen. The suitability of the scaffold was assessed by analyzing the expression of cell adhesion molecules in fibroblasts and cardiac mesenchymal cells (CMCs). It was observed that N-Cadherin expression was augmented in CMCs, which could be due to the transient increase in microRNA 200c that could differentiate CMCs into cardiomyocyte-like cells.

#### 7. Periodontal ligament regeneration

The Division was engaged in research related to the regeneration of dental pulp stem cells. Protocols for isolation, culture, characterization and differentiation to dental stem cells were optimized. Stem cells were isolated from periodontal tissue, dental pulp, apical papilla and deciduous tooth. Cell-material interaction studies on calcium-containing bioactive cement formulations for dental regeneration were done. These materials were proposed as alveolar bone graft substitutes for periodontal regeneration and dental pulp capping agents.



## 8. Silk fibroin membrane for corneal tissue engineering

According to the latest visual impairment statistics from WHO, there are 36 million blind people across the globe and India is home to nearly 10 million blind people. It is reported that a major cause of blindness in India is corneal damage, which can be treated by corneal transplantation. The availability of donor cornea is limited and an artificial corneal equivalent remains as an unmet clinical need. The main challenge in developing corneal equivalent is in realizing the necessary optical properties. The objective was to develop Bombyx mori cocoon-derived, silk fibroin-based membranes as a biocompatible and a bioresorbable alternative. Membranes from reconstituted silk fibroin were prepared under different conditions and the physico-chemical properties of the resultant film were investigated. Silk-based biomaterials are often criticized for source-dependent variations, despite their good biocompatibility. We also tried to understand the properties of silk fibroin biomaterials, particularly the optical properties, collected from various geographical locations.

### Testing and Evaluation

The Division actively participated in the preliminary cytotoxicity evaluation of the biomaterials and biomedical devices developed in the Institute under various research programmes. Initial screening of materials was done for various programmes under the Technical Research Centre. During the year, a total of 109 samples (76 internal, 33 external customers) were evaluated under different test categories. The Division also provided 4 test services where study plans were prepared as per customer requirements.

## DIVISION OF TISSUE ENGINEERING AND REGENERATION TECHNOLOGIES

The major area of research in the Division is designing suitable biological substitutes/tissue-engineered constructs through tissue engineering. Research is focussed on: (a) developing novel, biodegradable and biomimetic “designer” scaffolds, (b) understanding the regeneration process using adult cells and directed

stem cell differentiation, and (c) delineating the molecular pathways that regulate growth factors and other molecules that promote regeneration. Other interests relate to the use of 3D bioprinting technology to generate cell-incorporated tissue constructs for various applications. Scaffolds made by conventional techniques, electrospinning, 3D bioprinting and regulator combinations generated by the Division are used for drug delivery, wound healing and haemostasis.

### Product Development

#### 1. Lint-free absorbent dressing for surgical and highly exudative chronic wounds

Lint-free absorbent dressing with channeled pores was made out of a blend formulation of the polysaccharide chitosan and polyvinyl alcohol, fabricated via controlled freeze-drying process. This was evaluated in vitro for physical properties like fluid handling, mechanical integrity, bioadhesion and blood clotting properties. Cytocompatibility and haemocompatibility tests were also carried out. In vitro wound healing assay was performed to evaluate the healing response. Toxicological safety evaluation tests like acute systemic toxicity, skin irritation and sensitization tests were also performed. The dressing was biocompatible with a good absorbency rate of  $0.63 \pm 0.13 \text{ g/cm}^2$ , enhanced mechanical integrity, low bioadhesive strength with good healing characteristics and non-toxic nature indicative of an ideal nonadherent absorbent wound dressing. The technology was transferred to M/s Phraction Scientific, a start-up industry incubating at TiMed.

#### 2. Injectable hydrogel for repair of cartilage injury and growth plate defects

This product is a two-component system for treating cartilage injury and growth plate defects. The technology also included an applicator through which the two component system could be mixed and injected into the site in the form of a biodegradable and biocompatible gel. The gel was further used as a delivery agent to encapsulate cartilage cells for surgical correction of both types of injuries. This technology



was also transferred to M/s Phraction Scientific and was at clinical trial stage.

### 3. Modified emergency bandage with pressure pad and a hemostat for pre-hospital emergencies

The product is a hemocompatible, non-toxic, pliable haemostatic wound dressing from natural biopolymers that will be in direct contact with wound area. It was prepared from natural biopolymers by blending and lyophilizing to obtain porous sponges (CH-Gel) (Figure 9). The developed dressing was compared with a commercially available gelatin sponge, Karespon. Functional groups (using FTIR), percentage blood clotting index, absorption rate, fluid uptake capacity and moisture vapour transmission rate were studied in both the dressings and the results were compared. The CH-Gel showed a good absorption rate of  $2.24 \pm 0.6$  g/cm<sup>2</sup> with a high moisture vapour transmission rate of  $0.0091 \pm 0.004$  g/cm<sup>2</sup>/day. SEM analysis showed open pores with bottom pores of size  $100 \pm 25$   $\mu$ m. The CH-Gel sponges also exhibited good cytocompatibility and had a very low % BCI of only 6.17 % within the first 2 minutes. The product is suitable as a dressing for trauma-related wounds.

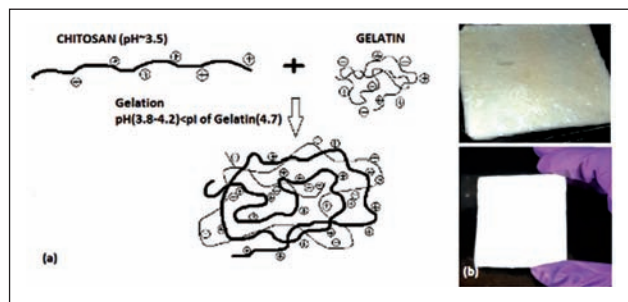


Figure 9. (A) Gelatin exhibits negative charge when the pH of the medium is above its isoelectric point (pH = 4.7). The positively charged NH<sub>2</sub> ions from chitosan react with the carboxylate groups from the ampholytic gelatin to form a polyelectrolyte complex (B) Porous sponge dressings prepared by the lyophilization process

### 4. Fibrous mesh sheets as scaffolds for increasing the area of neovascularisation in Moyamoya disease

Moyamoya is a disease characterised by occlusion of the terminal portions of the internal carotid artery or the proximal areas of the anterior or the middle cerebral arteries and abnormal vascular networks in the arterial territories near the occlusive or stenotic lesions, as shown by cerebral angiography. Since there are no effective treatments for Moyamoya, surgical revascularisation procedures is considered to be most effective in preventing the risk of stroke in these patients. The present technology used fibrous mesh sheet scaffolds as tissue extenders for neovascularisation to occur beyond the margins of the craniotomy. The mesh sheets were sutured to the edges of the dura and muscle and were allowed to lie as flaps on the brain surface by inserting it between the dura and the brain in rabbit models.

The materials used were: polycaprolactone/Gelatin vinyl acetate (P/GV) and Polycaprolactone/Polycaprolactone-polytetrahydrofuran-polycaprolactone (PCL/PCL-PTHF-PCL). The electrospun membranes of P/GV ( $64 \pm 0.002$   $\mu$ m thickness) and PCL/PCL-PTHF-PCL ( $100 \pm 0.004$   $\mu$ m thickness) were characterised for their morphology using SEM, where they demonstrated fibrous morphology with nanometer diameter. The tensile strength of the P/GV and PCL/PCL-PTHF-PCL membranes were  $1.76 \pm 0.16$  and  $0.97 \pm 0.10$ , respectively. In contact angle analysis, P/GV membranes showed good hydrophilic-hydrophobic balance and PCL/PCL-PTHF-PCL membranes were more hydrophilic. The membranes were implanted intracranially in rabbits and were assessed for vascularisation. To enable better vascularisation, the membranes were coated with VEGF along with sodium alginate.

### Research Programmes

#### 1. Construction of a bi-layered scaffold for osteochondral defects

Nanoparticles and other scaffolds, which can be used to deliver specific drugs, biochemicals, miRNA or exosomes specific for bone or cartilage lineages from

stem cells, were pursued as part of an Indo-Danish Program funded by DBT, India. Three groups of cubic scaffolds (PCL/PVP/PAA, PCL/PVP/PAA/BTCP, PCL/PVP/PAA/CS) of dimensions 20X20X3.5mm were fabricated for in vitro bioactivity studies using 3D additive manufacturing system (3D Printer by Makercity, India) at room temperature. A bilayer scaffold with upper layer favouring chondrogenesis and lower layer favouring osteogenesis was fabricated through the technique of bioprinting (Figure 10). In vitro studies proved that this construct could direct a single stem cell population towards osteogenic and chondrogenic differentiation simultaneously. This is an essential requirement for regeneration of critical size osteochondral defects.

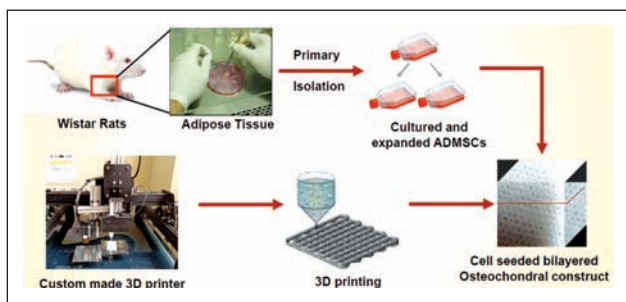


Figure 10. Construction of a bi-layered scaffold for osteochondral defects

## 2. Development of an active biomolecule-conjugated, gold nanoparticle-loaded gel for cartilage repair

Osteoarthritis is a degenerative joint disease that wears down the articular cartilage and ultimately leads to disability. Molecules that promote the selective differentiation of multipotent mesenchymal stem cells (MSCs) into chondrocytes may stimulate the repair of damaged cartilage. An injectable hydrogel (CH-HAD) of a specific biomolecule, KGN conjugated with gold nanoparticles (XANP), was developed for cartilage repair. The nanoparticles were expected to significantly decrease the free release of KGN into blood plasma in vivo and induce chondrocyte differentiation from MSCs in vitro. Characterisation of the materials and cytocompatibility and drug release characteristics were undertaken. The ability of the biomolecule-nanoparticle-loaded gel to promote chondrogenic differentiation of adipose stem cells

was tested. Formation of chondrogenic nodules and release of glycosaminoglycans suggested that the desired chondrogenesis was possible (Figure 11).

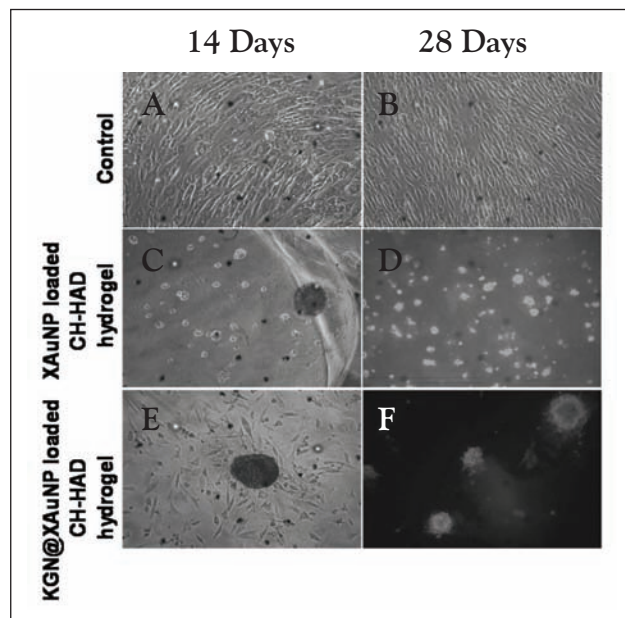


Figure 11. Promotion of chondrogenic differentiation by the biomolecule-nanoparticle-loaded hydrogel

## 3. Glutamic acid-based dendritic peptides for enhancing chondrogenic differentiation of Rabbit ADMSCs

Peptide-like derivatives of glutamic acid can self-assemble in solution and form various ECM-like dendritic structures. Three sets of glutamic acid-based dendritic peptides were designed, differing in degree of lipidation and branching. Each set comprised N-terminal protected as well as corresponding N-terminal deprotected peptides. Altogether, six peptides [BE12, E12, BE3(12)4, E3(12)4, BE3OMe, E3OMe] were tested for their chondrogenesis enhancing potential in vitro, using rabbit adipose-derived mesenchymal stem cells (ADMSCs). Immunohistochemical, gene expression and biochemical studies revealed that the lipopeptides [E12 and BE3(12)4] were able to enhance chondrogenic differentiation of ADMSCs significantly as compared to control group (chondrogenic medium alone). Glycosaminoglycan content, and the chondrogenic marker genes like Aggrecan (Acan), Type II collagen (Col2a1), Hyaluronan synthase 2 (Has2), and SRY-box 9 (Sox9) expressions were found to be significantly

increased in E12- and BE3(12)4- treated groups. The latter lipopeptides could be useful for realizing the hyaline nature of regenerated cartilage tissue in tissue engineering.

#### 4. Materials for drug delivery and imaging

Blue light emitting carbon dots (C-dots) were synthesized via thermal degradation of plant proteins for imaging of cells. C-dots were found to be stable over the long term under standard atmospheric conditions. The system could perform well for drug delivery and imaging in vitro. Fluorescent ZCIS nanoparticles were synthesized for use as imaging vector and drug delivery (Figure 12).

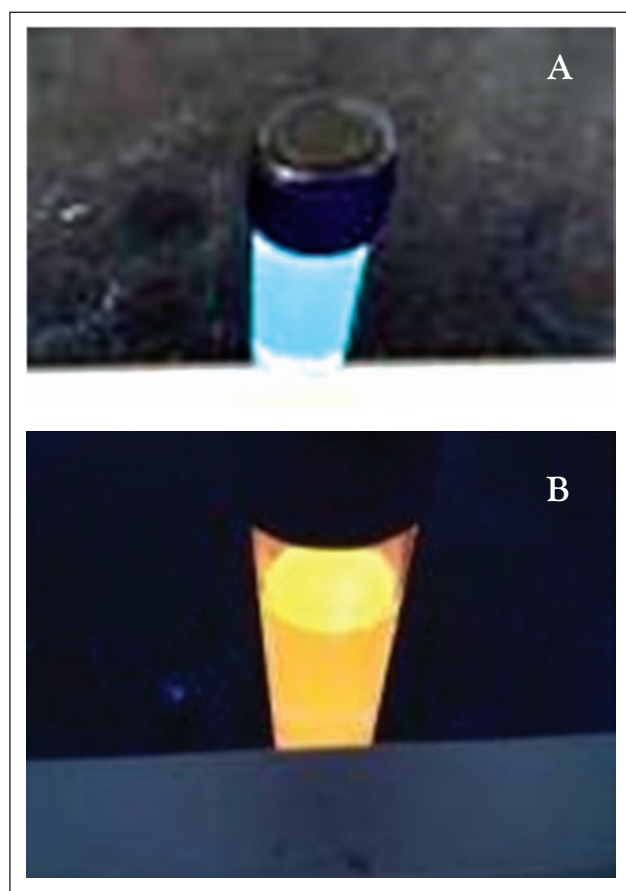


Figure 12. Nano systems for tissue engineering applications  
(A) Blue emitting carbon dots (B) ZCIS QD in aqueous medium

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

The work aimed to generate a tissue-engineered 3D bioprinted skin construct with embedded pits for the incorporation of hair follicle stem cells. The selected bioink that consisted of 2% w/v gelatin and 20% w/v alginate in the ratio 1:2 enabled reasonable extrusion, printability and preserved 3D structural integrity during the procedure. Three layers of rectilinear infill pattern was printed initially to fabricate the fibroblastic dermal layer. Over this layer, honeycomb infill pattern was printed to generate equidistant microwells, thereby mimicking the spacing of hair follicles in normal skin. The microwells enclosed in the honeycomb pattern provided a structural barrier protecting direct fusion of individual hair follicle cell aggregates. Hair follicle stem cells (HFSCs), dermal fibroblasts and keratinocytes were isolated and characterized from cadaveric rat skin. As hair follicle stem cells are aggregated in the follicular bulge region, induction of hair follicles can be achieved only if they are introduced between dermal and epidermal layers as aggregates. Hanging-drop array technique was employed to develop HFSC spheroids in culture.

#### DIVISION OF THROMBOSIS RESEARCH

The Division is involved in different activities, contributing successfully towards product development, translational research and testing services. A new project (TDF-funded) was initiated on the development of a cost-effective device for the isolation of autologous Platelet Rich Plasma (PRP) for various therapeutic purposes. The Division collaborated with the Department of Biomedical Engineering and developed a point-of-care instrument for measurement of prothrombin time and determining International Normalized Ratio (PT/INR) to enable monitoring and modulation of anti-thrombotic drug therapy in patients with cardiovascular diseases. Biopharmaceutical Development Programme of the Division progressed well during the year.





## Product Development

### 1. Blood component production

The Class10000 Facility was evaluated and test license was received from CDSCO for the year 2019-20 for plasma products like fibrinogen, thrombin, albumin and IVIG. Two batches of the fibrinogen and thrombin were produced and were found sterile. The technology of fibrin glue was transferred to Aegis Life Sciences, Ahmedabad, Gujarat.

### 2. PT/INR Device

Novel Prothrombin Time/International Normalized Ratio monitoring technology, including the strip for point-of-care application, was developed and technology was transferred to Agappe Diagnostics Pvt. Ltd. The industry team was trained for the technology and clinical validation was initiated. Strip design modification was taken up based on the suggestion of the industry.

### 3. 3D Bioprinted skin tissue construct

Functional studies were carried out using the ADA-Gel-PRP-based hydrogel. Cell viability, proliferation and ECM synthesis were evaluated. In addition, optimization of the cellulose-alginate-gelatin-based bioink for skin tissue application was initiated (Figure 13). Stability analysis of gel showed no shrinkage of the hydrogel system over 21 days, which makes it a better hydrogel for 3D bioprinting application.

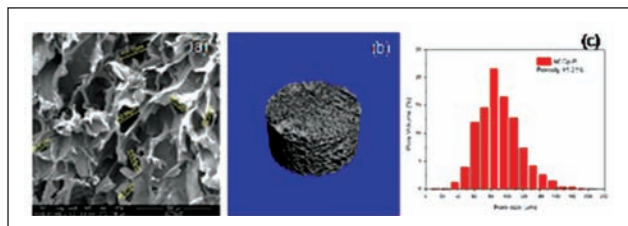


Figure 13. SEM and Micro-CT analysis shows porous nature of bioink with pore sizes ranging from 80  $\mu\text{m}$  to 100  $\mu\text{m}$

### 4. Skin substitute

Development of 2 different but related skin substitutes was undertaken with support from TRC. Both were fibrin-hyaluronic acid-based but one was combined with biodegradable synthetic polymer (PLGCFIBHA) and the other was combined with amniotic membrane (AMFIBHA). Proof-of-concept and preclinical evaluation was completed for both products. Test license was obtained to produce 400 samples of PLGCFIBHA to conduct validation of shelf life and stability in the final form. Expression of interest was received from a prospective entrepreneur for technology transfer and discussions were ongoing for technology transfer of PLGCFIBHA.

### 5. Anti-Cancer Drug Formulation (SCTAC2010)

Scale-up potential of the curcumin-conjugated human serum albumin (SCTAC2010) anti-cancer formulation (Figure 14) production at 2 levels (3g and 10g HSA) was evaluated. Single dose toxicity (SDT), maximum tolerant dose (MTD) and anti-cancer effectiveness in xenogenic lung cancer model were completed. Effect of raw material on recovery and yield of SCTAC2010 was evaluated. Drug extraction process from blood and tissue samples was standardized. MoU was signed with EightOaks Bio Ltd., Angamali, Kerala, for sharing the know-how pertaining to the SCTAC2010.

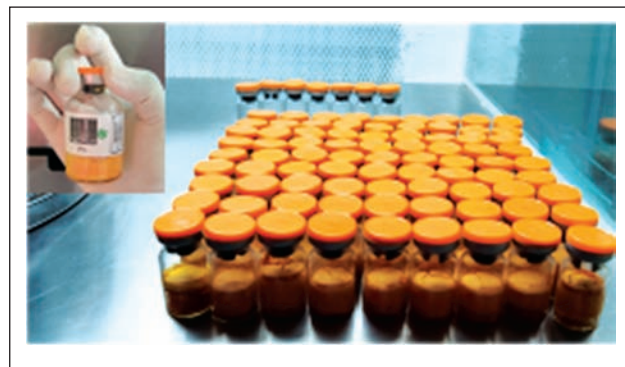


Figure 14. Curcumin-albumin conjugates





## Research Programmes

The Division continued working on various regenerative approaches using adipose- derived mesenchymal stem cells (ADMSCs) and their differentiation. The differentiation of ADMSCs into neurons and cardiomyocytes was validated and published. Application of cell therapy in animal models for cardiac and neural diseases was also established. A 3D-printed tissue patch for anticancer drug screening was developed in the laboratory. DEAE cellulose-alginate-peptide-based bioink was used to print these tissue patches. Degradation studies were carried out and the formulation was found to be stable for 2 weeks. A device for the isolation of autologous Platelet Rich Plasma (PRP) was designed, proof-of-concept prototype developed and patent application filed.

## Testing and Evaluation

Various accredited tests were offered to evaluate materials/components used for devices. During the year, a total of 270 samples were tested under different test categories and 530 test reports were issued. Platelet function tests were carried out for internal and external patients as a special service. The Division supported Quality Control Programme of the Institute's Blood Bank by testing components such as cryoprecipitate for factor VIII, fibrinogen and platelet-rich plasma for aggregatory response. Three new tests for the coagulation pathway (FPA TAT and SC3-5b) were validated and accredited by COFRAC as per the new standard ISO10993:4. The Division participated in inter-laboratory comparison with an accredited laboratory.

## 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 facility for the pre-clinical safety and toxicity evaluation of various materials and medical devices as per International Standards such as ISO, USP and ASTM. The toxicological studies are an

integral and indispensable part of development of medical device technology. The main aim of the Division is the toxicity/biocompatibility evaluation of materials, medical devices, tissue-engineered products intended for the fabrication of medical products and investigation of potential safety/biological hazards of nanomaterials used for health care applications. The Division successfully completed the inspection by the Central Drugs Standard Control Organization (CDSCO), New Delhi, on 17-18 July 2019. Development of 'Human-on-a-Chip' device technology was a new initiative during this year, funded by the Department of Science and Technology, Government of India. Development of anti-microbial peptide loaded-multifunctional 3D collagen scaffold for vascularised bone tissue regeneration was another new initiative under the Indian-Japan Cooperative Science and Technology Programme (IJCSP), Government of India.

## Product Development

1. Development of a kit for the evaluation of pyrogenicity
2. Development of a composite sponge for haemostatic and wound healing applications

## Research Programmes

1. Investigation of toxicity of Zinc Selenide/ Zinc Sulfide (ZnSe/ ZnS) quantum dots at the molecular level (Funded by: DST, Inspire)
2. Investigation of Interleukin-1 $\beta$  from pooled human blood stimulated with toxicants and associated molecular toxicity (Funded by: CSIR)
3. Bio-nano interactions of polymer-coated Titanium dioxide nanotubes (Funded by: CSIR)
4. Biological interactions of 2D Zn-Al layered double hydroxides in in vitro and in vivo systems.
5. Molecular toxicity, bio-distribution and foetoplacental transmission of tungsten disulphide (WS<sub>2</sub>) quantum dots using rat model (Funded by: UGC-CSIR)
6. Multiorgan chip for disease model and assessment of nano-based therapeutics (Funded by: DST)



## Testing and Evaluation

During the year, 242 samples were received for testing. 60 test reports were issued, which included 34 accredited reports and 26 non-accredited reports. The tests performed were: Maximization test for delayed hypersensitivity - 9; Closed patch test for delayed hypersensitivity - 2; Animal intracutaneous reactivity test - 9; Acute systemic toxicity test (Intravenous) - 18; Acute systemic toxicity test (Intraperitoneal) - 8; Pyrogen test - 1; Muscle implantation - 1; Subcutaneous implantation - 1; Bone Implantation - 1; Animal irritation - 3; Haemolysis - 4; Physico-chemical analysis of potable water - 26; Repeated dose toxicity - 4; Haematology analysis - 55; Biochemical analysis - 35; In vivo blood absorption - 1; Blood collection from rabbits for kinetics - 25; Sample retrieval (knee joint) - 4.

## DIVISION OF IN VIVO MODELS AND TESTING

The Division conducts animal evaluation of medical devices and biomaterials using normal animals or animal models of human disease. This consists of either proof-of-concept or preclinical evaluation of medical device/biomaterials in large animal and small animal models, simulating actual clinical use in human patients for assessing their functional safety and performance. To achieve this objective, the Division has qualified and trained staff, infrastructure such as operation theatre, catheterisation OT, clinical laboratory, acute care rooms, animal preparation/explantation rooms and CPCSEA-registered large animal house that provides healthy, traceable large experimental animals such as pigs and sheep. The animal testing capacity of the Division was significantly enhanced this year by the new 'In vivo Evaluation Facility'.

### New Facilities

1. A 'GMP Tissue Harvesting Facility for Medical Devices' was established at Meat Products of India Ltd., Koothattukulam. The speciality of this Facility is that animal tissue is collected as per international standard (ISO 22442 Part 2), which deals with 'Medical devices utilizing animal tissue and their derivatives'. This ensures checking the source of the animal, its health status and microbial status of the animal tissue to be used for the manufacture of medical devices. The Staff of Meat Products of India Ltd., were trained at SCTIMST for the implementation of work procedure for collection, cleaning, sorting, microbial monitoring and dispatch of animal issue as per ISO 22442 Part 2. The first collection of animal tissue for heart valve fabrication from the Facility was accomplished on 19 June 2019. The Facility also supplied bovine pericardium to SCTIMST.
2. A new In Vivo Evaluation Facility for animal studies was commissioned by the Division (Figure 15). This is a state-of-the-art Facility for housing large experimental animals. The Facility has the capacity to house 40 adult pigs and 70 adult sheep in compliance with the recommendations and requirements of the CPCSEA. The Facility has enclosures for housing experimental animals, space for minor procedures, acute pre- and post-operative management of experimental animals and secure space for animal feed storage. The Facility is a step towards a GLP-certified Animal Testing Facility for Medical Devices in the country.



Figure 15. In Vivo Evaluation Facility

## Product Development

A TRC Project, 'Development of bioprosthetic heart valve', was ongoing. Valve prototypes were made from molded components, custom-made fabric and laser cut processed pericardium (Figure 16). In vitro evaluation as per ISO 5840 and preliminary animal testing in sheep orthotopic implantation model were carried out.



Figure 16. Bioprosthetic heart valves (A) Internal mounted valve (mitral and aortic) (B) External mounted valve (aortic)

## Research Programmes

Research was undertaken to improve the performance and safety of processed bovine pericardium used for valve leaflet application. A new process was identified which preserved collagen structure, was non-cytotoxic and less calcifying as demonstrated in juvenile rat subcutaneous implantation model. This pericardium was surface-immobilized with heparin to induce thromboresistance, and anti-calcification property was achieved through magnesium immobilization. This improved bovine pericardium was shown to be substantially equivalent to imported products such as DuraGaurd™ (Synovis, USA) and better than Biocor™ (SJM, Brazil) in juvenile rat subcutaneous implantation model. Externally-mounted bioprosthetic valve made from this material was implanted in a sheep orthotopic implantation model to study in vivo calcification and healing.

### Testing and Evaluation

1. As part of a TRC Project, blood pump was tested in sheep for 3 and 6 hours of pump support during standard cardiopulmonary bypass. The animals were observed for 72 hours for any adverse events, followed by detailed autopsy. The purpose of the experiment was to assess haemolysis, activation of coagulation and complement, pump thrombosis, thromboembolic events and device-related morbidity and mortality.
2. Preliminary implantation of bioprosthetic heart valve was started in sheep. Two implantations were carried out. Data was obtained on sheep annular size comparison in female and male sheep, handling of device, implantation technique, acute hemodynamic function, initial healing of sewing ring, thromboembolic phenomenon and duration of anti-platelet therapy required.
3. Small animal studies conducted for other Divisions included:
  - Testing of 'Scaffolds based on self-assembling peptide dendrimers and resorbable calcium phosphates for endodontic tissue regeneration' in rats.



- Prevention of post-surgical adhesions - Role of alginate dialdehyde-gelatin hydrogel as a pericardial adhesion barrier in cardiac surgery' in rat caecal abrasion model and rabbit cardiac injury model.
- Evaluation of fibrous mesh sheets as scaffolds for increasing the area of neovascularisation in Moyamoya disease in rabbit models of craniotomy.

### Staff

#### Faculty

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

Dr Prabha D Nair, Scientist G (Senior Grade)

Dr Lissy K Krishnan, Scientist G (Senior Grade), (till 31-05-2019) & Emeritus Scientist (since January 2020)

Dr Mohanan P V, Scientist G

Dr Anoopkumar Thekkuveetil, Scientist G

Dr P R Umashankar, Scientist G (Veterinary)

Dr T V Anilkumar, Scientist G

Dr Anil Kumar P R, Scientist F

Dr Sachin J Shenoy, Scientist F (Veterinary)

Dr A Sabareeswaran, Scientist F

Dr Kamalesh K Gulia, Scientist F

Dr Anugya Bhatt, Scientist F

Dr V S Harikrishnan, Scientist E

Dr Lynda V Thomas, Scientist D

Dr Naresh Kasoju, Scientist C

Dr Renjith P Nair, Scientist C

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

Ms Vandana Unnikrishnan, Technical Assistant (Lab) - A

Mr Vishwanatham Naik, Technical Assistant



# DEPARTMENT OF BIOMATERIALS SCIENCE AND TECHNOLOGY

The Department focuses on the development of novel biomaterials and translation of these technologies into viable and affordable products. It consists of :

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

## DIVISION OF BIOCERAMICS

The Division is engaged in developing bioceramics-based tissue repair materials for orthopaedics and dentistry. Current areas of interests are bone graft substitute materials, bioceramic coatings, drug delivery systems and regenerative dentistry. During the year, 2 Indian patents were granted and a new patent was filed. A new project, "Bioceramic cages with axially aligned pores as a substitute for tricortical bone graft", funded by TRC, was initiated.

### Product Development

#### 1. Plasma Spray Coating Facility

Permanent bone implants based on titanium metal are widely used for load bearing applications, but the inability of the metal to bond with the host bone can lead to loosening of the implant in the long term. Surface coating made of hydroxyapatite (bone mineral) is suggested as a solution to prevent loosening and several techniques were developed for the same. Plasma spray is a viable technique to coat hydroxyapatite on titanium on commercial scale. The Division set up a Facility for Plasma Spray Coating of hydroxyapatite on titanium implants (Figure 17). All the components, from the raw material to the plasma driving system, were procured and integrated indigenously.

It was possible to make adherent, thick and dense

coating at lower plasma powers (below 10kW) with typical plasma-molten features. The coatings were subjected to tests for assessing the physicochemical (microstructure and phase) and mechanical properties (microhardness and adhesion strength). The chemical phase of the coating was 'apatitic', corresponding to the bone mineral, and lamellar growth structure was observed. Coatings made at 9kW power showed an adhesion strength of >7MPa and a surface microhardness above 260HV, which indicated a mechanically strong and adherent coating. Human periodontal cells grown over the coating surface showed good attachment and proliferation, pointing towards the bone bonding ability. The hydroxyapatite coating formed by the custom-made plasma spray set up was found to be highly suitable to coat titanium-based implants to achieve bone bonding.



Figure 17. Plasma spray coating Facility

### Research Programmes

#### 1. Calcium sulfate-based bioactive cement – Response of human periodontal ligament cells

Various types of bioceramic graft materials are used for the management of alveolar bone defects occurring due to periodontal disease. Cements based on inorganic calcium salts are mouldable and convenient for alveolar reconstruction. New calcium sulfate-based bioactive bone cement (BioCaS) that was affordable



and effective was developed by the Division. The response of primary human periodontal ligament (hPDL) cells to this material was investigated through in vitro cell culture.

The cytotoxicity and cytocompatibility of the BioCaS samples were evaluated using hPDL cells, with hydroxyapatite (HA, the bone mineral) as control. Osteogenic differentiation of hPDL cells in presence of BioCaS was evaluated using Alizarin red, von Kossa and Masson's trichrome stains and Alizarin red assay (Figure 18). The cells exhibited good viability, adhesion and spreading on the BioCaS cement in comparison with HA. The cells differentiated into osteogenic lineage in the presence of the BioCaS cement, without extraneous osteogenic supplements, confirming the inherent bioactivity of the cement. The mineralization potential of the BioCaS cement was higher than that of HA. This new calcium sulphate-based bioactive bone cement is a potential candidate for the repair of periodontal defects and is more useful than the ceramic counterparts.

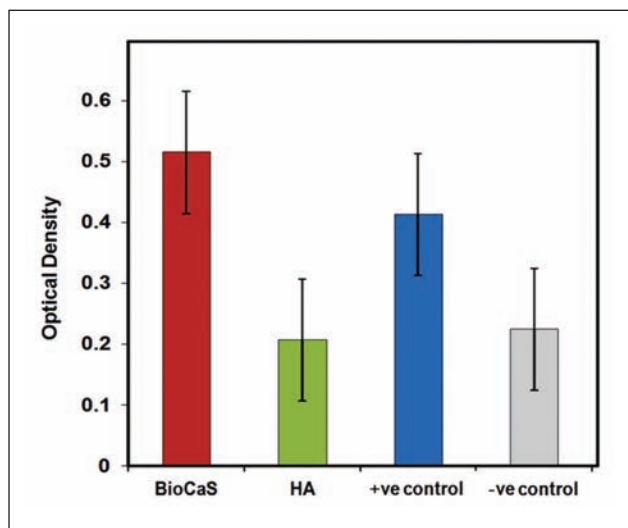


Figure 18. Alizarin red assay done for quantifying the mineralization of BioCaS in comparison to bone mineral (HA) using hPDL cells. The positive control is cells + osteoinduction medium and the negative control is cells + alpha MeM. BioCaS shows higher value than the positive control, which is significantly higher than the bone mineral HA.

## 2. Enamel remineralisation potential of nano-calcium strontium apatite

Dental caries can be prevented and even reversed by applying calcium phosphate containing medicaments that can compensate for the local loss of mineral from teeth. Nanoparticles will be more helpful as they can quickly release calcium ions and also occlude the tubules to control tooth sensitivity. A dentifrice containing nano-calcium strontium apatite (named 'Calstrotite 25') was developed in the Division to re-mineralise the enamel subsurface. The enamel remineralisation potential of the new dentifrice was evaluated in vitro by a pH cycling model, simulating the natural demineralisation-remineralisation process. The test sample group was brushed with the new dentifrice, in addition to the remineralising cycle. Changes in the mineral concentration of the samples at the subsurface regions were measured using Energy Dispersive (EDS) analysis after sectioning across.

The baseline Ca/P ratio at the enamel subsurface obtained by the EDS analysis was significantly reduced after demineralisation. The re-mineralised samples showed increased Ca/P values that were further enhanced in samples brushed with dentifrice. The difference between them was statistically significant. It was concluded that the dentifrice containing Calstrotite 25 helped to re-mineralise the de-mineralised subsurface of the enamel. It was also observed that its nano-sized particles occluded the exposed dental tubules, indicating its additional use as a desensitizing paste.

## 3. Synthesis of Strontium Orthosilicate by Sol-Gel Method

Strontium orthosilicate ( $\text{Sr}_2\text{SiO}_4$ ) is identified as a potential biomedical material and radio-contrast due to the presence of strontium ions. The Division developed a viable sol-gel-based method to synthesize strontium orthosilicate. Briefly, a stoichiometric amount of tetraethyl orthosilicate was added to an equal volume of ethanol with continuous stirring on a water bath at  $60^\circ\text{C}$  and was acidified with dilute  $\text{HNO}_3$ . After 30 minutes, the required amount of

strontium precursor, strontium nitrate, was added to the solution and stirred for another 30 minutes. The solution was transferred to an evaporating dish and maintained at room temperature for 24 hours until gelation occurred. The gel was dried at 120°C and then calcined at 650°C, determined through Differential Thermal Analysis (TGA-DTA). Under these conditions, crystalline material with an average particle size of 3 µm was obtained, which was confirmed to be alpha-strontium orthosilicate through phase analysis using XRD and FTIR. The radio-contrast property was measured with respect to an aluminium step-wedge in a fluoroscope and it was found that the value is equivalent to nearly 10 times the thickness of aluminium (Figure 19).

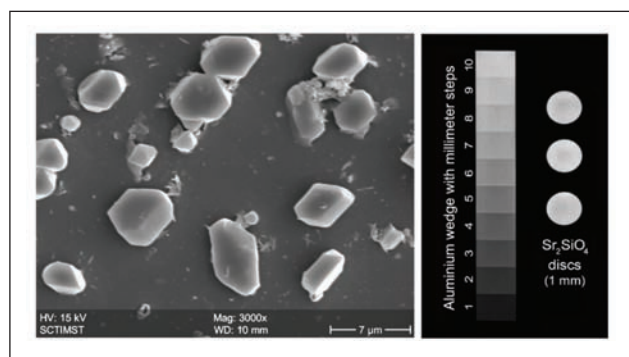


Figure 19. Strontium orthosilicate particles and their radio-opacity

## Testing and Evaluation

The Division offers tests and analyses like X-ray Powder Diffraction, Scanning Electron Microscopy, Environmental Scanning Electron Microscopy, Energy Dispersive analysis and Atomic Emission Spectroscopy with Inductively Coupled Plasma (AES ICP) for elemental analysis. These tests are available to both internal and external customers.

## DIVISION OF BIOPHOTONICS AND IMAGING

The Division focuses on the development of nanomaterials and their application in biophotonic and imaging devices. New research work dealt with development of blood-brain barrier-permeable nanocarriers for diagnosis and therapy of

neurodegenerative diseases. The Division is involved in research programmes, training students and supporting the teaching and academic activities of the Institute.

## Product Development

1. The feasibility of developing an optical peripheral nerve stimulation device was explored with TRC funding. A prototype of the Optical Peripheral Nerve Stimulator was set up using 1855 nm laser diode that gave positive indication of nerve stimulation non-invasively. Confirmatory studies and validation process continued.
2. The Division was engaged in synthesizing biomaterials for imaging, sensing and therapeutic applications. These included: vanadium pentoxide nanoparticles for cancer therapy, gold nanocluster for diagnosis and therapy of neurodegenerative disorders, polysaccharide-based nanomaterials for stem cell tracking, gold cluster for imaging and sensing and graphene-based system as an all-in-one nanopatform for multiple imaging and therapies.

## Research Programmes

1. Gold Nanorod-Photosensitiser (GNR-PS) complex, which retains the fluorescence and also enhances the NIR fluorescence through energy transfer mechanism, was developed to be used as a theranostic platform.
2. Quantum dot (Qd)-based nanosensor was developed for the simultaneous detection of copper and creatinine, two biologically relevant molecules. The dual independent emissions of the Qd-EDC complex were used for the simultaneous detection of creatinine and copper by a turn-on/turn-off method. The nanosensor successfully detected the 2 molecules with a sensitivity of nanomolar to millimolar (copper) and micromolar to millimolar (creatinine) range. A simple method to detect creatinine using sensor strips and cell phone camera was developed and validated on human blood samples (Figure 20).

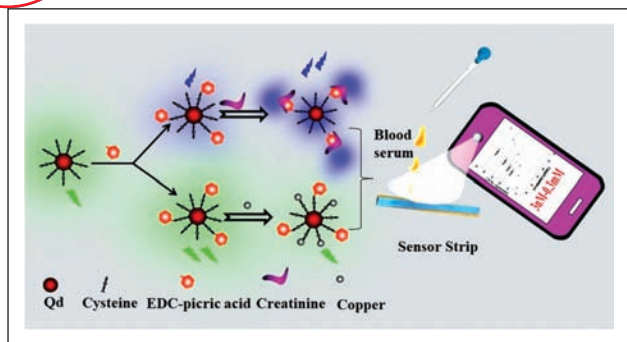


Figure 20. Schematic representation of the Quantum dot (Qd)-based nanosensor for simultaneous detection of copper and creatinine

3. A novel theranostics device was conceived for Alzheimer's Disease, which is one of the most common neurodegenerative diseases affecting the aged population. A one-pot synthesis of fluorescent gold nanoclusters (CyAuC) using cysteine as a reducing agent was attempted as the base material for theranostics. The emission spectrum of the nanoclusters showed peak at 608 nm for an optimum excitation wavelength of 370 nm. The internalisation of these clusters and their behaviour towards brain endothelial cells need further optimisation by targeting the system with specific molecules.
4. Vanadium pentoxide nanoplates (VnNp) with unique shape were synthesised and their antibacterial properties were studied. Morphological alterations on the bacterial surface of representative Gram-positive, *Staphylococcus aureus* and Gram-negative, *Escherichia coli* were identified upon VnNp treatment (Figure 21). Further, the study showed reactive oxygen species (ROS) generation in *E. coli* biofilms. These results indicated the possible use of VnNp as a potential surface coating agent to impart antibacterial activity.

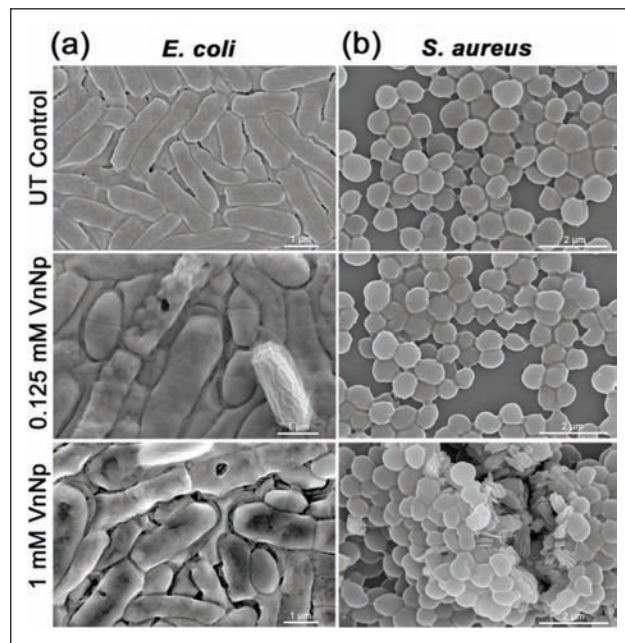


Figure 21. Scanning electron micrographs depicting morphology of *E. coli* and *S. aureus* with different concentrations of VnNp

## DIVISION OF BIOSURFACE TECHNOLOGY

The major activity of the Division is the development of polymeric biomaterials for drug delivery, wound dressing applications and gene delivery. The main focus is on translational research for product development. The Division is focused on development of wound dressings and nanogel-based oral insulin.

### Product Development

#### 1. Wound dressings

Chronic infectious wounds are mostly non-healing. In such cases, the orally- or systemically-administered drugs do not reach the wound site at desired therapeutic dose owing to poor blood permeation and damaged tissue. Chitosan-based antioxidant sponges were developed for treating such chronic wounds. These sponges were designed to have free radical scavenging capacity and can be loaded with any therapeutic molecule that can be delivered directly to the wound site, thereby ensuring adequate dosage of



drug. In addition, the high swelling capacity of these sponges made them suitable for managing moderately exuding wounds. The drug-loading and release characteristics of these sponges were evaluated using various antimicrobial drugs. The in vitro antimicrobial efficacies of these drug-loaded sponges were evaluated with 2 different drugs against *Escherichia coli*. The technology transfer of this product to industry was underway (Figure 22).

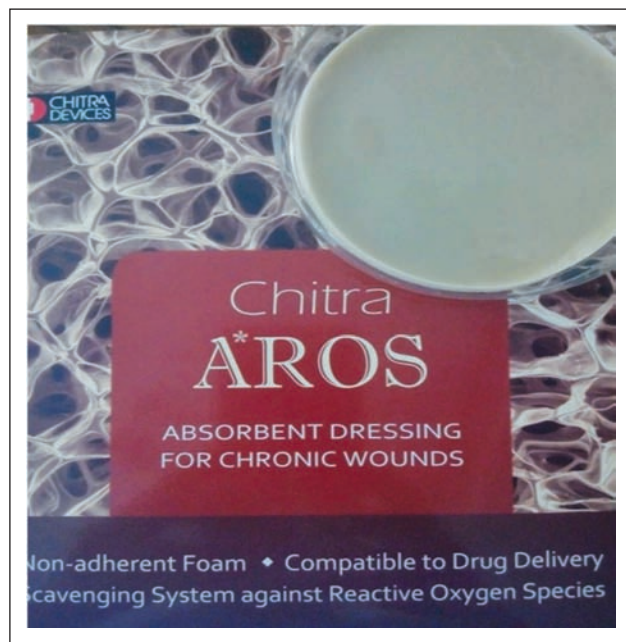


Figure 22. Chitosan-based anti-oxidant sponge in product form

## 2. Oral insulin delivery system

Development of polymeric oral insulin carrier continued and the problem areas were addressed. Initially, insulin-loaded nanogels were developed and tested for efficacy in diabetic rats, with promising results. The nanogels were then converted into free flowing powder to be filled in gelatin capsules. Assessment of the blood glucose lowering efficacy of this formulation in diabetic rats showed about 51% reduction of blood glucose by the 5th hour, which continued for another 3 hours, indicating the prolonged effect of these nanoparticles.

## Research Programmes

### 1. Wound dressing

Alginate grafted-polymethacrylate xerogels were developed for wound healing application. Optimization of various xerogels was performed through physico-chemical characterization. In addition, the suitability of this matrix to deliver therapeutic molecules and inorganic ions was also evaluated under in vitro conditions. To evaluate the wound healing potential of these molecules, in vitro scratch wound assay was also done on fibroblast and epithelial cell lines.

The effect of strontium ions in wound healing was studied. Alginate-g-polymethacrylate was crosslinked with varying concentrations of strontium ions and the physico-chemical properties of the xerogels were studied. With increasing strontium crosslinking, there was reduction in percentage swelling, water vapour transmission rate, weight loss and porosity. The xerogels were also hemostatic through the release of strontium ions. The amount of strontium ions was quantified by XPS analysis and its binding energy was calculated. The released strontium ions promoted in vitro wound healing activity, as analysed by scratch wound assay, and also favoured collagen deposition by fibroblasts.

### 2. Gene delivery

Safe and efficient polymeric gene delivery systems were synthesised to deliver the therapeutic gene, TP53, since this gene is mutated in almost 50% of human cancers. Polymeric vectors were developed using hydrophilic, biocompatible polysaccharides (pullulan and dextran) as backbone, which was then cationised with polyethyleneimine (PEI 10K). Polysaccharides helped improve blood circulation time while PEI effectively condensed DNA into nanosized complexes (nanoplexes) and aided endosomal escape. These were further modified with 2-diethyl aminoethyl methacrylate (DEAEM) as these molecules transiently disrupt cell membrane that in turn promotes cellular internalisation.

The nanoplexes formed by these polymer derivatives were capable of protecting DNA from degradation by DNase. They also reduced the interaction of DNA with plasma proteins, thereby increasing the time in circulation. The derivatives were cytocompatible and exhibited about 80% cell viability in C6 glioma, HeLa and L929 cell lines. Good cellular uptake and transfection efficiency were observed selectively in cancer cells (C6 and HeLa) and not in L929 cells. Polymer trafficking studies revealed that vector unpacking may have occurred in the cytoplasm as DNA alone reached the nucleus. Immunostaining studies confirmed the expression of TP53 gene in C6 cells. Biodistribution studies carried out in Balb/C mice revealed good renal clearance of these polymer derivatives and also demonstrated that they did not accumulate in any of the vital organs like brain, heart and lungs.

## DIVISION OF DENTAL PRODUCTS

The Division was involved in dental material research, teaching and training and testing activities. During the year, the Division focused on bioactive bone cement and micro needle for animal vaccine development.

### Product Development

1. A novel in-house composite was evaluated for antimicrobial efficacy and resistance to biodegradation. The zinc oxide nanoparticle-incorporated composite was evaluated against *S.mutans*, UA159. This study was completed in collaboration with Dr A Devadathan, Professor and Head, Department of Conservative Dentistry and Endodontics, Pushpagiri College of Dental Sciences, Thiruvalla.
2. Shell nacre-integrated polycaprolactone scaffold for bone defect management was fabricated. The surface morphology, porosity and compressive strength were characterised.

### Research Programmes

1. Research for the development of bioactive radiopaque antimicrobial low shrinkage dental composite with improved properties was initiated (Figure 23).

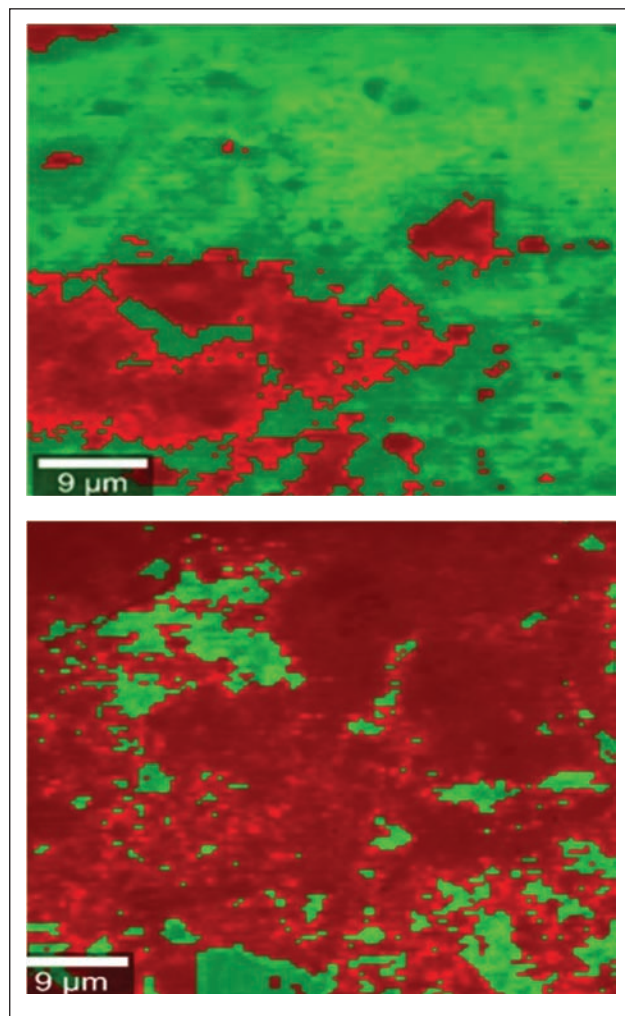


Figure 23. Confocal Raman image of biofilm structures on the surfaces of commercially available composite (A) and the in-house composite (B) samples, containing both live (green signal) and dead (red signal) bacteria obtained in Biofilm inhibition test

2. Formulation optimization by physico-mechanical evaluation of radiopaque antimicrobial low shrinkage dental composite with varying concentration of zinc oxide (ZnO) nanoparticles.
3. Synthesis, modification and characterization of zinc oxide nanoparticles and in vitro evaluation of the antimicrobial composite. The direct contact test and MTT assay of the optimized concentration proved that 2% silanated ZnO nanoparticles-integrated bioactive dental composite was non-cytotoxic.



4. In vivo osteogenesis study of shell nacre-containing biocomposite was initiated.
5. New formulations of click-gels were developed as bioinks for 3D bioprinting of skin

### Testing and Evaluation

The Division offered the testing facilities, including Thermal cycling, High Performance Liquid Chromatography, Micro CT, FTIR, FT Raman and UV-visible spectrophotometer, Universal Testing Machine and particle size analysis, to external and internal customers.

### Awards and Honours

1. Dr Jayasree R S, Scientist F, Division of Biophotonics and Imaging, was nominated to the Task Force Committee of Empowerment and Equity Opportunities for Excellence in Science (EMEQUE) Program of SERB, DST.
2. Dr Jayasree R S, Scientist F, Division of Biophotonics and Imaging, was nominated to the SERB Expert Committee under the Intensification of Research in High Priority Areas (IRHPA) to support high priority areas in the country in the area of 3D Bioprinting.

### 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)

Mr Nishad K V, Scientific Assistant (Instruments)

Ms Susan Mani, Technical Assistant (Lab) - A

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

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

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

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



## DEPARTMENT OF MEDICAL DEVICES ENGINEERING

The Department focuses on the 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 5 Divisions, 4 of which have established their own domains of medical devices development while the 5th strongly supports the device development activities in precision fabrication of prototype devices.

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

The Department also extends support services to other internal Divisions and external customers, like Rapid Prototyping Facility, regulatory affairs, ethylene oxide sterilization, package validation, material characterization and computer-aided design and analysis.

The Department made substantial contribution to the fight against COVID-19 by developing a number of devices: AMBU-based ventilator, Disinfection Gateway, and Personal Protective Equipment, to name a few.

### DIVISION OF ARTIFICIAL INTERNAL ORGANS

The Division is executing different projects aimed at development of high-risk medical devices. Various projects, initiated this year through Technical Research Centre (TRC), Technology Development Fund (TDF) and other sources of support, progressed well.

The following new Projects were initiated:

1. TiN-Coated Coronary Stent - TRC Project
2. Reconstruction geometry optimization and methodology development using computational fluid dynamics evaluation for patient-specific vascular model acquired by MRI Scanning - TDF Project
3. Reverse Suction and Suction Arrester Device - TDF Project
4. Development of high-strength Ti-6Al-4V castings for orthopaedic applications - TRC Project
5. Development of a point-of-care device for measuring N-terminal fragment of BNP precursor (NT-ProBNP) from blood samples - ICMR Project
6. Spinal fixation device for thoracic lumbar stabilization -TRC project
7. Design of novel polyaxial pedicle screws for thoracolumbar stabilization: A pilot study - TDF Project

### Product Development

#### 1. 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. Technology transfer activities were ongoing. Preparations were underway to initiate animal experiments.

#### 2. Programmable Hydrocephalus Shunt

Hydrocephalus is a condition in which the cerebrospinal fluid over-accumulates either due to blocks in the ventricles or overproduction, thereby increasing the intracranial pressure.



The Hydrocephalus Shunt is a valve and catheter device that can be implanted in a patient with hydrocephalus between the cerebral ventricles and other body cavities (especially peritoneal cavity) so that CSF will drain through the catheters via a pressure valve that opens at a minimum intracranial pressure into other body cavities. Basic computer-aided simulation and analysis was done for the shunt valve design (Figure 24).



Figure 24. Hydrocephalus Shunt test setup

### 3. TiN-coated Coronary Stent

Coronary artery disease (CAD) occurs when the coronary arteries are blocked with fatty deposits (plaque) causing the arteries to narrow. Percutaneous transluminal coronary angioplasty, coronary stenting and coronary artery bypass grafting are the possible approaches for the management of CAD. Of these, coronary stenting offers better performance, minimal invasiveness, and low risk levels. Coronary stents are usually made of metal alloy and are introduced on a balloon catheter in the crimped state into the lumen of the diseased artery and expanded by inflating the balloon at the point of implantation.

The Chitra Stent is cobalt-chromium-nickel-tungsten alloy L605-based, titanium nitride-coated “bare metal” coronary stent system. It is indicated for improving the coronary luminal diameter in patients with native coronary lesion length of < 50 mm, and reference vessel diameter 2.5 mm to < 4.5 mm. Crimping and expansion, testing and validation studies made good progress. The test set-up was prepared for balloon expansion and crimping tests (Figure 25).

### 4. Aortic Stent Graft

This device, used for aortic aneurysm, is a tube made of a thin metal mesh (the stent) covered with a thin



Figure 25. Coronary stent test setup

polyester fabric (the graft). This stent graft is opened inside the aorta in the region of the aneurysm and fastened in place. The stent graft stays in place and blood flows through it.

Device prototypes were made and prototyping of the delivery system continued. An Expression of Interest (EOI) for technology transfer was invited and some industries showed interest in taking up the technology.

### 5. Atrial Septal Defect Occluder

Atrial Septal Defect (ASD) is a hole in the septum, which is the muscular wall that separates the heart's two upper chambers (atria). An ASD is a defect you are born with (congenital defect) in which the septum does not form properly. The ASD closure device - occluder is used to close the defect. Device prototypes were prepared and prototyping of the delivery system continued. An Expression of Interest (EOI) for technology transfer was invited and some industries showed interest in taking up the technology.

### 6. Flow Diverter Stent



This is a device used inside the cerebral blood vessels so that blood flow is diverted away from the aneurysm, thereby preventing haemorrhage. Device prototypes were fabricated and prototyping of the delivery system continued. An Expression of Interest (EOI) for technology transfer was invited and few industries showed interest in taking up the technology.

#### **7. Development of a point-of-care device for measuring N-terminal fragment of BNP precursor (NT-ProBNP) from blood samples**

NT-proBNP is a biomarker produced during the initial stages of heart failure. This test ensures the detection of heart failure before it becomes critical. A test kit was prepared that detected the presence of biomarker in blood samples.

#### **8. Reverse Suction and Suction arrester device setup**

The suction device is used in surgery (especially neurosurgery) to remove the fluid (especially blood) in the surgical site for effective surgical tooling. During neurosurgery, the tissues inside the dissected brain and blood vessels get locked within the suction tip, presenting the risk of vessel damage and life-threatening haemorrhage. A device setup was developed to create a back push that helps in safe removal of soft tissues and blood vessels from the suction tip without causing haemorrhage (Figure 26).



Figure 26. Validation setup for reverse suction and suction arrester device

### **Research Programmes**

#### **1. Coronary stent CAE studies**

The structural analysis of coronary stent was conducted, and the simulations were carried out to check the crimping behaviour of the stents. The results were matched with the experimental analysis.

#### **2. Hydrocephalus Shunt Flow studies**

The flow analysis of the Hydrocephalus Shunt conical design was conducted. The results were matched with the analytical analysis. The experimental setup was also prepared for evaluating the performance aspects.

#### **3. Orthopaedic material analysis**

The analysis was done to check the heat treatment behaviour of alloys used for orthopaedic applications.

#### **4. Rehab and Orthotics Program**

Models and prototypes were prepared and related experiments were carried out.

#### **5. Experimental work on arteriovenous malformation studies**

The aim of embolization is to fill the nidus fully with embolic agents that precipitate in the area and inhibit blood flow across the nidus. A wide variety of embolic agents are available in the market. However, the success rate of arteriovenous malformation (AVM) embolization ranges from 16% to 100%, which is not satisfactory. As a result, new embolic agents are being introduced and are under research but their efficacy is of great concern. This is due to lack of quality nidus design and test platform to simulate cerebral AVMs. This document describes step by step procedure to carry out experiments in novel in vitro nidus construct with feeding arteries and draining veins that closely mimics flow characteristics and architecture of cerebral AVMs (Figure 27).

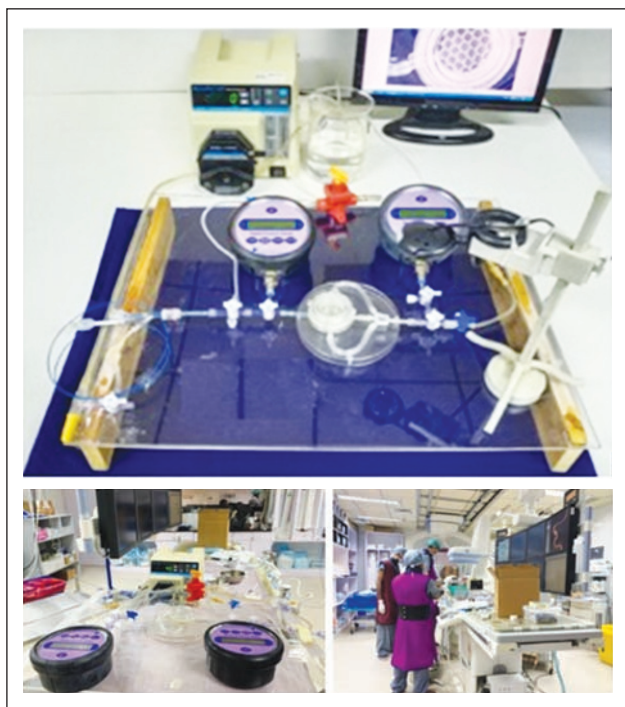


Figure 27. AVM test setup

## Testing and Evaluation

### Package Validation Test Setup

Test systems were developed for testing the integrity of medical device packaging. The systems included: hardware, accompanying software, display, controls and pneumatic setup.

## DIVISION OF EXTRACORPOREAL DEVICES

The Division is entrusted with the development of extracorporeal medical devices, focusing on the cardiopulmonary system. The major ongoing activities in the Division include developing paracorporeal 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.

The Regulatory Affairs 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 also takes part in the

Materiovigilance Programme of India (co-ordinated by the Indian Pharmacopeia Commission, Ghaziabad) as an expert member 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 R & D programs.

## Product Development

### 1. Paracorporeal Left Ventricular Assist Device

Ventricular Assist Devices (VADs) are circulatory support devices that help maintain a nominal cardiac output for various physiological functions of the human body in end stage cardiac failure patients. The Chitra pLVAD is a magnetically-levitated third generation LVAD composed of a centrifugal blood pump with a miniature brushless DC motor, a controller and a cable connecting controller to the pump (Figure 28).

In vitro evaluations using blood analogous fluid and animal blood were carried out (Figure 28) and, based on the results, design improvements were incorporated. Lower blood cell damage, increase in efficiency and reduction in surface temperature were achieved. Integrated battery pack and battery charger were added. Control system was modified using surface mount electronic components. Preliminary evaluations using LVAD simulator for various clinical conditions were carried out. The technology was transferred to M/s. Meril Life Sciences, Vapi. The 1st phase of the training, as part of the know-how transfer, was conducted for a 7-member team from the industrial partner for a week (Figure 28).





Figure 28. (A) Chitra paracorporeal Left Ventricular Assist Device (pLVAD), (B) pLVAD with controller, battery pack, and charging unit, (C,D) Training on device fabrication and evaluation to industrial partner (E,F) In vitro evaluation of LVAD for estimation of haemolysis

## 2. 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. The drive and the pump can be kept close to the patient to reduce the priming volume of the fluid required during surgery. A portable blood flow meter measures the velocity of the blood flowing through the tubing and displays the fluid flow rate in litres/minute (Figure 29). Preliminary ex vivo evaluation was successfully conducted with 2 devices and a control device in sheep under cardiopulmonary bypass for 3 and 6 hours (Figure 30).



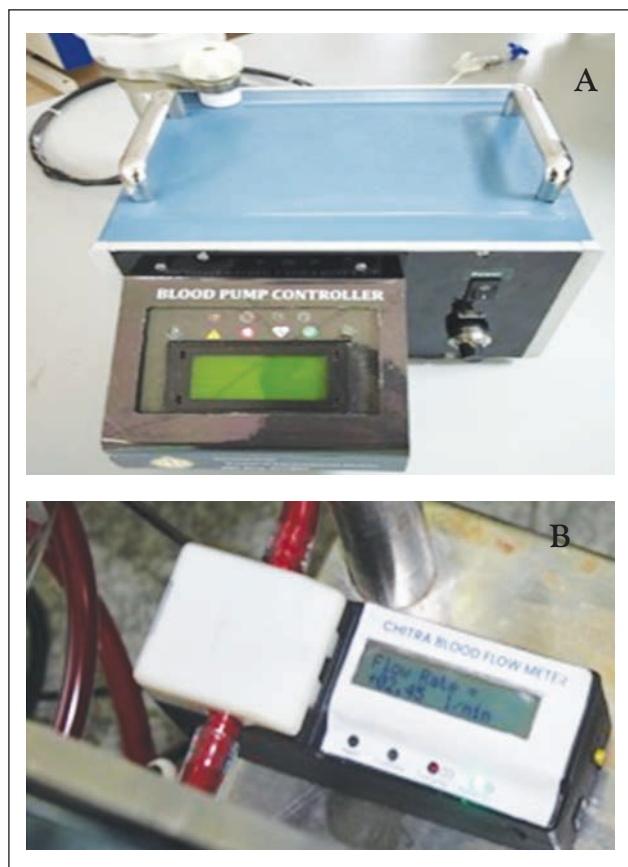


Figure 29. (A) Chitra blood pump controller and drive unit  
(B) Chitra blood flow meter



Figure 30. Chitra blood pump during ex-vivo animal evaluation

### 3. Implantable Micro Infusion Pump

In this project, an implantable device for the precise delivery of drugs to diseased portions of the body was developed. The device has a storage unit and a driving unit with associated electronics to deliver drugs like insulin, chemotherapeutic agents and pain management drugs (Figure 31).



Figure 31. Implantable micro infusion pump

#### 4. Vein Viewer

It is a device for viewing the veins or blood vessels of patients, especially paediatric patients, using infrared technology and image processing. The pilot production of the industrial model of the device manufactured by M/s Agappe Diagnostics Ltd. named as “mispaView” (Figure 32) was sent to different hospitals for getting first-hand user experience feedback.



Figure 32. Vein viewer - industrial model

#### 5. Infrared infant warming wrapper and bassinet

These are for efficient and non-contact warming of a premature born baby, thereby preventing excessive heat loss from the body, which may otherwise lead to death. The infant warming wrapper device consists of a portable baby wrapper fitted with infrared warming pad, which can be powered continuously by low power batteries. The bassinet consists of a portable baby bassinet fitted with a removable infrared warming pad that can be powered continuously by low power batteries or using home mains power supply (Figure 33). Multiple prototypes were developed, and safety as well as efficacy tests were conducted to meet international standards.

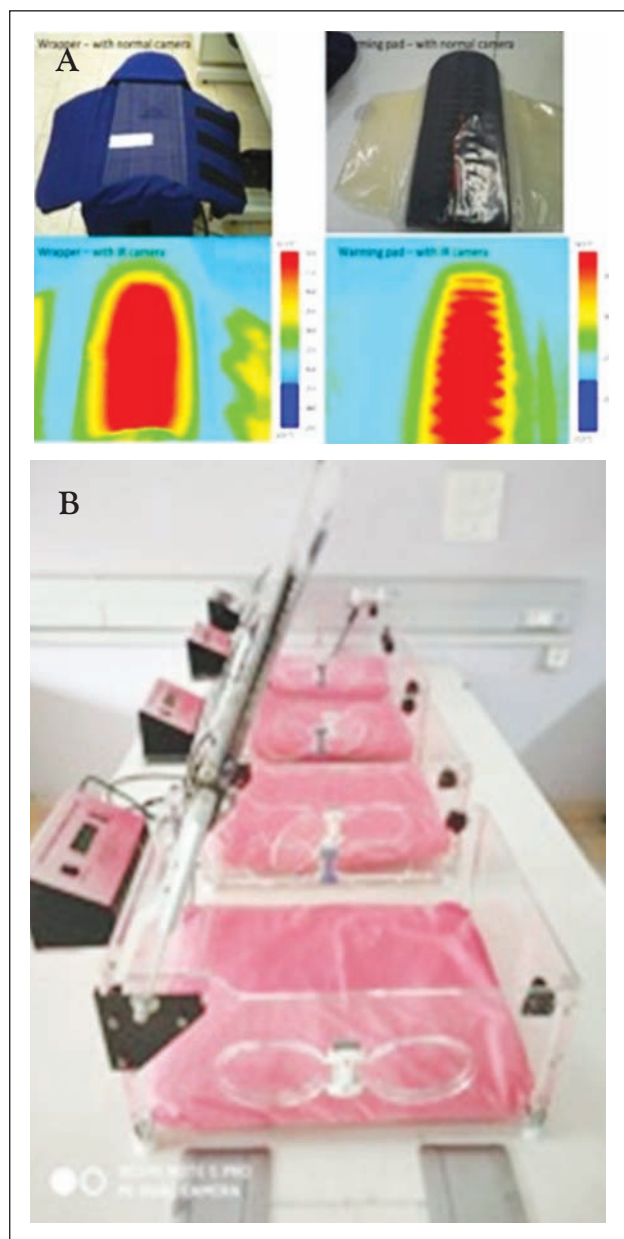


Figure 33. Infrared infant warming wrapper (A) and bassinet (B)

**6. Infrared blood and IV fluid warming system** is a device for warming of blood and IV fluids to physiological conditions from refrigerated conditions using infrared radiation emitted from small low-cost IR LED cluster. The device consists of a blood bag warming unit and an IV tube warming unit that ensures flow rate- independent warming suitable for massive as well as slow transfusion (Figure 34). The IV tube warmer also provides inline temperature drop compensation for reduction in temperature of

the blood due to influence of ambient environment. Multiple prototypes were developed, and safety as well as efficacy tests were conducted to meet international standards.

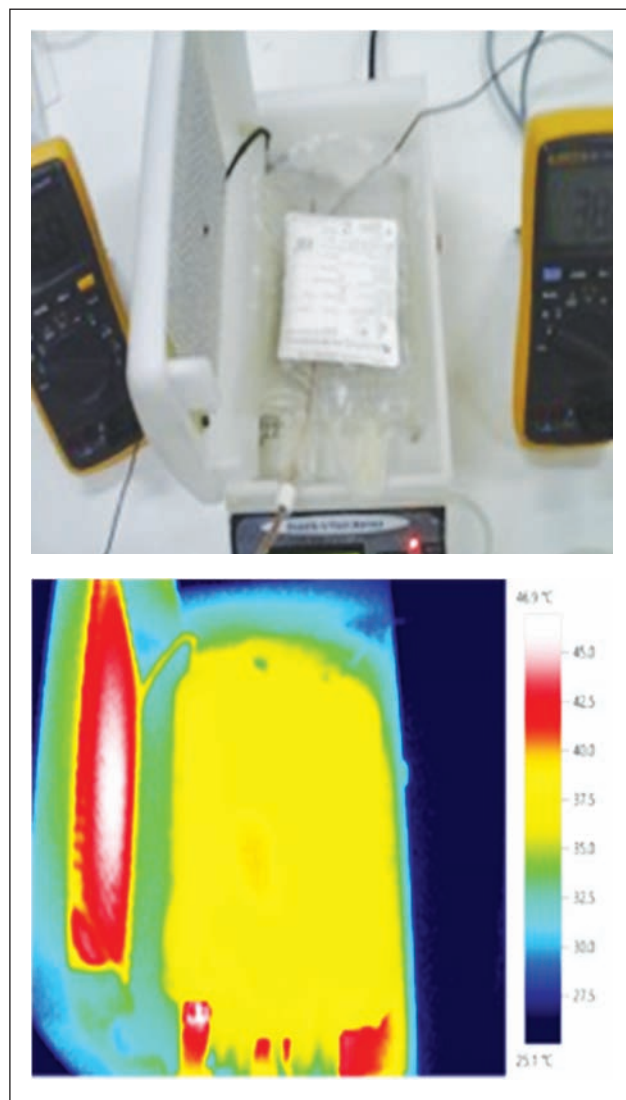


Figure 34. Infrared blood and IV fluid warming system with inline temperature loss compensation

## 7. 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 microdialysis 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 35).

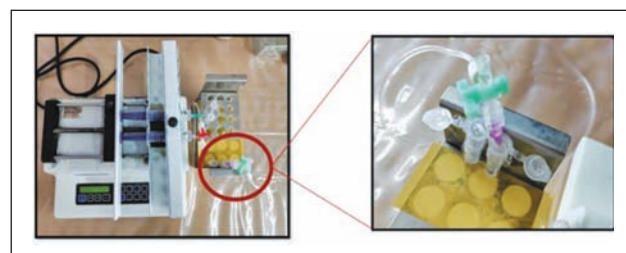


Figure 35. In vitro evaluation of microdialysis device

## Research Programmes

### Development of membrane oxygenator using active gas transfer enhancement techniques

Membrane oxygenators are artificial gas exchange devices used for supporting lungs. This project aimed to study techniques for enhancing gas transfer efficiency of membrane oxygenators. A novel technique for enhancing gas transfer efficiency was devised and the performance was evaluated using Computational Fluid Dynamics technique (Figure 36).

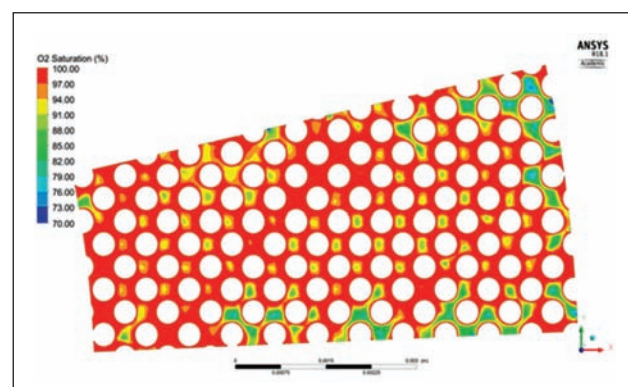


Figure 36. Oxygen saturation visualisation in oxygenator using computational fluid dynamics

## Testing and Evaluation

### 1. Medical Device Regulatory Support

The Regulatory Affairs Cell of the Institute is focused on supporting the research teams and commercial





partners for different technologies developed by the Institute for a range of regulatory activities in compliance with the new Medical Devices Rules 2017.

- The major services extended were:
  - a. Review of technical documentation for compliance with the regulatory requirements
  - b. Online submission and follow-up for getting various permissions from CDSCO (Eg. test manufacturing license)
  - c. Registration of medical device testing laboratories, clinical trial permission and manufacturing licenses of medical devices
  - d. In vitro diagnostics and drugs
- Other services offered were risk management of medical devices and review of technology transfer document. A project proposal was submitted under the TRC Scheme of the Institute for funding and approval to develop a single-window system that offers: fast and accurate identification of product regulatory classification, product standards landscaping, technical regulatory dossier formats, downloadable checklists, process flow charts, guidelines, formats, timely updates and notifications on changing regulatory requirements, hassle-free online submission of large regulatory documents for review and approval and keeping track of regulatory compliance of the products under development.
- The regulatory services were extended to all the commercial partners for the COVID-19 emergency technologies for faster commercialization and necessary approvals from CDSCO.

2. The Institute is now approved by CDSCO as a National Testing Laboratory for Biocompatibility Evaluation as per ISO 10993 for all medical devices and materials. The CDSCO inspection for Registration of Medical Device Testing Laboratory was conducted on 17-18 July 2019.

## 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. Currently, the core research at the Division focuses on the development of highly sophisticated implants like deep brain stimulators, cardiac defibrillators, spinal cord stimulators and different types of sensors and electrodes such as subdural and depth electrodes.

## Product Development

### 1. Deep brain stimulator system for Movement Disorders

Deep brain stimulation involves implanting electrodes within certain areas of brain to produce electrical impulses that regulate abnormal impulses. The electrical impulses can affect certain cells and chemicals within the brain. The amount of stimulation in deep brain is controlled by a pacemaker-like device placed subcutaneously in the upper chest and connected by a wire to the electrodes in the brain. Deep brain stimulation is used to treat a number of neurological conditions, such as Parkinson's Disease, essential tremor and dystonia. Deep brain stimulation is also being studied as a treatment for epilepsy, cluster headaches, Tourette syndrome, chronic pain and major depression. The Deep brain stimulator system consists of a neurostimulator module, leads and electrodes, extension cables and programmer module. This Project was executed with the Bhabha Atomic Research Centre (BARC) as co-development partner. The first sets of prototypes were evaluated for safety and performance. The prototypes were tested by various mechanical tests illustrated in Figure 37.





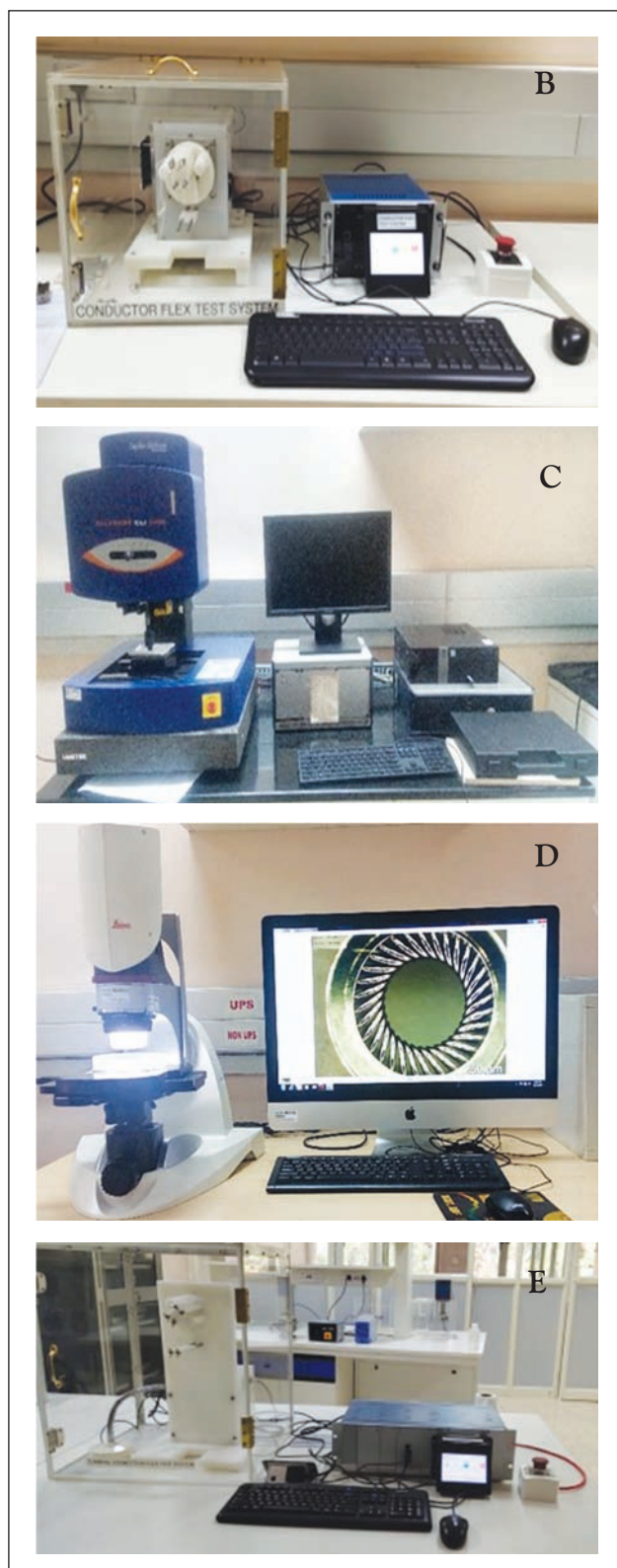


Figure 37. Mechanical tests for deep brain stimulator system (A) Lead body flexion testing (B) Conductor flex testing (C) Surface profilometry (D) Surface inspection (E) Terminal connection flex testing

## 2. Automated Implantable Cardioverter Defibrillator

An Implantable Cardioverter Defibrillator (ICD) is a battery-powered pulse generator that monitors the heart rate when implanted in a subcutaneous pouch in the chest or abdomen, often just below the clavicle. It uses batteries to send electric signals to a heart that is beating too slowly. It can also deliver an electric shock to help restore normal heartbeat to a heart that is beating chaotically and too fast. An ICD monitors the heart's electrical activity using wires with electrodes at 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-chest surgery. The ICD responds to irregular life-threatening heart 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. The Project was 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 and 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. The Project completed the proof-of-concept and preclinical studies were initiated.

## 4. Design and development of a new kind of steering electrodes with feedback for deep brain stimulator applications

The next generation of Deep Brain Stimulation (DBS) devices are expected to be fully and automatically programmable, compatible with biomarker variations,



and flexible in stimulation type and pattern to yield greater benefits and fewer side effects. Since a new technology has to be accessible to patients all over the world, the next closed-loop designs need to be inexpensive. In addition, the device should operate based on multiple biomarkers to decrease the chance of malfunction and guarantee the robustness of the closed-loop DBS operation. The Project aims to develop a hybrid electrode that performs the dual functions of current steering and a feedback sensor for closed-loop control of deep brain stimulation with the addition of a sensory element into the electrode.

### 5. Automated External Defibrillator

Automated External Defibrillator (AED) 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 super capacitor (which powers the entire device), multifunction electrodes (ECG rhythm analysis and detection of heart rate abnormalities), charge storing capacitor and a microprocessor-based electrical circuit.

### DIVISION OF POLYMERIC MEDICAL DEVICES

The Division focuses on the development of a number of polymeric medical devices. Various device development projects in the Division such as radiopaque liquid embolic system for the treatment of arteriovenous malformation, radiopaque polymeric microspheres for embolization therapy, development of dosimetric head phantom and parylene coating for implantable medical devices/device delivery systems progressed well with outputs in terms of patents, design registrations and publications. Most of the projects received funding from the Technical Research Centre (TRC) Scheme, Department of Science and Technology, Government of India. Other projects were funded by Technology Development Fund (TDF) of the Institute and the Kerala State Council for Science, Technology and Environment, Trivandrum. The Faculty members of the Division collaborated with other Divisions, Departments and institutions in various ongoing programmes. The Division gives thrust to the PhD Programme as well. Presently, 10 students were pursuing their PhD in the Division and their research was related to medical devices. One student is doing PhD in a joint program with the Indian Institute of Technology, Madras.

One MPhil student completed the dissertation in the Division. The Division is equipped with a chemical laboratory, polymer processing laboratory and polymer/device testing facilities. In addition, the Division offers services such as mechanical testing, dynamic mechanical analysis and viscosity measurements to internal and external customers.

The Division added two equipment - fused deposition modelling machine and chemical reactor (Figure 38) to strengthen the research activities.



Figure 38. Chemical Reactor

## Product Development

### 1. Development of liquid embolic agent

The aim of this Project was to develop injectable radiopaque liquid embolic agent (LEA) free of metal particles for the treatment of arteriovenous malformation (AVM) in the brain. A number of formulations were derived and optimized based on their viscosity and radiopacity. The radiopaque polymer developed was found to be non-toxic. The Project resulted in filing 3 patent applications and 3 design registrations. An in vitro test system to assess the performance of the liquid embolic agent was designed and fabricated in collaboration with Mr Arvind Prajapati, Engineer C, Division of Artificial Internal Organs (Figure 39). The system simulates the AVM nidus, and precipitation behaviour was monitored under fluoroscopic conditions (Figure 40).

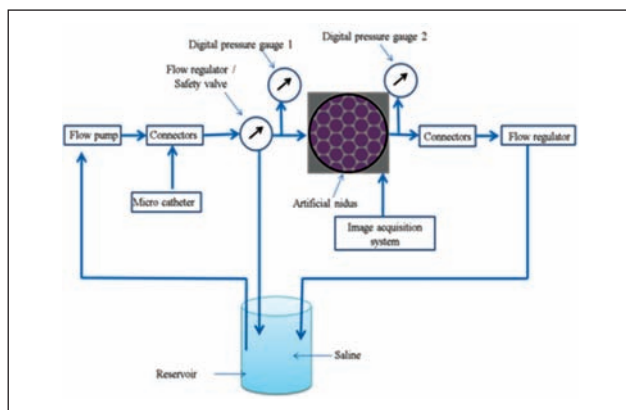


Figure 39. Schematic representation of the in vitro test system to study precipitation of liquid embolic agent

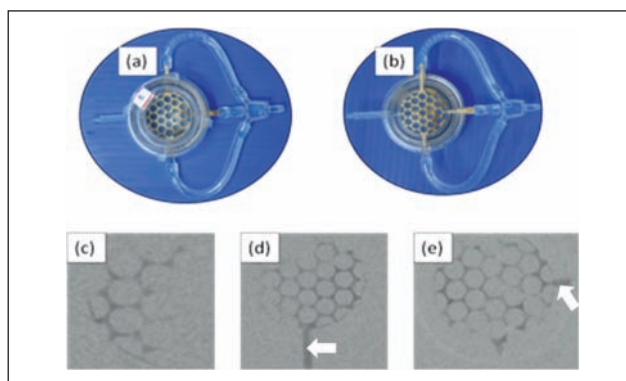


Figure 40. Flow and precipitation of liquid embolic agent in an in vitro AVM model under fluoroscopy (a) Top view (b) Bottom view of precipitated LEA in artificial nidus recorded with a camera, (c) - (e) flow and precipitation of liquid embolic agent under fluoroscopy (white arrows indicate precipitated embolic agent in the draining veins)

### 2. Development of radiopaque polymeric microspheres for embolization therapy

In this programme, a number of iodinated compounds were synthesized and grafted onto polymers. The resultant radiopaque polymers were converted into microspheres with good radio-opacity. An optimized system showing microspheres and radio-opacity is shown in Figure 41. Further evaluation of the material was ongoing.

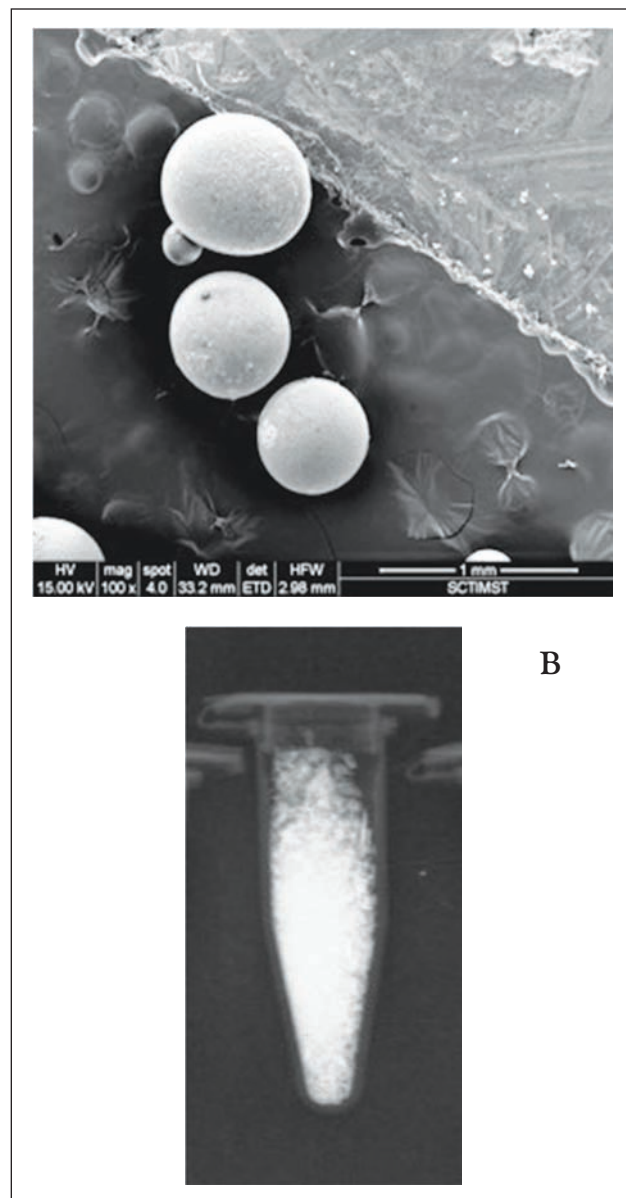


Figure 41. (A) Radiopaque polymeric microspheres (B) X-ray image of microspheres showing radio-opacity





### **3. Design and fabrication of a head phantom for the dosimetric evaluation of radiotherapy treatment plans**

A commercial head phantom was analysed for its composition and physico-chemical properties and a new polymeric composite formulation was developed that matches closely with the commercial phantom. A comparative analysis of the commercial phantom and newly formulated polymeric composite system was ongoing using computed tomography.

### **4. Development of skull base buttress device for closure of osteodural defects**

Under this TDF Project, several prototype skull base defect closure devices were designed and fabricated in collaboration with the Precision Fabrication Facility. Product design was optimized and prototype was developed for detailed in vitro and in vivo evaluation. The device can be used, in a minimally invasive way, via transsphenoidal route for closing defects in the skull base bone, incurred during the removal of pituitary tumours.

### **5. Development of Leukodepletion filter**

Imported membranes were used to fabricate leukodepletion filter. The physicochemical properties of the membranes and the filter performance characteristics were evaluated and found to be satisfactory for the proposed application.

### **6. Parylene coating for implantable medical devices and device delivery systems**

Specifications for the parylene coating equipment were prepared and the order was placed for the procurement of the same.

### **7. Development and evaluation of dural substitute prepared by electrospinning of polycarbonate urethane**

The mechanical properties of the developed dural substitute were evaluated under different processing conditions and biological evaluation was initiated.

A number of exploratory research activities were ongoing in the Division, most of them as part of the PhD Programme. These included: injectable hydrogels for meniscal repair, bioinks for 3D bioprinting of tissues, curcumin-metal complexes for better bioavailability and bioactivity, electrospun membranes for different biomedical applications and polymeric tissue adhesives.

### **Testing and Evaluation**

The Division is equipped with facilities for mechanical testing of materials, dynamic mechanical analysis of polymers and falling ball micro-viscometer for viscosity measurements. These facilities were extended to internal and external customers for their material characterization. 473 samples (113 external and 360 internal) were tested for mechanical properties. The samples tested included polymer and ceramic materials, soft and hard tissues and composite materials. Viscosity measurements were performed on 102 samples and 30 samples were analysed for dynamic mechanical properties.

### **Student training/internship**

1. Ms Asha VNath submitted her MPhil dissertation titled, 'Radiopaque iodinated microspheres for embolization: preparation and characterization'. The project work was supervised by Dr Roy Joseph, Scientist G.
2. Ms Bhavana Pulipaka, student of Trivandrum International School carried out her internship at various Divisions of BMT Wing from 1 - 15 November 2019.

## **DIVISION OF PRECISION FABRICATION**

This Division provided service support to other scientific/technical laboratories of the Institute in fabricating moulds, dies, jigs, fixtures and machining of prototype components related to various projects utilizing the CNC and conventional machines to deliver high precision fabrication and moulds.

Major support was provided for the ongoing TRC

## **Research Programmes**



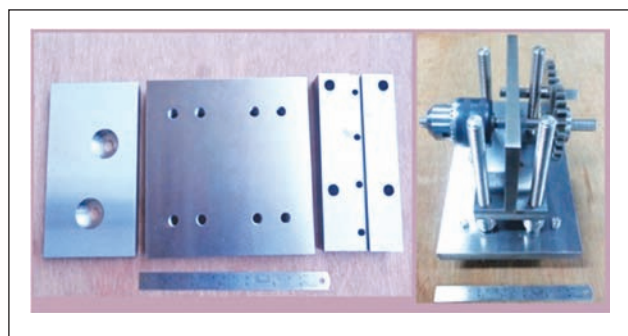
Projects like paracorporeal left ventricular assist device, annuloplasty ring, centrifugal blood pump, bioprosthetic heart valve, implantable pulse generator, leukodepletion filter, microinfusion pump, intracranial electrodes and atrial septal defect occluder.

From the Precision Fabrication Facility, nearly 90 major work orders related to fabrication, machining of test setups and prototypes were executed and delivered to various R & D activities during the year.

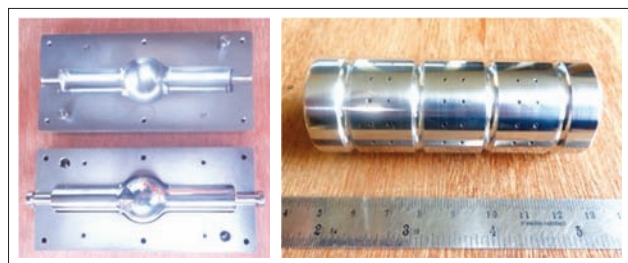
Photographs of selected components and devices fabricated in the Division (Figure 42) are shown below:



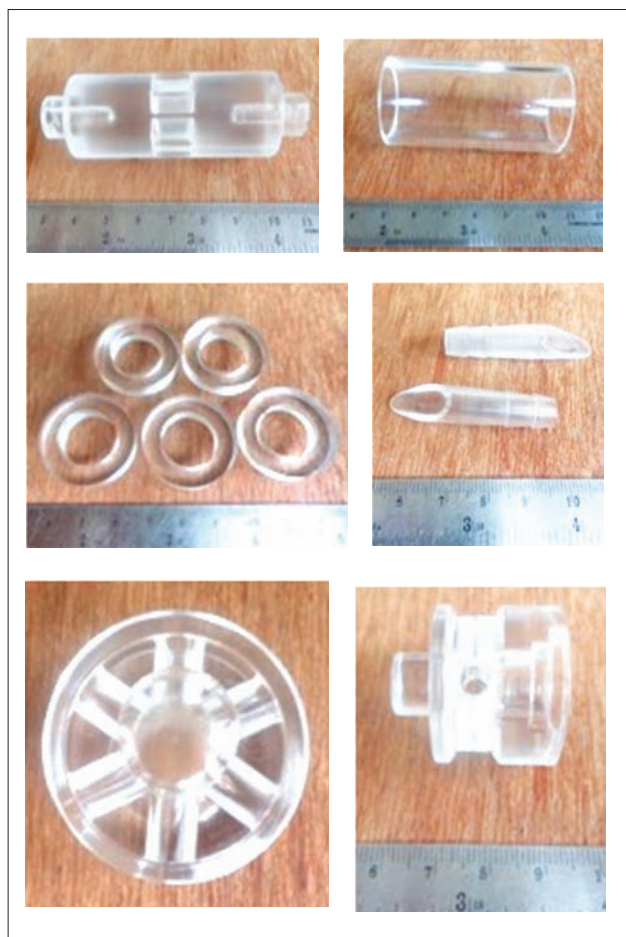
*Liquid Elastomer Gun Assembly*



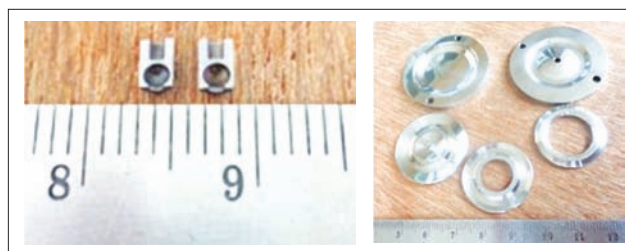
*M S base, M S collect holder and S S collect holder of plasma spray system*



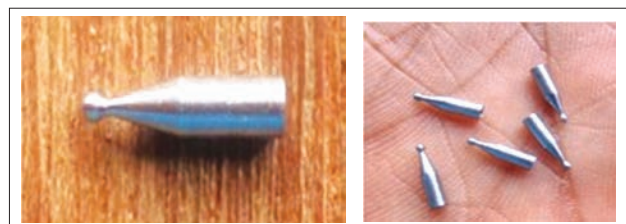
*SS mould components for the aorta model and the heat treating fixture used to heat-treat NiTi end-cuff*



*Components of paediatric oxygenator*



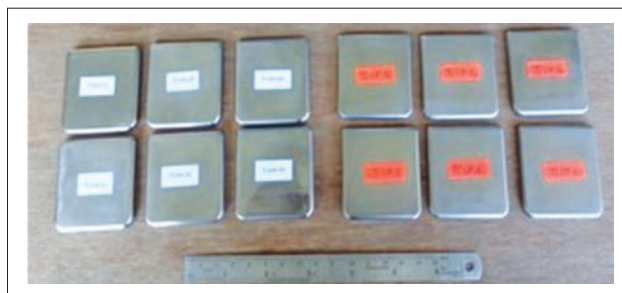
*NiTi ASD occluder hub and five SS components of the heat treatment mould*



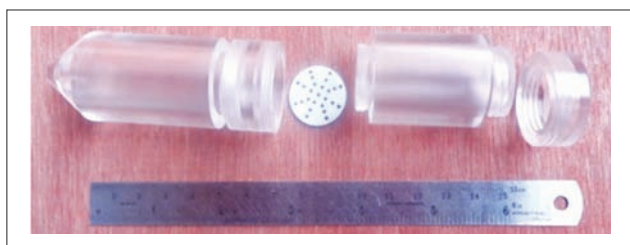
*SS pronged tip of ASD occluder delivery system*



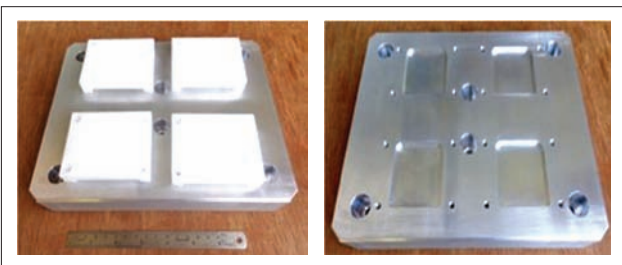
Machined samples for biocompatibility evaluation of various materials



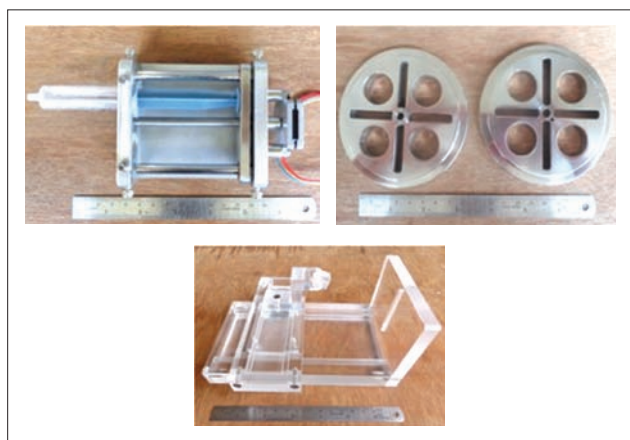
Ti CP Grade 2 IPG cases and Ti -6Al-4V IPG cases



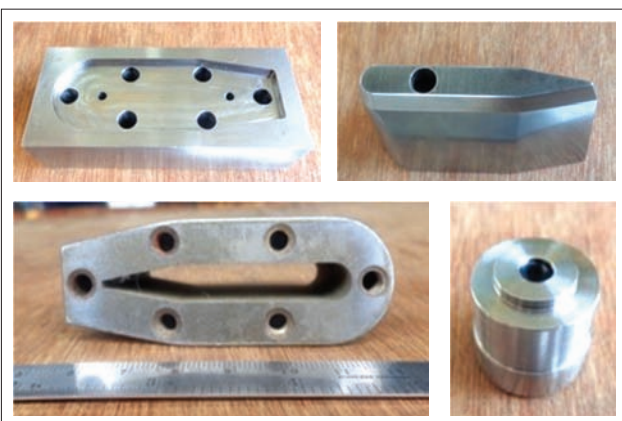
Acrylic centrifuge tube with teflon filtering unit



Al IPG holder plate and polypropylene clamp



Components for the microdispenser assembly - TETS testing components for IIP and TETS mold SS components of microinfusion pump



HCHCr Punch-before hardening and after hardening, SS Punch Holder and SS Shank to punch electrode flap



Polycarbonate thin shell housings for Leukodepletion filter



Brass electrodes for R F welding - weld, weld head and weld base

Figure 42. 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

### CENTRAL ANALYTICAL FACILITY

Central Analytical Facility (CAF) is the analytical service Facility open to both internal and external customers. CAF is capable of performing physicochemical evaluation of biomaterials and biomedical devices using equipment like FTIR Spectrophotometer, UV-Vis Spectrophotometer, Spectro-fluorometer, Thermo Gravimetric Analyser, Differential Scanning Calorimeter, High Performance Liquid Chromatography, Gel Permeation Chromatography, Gas Chromatography, Confocal Raman Microscope, Textural Analyzer and Luminescent Image Analyzer. The Facility is actively involved in various projects of the Institute by providing technical guidance and support. CAF also hosts M Phil/M Tech students during their laboratory modules or internships and is engaged in other academic activities of the Institute such as laboratory demonstrations during student or industrial visits.

#### New Initiatives

Instruments of the Central Analytical Facility were moved to S&T and the Facility was refurbished. An application was submitted to NABL for obtaining accreditation for some of the physicochemical tests performed at CAF such as compositional analysis by Thermogravimetry, determination of glass transition temperatures and enthalpies of fusion and crystallization of materials by Differential Scanning Calorimetry and estimation of residual ethylene oxide by headspace GC analysis.

#### Testing and Evaluation

Physicochemical properties of materials used in medical devices are characterized in the Analytical Facility on a routine basis. About 920 samples from various internal and external customers were characterized during the year. The department also generated 7 new test methodologies and test services

were offered to internal and external customers through the Customer Service Cell (CSC). Liquid Chromatography with tandem mass spectrometry, Universal Testing Machine and Force Tensiometer were activated and steps were taken to initiate tests based on them.

### CALIBRATION CELL

NABL Audit was completed by November 2019 in mechanical, thermal and electro-technical calibrations. In Electro-technical calibration, an additional electrical parameter such as AC voltage was included and the scope of accreditation was expanded.

#### Product Development

The TRC-funded project 'Preparation and Standardization of Reference Biomaterials for Biological Evaluations' was completed. A batch of Reference Materials prepared was used as control materials for biological evaluations based on ISO 10993. Metal, polymer and ceramic materials were used in muscle and bone implantation studies and polymer was used as a positive control for cytotoxicity studies.

#### Research Programmes

The following projects were initiated:

1. Surface characterisation of TTK-Chitra heart valve – study on UHMWPE discs for evaluating surface finish (Funded by: TTK Health Care Pvt. Ltd.),
2. Validation of Ethylene Oxide Sterilisation System (Funded by: TRC)
3. Calibration study of equipment (Funded by: Government Analysts Laboratory, Trivandrum).



## Testing and Evaluation

Mechanical, thermal and electro-technical calibrations carried out by the Calibration Cell were accredited by NABL, India. Mechanical calibration included calibration of volumetric glassware, micropipettes, electronic balances, mass sets and rotational speed. Thermal calibrations included Relative Humidity monitors, thermometers and temperature chambers like incubators.

Summary of calibrations and measurements performed during the year:

- Calibrations - 420
- Surface Profile Measurement - 243
- Preparation and issue of new work procedures for electro technical calibrations - 5.

## ENGINEERING SERVICES

This Division provides technical support for general maintenance of equipment and environment at various facilities, management of utility supply (power, water), and 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.

### Activities

The year 2019-20 witnessed major infrastructure up-gradation in the BMT Wing. The following facilities were commissioned and completed:

1. Network backbone of the BMT Wing was enhanced to 10 GBPS capacity
2. A full High Definition (HD) Video Conferencing Facility (Figure 43) supporting hardware, codec and software-based meetings
3. In Vivo Evaluation Facility under the Division of In Vivo Models and Testing
4. Renovation of Division of Histopathology and Central Analytical Facility
5. Specification development and design of electrical requirements as part of renovation of Animal Facility in the Division of Laboratory

### Animal Sciences

6. Feasibility study for the use of 750 KVA transformer for new Combinational Devices Block was carried out with support from the Division of Clinical Engineering, Hospital Wing
7. A Telephone Exchange on rental basis was set up with 100 intercom connections for use in the BMT Wing. A booster antenna for BSNL mobile communication was installed for enhancing communication.
8. Design specification development for Controlled Environment for Laboratory Animal Sciences Facility
9. Installation of New Electrical Pane (Figure 44)



Figure 43. High Definition Video Conferencing Facility



Figure 44. Inauguration of New Electrical Pane by Dr Harikrishna Varma, Head, BMT Wing



## QUALITY CELL

Activities of the Quality Cell include the implementation, maintenance and continual improvement of Quality Management System. The Cell also ensures that the facilities, equipment, personnel, methods, practices and records are in conformity with the requirements of International Standard ISO 17025.

### Activities

#### 1. COFRAC Surveillance Assessment

COFRAC assessment was conducted on 11-12 July 2019. Assessors reported confidence in the Institute to provide services in compliance with ISO17025:2017 standard requirements for all accreditation and included all extensions. Three new tests were introduced with effect from October 2019.

#### 2. NABL Renewal Assessment

Renewal assessment of NABL for accreditation of Calibration Cell (Thermal, Mechanical and Electro-technical Calibration) as per revised ISO/IEC 17025:2017 was conducted on 31 October and 1 November 2019. The accreditation was successfully renewed for 2 years from 14 February 2020.

#### 3. NABL accreditation of physicochemical testing at the Central Analytical Facility

Initial online application for NABL accreditation for the Laboratory was completed by 24 February 2020.

#### 4. Management Review

Management Review Committee meeting was held on 9 January 2020. Two Technical Management Committee meetings were held on 29 June 2019 and 18 December 2019.

#### 5. Internal Audits

Two internal audits were carried out during 13-21 May

2019 and 11-18 November 2019 and corresponding post-audit meetings on 17 June 2019 and 10 December 2019.

#### 6. Documents initiated/revised during the year:

- A total of 18 system procedures, 118 work procedures and 6 guidelines were revised/issued
- 74 Lab notebooks were issued
- 134 Registers and Logbooks were prepared and issued to various Divisions
- 38 corrective actions were generated by different Laboratories

#### 7. CDSCO-Medical Device Testing Laboratory Registration

For registration of the BMT Wing as a Medical Device Testing Laboratory (MDTL), the Quality Cell, in collaboration with the nodal official, prepared all the documents for online registration and facilitated CDSCO inspection on 17-18 July 2019. The Certificate of CDSCO-MDTL registration was received with effect from 25 September 2019.

#### 8. Monitoring and streamlining of purchase activities

As per the Order, Per&G.Admn/BMT/HBO/20/2018 dated 31 July 2018, a Committee that included Quality Cell personnel was constituted by the Head, BMT Wing, to monitor and streamline purchase activities. Several meetings were convened and 4 new work procedures were prepared to cover the entire activities of the Purchase Section. The Committee submitted its Report on 31 May 2019.

#### 9. Archival of Documents

The old Quality Management System documents were segregated, indexed and 18 hard bound books were handed over to the Archival Cell on 25 October 2019.



## TECHNOLOGY BUSINESS DIVISION

The Technology Business Division focuses on the following activities of the Institute:

1. Co-ordinating Institute-Industry interactions related to technology transfer and research project collaborations
2. Co-ordinating all the Intellectual Property Rights like patent, design and trademark registration of the Institute
3. Co-ordinating testing services and specific protocol-based study requests from the industry and academia for medical devices and biomaterials
4. Co-ordinating training, problem solving and consultancy activities of the Institute through the Industry-Institute Partnership Cell
5. Co-ordinating internal research project funding of the Institute comprising Technology Development Fund Scheme, internal review of the project application and interim status reviews of the projects
6. Preparing various reports/questions for submission to external agencies such as DST, DSIR, ICMR, Lok Sabha and Rajya Sabha on the activities of Institute
7. Outreach Programmes – providing exposure to students from different institutions across India to the development of medical devices at the Institute
8. Co-ordinating discussions with clinicians on future projects and projects under development

### Activities

#### *Expression of Interest*

An advertisement for Expression of Interest for technology transfer and industry-driven products was circulated in the All India edition of the Economic Times on 28 June 2019. The details were also updated on the Institute Website. The Institute received requests for some of the products, and discussions were ongoing

## *Memorandum of Understanding*

The following agreements were signed during the year:

1. Paracorporeal Left Ventricular Assist Device with M/s Meril Life Sciences Pvt. Ltd.
2. Lint-free absorbent wound dressing with M/s Phraction Scientifics Ltd.
3. SCTAC2010 - Human serum albumin-conjugated anti-cancer drug formulation with M/s Eight Oaks Bio Pvt. Ltd.
4. Calcium sulfate cement and calcium phosphosilicate cement with M/s Prevest Denpro Ltd.
5. Co-development of Real-time PCR kit with Origin Diagnostics and Research, Karunagappally
6. AMBU bag-based Ventilator System with Wipro Enterprises Pvt. Ltd. (through the Wipro 3D Division), Bengaluru

## *Non-Disclosure Agreements*

The following Non-Disclosure Agreements were signed during the year:

1. Bioprosthetic valve with M/s Kamal Encon Industries Ltd.
2. Oral insulin delivery with M/s Wockhardt
3. Leukodepletion filter with M/s Biolife Medical Pvt. Ltd.

## *Technology Development Committee*

The newly-constituted Technology Development Committee met on 24 January 2020. The Committee reviewed the presentations on ongoing TRC Projects, Technology Transfer activities and matters related to Intellectual Property. The Committee also discussed Technology Transfer – current policies, challenges and strategies for partnership with industries.

## *Technology Transfer Committee*

The Committee met on 5 July, 8 August, 20 August, 5 November, 9 December 2019 and 2 January and 7 February 2020.



### **Industry Visits**

The Division co-ordinated with the following industries for the purpose of exploration of technology transfer and for project or R&D collaboration:

- Meril Life Sciences Ltd.
- Sahajanand Medical Technologies Pvt. Ltd.
- Eight Oaks Bio Pvt. Ltd.
- Agappe Diagnostics Ltd.
- Cologenes Pvt. Ltd.
- Tynor India Ltd.
- enProducts Pvt. Ltd.
- Phraction Scientifics Pvt. Ltd.
- Pulse Biomed
- Anabond Stedman Pharma Research Pvt. Ltd.

### **Intellectual Property Rights**

1. The details of intellectual property made by the Institute during the year are as follows:

- Patents Granted: 10 (Foreign = 1, Indian = 9)
- Patent Applications Filed: 31 (Foreign = 3, Indian = 28)
- Design Registrations Filed: 13

2. One trainee was undergoing on-job training at the Intellectual Property Cell for a period of 11 months under the Knowledge Involvement in Research Advancement through Nurturing (KIRAN-IPR) Scheme, Technology Information Forecasting and Assessment Council (TIFAC), Department of Science and Technology.

### **Placement Cell**

A Campus Selection Aptitude Test and Recruitment Interview was conducted for M Tech Clinical Engineering students by HCL Technologies, Chennai, and 4 students were selected for the HCL Medical Devices Team.

### **Exhibitions**

The Institute was represented in the following exhibitions.

1. India International Science Festival 2019, Ministry of Science and Technology, Ministry of Earth Sciences and Vijnana Bharati from 5-8 September 2019 at Kolkata
2. 107th Indian Science Congress from 3-7 January 2020 at GKVK Campus, Bangalore, Karnataka
3. 27th National Children's Science Congress, Kerala State Council for Science, Technology and Environment, Government of Kerala, from 27-31 December 2019 at the Mar Ivanios Vidya Nagar, Nalanchira, Thiruvananthapuram.
4. Kanakolsavam 2019 from 5-15 April 2019 at Kanakakunnu Palace, Thiruvananthapuram
5. Aavishkar 2019 from 27-29 April 2019 at Christ Nagar Public School, Maranalloor.

### **Student Visits**

The Division co-ordinated student and Faculty visits from different academic institutions and introduced them to medical device development and other activities of the Institute. During the year, students from the following institutions visited BMT Wing:

- Medical Trust Institute of Medical Sciences, Kochi
- APJ Abdul Kalam Technological University, Thiruvananthapuram
- Avinashilingam Institute for Women, Coimbatore
- K S Rangasamy College of Technology, Tiruchengode
- Members of IEEE Engineering in Medicine and Biology Society
- Government College for Women, Thiruvananthapuram
- Trivandrum International School
- Sree Narayan College for Women, Kollam
- School of Medical Education, Manimalakunnu, Ernakulam





- Fatima Mata National College, Kollam
- Mar Ivanios College, Thiruvananthapuram
- Government Vocational Higher Secondary School, Njekkadu

### Customer Service Cell

Customer Service Cell co-ordinated 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		
	2017-18	2018-19	2019-20	2017-18	2018-19	2019-20
Number of Work orders	463	391	565	143	300	374
Number of test materials	935	735	978	435	945	1030
Income (Rs)	44	29	43	11	35	29
	86	31	04	23	07	73
	133	350	180	300	325	300

### 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

Mr Vinodkumar V, Scientist F

Dr Anugya Bhatt, 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

Ms 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 A U, Technical Assistant - A

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

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 Sajlmon 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)

### Events Organized

1. The Industry-Institute Partnership Cell conducted the following Workshops for the academia and medical device industry, including 3 Workshops conducted as special call for SC/ST candidates:

- 'Abhiruchi' – An interactive session for government school students, from 22



November 2019 - 31 January 2020 (Figure 45)

- Intellectual Property Rights and its significance, on 25 November 2019
- Introduction to in silico evaluation of medical devices, on 17-18 January 2020
- Intellectual Property Rights and its significance, on 12 Mar 2020
- Materials in Medicine, on 6 - 7 February 2020
- Tissue engineering for medical applications, on 5 - 6 December 2019 (Special call for SC/ST candidates)
- Avenues of engineering in biomedical research, on 8 - 9 August 2019 (Special call for SC/ST candidates)
- An insight into analytical instruments in research, on 23 - 24 January 2020 (Special call for SC/ST candidates)
- Nanotechnology and its applications in Medicine, on 25 - 26 July 2019
- Biological safety and efficacy evaluation of medical devices, on 4 - 6 July 2019
- Tissue engineering for medical applications, on 28 - 29 June 2019
- Cleaning, packaging and sterilization of medical devices, on 30 - 31 May 2019





Figure 45. Abhiruchi – interactive session for Government school students





2. Laboratory demonstrations to 18 engineering students as part of providing Internship/ Observership was organized by the Calibration Cell in June 2019, July 2019 and February 2020.
3. The Quality Cell organized Internal Auditor Training in ISO 13485:2016 on 2-5 April 2019 at Hotel Central Residency, Thiruvananthapuram. 27 personnel of the Institute were trained by Sri M G Sathyendra, Faculty, QMart Global, Bengaluru.
4. The Quality Cell organized 1-day training on revised standard ISO/IEC 17025: 2017 on 12 June 2019 at the BMT Wing. 27 personnel including supporting and technical Staff were trained by Ms P K Padmakumari Amma, Faculty,



Figure 46. 13th Annual World Sleep Day

- HLL Infra Tech Services Ltd., Trivandrum.
5. Dr Kamalesh K Gulia organized the 13th Annual World Sleep Day on 13 March 2020 at the BMT Wing (Figure 46). The slogan for this year was 'Better Sleep, Better Life, Better Planet', highlighting the important role of sleep as a pillar of health, allowing for better decision-making and cognitive understanding of big issues, including our planet.
6. Hands-on Workshop on Microscopy and Image Analysis was organized by Drs Naresh Kasoju and Anil Kumar P R on 25-27 November 2019 at the BMT Wing (Figure 47).
7. Hands-on Workshop on Flow Cytometry was organized by Drs Anugya Bhatt and Renjith P Nair on 5-7 December 2019 at the BMT Wing.
8. The Department of Medical Device Engineering conducted a series of Outreach Programmes in schools and colleges for knowledge dissemination and to popularise Science. Exhibitions, motivational talks and Science Magic Shows were conducted. One such Outreach Programme was conducted at the Puvathoor Government HSS on 17 July 2019 (Figure 48) by the Departmental Faculty, Mr Nagesh D S, Mr Vinodkumar V, Mr Sarath S Nair, Mr Jithin Krishnan and Dr Gijo Raj. More than 100 students studying in 10-12 standards benefited. Dr Gijo Raj also presented a Science Magic Show where the principles of various scientific concepts were





Figure 47. Hands-on Workshop on Microscopy and Image Analysis

demonstrated using disposable plastic materials and the importance of plastic recycling and environmental protection was highlighted.

9. The Faculty from various Departments also delivered talks at various schools and colleges in Thiruvananthapuram (Figure 49), which

included the VTNSS College of Science, Dhanuvachapuram, Bharatiya Vidya Bhavan, Kodunganoor, Christ Nagar School, Maranalloor, Rajadhani Institute of Engineering and Technology, and St. Xaviers College, Thumba.





Figure 48. Outreach Programme was conducted at the Puvathoor Government HSS by the Department of Medical Device Engineering on 17 July 2019



Figure 49. Talks at various schools and colleges by the BMT Wing Faculty



# 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 is the main activity of AMCHSS. During the academic year 2019-20, 19 students had enrolled for the 2-year Master of Public Health (MPH) Programme. As part of the affiliate programme for MPH at the Indian Institute of Public Health-Delhi, National Institute of Epidemiology-Chennai and Christian Medical College-Vellore, 40, 15 and 11 students joined during the academic year 2019-2020, respectively. Further, 1 student joined for the Diploma in Public Health at AMCHSS. In total, 72 students graduated with MPH degree during the academic year 2019-20.

### Training

AMCHSS supported the research activities of the Institute by conducting short training programmes in research methodology, computer-based statistical and data analysis, Workshops on systematic reviews and meta-analyses, grant writing skills, and basic and advanced epidemiology.

### Research

The key 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.

## New 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 study will demonstrate, in the 2 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 community and systems levels. Our approach will integrate with and strengthen both state governments' current efforts by building the capacity of the existing health workforce and promoting the strengthening of the health systems. Our findings will also inform decision makers about: (1) How to allocate resources for 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 1,007 K-DPP study participants. The major objectives are as follows; (1) To understand the impact of a lifestyle modification programme on cardiometabolic risk factors and preclinical changes in the microvasculature (retinal microvasculature and albumin-to-creatinine ratio), the reversibility of key CVD risk factors and the impact on predicted 10-year CVD risk, using the recently developed risk equation for Indians, Globorisk, (2) To undertake economic analysis to justify investments in CVD and related chronic prevention programmes, and (3) To measure community engagement and programme sustainability of KDPP.

### ***3. Systems thinking approach to developing an integrated and patient-centred intervention model for multi-morbidity care in primary care settings in India***

PI: Dr Jeemon Panniyammakal (Funded by: Medical Research Council, UK)

This proposal will use a systems thinking approach and causal loop model to conceptualize how health systems manage patients with multi-morbidity in primary health care settings in India. Evidence will be sought from the literature by conducting a systematic review of the benefits of existing interventions for patients with multimorbidity in LMIC. An interdisciplinary research team of health system

researchers, epidemiologists, and social scientists will conduct the study in 2 phases: (1) development of the intervention structure and causal loop modelling, and (2) piloting of multi-level intervention for integrated management of multimorbidity. In the first phase, potential interventions will be identified and gaps in the current system would be addressed from the perspectives of patients, providers and the health system. A causal loop modelling will be employed to identify feedback loops and evaluate impacts of the potential interventions at the level of patients and care providers. We will also look into ways in which the care of people with multiple chronic conditions can be organized 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 the feasibility of the interventions will be evaluated.

### ***4. Understanding disease clustering (Multimorbidity) in the tribal population of Kerala***

PI: Dr Jeemon Panniyammakal (Funded by: SCTIMST (Intra-mural))

In this project, a cross-sectional community-based study will be conducted in 3 districts in Kerala (Malappuram, Wayanad and Trivandrum) to understand the pattern and distribution of multimorbidity at the individual, household and community levels 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 levels. Tackling multiple morbidities provides a greater understanding of the underlying biology to map clusters of conditions and explore sequential and spatial relationships in order to identify key targets for interventions. The ultimate aim is to convert this into a cohort and follow them up 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, Government of India)

It is a study to understand the impact of industrialization on the rural environment and population health. The main objective of the project 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; (a) Effects on livestock, agriculture, water and soil, (b) Long-term consequences of industrial pollution on the rural environment in terms of social structure, the land owning and other economic well-being in the surrounding areas of tanneries, and (c) Specific consequences such as illnesses, deaths and other events in the villages.

### ***6. Effectiveness of drugs control and regulating mechanism of the Drugs Control Department in Kerala State***

PI - Dr Ravi Prasad Varma (Funded by: Kerala State Planning Board)

The major objective of the project is to review the structure and functioning of drug regulatory mechanisms in Kerala state, including mechanisms to increase provider and consumer trust of these regulatory mechanisms.

### ***7. 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 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 to engage 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 the ST community to foster engagement of ST in the upgradation of PHCs in tribal areas as part of the Aardram Mission of the Government of Kerala. It also aims to document good practices of quality improvement and service delivery for ST population in PHCs catering to ST population being upgraded as part of the Aardram Mission of the Government of Kerala.

### ***Ongoing Research Initiatives***

#### ***1. 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: 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. 2: To measure the effectiveness of the programme among participants by evaluating the change in number of individuals reaching two or more of cardiometabolic risk goals, namely reductions in blood pressure, triglycerides, and HbA1c (the primary outcome), and through changes in secondary outcomes including rates of diabetes incidence and regression to normoglycemia. 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.

## ***2. 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: 1: To identify barriers to implementing an integrated cardiovascular risk management programme in families of individuals with a positive history CHD. 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. 3: To estimate the scalability of the integrated cardiovascular risk reduction strategy in families of individuals with a positive history of 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.

## ***3. Mobile Telemedicine Project for Wayanad***

PI - Dr Biju Soman (Funded by: Department of Science and Technology, Government of India)

This project was started in November 2017 with financial support from the Department of Science and Technology, Government of India. The project explores the potential to use modern technologies like Telemedicine to improve the coverage of secondary health care services in remote areas that are inhabited by tribal people in Kerala. The 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. Two mobile Telemedicine Units are already deployed in Wayanad along with its crew, including one medical officer, one staff nurse and a driver-cum-technician in each Unit. The local office for the project is located in the old General Hospital building in Kalpetta (Wayanad), and the Telemedicine Units have started services to all the 32 peripheral centres on a trial basis. Two medical doctors, 2 BSc nurses, two Medico-social workers and 2 driver-cum-technicians work under the project to provide telemedicine services and encourage community mobilisation efforts in the tribal population in the district to utilise the health services.

The telemedicine services got disrupted due to certain exigencies like 2 major floods in Kerala in 2018 and 2019. On all these occasions, the project activities had to be temporarily halted, and the entire Units had helped the district authorities in emergency healthcare services. In the present situation of Covid-19 pandemic also, the Units are assisting the district health authorities, as per the special request from the district collector. Besides, the lockdown had hampered attempts to reach out to the tribal hamlets with various empowerment measures. Another significant activity that needs to be taken up once the situation gets back to normal is the detailed Health Technology Assessment of the entire exercise.



#### ***4. Efficient portable stand-alone vaccine refrigerator for rural application***

PI - Dr Biju Soman (Funded by: Department of Science and Technology, Government of India)

This 2-year project with financial support (Rs 1.31 Crores) from the Department of Science and Technology, Government of India, was started in 2019. It was initiated with a tripartite Memorandum of Agreement (MoA) with the Centre for Development of Advanced Computing (CDAC)-Trivandrum and the Indian Institute of Science, Bangalore and SCTIMST, Trivandrum. In this project, we aim to create 2 prototypes of portable refrigerators that can be used in rural areas for maintaining cold chain for safe transport of vaccines and such medicines by the field health workers. The aim is to replace the present-day vaccine carriers with these sophisticated electronic carriers, which can keep the ideal temperature for a longer duration, keep an automatic log of the temperature readings and the number and length of openings of the device. Besides, we envisage built in alarm systems to alert the user and the district authorities if the temperature tends to go up above the threshold limit. The work progressed well, and the simulated computer models were ready. The pre-prototype was fabricated in CDAC.

#### ***5. The Regional Technical Resource Centre 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 was established in AMCHSS on 27 February 2018. The basic mandate vested in the Centre is to conduct Health Technology Assessment (HTA) research for the needs specified by the DHR, Government of India, 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. A

few of our significant efforts in this line in 2019 were: completion of HTA on the use of pulse oximeter at the community level in the management of pneumonia, as per the request of the DHR; and the analysis of package rates for MEDISEP, as per the request from the Kerala Government. Another important engagement of the project in 2019 was the conduct of a series of virtual seminars to the district level decision-makers in Kerala Health System, as per the request from the Government of Kerala, on the value and use of HTA in health policy-making for Kerala.

#### ***6. National Environment Health Profile (NEHP): 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 20-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 modelling.

#### ***7. Availability, distribution and utilization of health care facilities in Kerala***

PI - Dr Manju Nair (Funded by: Kerala State Planning Board)

The main objectives of the project are to document the existing distribution and coverage of health care facilities in Kerala, study the patterns of health services utilization in the state and factors that influence the differential use of public and private services.

#### ***8. 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 programme of research explores the hypothesis that IR promotes breast cancer development and progression by DNA methylation-based reprogramming of genes. The proposed research programme has the following specific aims: 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. 2: Conduct genome-wide DNA methylation profiling of breast cancer tissue samples from IR and IS patients to identify progression-associated loci. 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. 4: Explore the functional relevance of DNA methylation differences associated with IR-driven breast cancer progression.

### **9. Baseline surveillance of major risk factors for Non-communicable diseases in Kerala**

PI - Dr Sankara Sarma (Funded by: Government of Kerala)

A community-based, cross-sectional survey was carried out to estimate the prevalence of non-communicable disease (NCD) risk factors in Kerala. A multistage, cluster sampling technique was employed to survey 12 012 (aged 18–69 years) participants from all 14 districts of Kerala. We observed higher rates of NCD risk factors and lower rates of hypertension

and diabetes control in Kerala. It calls for concerted primary and secondary prevention strategies to address the future burden of NCDs.

### **10. Non-Communicable disease risk factors among working population: An institution-based study in Kerala, India**

PI - Dr Sankara Sarma (Funded by: Public Health Foundation of India and Department of Science and Technology, Government of India)

The main objective of the project was to find out the impact of a tailor-made intervention on the control rates of hypertension among school teachers. This was a cluster randomized controlled trial on control of hypertension. A baseline survey was conducted in 92 schools (government and government-aided) to assess the prevalence of hypertension and its risk factors among school teachers in Thiruvananthapuram district of Kerala State, India. After the baseline survey, the schools were equally randomised to intervention and control groups. The intervention schools received self-management education and behavioural intervention programmes delivered by trained intervention managers along with measurement of weight, waist circumference and blood pressure. After this, a post-survey was conducted among the same teachers of both control and intervention schools. The primary outcome was a change in the control of hypertension, and the secondary outcome was a change in behavioural risk factors of hypertension, both in the control and intervention groups.

#### **Completed projects**

#### **1. Concurrent Monitoring of Mahatari Jatan Yojana in Chhattisgarh**

PI: Dr Mala Ramanathan (Funded by: Institute of Economic Growth, Delhi)

#### **2. Control and Prevention of Non-communicable diseases in Kerala**

PI: Dr Sankara Sarma (Funded by: Government of Kerala)



### 3. KDPP-KSM project

PI: Dr Jeemon Panniyammakal (Funded by: World Diabetes Federation)

#### Events Organized

1. The AMC seminar series is a periodic academic event with seminars held by invited national and international experts in Public Health.
  - Dr Sharad D Iyengar, Chief executive, Action Research and Training for Health, Rajasthan, and Adjunct Professor at the Sanford School of Public Policy, Duke University, Durham, USA, delivered a seminar on 'Interventions in Maternal and neonatal care - SAMPARK and a right-based alternative to target and incentive based approaches to family planning - TARUNI: Experiences from ARTH, Udaipur' on 10 April 2019.
  - Professor Murphy Halliburton, Professor of Anthropology at Queens College and the Graduate Center, City University of New York, conducted a seminar on 'Indian Pharma and Global Patents: Pharmaceutical Production under a New Intellectual Property Regime' on 25 April 2019.
  - Prof Venkat Narayan, a member of the US National Academy of Medicine and Ruth and O C Hubert Chair of Global Health, Director, Emory Global Diabetes Research Center and Professor of Medicine and Epidemiology at Emory University in Atlanta delivered a seminar on 'Type 2 Diabetes in South Asians: Many Mysteries' on 7 November 2017 (Figure 1).
2. Drs Ravi Prasad Varma and Jissa V T conducted a 2-day Workshop on "The science of numeric data, why, where and how to report" on 29-30 May 2019 at AMCHSS.
3. Drs Ravi Prasad Varma and Jissa V T conducted a Workshop on "Size and the process – for a good sample" as part of the AMCHSS annual short course series in Epidemiology and Biostatistics for Medical and Health Researchers on 27-28 June 2019.
4. Dr Biju Soman presided over the inaugural session of the colloquium on "Integration of Yoga in cardiac and neurologic conditions" held at SCTIMST on 24 June 2019 and was the moderator for the panel discussion that followed.
5. Dr Jeemon Panniyammakal organized a special interaction session with Prof D Prabhakaran, Vice-President, Public Health Foundation of India, with the DM Residents, MPH students and PhD students on 11 November 2019 at AMCHSS (Figure 2).
6. Dr Srikant A organized talks on 'Genetics and Epigenetics of complex diseases' by Prof George Davey Smith and Prof Caroline Relton from University of Bristol, UK, on 11 December 2019 at AMCHSS (Figure 3).
7. Dr Rakhal Gaitonde organized a Workshop on 'Use and value of HTA in decision making in Kerala State', for staff from the Department of Health and Medical colleges on 27-28 November 2019 at SCTIMST. The resource persons were Prof Louis Neissen of LSTM and Denny John of the Campbell Collaborative.
8. Drs V Raman Kutty and Srikant A conducted a short course 'A practical course on analysing Medical and Health Data using 'R', from 19-21 December 2019 at AMCHSS.
9. Dr Biju Soman was the resource person for the "Bibliographic software-hands on training" organized by the Academic Division for postgraduate students and faculty on 7 January 2020 at SCTIMST.
10. Dr Biju Soman organized and moderated an in-house discussion on the "Current Public Health Emergency of International Concern (PHEIC) on Wuhan Corona Virus (2019-nCoV)" at AMCHSS on 1 February 2020. Dr Dinoop K P (Assistant Professor-Microbiology), Dr Gurpreet Singh (PhD Scholar-AMCHSS) and Dr Tony Lawrence (PhD Scholar-AMCHSS) spoke on various aspects of the COVID-19 outbreak and around 60 students and staff members actively participated in the discussions.
11. Dr Ravi Prasad Varma conducted a Workshop on 'Regression models for estimating relationships in epidemiological studies' on 8-10 January 2020 as part of the AMCHSS annual short course series in



Epidemiology and Biostatistics for Medical and Health Researchers.

12. Dr Jeemon P conducted a "Research Methodology" Workshop at Rajagiri Institute of Social Sciences, Cochin, from 1-6 April 2019. In total, 24 participants were trained as part of the Workshop. Participants included young faculty members and PhD students from various institutions in Kerala.

13. Dr Biju Soman conducted an interactive session with the medical college faculty at Kozhikode Medical College on 11 April 2019 for harnessing support for the Telemedicine Project. Dr V R Rajendran, Principal, Government Medical College, Kozhikode, and other senior faculty members were among those who attended the event.

14. Dr Jeemon P conducted a Workshop on "Grant Writing" at the Medical College, Trivandrum, from 11-13 May 2019. The Workshop was attended by 33 faculty members of the Government Medical College, Trivandrum, and 2 from SCTIMST.

15. Dr Jeemon P conducted a 2-day "Grant Writing Workshop" at Health Action by People on 18-19 July, 2019. A total of 20 participants from various institutions in Kerala attended the Workshop.

16. Dr Srikant A conducted a course on "An introduction to R" at Health Action by People/ C R Soman School of Health Research in July 2019.

17. Dr Jeemon P delivered a guest lecture titled "Critical analysis of a research paper" at the Government Medical College, Trivandrum, as part of the State Board of Medical Research (Kerala) initiative on 14 August 2019. It was attended by about 50 faculty members and post-graduate students from the Government Medical College, Trivandrum.

18. Dr Mala Ramanathan taught the module on 'Qualitative Research Methodology' for the students of Masters of Research Ethics Program, Centre for Ethics, Yenepoya University, Mangaluru, from 9-13 September 2019.

19. Dr Ravi Prasad Varma P conducted a session on 'Clinical Consensus – Materials and Methods' Faculty Improvement Programme for teachers under KUHS, School of Research in Ayurveda at the Government Ayurveda College, Tripunithura, on 24 September

2019.

20. Dr Mala Ramanathan co-ordinated the Workshop on 'Gender analysis in health: Workshop for researchers using large scale data sets' organized jointly by the International Institute of Population Sciences, Mumbai, and Tata Institute of Social Sciences, Mumbai, from 10-15 October 2019.

21. Dr Mala Ramanathan, Mr Bevin Vinay Kumar and Dr Tijo George (PhD students) jointly co-ordinated and taught a pre-conference Workshop of the National Association of Preventive and Social Medicine 2020 on 'Data visualisation - Let your numbers speak loud and clear', at the Institute of Community Medicine, Madras Medical College, Chennai, on 27 January 2020.

### Awards and Honours

1. Dr Jeemon Panniyammakal was selected Emerging Leader, World Heart Federation 2019.
2. Dr Rakhal Gaitonde was selected Member of the Expert Committee on COVID-19, Government of Kerala.
3. Dr Rakhal Gaitonde was selected Member of the National Task Force on COVID-19, Indian Council of Medical Research.

### Staff

#### Faculty

Dr Sankara Sarma P, Professor and Head

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





Figure 1. AMC Seminar by Prof Venkat Narayan on 7 November 2019



Figure 2. Special interaction session with Prof D Prabhakaran on 11 November 2019



Figure 3. AMC Seminar by Prof George Davey Smith and Prof Caroline Relton on 11 December 2019





## **DIVISION OF ACADEMIC AFFAIRS**



## DIVISION OF ACADEMIC AFFAIRS

The Institute continues to be a much sought-after destination for super-speciality Courses leading to DM or MCh Degrees in Cardiac and Neurosciences. This is also one of the few institutions that offer Post-Doctoral Fellowship Programmes in the sub-specialty areas of Cardiac and Neurosciences. In addition, the Institute offers Masters and PhD courses in Medical, Biomedical and Health Sciences and Diploma and PG Diploma courses in related areas.

### Activities

#### Programmes offered during the year

##### Post-doctoral courses

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 MS)
10. MCh Neurosurgery - 5-year course (after MBBS and 1 year Senior House surgery/ 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/Masters Courses

1. MD in Transfusion Medicine
2. Master of Public Health (MPH)
3. M Phil (Biomedical Technology)
4. PhD (Full-time) & (Part-time)

##### Diploma Courses

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 Courses

1. Cardiac Laboratory Technology
2. Neuro-Technology
3. Medical Records Science
4. Clinical Perfusion
5. Blood Banking Technology

##### Advanced Certificate Courses

##### Advanced Certificate Program in Physiotherapy

- Advanced Certificate Program in Physiotherapy in Neurological Sciences
- Advanced Certificate Program in Physiotherapy in Cardiovascular Sciences

##### Other Programmes

##### Joint Programmes with other institutions

1. M Tech (Clinical Engineering)
2. PhD (Biomedical Devices and Technology)



## Affiliated Programmes with other Centres

### A. National Institute of Epidemiology, Chennai

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 (Medical Imaging Technology)

### D. Indian Institute of Public Health, New Delhi

1. Master of Public Health
2. PhD

The annual selection process for admission to various programmes was carried out in the months of November and December. The selection for PhD (Fellowship holders) and MPhil (Biomedical Technology) was conducted in June 2019.

The freshly-admitted students were welcomed at a function held on 4 January 2020 at which the Director, Dean and various senior faculty members addressed them.

The student community attended national and international conferences, and brought laurels to the Institute by winning Best Oral and Poster Presentation Awards. They participated actively in the Science Fete.

The Orientation Programme for the Senior Residents was conducted during the months of April and October 2019 in 2 batches. They spent 1 week in the Biomedical Technology Wing, visiting various laboratories for exposure to areas relevant to medical device development. They also made industry visits to M/s Terumo Penpol Ltd. and M/s HLL Lifecare Ltd., where medical devices are manufactured using technologies developed and transferred by SCTIMST.

## Admission Process

Admissions to various programmes of study were regulated by policies and procedures approved by the Academic Committee of the Institute from time to time. The Admission announcement was published all over India through advertisements in leading newspapers, and on the Institute website, in the 1st week of September. The assessment and interviews for admission to postdoctoral, doctoral, postgraduate and diploma programmes were held in the Institute during the months of November/December. Admissions to PhD (Fellowship holders) and MPhil (Biomedical Technology) were carried out during July/August.

Number of students enrolled from 01.04.2019 to 31.03.2020

Programme	Number
DM	27
MCh	7
PDF	9
PDCC	5
MD	1
MTech	12
DPH	1
MPH (SCTIMST)	19
MPH (IIPH, New Delhi)	40
MPH (NIE, Chennai)	15
MPH (CMC, Vellore)	11
PhD (BMT/Hospital/AMCHSS)	20
MPhil	4
MS Bioengineering	5
Diploma/PG Diploma/Certificate Courses	26

202 students joined in the academic year. The details of the students/residents admitted to various academic programmes from April 2019 to March 2020 are summarized in the Table below:

The total strength of students on the rolls of the Institute (including the joint and affiliated



programmes) was 484.

### Short-Term Training/Observership

The Institute provided short-term training/observership to candidates sponsored by Government/Autonomous institutions, Health Sector Organizations, Approved Medical/Dental/Nursing/Engineering Colleges and other paramedical institutions. The training/observership was arranged in consultation with the respective Department/Discipline. Observers from various institutions all over the country spent varying periods from 15 days to 3 months in different Departments of the Institute. A total of 321 observers completed their observership at SCTIMST.

### Annual Convocation

The Annual Convocation of the 35th batch of graduates was held on 18 May 2019. Prof Balram Bhargava, Secretary, Department of Health Research, Union Ministry of Health and Family Welfare and Director General, Indian Council of Medical Research (ICMR), was the Chief Guest and delivered the convocation address. Dr E Sreedharan, Former IES Officer and MD, Delhi Metro, was the Guest of Honour. Dr Vijay Kumar Saraswat, Member, NITI Aayog, and President of the Institute, presided over the function. In total, 176 graduates received their degrees during the Convocation.

### Degrees / Certificates Awarded

Programme	Number
DM	24
MCh	6
PDF	9
PDCC	6
MD	1
MTech	12
DPH	0
MPH (SCTIMST)	0
MPH (IIPH, New Delhi)	45
MPH (CMC, Vellore)	14

MPH (NIE, Chennai)	13
PhD (BMT/Hospital/AMCHSS)	17
MPhil	8
MS Bioengineering	0
Diploma in Cardiovascular and Thoracic Nursing	10
Diploma in Neuro Nursing	4
Diploma in Advanced Medical Imaging Technology	3
Diploma in Operation Theatre Technology	2
PG Diploma in Blood Banking Technology	2
PG Diploma in Clinical Perfusion	2
PG Diploma in Cardiac Laboratory Technology	3
PG Diploma in Medical Records Science	2
PG Diploma in Neuro Technology	4
ACP in Physiotherapy in Neurological Sciences	1

### D-Space

Student theses, dissertations and project reports are archived in D-Space, a digital content management system of SCTIMST.

### Training Programmes

The Division organized the following training sessions:

1. Training in SPSS Statistics software 'Introduction to SPSS v25.0' on 20 July 2019. Mr Siriyak C R, Technical Consultant, SPSS South Asia Pvt. Ltd., was the Resource Person.
2. 'Introduction to Bibliography software (Zotero)' was conducted on 07 January 2020, and Dr Biju Soman, Professor, AMCHSS, was the Resource Person.



### National Science Day 2020

National Science Day 2020 was celebrated at the Biomedical Technology Wing. 85 students and 3 faculty members from the NSS College for Women, Neeramankara, Thiruvananthapuram, attended the programme (Figure 1). The theme for this year was 'Women in Science'. Dr Ruby John Anto, Scientist G, Rajiv Gandhi Centre for Biotechnology, Trivandrum, was the Chief Guest and delivered the

Science Day message. Dr Manoj Komath, Scientist G and Head of the Department of Biomaterial Science and Technology, BMT Wing, introduced the flagship products of the Institute, explained the new projects and described the future technology development programme of the Institute. The participants visited the laboratories and were shown the facilities and research activities. Quiz competition and Science Magic Show were also conducted.



Figure 1. National Science Day Celebration

### Institute Open Day

The 'Open Day' was conducted at the Biomedical Technology Wing on 6 March 2020. The Institute opened its doors to the general public with the objective of acquainting them with the clinical, and research and development activities of the Institute. The BMT Wing Campus and laboratories were open to the public from 10 AM to 4 PM. 34 schools and colleges participated in the Open Day celebrations. 1012 participants took part in this outreach programme (Figure 2).

The activities included:

- Exhibition of the prototypes of devices, finished models and products developed at the BMT Wing. The visitors were shown equipments such as conventional and CNC machines, measuring microscope, profile projector and digital height gauge
- Demonstration of videos of various clinical procedures and operation of different diagnostic instruments by the Clinical Departments
- Display of heart and brain specimens and instruments, and demonstration sessions, organized by the laboratories from the Hospital Wing and the Department of Clinical Engineering
- Demonstration, by the Nursing Division, of cardiopulmonary resuscitation for basic life support with the help of mannequin, display of various types of personal protective equipment and models depicting control and prevention of COVID-19 infection
- Models for risk factors and lifestyle modifications for cardiovascular diseases by AMCHSS



Figure 2. Institute Open Day

### 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 were held for the employees in Hindi. Hindi Fortnight/Hindi Day was observed

(Figure 3). Hindi Workshops were conducted for the benefit of staff members to increase the knowledge of functional Hindi. Letters received in Hindi were replied to in Hindi. The Institute participated in the Town Official Language Implementation Committee (TOLIC) meetings.



Figure 3. Hindi Fortnight Celebration

### Financial Support

The Institute provided financial support to the following Faculty and students to attend conferences abroad:

Name	Details
Dr Jayanand Sudhir B Assistant Professor, Department of Neurosurgery	<ul style="list-style-type: none"><li>• Title of the Conference - International Conference on Intelligent Informatics and Biomedical Sciences</li><li>• Organizers - National Institute of Technology</li><li>• Venue - Okinawa, Japan</li></ul>



Dr Harikrishnan S Professor, Department of Cardiology	<ul style="list-style-type: none"> <li>• Title of the Conference - World Congress of Acute Heart failure of the European Society of Cardiology</li> <li>• Organizers - European Society of Cardiology</li> <li>• Venue - Athens, Greece</li> </ul>
Mr Arun K M PhD student, IS & IR	<ul style="list-style-type: none"> <li>• Title of the Conference - Salzburg mind - brain Annual Meeting 2019</li> <li>• Organizers - Centre for Cognitive Neuroscience at University of Salzburg</li> <li>• Venue - University of Salzburg, Austria</li> </ul>
Mr Amal Wilson Varghese, PhD student, Division of Molecular Medicine	<ul style="list-style-type: none"> <li>• Title of the Conference - 22nd International C.elegans conference</li> <li>• Organizers - Genetics Society of America (GSA)</li> <li>• Venue - University of California, Los Angeles</li> </ul>
Dr Jaffarvali Sayyed Senior Resident, Department of Neurology	<ul style="list-style-type: none"> <li>• Title of the Conference - World Congress of Neurology</li> <li>• Organizers - World Congress of International Society</li> <li>• Venue - Dubai</li> </ul>
Dr Ganwani Manish Lakshmichand Senior Resident, Department of Cardiology	<ul style="list-style-type: none"> <li>• Title of the Conference - 12th Asia Pacific Heart Rhythm Society Scientific Session (APHRS 2019) Organizers - Asia Pacific Heart Rhythm Society</li> <li>• Venue - Bangkok</li> </ul>

### Faculty

Prof Asha Kishore, Director and Chairperson

Prof Sankara Sarma P, Dean of Academic Affairs

Prof Prasanta Kumar Dash, Associate Dean (Student and Faculty Affairs)

Prof Kesavadas C, Associate Dean (Research and Publications Cell)

Prof Manikandan S, Associate Dean (Examinations and Curriculum)

Dr Roy Joseph, Associate Dean (PhD Program)

Prof Biju Soman, Associate Dean (Health Sciences)

Dr Santhosh Kumar B, Registrar

### Staff

Ms Jeeva K H, Assistant Administrative Officer (Academic)

Mr Sarath Sam S S, Executive Assistant

Mr Subin D Savio, Upper Division Clerk





## NURSING EDUCATION

### Activities

The Division co-ordinated the nursing-related educational programmes of the Institute. 16 students were enrolled for Diploma in Cardiovascular and Thoracic Nursing and Diploma in Neuro Nursing courses and 11 students graduated in these Specialty Programmes.

### *Clinical Observership*

93 MSc Nursing students from 30 institutions within and outside Kerala underwent clinical observership in various departments during the year. Seven staff nurses from the Government Medical Colleges in Kerala underwent training in the CVTS Department.

### *Other Activities*

1. The students conducted a play and dance based on the importance of hand washing as part of Global Hand Washing Day, organized in association with the Hospital Infection Control Unit at the Government Medical College Higher Secondary, Kumarapuram.
2. Mrs Suja Raj L, Lecturer in Nursing, delivered a talk on “Ill effects of smoking and alcoholism” at the Health Camp in Idinjar, organized as part of community outreach activities by the Nursing Service Division.

### Faculty

Mrs Suja Raj L, Lecturer in Nursing

## LIBRARY, HOSPITAL WING

The Hospital Wing library has a collection of 15996 books and 15847 back volumes of journals. Currently, the library subscribes to 110 journals. Electronic access to the subscribed journals was activated and made available in both the campuses of the Institute.

Being part of the National Knowledge Resource Consortium (NKRC), the library continued to have access to full-text articles in select journals from Elsevier, Wiley, Springer, Oxford University Press, American Chemical Society, Royal Society of Chemistry, Nature Publishing Group, Taylor & Francis, and so on, and databases of Web of Science and ASTM Standards.

The publications of the Institute from 1977 onwards were listed in the library site 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 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 - A

Ms Seema S, Librarian-cum-Documentation Assistant - A





## LIBRARY, BMT WING

The library of the Biomedical Technology Wing has 11353 books, 6019 back volumes and subscribes to 51 journals. It continued to subscribe to ASM Medical Materials Database, a comprehensive peer-reviewed database developed by ASM International, which provides a single relational resource to summarize scientific and engineering knowledge on implantable medical materials data to support surgical, cardiovascular, orthopedic and neurological medical devices design. The Library has a good collection of standards and patents. The standards essential for the Quality Management System and R&D activities of the BMT were updated on a regular basis.

The Document Archiving Cell forms part of the library and the Librarian-cum-Documentation Officer acts as 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 documents/archives operations, treatment procedures and patient progress for training and development purposes. These images can also be used to educate trainee doctors and budding medical scientists. In addition, the Section also creates charts, posters and other resources used for annual reports, journal publishing, education, and research and development activities.

Audiovisual services such as web streaming, video conferencing and live broadcast services were provided. Computer-based audiovisual equipment was used in clinical education, national and international conferences and seminars.

### Staff

Mr Lijikumar G, Scientific Officer

Mr Viji Kumar N, Projectionist



## REPORT ON SCTIMST RESPONSE TO COVID-19

The activities of the Institute related to the COVID-19 pandemic are compiled under this Section.

### 1. Technology Development

◆ In early March, the Biomedical Technology Wing of the Institute started developing devices and biomedical products that help in the management of the COVID-19 pandemic. The devices and products developed by the BMT Wing include:

- UV-based facemask and disposal bin
- Deployable hospital medicab
- Deployable emergency tents
- Bubble helmet
- Emergency respirator
- Isolation pods for transferring infected patients
- Chitra Acrylosorb
- Single-chamber swab collection booth for contagious diseases
- Double-chamber swab collection booth for contagious diseases
- Patient examination booth for contagious diseases
- Viral Transport Medium
- Oropharyngeal and nasopharyngeal swabs
- Rapid SARS-CoV-2 Test Kits (IgM/IgG Test Kit and Rapid SARS-CoV-2 antigen rapid test kit)

- Chitra GeneLAMP-N kit and device
- Chitra Magna - RNA isolation kit

◆ The R&D work at the Institute to combat the pandemic resulted in several MoUs being signed, patents being filed, and designs being registered. The process of technology transfer to industry has been completed or initiated at the time of this Report.

### 2. Medical Services

**The essential and emergency services of the Hospital Wing continued unhindered all through the lockdown period.**

◆ The Institute COVID Cell was constituted in March 2019 as per the directions of the Kerala Government with Faculty from the Hospital Wing and AMCHSS. The activities of the Cell included monitoring and co-ordinating surveillance, containment and preparedness activities, formation of a Medical Board, policy formulation, development of clinical protocols, decision-making regarding personnel, drugs and consumables, training for medical and paramedical staff, preparation of Hospital Wing for isolation of COVID-19 cases if such service has to be provided, and to work with National and State scientific organizations to come up with data and technology that can be useful in disease prevention, surveillance and management.

### ◆ COVID-19 Testing Laboratory

- The Institute successfully assembled its facilities and manpower in the Departments of Biochemistry and Microbiology on a war footing to set up the ICMR-approved COVID-19 Testing Facility in the Department of Microbiology at the Hospital



Wing in March 2019. Faculty members, technical and other staff of Biochemistry and Microbiology contributed immensely to the Facility under the supervision of the Head, Department of Microbiology. The Facility was also assisted by faculty, staff and students from the Departments of Transfusion Medicine, Pathology and Cellular and Molecular Cardiology. In order to handle the increasing sample load, the BMT Wing was also involved in the testing process. The BMT Wing COVID-19 testing team comprised faculty, staff and students from the Department of Applied Biology.

- The Institute tested 1200 samples for SARS-CoV-2 by RT-PCR in 3 weeks, with the staff working round-the-clock to ensure that the Reports were issued on time.
- The COVID-19 testing Laboratory was selected by ICMR as Mentor Institute for SARS-CoV-2 testing for Kerala, Lakshadweep, and Andaman and Nicobar.

◆ The Institute Infection Control Team comprising Medical and Public Health Faculty, and Medical Social Workers of the Institute was established to address concerns related to COVID-19. A team of social workers was engaged in the daily screening of patients based on the protocols developed at the Institute.

◆ A team of experts from various Departments published protocols, manuals and guidelines related to COVID-19 that were made available on the Institute Website. The protocols are listed below:

- Cardiology Protocol
- Neurology Protocol
- Imaging and Interventional Radiology Protocol
- Anaesthesia, OT and ICU Protocol

- Patient's risk grading, PPE guidelines and protocols for aerosol handling in ORs, Cath Labs, Imaging suites and ICUs for health care workers

- Infection Control Manual

◆ The implementation of digital technology played an important role in routine functioning of the hospital and academic activities. Some of the measures implemented by the Computer Division included:

- Telemedicine, SMS for patient care, improvised Electronic Medical Record (EMR), consultation through telephone, EMR prescription and online payment
- Video conferencing for routine meetings and teaching, online platform for conduct of examinations and online thesis submission
- Maintenance of an exclusive page for COVID-19 activities

◆ The Institute applied for participation in the ICMR-sponsored 'Convalescent Plasma Clinical Trial'.

### 3. Public Health Initiatives

**The Achutha Menon Centre for Health Science Studies contributed by supporting the COVID-19-related activities of the Government of India and the Government of Kerala.**

- ◆ Dr Rakhal Gaitonde, AMCHSS Faculty, was a member of the ICMR Task Force.
- ◆ The Faculty developed Comprehensive Sentinel Surveillance Program for the Trivandrum District Disaster Management Authority.
- ◆ The Faculty helped the State Government develop epidemiological and seroprevalence studies in the State.
- ◆ Information, Education and Communication activities were conducted using both online and



offline media.

- Online media included blogs and web postings for creating awareness on COVID-19
- English and Malayalam Webinars were developed on the epidemiological basis of COVID-19
- Newspaper articles related to COVID-19 were published by the faculty members of Hospital and AMCHSS
- A sensitization talk on COVID-19 for staff was organized by AMCHSS

#### 4. Research Projects and Publications

- ◆ 37 project proposals were submitted
- ◆ 13 research papers were published

- ◆ 16 research papers were under consideration for publication

- ◆ Accelerated Technical Advisory Committee and Institute Ethics Committee (IEC) protocols for review and decision. The IEC developed 2 SOPs for dealing with the COVID-19 pandemic situation. An expedited IEC Review Protocol was developed based on the ICMR guidelines (2017) Section on Ethics in Humanitarian/ Disaster situations. IEC reviews were processed within 72 hours.

#### 5. Teaching and Training

- ◆ Training material for donning and doffing PPE was developed by the Infection Control Team. They also conducted training on infection control measures for the staff.
- ◆ 14 Webinars were conducted on various topics related to COVID-19.





## PUBLICATIONS

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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
Encoding of interhemispheric interactions in mirror dystonia: a window to the physiology of dystonia	Dr Asha Kishore	Dystonia Medical Foundation, USA	US \$ 36000	4 years
Deciphering the genetic architecture of Parkinson's disease in Indian population	Dr Asha Kishore	Michael J Fox Foundation, USA	US \$ 299922 (US \$ 46992 to SCTIMST)	2 years
Enhancement of Research and Clinical Resources of Movement Disorder Programme under the Comprehensive Care Centre for Movement Disorders, SCTIMST	Dr Asha Kishore	Dr T S Ravikumar Foundation, USA	16.77	5 years
Genetic architecture of Parkinson's disease in India	Dr Asha Kishore	Michael J Fox Foundation, USA	375.00	3 years
Quantitative EEG and multi-model neuro imaging biomarkers of memory dysfunction in epilepsy	Dr Sanjeev V Thomas	DST	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	6.18	2 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
Meres 1 trial: A prospective, multicentre, 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
Centre for Advanced Research and Excellence in Heart Failure - overall management of the Project	Dr Harikrishnan S	ICMR	28.14	5 years
Centre for Advanced Research and Excellence in Heart Failure - Biobank	Dr Harikrishnan S	ICMR	42.07	5 years
Centre for Advanced Research and Excellence in Heart Failure - NGS Genetics	Dr Harikrishnan S	ICMR	5.88	5 years
Centre for Advanced Research and Excellence in Heart Failure - National HF Database	Dr Harikrishnan S	ICMR	4.07	5 years
Centre for Advanced Research and Excellence in Heart Failure - Economic Impact	Dr Harikrishnan S	ICMR	17.97	5 years
Centre for Advanced Research and Excellence in Heart Failure - Quality of Life	Dr Harikrishnan S	ICMR	28.14	5 years
CARE in Heart Failure - NT proBNP proof-of-concept device development	Dr Harikrishnan S	ICMR	16.58	5 years
Trivandrum Heart Failure Cohort	Dr Harikrishnan S	ICMR	12.68	5 years



National Heart Failure Registry	Dr Harikrishnan S	ICMR	87.00	3 years
A resting state fMRI and task-based fMRI	Dr Kesavadas C	GE Technology Centre	9.00	3 years
International Stroke Perfusion Imaging Registry (INSPIRE)	Dr Sylaja P N	University of Newcastle, Australia	7.36	3 years
Establishment of the India Stroke Clinical Trial Network (INSTRuCT)	Dr Sylaja P N	ICMR	40.86	3 years
Improving Stroke Care in India (IMPROVISE)	Dr Sylaja P N	NIHR, UK	£ 48,382	3 years
Ayurvedic treatment in the rehabilitation of ischemic stroke patients in India: A randomized controlled trial (RESTORE)	Dr Sylaja P N	ICMR	82.40	3 years
Improvement of secondary prevention in stroke survivors by a primary health care approach	Dr Sylaja P N	ICMR	7.27	3 years
HTA of National Stroke Care Registry Programme: Development of Hospital Based Stroke Registries in different regions of India	Dr Sylaja P N	ICMR	5.00	5 years
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	ICMR	51.31	3 years
Real time assessment of shift of ICA during extended endoscopic skull base surgery using intraoperative doppler and the role of tumour consistency in causing ICA displacement	Dr Prakash Nair	SERB	18.64	3 years



Prospective single-arm, multicenter, 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
Exploring the human gut microbiome and metabolome in health and Parkinson's disease- a window to the gut microbiota brain axis alterations in Parkinson's disease	Dr Syam K	ICMR	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	DBT	18.73	3 years
Funding for human resources under National Health Mission for augmenting Paediatric Cardiac Surgery Services in SCTIMST	Dr Baiju S Dharan	National Health Mission	55.21	3 years
Effect of combined visual-auditory-sensory stimulation using a structured protocol in Hemineglect following right hemispheric ischemic strokes: 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	DST	32.15	3 years





Can cardiovascular patients with obstructive sleep apnea have adverse perioperative outcomes - a prospective study	Dr Sapna Erat Sreedharan	Resmed Foundation	3.80	2 years
Dynamic modelling of $\alpha$ -synucleinopathy pathology using hiPSC-derived cerebral organoids for biomarkers and drug screening application	Dr Divya M S	National Centre for Biological Sciences, Bangalore	37.80	2 years
Molecular, clinicoradiologic and pathological characterization of oligodendrogliomas with CIC and FUBP1 mutations	Dr Deepti A N	SERB	47.18	3 years
An obligate role for Discoidin Domain Receptor 2 in cell cycle progression and apoptosis resistance in cardiac fibroblasts	Dr Neethu Mohan/ Dr Shivakumar K	DBT	39.87	3 years
Three dimensional printing in congenital heart disease	Dr Kapilamoorthy	SERB	38.12	3 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	SERB	23.11	3 years
Resting state functional magnetic resonance imaging and its cognitive correlates in patients with intracranial dural arteriovenous fistulas before and after interventional therapy	Dr Bejoy Thomas	DST	22.68	3 years
Virtual reality-based solution for effective neuroanatomy teaching	Dr Kapilamoorthy	SERB	106.52	3 years



Development of portable low-cost disposable defibrillator for cardiac arrest management	Dr Manikandan S	DST	12.95	2 years
General Anesthesia vs Sedation-cognitive decline in elderly - A randomized controlled trial in patients with Chronic Subdural Hematoma (GAS-CDE)	Dr Smita V	DST	26.42	3 years
Transcriptional and translational regulation of periostin and its interaction with DDR2 in cardiac fibrosis	Ms Sruthi Radhakrishnan	DST	19.44	3 years



## EXTERNALLY-FUNDED RESEARCH PROJECTS (ONGOING)

### Biomedical Technology Wing

Project Title	Principal Investigator	Funding agency	Total outlay (Rs in Lakhs)	Duration
Defining the mechanobiology that leads to heterogeneity in muscle stem cells and its implication in regeneration	Dr Praveen K S	SERB (Ramanujan Fellow)	89.00	7 years
Programme support on translational research on biomaterials	Dr Manoj Komath	DBT	47.05	5 years
Differentiation of mesenchymal stem cells into chondrocytes by sustained delivery of miRNAs using chitosan hydrogel	Dr Prabha D Nair	SERB	76.97	3 years
Enteric coating and microencapsulation of antibodies	Dr Roy Joseph	DST	6.99	1 year
MUSTER - musuloskeletal stem cells targeting	Dr Prabha D Nair	DBT	209.96	4 years
MUSTER - musuloskeletal stem cells targeting	Dr Harikrishna Varma	DBT	96.00	4 years
Development of novel prototype mechanical clot retriever for the treatment of acute cerebral ischemic stroke	Dr Santhosh K	DBT	15.08	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	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 (amalingaswamy 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
Blood-brain barrier permeable nanocarriers for diagnosis and therapy of neurodegenerative diseases	Dr R S Jayasree	DBT	94.98	3 years
Development of 'Human on-a-chip' device technology	Dr P V Mohanan	DST	311.82	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
Evaluation of blood/platelet storage system	Dr Anugya Bhatt	HLL	38.04	3 years
Accelerated ageing studies on coronary stent system	Mr C V Muraleedharan	from various companies	42.58	3 years
Joint Programme on M Tech and PhD		DST	311.82	3 years
Validation of ETO	Ms Leena Joseph	TTK Health Care	4.16	3 years
Toxicity study of materials	Dr P V Mohanan	Eucare Pharmaceuticals	9.53	3 years
Raising antibodies in rabbit model against specific hormones	Dr V S Harikrishnan	HLL	7.43	3 years
Proof-of-concept study for short term LV support	Dr Umasankar	TTK Health Care	1.14	3 years





Biofunctional and histological evaluation of everolimus-coated bioresorbable polymeric stent system-pilot study	Dr Umasankar	Nano Therapeutics	7.61	3 years
In vitro evaluation of cellular uptake and cytotoxicity of nanomaterials	Dr P R Anilkumar	IIST,TVM	8.7	3 years
Histopathological evaluation of dental implants in rabbit femoral and tibial condylar implant for assessment of osteointegration	Dr A Sabareeswaran	Dr Ramesh Chowdary, Rajarajeswari Dental College	0.94	3 years
Fluoropassivated and hydrogel-sealed vascular graft	Dr Roy Joseph	TTK Health Care	45.3	3 years
Dose ranging study for DES with predicate device	Dr A Sabareeswaran	Sahajanand Vascular Technovention Pvt. Ltd.	15.7	3 years
Bioresorption test of cranial fixation for magnesium skull implant	Dr Harikrishnan V S	Surgiwear Ltd., IISER Trivandrum	5.1	1 year
Preparation of SCTAC2010 drug formulation for pharmacokinetics studies	Dr Renjith P Nair	Eight Oaks Bio Pvt. Ltd.	3.3	10 months



## 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	44.70	3 years
National Environmental Health Profile	Dr Manju R Nair	Ministry of Environment, Forest & Climate change, Government of India	52.67	3 years
Mobile Telemedicine Project for Wayanad	Dr Biju Soman	DST	564.00	3 years
A family based randomized controlled trial of cardiovascular risk reduction in individuals with family history of premature coronary heart disease in India	Dr Jeemon Panniyammakal	Wellcome Trust DBT India Alliance	202.06	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	50.86	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
Non-communicable disease risk factors among working population an institution based study in Kerala, India	Dr G K Mini	PHFI	29.78	2 years



## INSTITUTE-FUNDED TDF AND TRC PROJECTS (ONGOING)

Project Title	Principal Investigator	Total outlay (Rs in Lakhs)	Duration
Development of a novel device and a method of cell seeding for the establishment of an in vitro co-culture system	Dr Naresh.K	9.80	1 year
Estimation of Ethylene oxide (EtO) and other volatile organic compounds using headspace gas chromatograph	Mr Renjith S	9.80	1 year
An ultrasensitive sensor platform for the detection of circulating tumor cells	Dr Jayasree R S	9.90	3 years
Development of a dural substitute with mucoadhesive and antibacterial properties	Dr P Ramesh	9.99	1 year
Post-surgical adhesions - role of alginate dialdehyde gelatin hydrogel as a pericardial adhesion barrier in cardiac surgery	Dr Soumya Ramanan	5.74	1 year
Modified emergency bandage with pressure pad and a hemostat for pre-hospital emergencies	Dr Lynda V Thomas	5.80	1 year
Design and development of cerebral microdialysis device and methodology for estimation of cerebral metabolites	Dr Ajay Prasad Hrishi	7.50	1 year
Multilayered wrap- knitted polyester in strengthening valve annulus after valve repair	Dr Varghese T Panicker	6.76	2 years
Cavity conformable SSSR design and proof-of-concept	Dr George C Vilanilam	5	1.5 years
Evaluation of fibrous mesh sheets as scaffold for increasing the area of neovascularisation in Moyamoya disease	Dr B Jayanand Sudhir	4.99	1 year
Universal airway device for selective lung isolation	Dr P R Suneel	5.00	1 year
Automated external defibrillator	Ms Neethu S	5.00	1 year
Reconstruction geometry optimisation and methodology development using computational fluid dynamics evaluation for patient-specific vascular model acquired by MRI scanning	Mr Sourabh S Nair	4.99	2 years
Technology Research Centre	Mr Muraleedharan C V	9325.00	5 years



Development of centrifugal blood pump	Mr Vinod Kumar V	55.88	18 months
Development of paracorporeal left ventricular assist device	Mr Nagesh D S	209.26	3 years
Development of aortic stent graft	Mr Sujesh S	98.44	2 years
Development of deep brain stimulator system	Mr Muraleedharan C V	162.14	3 years
Implantable cardioverter defibrillator system	Mr Muraleedharan C V	187.41	3 years
Development of leukodepletion filter and its evaluation	Dr P Ramesh	19.83	2 years
Annuloplasty ring for mitral valve correction	Mr Ranjith G	59.78	18 months
Development of bioprosthetic heart valve	Dr P R Umashankar	142.01	3 years
Bioactive intervertebral spacers for lumbar fusion	Dr Manoj Komath	29.83	2 years
Bioactive material platform for drug delivery in bone	Dr Harikrishna Varma	55.05	2 years
Development of intracranial electrodes for use in electrocorticography	Mr Jithin Krishnan	25.37	18 months
Optical peripheral nerve stimulator	Dr R S Jayasree	28.54	12 months
Hydrocephalus shunt and pressure valve design	Mr Anoop Gopinathan	80.30	30 months
Standardization of albumin and FVIII production and purification of IVIG from 'small pool' human plasma	Dr Lissy K Krishnan	35.14	1 year
Development of novel wound healing matrix	Dr Lissy K Krishnan	15.00	1 year
3D printing of skin tissue constructs in vitro testing and applications	Dr Anugya Bhatt	140.20	24 months
Development of platform technology for an implantable infusion pump with wireless recharging system	Mr Sarath S Nair	73.74	36 months
Repair of cartilage injury	Dr Prabha D Nair	43.51	24 months
3D printing of liver tissue	Dr Roy Joseph	340.59	24 months
Development of assay platform and sensing device for PT/INR monitoring	Dr Anugya Bhatt	2.00	5 months
Chitosan /alginate antioxidant polymeric WD	Dr Rekha M R	12.68	18 months
A wound healing matrix from porcine cholecystic EM	Dr T V Anil Kumar	28.20	36 months





Lint-free absorbent dressing	Dr Lynda V Thomas	33.01	18 months
Point-of-care diagnosis for infectious diseases	Dr Anoop Kumar T	3.75	12 months
Alginate scaffold with recombinant growth factors	Dr Anoop Kumar T	40.80	24 months
Biodegradable PLGC-fibrin graft for skin regeneration	Dr Lissy K Krishnan	11.49	12 months
Development of atrial septal defect occluder	Mr Sujesh S	35.53	24 months
Development of radiopaque liquid embolization device	Dr Roy Joseph	34.35	36 months
Characterisation of bacillus species - Methicillin Resistant S Aureus (MRSA)	Dr Maya Nandkumar	40.02	12months
Oral insulin delivery system	Dr Rekha M R	26.44	12 months
Development of flow diverter stent for treatment of aneurysms	Mr Sujesh S	89.14	2 years
IT Infrastructure Upgradation Plan for TRC	Mr Sajith Lal M K	64.10	18 months
Toxicological evaluation for TRC projects	Dr P V Mohanan	42.84	36 months
Large animal evaluation for TRC projects	Dr P R Umashankar	37.77	36 months
Blood compatibility evaluation for TRC projects	Dr Lissy K Krishnan	14.49	36 months
Cytocompatibility evaluation for TRC projects	Dr P R Anilkumar	12.35	36 months
Histopathological evaluation for TRC projects	Dr Sabareeshwaran A	21.25	36 months
Microbiological evaluation for TRC projects	Dr Maya Nandkumar	11.20	36 months
Analytical characterization for TRC projects	Dr Roy Joseph	13.53	36 months
Design and Fabrication - prototyping, jigs and fixtures for TRC projects	Dr K Ramesh Babu	33.76	36 months
Development of equipment for package validation for TRC projects	Mr Ranjith G	39.73	36 months
Reference biomaterials for biological evaluation for TRC projects	Ms Leena Joseph	32.20	36 months
Parylene coating for implantable medical devices and device delivery systems	Dr P Ramesh	83.74	24 months
Development of titanium nitride-coated coronary stent system	Mr Subhash N N	53.75	18 months
Radiopaque polymeric microspheres for embolization therapy	Dr Roy Joseph	29.52	24 months



Development of “Patent Landscape Reports (PLRS)” and patent search reports to aid high stake decision making of product development from concept to product	Mr Rajkrishna Rajan	26.60	24 months
A primer for technology transfer with technical market, financial, clinical and regulatory inputs	Ms Sandhya C G	14.48	24 months
Point-of-care detection of human papilloma virus using loop-mediated amplification of DNA	Dr Anoop Kumar T	59.68	24 months
Spinal fixation system for thoracolumbar stabilization	Mr Arvind Kumar Prajapati	128.95	36 months
Development of high strength TI-6Al-4V (Ti64) casting for orthopaedic implants	Dr Sivakumar K G V	61.04	24 months
Bioceramic cages with axially aligned pores as a substitute for tricortical bone graft	Dr Manoj Komath	12.96	18 months
Corneal epithelial cell sheet engineering standardization and pre-clinical evaluation	Dr Naresh Kasoju	11.21	36 months
Role of resting state functional magnetic resonance imaging in patients with intracranial dural arterio- venous 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



## INSTITUTE-FUNDED (SEED FUNDING) PROJECTS (ONGOING)

Title of the Project	Principal Investigator	Total outlay (Rs in Lakhs)	Duration
Regulation of progenitor cell function in heart by Angiotensin II	Dr Neethu Mohan	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	3.75	2 years
Identification and characterization of neuronal derived circulating exosomal miRNA and protein cargoes in Parkinson's disease patients	Dr Madhusoodanan U K	4.85	2 years

## COMPLETED PROJECTS DURING 2019-20

### Hospital Wing & Achutha Menon Centre For Health Science Studies

Title of the Project	Principal Investigator	Funding agency	Total outlay (Rs in Lakhs)	Duration
Effect of Yoga on motor cortex plasticity motor learning and motor deficits on Parkinson's disease	Dr Asha Kishore	DST	32.81	3 years
Growing beyond barriers; epilepsy care through schools	Dr Sanjeev V Thomas	Social Justice Department, Government of Kerala	33.77	2 years
Electroencephalographic features and seizure risk in 12 to 18 year old children of women with antenatal antileptic drug exposure	Dr Sanjeev V Thomas	ICMR	32.38	3 years



Establishment of a biorepository of epilepsy and investigating the relation of multidrug transporter polymorphism with fetal malformations based on the repository	Dr Sanjeev V Thomas	DBT	48.23	3 years
Effect of Yoga on neuropsychological functions and brain connectivity networks in mild cognitive impairment (MCI) and cognitively normal subjects	Dr Ramshekhar N Menon	DST	33.82	3 years
Pilot study for establishing nationwide network of registries on Management of Acute Coronary Event (MACE Registry)	Dr Harikrishnan S	ICMR	23.84	4 years
A resting state fMRI and task based fMRI study: Optimization, memory lateralization and connectivity in normal subjects versus patients with epilepsy	Dr Smitha K A	IIS-DBT	17.03	5 years
eDelivery System for Health Care Management and Research at SCTIMST	Dr Geetha G	MEITY	895.00	2 years
Hypoxia and mineralisation in Alzheimer`s disease detected in vivo with Magnetic Resonance Imaging	Dr Sheela Kumari (PDF)	SERB	18.70	2 years
Understanding phenotypes in Moya moya disease by resequencing 17q25'ter region: An imaging genomics approach	Dr Arun K	Wellcome Trust DBT India Alliance	36.45	2 years





Evaluation of intermediate term cardiac and neurodevelopmental outcomes of children undergoing corrective arterial switch operation for complete transposition of great arteries	Dr Baju S Dharan	National Health Mission	2.81	
VAJRA Faculty Scheme	Dr Keasavadas C	SERB	11.23	3 years
Validation of the Malayalam version of Montreal Cognitive Assessment (MoCA) Scale and a prospective evaluation of MCI in Parkinson`s disease using the Malayalam version (MoCA-M)	Dr Syam K	ICMR	12.75	3 years
Impact of measles ,rubella vaccination campaign on population immunity in India (IMRV Study)	Dr Bju Soman	ICMR	18.70	6 months
Kerala Diabetes Prevention Program (KDPP II)	Dr Jeemon, Panniyammakal	World Diabetics Foundation, Denmark	US \$ 250541	3 years

**Biomedical Technology Wing**

Project Title	Principal Investigator	Funding Agency	Budget Outlay (in Lakhs)	bDuration
Mechanism of epileptogenesis in young and adult brain - role of NMDA receptor subtypes in hippocampal neurons and astrocytes	Dr Pradeep Punnakkal	DBT (Ramalingaswamy Fellow)	87.3	5 years
Alleviate cognitive deficits in the offspring induced by sleep loss during pregnancy by alpha-sarone	Dr Kamalesh Gulia	DST	44.09	3 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
The role of NMDA and dopamine receptors in spinal pain pathways	Dr Pradeep Punnakkal	DBT	107.28	3 years
Development of biomimetic strontium incorporated nanostructured ceramic coating on Cp-titanium for orthopaedic implants	Dr P V Mohanan	DBT	5.23	1 year
Development of bioactive bone cement based on novel inorganic-organic hybrid resins	Dr Lizymol P P	KSCSTE	18.44	3 years
Blood-brain barrier targeted nanoconstructs for the diagnosis of brain diseases and the delivery of therapeutics into the brain	Dr Jayasree R S	DBT	11.45	1 year
Scaffolds based on self-assembling peptide dendrimers and resorbable calcium phosphate for endodontic tissue regeneration	Dr Manoj Komath	DBT	20.75	3 years
Radiopaque liquid embolic materials for treatment of arteriovenous malformation	Dr Parvathy J	KSCSTE	4.724	2 years
Preclinical evaluation and commercialisation of anti-snake venom (IgY), anti-hemotoxins and anti-neurotoxins	Dr Lissy K Krishnan	DST	247.986	2 years



Evaluation of the bioavailability efficacy of human proteins as delivery vehicle of curcumin in animal models	Dr Lissy K Krishnan	Institute -TDF	9.8	2 years
Development of cell encapsulated click gels as bioink for 3D bioprinting	Dr Kalliyana Krishnan	Institute -TDF	8.1	18 months
Design of membrane oxygenator with active membrane vibration for enhanced gas filter	Mr Vinod Kumar V	Institute -TDF	9.5	2 years
Multimodality stimulator for therapeutic use in post-stroke patients with hemineglect	Dr Sajith S	Institute - TDF	5.8	1 year
Development of skull base buttress device for the closure of osteodural defects	Dr Prakash Nair	Institute -TDF	4.8	1 year
Bioceramic extrusions and top down approaches for custom-sized cranioplasty applications	Dr Francis Fernandez	Institute -TDF	5.2	18 months
Reverse suction and suction arrester device	Mr Anoop Gopinath	Institute -TDF	4.9	1 year



## NEW RESEARCH INITIATIVES FOR 2020-21

### Hospital Wing

Project title	Principal Investigator	Funding Agency	Total outlay (Rs in Lakhs)	Duration
Craniovertebral junction anomalies clinical and radiological outcome evaluation after surgical intervention	Dr Krishnakumar	Chitra Alumni Education and Research Foundation	4.62	1 year
Role of connexins in cardiac fibroblast phenotypic transformation and extra cellular matrix synthesis in cardiac diseases	Dr Neethu Mohan	ICMR	14.37	3 years
Centre for Advanced Research and Excellence in Heart Failure - Structured Physical Training	Dr Harikrishnan S	ICMR	16.07	5 years
Emotional face recognition: understanding the underlying neural connectivity in high functioning adolescents with autism	Dr Soumya Sundaram	DST	16.98	2 years
DNA methylation profiling of gangliogliomas and dysembryoplastic neuroepithelial tumors	Dr Rajalakshmi P	SERB	50.38	3 years





## Biomedical Technology Wing

Project title	Principal Investigator	Funding Agency	Total outlay (Rs in Lakhs)	Duration
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



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Scientist G & Head, Department of Applied Biology

Biomedical Technology Wing, SCTIMST

**TECHNOLOGY DEVELOPMENT  
COMMITTEE**

**Prof Asha Kishore (Chairperson)**

Director

SCTIMST

**Dr Harikrishna Varma P R**

Head, Biomedical Technology Wing

SCTIMST

**Dr Roy Joseph**

Scientist G & Head, Department of Medical Devices

Engineering

Biomedical Technology Wing

SCTIMST

**Prof Harikrishnan S**

Department of Cardiology

SCTIMST

**Prof Bejoy Thomas**

Department of Imaging Sciences and Interventional

Radiology

SCTIMST

**Dr Chitra Mandal**

CSIR-Indian Institute of Chemical Biology  
Raja S C Mullick Road  
Kolkata

**Dr Raghu Krishnapuram**

Distinguished Member of Technical Staff  
Robert Bosch Centre for Cyber-Physical Systems  
Indian Institute of Science  
Bengaluru

**Prof Jayesh Bellare**

Department of Chemical Engineering  
IIT Bombay

**Prof R Krishna Kumar**

Head, Paediatric Cardiology  
AIMS, Kochi

**Shri V Sashi Kumar**

Managing Director, Phoenix Medical Systems (P)  
Ltd., DP 42, SIDCO Industrial Estate  
Chennai

**BUILDING COMMITTEE****Prof Asha Kishore (Chairperson)**

Director  
SCTIMST

**Dr Harikrishna Varma P R**

Head, Biomedical Technology Wing  
SCTIMST

**Financial Advisor (Ex-officio Convener)**

SCTIMST

**Dr K P Sudheer**

Executive Vice-President  
Kerala State Council for Science, Technology &  
Environment  
Sasthra Bhavan, Thiruvananthapuram

**Shri S J Vijaya Das**

Chief Project Examiner  
Kerala Infrastructure Fund Board

**SENIOR STAFF SELECTION COMMITTEE**

Director (Chairman - Ex-Officio)  
Head, Biomedical Technology Wing  
Nominee of the Secretary, DST  
An expert from outside the Institute nominated by

the President

Scientist nominated by the President from among the  
members of the Institute

Senior academic staff of the Institute not below the  
rank of Professor/Scientist G/Engineer G

**JUNIOR STAFF SELECTION COMMITTEE**

Medical Superintendent

Head, Biomedical Technology Wing

A Representative of the Academic Wing of the  
Institute nominated by the Director

Three Members nominated by the President

**SPECIAL RESERVATION CELL****Smt Preethamol P (Special Reservation Cell Officer)**

Nursing Officer - C  
SCTIMST

**Shri Rajesh R P**

Senior Scientific Assistant (Instruments)  
Calibration Cell, Biomedical Technology Wing  
SCTIMST

**Smt Anju Jose**

Upper Division Clerk, Stores & Purchase  
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

**Sri Gireesh V M (Nodal Officer)**

Administrative Officer Grade I  
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

**Smt Sithara Kariat (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

**RESERVATION AND OTHER  
WELFARE MEASURES FOR  
SCHEDULED CASTES/SCHEDULED  
TRIBES/ OTHER BACKWARD  
CLASSES 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 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.

The following were the major activities by the Institute for Scheduled Castes/ Scheduled Tribes/ Other Backward Classes and Persons with Disabilities:

1. Appointment of Liaison Officer for SC/ST and Persons with Disabilities and Liaison Officer for OBC
2. Constitution of a three member Reservation Cell including one officer-in-charge of the Cell
3. Implementation of reservation in all temporary and project appointments above 45 days
4. Governing Body decided to implement reservation in Group A Scientific and Technical posts after making the necessary regulation amendment
5. Conduct of special drive recruitment to fill shortfall/backlog vacancies of SC/ST
6. Corrective measures were taken for Group B post as per rule which resulted in increased percentage of reservation for SC/ST
7. Introduced Fellowship for SC/ST students
8. Appointment of Nodal Officer for implementation of fellowship and scholarship for ST students
9. Provided separate office for Reservation Cell at BMT Wing
10. Free treatment for SC/ST patients (both OP and IP) utilizing the fund received from Government of Kerala
11. 6-10 Tribal Projects were ready for initiation out of ST Grants amounting to approximately 10 Crores
12. The Institute has two fully equipped telemedicine ambulance to provide telemedicine facility to the tribal population of Wayanad under the Mobile Telemedicine Project for Wayanad funded by DST



## 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: Nil
2. Number of complaints disposed of during the year: Nil
3. Number of cases pending for more than 90 days: Nil
4. Number of Workshops or Awareness Programmes against sexual harassment carried out: Training/Awareness Programme was organised by ICC-SCTIMST for students and faculty in January 2020

## 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 year 2019-20.

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



# STATEMENT OF ACCOUNTS 2019-20





# SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

BALANCE SHEET AS AT 31st March 2020

CORPUS/CAPITAL FUND AND LIABILITIES		2019-20	2018-19
		Rs.	Rs.
CAPITAL FUND	1	3993230310	3576749148
RESERVES & SURPLUS	2	242526805	235362851
EARMARKED ENDOWMENT FUNDS	3	853496857	865922085
SECURED LOANS & BORROWINGS, UNSECURED LOANS & BORROWINGS, DEFERRED CREDIT LIABILITIES	4,5,6	0	0
CURRENT LIABILITIES & PROVISIONS	7	719462202	689303572
<b>TOTAL</b>		<b>5808716173</b>	<b>5367337656</b>
ASSETS			
FIXED ASSETS	8	1635762678	1262838554
INVESTMENTS FROM EARMARKED ENDOWMENT FUNDS	9	731227132	816074767
INVESTMENTS-OTHERS	10	242526805	235362852
CURRENT ASSETS , LOANS, ADVANCES ETC	11	3199199558	3053061484
MISCELLANEOUS EXPENDITURE (TO THE EXTENT NOT WRITTEN OFF)			
<b>TOTAL</b>		<b>5808716173</b>	<b>5367337656</b>
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES & NOTES ON ACCOUNT	25		

Sd/-  
Financial Adviser

Sd/-  
Director



## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

### INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR 2019-20

	Schedule	2019-20	2018-19
		[Rs.]	[Rs.]
INCOME		Total	Total
		Rs.	Rs.
Income from Sales / Services	12	1188616696	1198696987
Grants Received from Govt of India(Salary & General)	13	1416606000	1344142000
Fees/Subscription	14	15450906	15771586
Income from Investments }	15	20753549	6676134
Withdrawal from ERF }		0	0
Income from Royalty, Publication etc	16	1439767	2905743
Interest earned	17	35105209	58962388
Other Income	18	17131990	214787289
<b>Total</b>		<b>2695104117</b>	<b>2841942127</b>
EXPENDITURE			
Establishment Expenses	20	1854401640	2063317897
Other Administrative Expenses	21	1056882434	947107375
Bank Charges	23	1276137	1115084
Depreciation - Current Year		142920964	136480238
		3055481174	3148020593
Balance being Excess Expenditure over Income (-)/Excess income over expenditure(+)		360377058	306078467
Add: Transfer to Special Reserve Account		5250964	6618727
<b>BALANCE BEING DEFICIT CARRIED TO CAPITAL FUND</b>		<b>365628021</b>	<b>312697193</b>

Sd/-  
Financial Adviser

Sd/-  
Director



## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM SCHEDULES

SCHEDULE 1 - CORPUS/CAPITAL FUND		2019-20	2018-19
PARTICULARS		[Rs.]	[Rs.]
Balance as at the beginning of the year		6478338829	6079965277
Less Depreciation up to the end of the previous year		2901589680	2765109442
Net balance at the beginning of the year		3576749149	3314855835
Add: Plan Grants received from Government of India for creation of Capital Assets		844878000	723349000
Add: Grants received under CSR scheme		4860301	2862700
Less: Unutilized Grant-in-Aid ST-General		0	107332000
Deduct: Balance of net expenditure transferred from the Income and Expenditure Account		365628021	312697194
Less: Value of Assets Written off during the year		67629119	44289192
Deduct Transfer to BMT/Add Transfer from CHO		0	0
<b>BALANCE AS AT THE YEAR-END</b>		<b>3993230310</b>	<b>3576749148</b>
<b>SCHEDULE 2-RESERVES AND SURPLUS:</b>			
1. Capital Reserve:			
As per last Account		--	--
Addition during the year		--	--
Less: Deduction during the year		--	--
3. Special Reserves:			
As per last Account		235362851	229938803
Addition during the year (Current year transfer- Increase in provision)		7163954	5424048
Less: Deductions during the year		0	0
4. General Reserve:			
As per last Account		--	--
Addition during the year		--	--
Less: Deductions during the year		--	--
<b>TOTAL</b>		<b>242526805</b>	<b>235362851</b>

Sd/-  
Financial Adviser

Sd/-  
Director





## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULE 3-EARMARKED/ENDOWMENT FUNDS		2019-20	2018-19
	a) Opening balance of the funds	865922085	714266971
	b) Additions to the funds:		
	i. Donations/grants	980189504	1043315047
	ii. Income from Investments made on account of funds		
	iii. Other additions (Specify nature)	0	0
	<b>TOTAL (a+b)</b>	<b>1846111589</b>	<b>1757582018</b>
	c) Utilisation / Expenditure towards objective of funds		
	i. Capital Expenditure		
	- Fixed Assets	116523789	94030783
	- Others	0	1585255
	Total (Detailed Schedule Attached)	116523789	95616038
	ii. Revenue Expenditure		
	- Salaries, Wages and allowances etc.	78683502	75200964
	- Rent & Consumables etc.,	195404229	54433608
	- Other Administrative expenses	602003213	666409322
	Total	876090943	796043894
	<b>TOTAL (c)</b>		
	<b>NET BALANCE AS AT THE YEAR-END (a+b+c)</b>	<b>853496857</b>	<b>865922085</b>

Sd/-  
Financial Adviser

Sd/-  
Director



## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL

### SCHEDULE 3-EARMARKED/ENDOWMENT FUNDS - AS ON 31.03.2020

PROJ #	NAME OF GRANTEE/PRINCIPAL INVESTIGATOR	FUND-WISE BREAK UP					
		OPENING BALANCE	ADDITIONS TO FUND		TOTAL		
			GRANTS	OTHER RECEIPTS			
	HOSPITAL PROJECTS		ADDITIONS TO FUND				
5000	PROJ-MISCELLANEOUS	8223184	5400117	5099588	18722889	0	
5008	GENERAL CONFERENCE,WORKSHOP	10916	0	0	10916	0	
5033	MPH PROGRAMME	1480	0	0	1480	0	
5040	DEVELOPING EXPERIMENTAL THERAUPEUTICALS	633942	0	0	633942	0	
5055	ROCKFELLER FOUNDATION,USA	686120	0	0	686120	0	
5078	PROJECT GRANT/DR MALA RAMANATHAN	5810	0	0	5810	0	
5094	KERALA STATE AIDS CONTROL SOCIETY	442618	211483	0	654101	0	
5100	AMC/MAC ARTHUR FOUNDATION/02-70546	46315	0	0	46315	0	
5108	EVAL.SUB-TYPES DEMENTIA/DR.MATHURA	15801	0	0	15801	0	
5119	STAKE HOLDER-PERCEPT/INST.REV BO	104493	0	0	104493	0	
5133	WHO FELLOWSHIP TRAINING CBICD	215059	0	0	215059	0	
5135	A 16-WEEK,DOUBLE BLIND/ASHA KISHORE	743029	0	0	743029	29990	
5139	A 24 WEEK, MULTICENTER/DR. MATHURANATH	2602047	0	0	2602047	0	
5140	HARVARD SCHOOL OF PUBLIC HEALTH	91794	0	0	91794	0	
5142	BANKING FOR BETTER HEALTH-MEDISAVE	153911	0	0	153911	0	
5146	DEVELOPMENT OF SPECTROSCOPIC PROTOCOL	11026	0	0	11026	0	
5150	PROTOCOL 6002-INT 001	20734	0	0	20734	0	
5153	DEV REF. MANUAL FOR PRIMARY	155802	0	0	155802	0	
5155	COMM BASED DETECTION	209315	0	0	209315	0	
5159	NCD RISK FACTOR SURVEILLANCE	71123	0	0	71123	0	
5161	DOSE RANGING STUDY:CGHR	1251452	0	0	1251452	0	



## SCIENCE &amp; 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	0	0	0	6779986	6779986	6779986	11942903
0	0	0	0	10916	10916	10916	0
0	0	0	0	1480	1480	1480	0
0	0	0	0	11900	11900	11900	622042
0	0	0	0	0	0	0	686120
0	0	0	0	0	0	0	5810
0	0	0	0	170287	170287	170287	483814
0	0	0	0	0	0	0	46315
0	0	0	0	0	0	0	15801
0	0	0	0	0	0	0	104493
0	0	0	0	0	0	0	215059
0	29990	60000	168356	6650	235006	264996	478033
0	0	0	0	0	0	0	2602047
0	0	0	0	0	0	0	91794
0	0	0	0	0	0	0	153911
0	0	0	0	0	0	0	11026
0	0	0	0	8637	8637	8637	12097
0	0	0	0	0	0	0	155802
0	0	0	0	209315	209315	209315	0
0	0	0	0	0	0	0	71123
0	0	0	0	8400	8400	8400	1243052



5168	PROJ/VERMEER STUDY	595894	0	0	595894	0
5170	SAFETY OF E 2007 IN LEVODOPA	1005800	0	0	1005800	0
5174	CHANGES IN SLEEP WAKEFULNESS-Dr.Mohanku.	49317	0	0	49317	0
5175	SURGICAL TRIAL IN LOBAR INTRACEREBRAL	39125	0	0	39125	0
5176	WOMEN COMPONENT PLAN	59065	0	0	59065	0
5180	COMMUNITY BASED INTRVEN-CV DIS	18308	0	0	18308	0
5182	KERALA REGISTRY FOR EPILEPSY AND PREGNANCY	2441	0	0	2441	0
5184	COMP HEALTH CARE PROJECT ST	2001479	3000000	0	5001479	0
5190	PREVALENCE OF TYPE II DIABATES IN RURAL	42210	0	0	42210	0
5192	TO PROVIDE INFRASTRUCTURE TO AMCHSS	147206	0	0	147206	0
5193	SAFE MOTHERHOOD PROGRAMME	71796	0	0	71796	0
5201	OPEN LABLE TRIALI IN PARKINSON	2889074	0	0	2889074	0
5203	STUDY IN MRI - ISIR	26183	0	0	26183	0
5207	BRAIN MRI STUDIES	6692	0	0	6692	0
5209	MANAGEMENT - CORONARY EVENT	485041	0	0	485041	0
5213	CREATION OF AMC FUND	17029748	0	888532	17918280	0
5216	PROTOCOL SP921 A MULTICENTRE	999394	0	0	999394	0
5217	STUDY ON WORKLOAD ON NURSES	954578	0	0	954578	0
5219	HEALTH IMPACT OF TECHNOLOGY	1045488	0	0	1045488	0
5220	CAPACITY BUILDING WOMEN HEALTH	650101	0	0	650101	0
5221	RESEARCH PROJECT EQUITY ISSUES	19399	0	0	19399	0
5226	ISOLATION, CHARACTERIZATION OF GLIOMAS	265709	0	0	265709	0
5227	MONOTHERAPY/ ACTIVE CONTROL	475323	0	0	475323	0
5232	CEREBELLUM AND CORTICAL	31438	0	0	31438	0
5234	IMPROVING LOCALIZATION IN LESION NEGATIVE	-2860415	0	0	-2860415	0
5237	KERALA DIABETES PREVENTION PROGRAM(K-DPP	26957	0	0	26957	0
5238	IMPROVING LOCALIZATION IN LESION NEGA...	4884	0	0	4884	0
5245	IMPROVING LOCALIZATION IN LESION N..	184938	0	0	184938	0
5246	COMPREHENSIVE HEART FAILURE	100000	0	0	100000	0





0	0	0	0	84180	84180	84180	511714
0	0	0	6380	269818	276198	276198	729602
0	0	0	0	0	0	0	49317
0	0	0	0	0	0	0	39125
0	0	0	0	59065	59065	59065	0
0	0	0	0	0	0	0	18308
0	0	0	0	2441	2441	2441	0
0	0	0	0	2222367	2222367	2222367	2779112
0	0	0	0	0	0	0	42210
0	0	0	0	2183	2183	2183	145023
0	0	0	0	0	0	0	71796
0	0	240000	0	121303	361303	361303	2527771
0	0	0	0	0	0	0	26183
0	0	0	0	6692	6692	6692	0
0	0	124984	0	195446	320430	320430	164611
0	0	0	0	22861	22861	22861	17895419
0	0	0	0	119523	119523	119523	879871
0	0	0	0	954578	954578	954578	0
0	0	0	0	1045488	1045488	1045488	0
0	0	0	0	650101	650101	650101	0
0	0	0	0	19399	19399	19399	0
0	0	0	0	0	0	0	265709
0	0	200000	0	101953	301953	301953	173370
0	0	0	0	0	0	0	31438
0	0	0	0	0	0	0	-2860415
0	0	0	0	0	0	0	26957
0	0	0	0	0	0	0	4884
0	0	0	0	0	0	0	184938
0	0	0	0	0	0	0	100000



5247	A PHASE 3, 12-WEEK, DOUBLE BLIND, PLA...	1961232	0	0	1961232	0
5248	A PHASE 3, DOUBLE BLIND, PLACEBO AND A..	1368421	0	512674	1881095	0
5249	CNRS-INDO-FRENCH PROJECT	2521	0	0	2521	0
5252	INDO-US COLLABERATIVE STROKE	475753	0	0	475753	0
5256	HEALTHY LIFE STYLE	4964479	0	0	4964479	0
5263	MITOCHONDRIA SPECIFIC ANTI-OXI	13465	0	0	13465	0
5264	FLUORESCENCE OPTICAL BIOPSY	82	0	0	82	0
5265	DEVELOPING PHYSICIAN EDUCATION	618	0	0	618	0
5267	EVALUATION STUDY OF THE ASHA	190689	0	0	190689	0
5273	INTERNATIONAL STROKE	3938	276216	0	280154	0
5275	ENCODING OF INTERHEMISPHERIC -	1332679	0	0	1332679	0
5277	VASCULAR CONGNITIVE IMPAIRMENT	151870	0	0	151870	0
5279	FAMILY LED REHABILITATION AFTER STROKE..	25860	0	0	25860	0
5281	LDL RECEPTOR ON MACROPHAGES	948	0	0	948	0
5284	INTERNATIONAL STUDY FOR COMPARATIVE	125660	101915	0	227575	0
5286	INDIAN HEART RHYTHM SOCIETY	1260	0	0	1260	0
5287	STUDY OF CARBAMAZEPINE ...	789	0	0	789	0
5289	MITOCHONDRIAL METABOLISM...	253216	0	0	253216	0
5292	A RESTING STATE FMRI & TASK ..	148898	87840	0	236738	0
5293	DECIPHERING LRRK2 GENE	7077	0	0	7077	0
5294	MTP/EC SERVICES OF WOMEN	227053	0	0	227053	0
5296	ELECTROENCEPHALOGRAPHY WORKSHOP	25230	0	0	25230	0
5297	THE HUMAN BRAIN MAPPING PROJ..	2963	0	0	2963	0
5300	ANALYSING FUNCTIONAL NETWORKS	684034	0	0	684034	0
5301	IN VITRO BETA AMYLOID UPTAKE	215979	0	0	215979	0
5302	/DISABILITY STUDIES IN EPILEPSY	99458	0	0	99458	0
5303	MITOCHONDRIAL REMODELING	124419	0	0	124419	0
5305	A FAMILY BASED RANDOMIZED	2581140	4941330	16305	7538775	0
5306	3 DAYS TRAINING	48388	0	0	48388	0
5307	A RESTING FMRI	334669	0	0	334669	0



0	0	0	0	143500	143500	143500	1817732
0	0	0	0	44186	44186	44186	1836909
0	0	0	0	0	0	0	2521
0	0	0	0	0	0	0	475753
0	0	0	0	4964479	4964479	4964479	0
0	0	0	0	13465	13465	13465	0
0	0	0	0	82	82	82	0
0	0	0	0	618	618	618	0
0	0	0	0	0	0	0	190689
0	0	240000	0	819	240819	240819	39335
0	0	216000	0	45576	261576	261576	1071103
0	0	0	112530	0	112530	112530	39340
0	0	0	0	0	0	0	25860
0	0	0	0	948	948	948	0
0	0	0	3990	188089	192079	192079	35496
0	0	0	0	1260	1260	1260	0
0	0	0	0	789	789	789	0
0	0	0	0	213490	213490	213490	39726
0	0	225576	8880	0	234456	234456	2282
0	0	0	0	0	0	0	7077
0	0	0	0	0	0	0	227053
0	0	0	0	0	0	0	25230
0	0	0	0	0	0	0	2963
0	0	20903	14470	44900	80273	80273	603761
0	0	0	58011	42238	100249	100249	115730
0	0	0	0	54051	54051	54051	45407
0	0	0	0	124419	124419	124419	0
0	0	1656465	0	3681152	5337617	5337617	2201158
0	0	0	0	48388	48388	48388	0
0	0	0	13160	45757	58917	58917	275752



5308	EPILEPSY CARE THROUGH SCHOOLS	595766	0	0	595766	133850	
5310	KERALA DIABETES PREVENTION	2102189	0	0	2102189	0	
5313	EQUIPMENT FOR HEART FAILURE	1673701	0	128992	1802693	4226	
5314	NON COMMUNICABLE DISEASES	281633	25151813	20409	25453855	0	
5315	PROSPECTIVE SINGLE ARM MUL	566335	467100	0	1033435	0	
5317	MERES1 TRIAL A PROSPECTIVE	2595	62370	0	64965	0	
5319	ENCORE	20682	245463	0	266145	0	
5320	EFFECT OF YOGA ON MOTOR CORTEX PLAST	0	1200000	0	1200000	0	
5321	EFFECT OF YOGA ON NEUROPSYCHOLOGICAL F	400163	0	0	400163	0	
5323	CHITRA DHWANI	35500	0	0	35500	0	
5325	DECIPHERING THE GENERIC	2386620	0	0	2386620	0	
5326	NEURO DEVELOPMENTAL DISORDERS	2205732	6463047	135427	8804206	86100	
5327	MOVEMENT DISORDER	1850215	0	0	1850215	0	
5329	E-DELIVERY FOR HEALTH CARE	37562560	0	0	37562560	30094316	
5331	MONTREAL CONGNITIVE MOCA-M	270	546940	0	547210	0	
5332	HYPOXIA AND MINERALISATION	83095	0	0	83095	0	
5333	ELETROENCEPHALOGRAPHIC	65527	1148073	0	1213600	0	
5335	AUGMENTING PAEDIATRIC SURGERY	1465011	0	0	1465011	0	
5336	ESTABLISHMENT OF THE INDIAN STROKE CLINICAL TRIAL NETWORK (INSTRUCT)	569682	1499189	0	2068871	0	
5337	SECONDARY PREVENTION BY STROKE	668853	0	0	668853	0	
5338	ESTABLISHMENT OF A BIOREPOSITORY	556048	0	0	556048	0	
5339	ANTI EPILEPTIC DRUGS	20950	0	0	20950	0	
5340	STRUCTURAL AND FUNCTIONAL IMAGING	334072	700000	0	1034072	0	
5341	SLEEP APNEA	353252	0	0	353252	0	
5342	TRIVANDRUM HEART FAILURE	220555	326874	0	547429	44800	
5343	BRAIN IRON DEPOSITION	240121	790320	0	1030441	0	
5344	IMPROVEMENT OF SECONDARY	84525	0	0	84525	0	
5345	MOBILE TELEMEDICINE PROJECT	41139445	0	0	41139445	304411	
5346	DISEASE RISK FACTORS	325590	744720	0	1070310	0	





0	133850	4300	0	195692	199992	333842	261924
0	0	225286	0	801836	1027122	1027122	1075067
0	4226	0	0	0	0	4226	1798467
0	0	83613	0	24280073	24363686	24363686	1090169
0	0	0	0	99500	99500	99500	933935
0	0	0	0	0	0	0	64965
0	0	174731	0	40882	215613	215613	50532
0	0	834351	0	80000	914351	914351	285649
0	0	400163	0	0	400163	400163	0
0	0	0	0	0	0	0	35500
0	0	0	0	37400	37400	37400	2349220
0	86100	1019916	0	607401	1627317	1713417	7090789
0	0	198000	0	0	198000	198000	1652215
0	30094316	0	0	0	0	30094316	7468244
0	0	413440	0	133770	547210	547210	0
0	0	9167	10170	63117	82454	82454	641
0	0	821916	0	187039	1008955	1008955	204645
0	0	267471	0	1197540	1465011	1465011	0
0	0	1365801	0	454598	1820399	1820399	248472
0	0	0	0	286673	286673	286673	382180
0	0	481665	40404	7129	529198	529198	26850
0	0	0	0	0	0	0	20950
0	0	552084	141110	86000	779194	779194	254878
0	0	0	0	19500	19500	19500	333752
0	44800	248000	0	58383	306383	351183	196246
0	0	452015	94150	20161	566326	566326	464115
0	0	0	0	70511	70511	70511	14014
0	304411	3232429	0	3158674	6391103	6695514	34443931
0	0	15065	0	503305	518370	518370	551940



5347	UNDERSTANDING PHENOTYPES	569860	0	0	569860	0	
5348	PROSPECTIVE STUDY OF PATIENTS	169000	450000	270000	889000	0	
5349	FRACTIONAL FLOW REVERSE	49779	10931	0	60710	0	
5350	ICMR-THSTI FORMS	106715	0	0	106715	0	
5351	INFLAMMATORY BIOMARKERS	59500	0	0	59500	0	
5352	HYPER ACUTE STROKE	7657	0	0	7657	0	
5353	PROSPECTIVE OBSERVATIONAL	270000	0	0	270000	0	
5354	WORKSITE BASED LIFESTYLE	1001579	1190600	0	2192179	0	
5355	REGIONAL TRC FOR HEALTH ASSESSMENT	1981491	3077090	0	5058581	238500	
5356	AROGRAM NETWORK (KIRAN)	22182448	0	0	22182448	323910	
5357	MOLECULAR, CLINICORADIOLOGIC AND PATHOLOGICAL CHARACTERIZATION OF OLIGODENDROGLIOMAS WITH CIC AND FUBP1 MUTATIONS (EMR/2016/005832)	1082408	1300000	0	2382408	0	
5358	AN OBLIGATE ROLE FOR DISCOIDIN DOMAIN RECEPTOR 2 IN CELL CYCLE PROGRESSION AND APOPTOSIS RESISTANCE IN CARDIAC FIBROBLASTS	412113	1060353	0	1472466	0	
5359	THREE DIMENSIONAL PRINTING IN CONGENITAL HEART DISEASE	2224533	700000	0	2924533	2105973	
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?	434124	500000	0	934124	221760	
5361	IMPROVING STROKE CARE IN INDIA (IMPROVISE)	1784440	2133984	0	3918424	19597	
5362	AYURVEDIC TREATMENT IN THE REHABILITATION OF ISCHEMIC STROKE PATIENTS IN INDIA: A RANDOMIZED CONTROLLED TRIAL (RESTORE)	4205784	2311613	6000	6523397	0	
5363	NATIONAL HEART FAILURE REGISTRY	2072601	751579	0	2824180	0	
5365	NATIONAL ENVIRONMENTAL HEALTH PROFILE	1450421	500000	0	1950421	13400	
5366	IMPACT OF MEASLES ,RUBELLA VACCINATION CAMPAIGN ON POPULATION IMMUNITY IN INDIA (IMRV STUDY)	1899057	0	0	1899057	0	



0	0	244357	0	0	244357	244357	325503
0	0	471725	0	0	471725	471725	417275
0	0	0	0	0	0	0	60710
0	0	0	0	0	0	0	106715
0	0	0	23100	36400	59500	59500	0
0	0	0	0	7657	7657	7657	0
0	0	0	0	270000	270000	270000	0
0	0	588000	213294	0	801294	801294	1390885
0	238500	2272470	0	1060379	3332849	3571349	1487232
0	323910	2867932	0	1856513	4724445	5048355	17134093
0	0	0	1128240	96296	1224536	1224536	1157872
0	0	368123	252516	245419	866058	866058	606408
0	2105973	190959	93406	100195	384560	2490533	434000
0	221760	86129	270493	39792	396414	618174	315950
0	19597	904283	18100	321359	1243742	1263339	2655085
0	0	722667	83840	1526628	2333135	2333135	4190262
0	0	1027477	0	781865	1809342	1809342	1014838
0	13400	372000	0	170416	542416	555816	1394605
0	0	435854	1020	1462183	1899057	1899057	0



5367	EVALUATION OF INTERMEDIATE TERM CARDIAC AND NEURODEVELOPMENTAL OUTCOMES OF CHILDREN UNDERGOING CORRECTIVE ARTERIAL SWITCH OPERATION FOR COMPLETE TRANSPOSITION OF GREAT ARTERIES	149388	0	0	149388	0	
5368	VIRTUAL REALITY-BASED SOLUTION FOR EFFECTIVE NEUROANATOMY TEACHING	2681496	0	0	2681496	0	
5369	WORKSHOP ON BRAIN CONNECTIVITY ANALYSIS AND CONFERENCE ON BRAIN COMPUTER INTERFACE	96473	0	0	96473	0	
5370	TRANSCRIPTIONAL AND TRANSLATIONAL REGULATION OF PERIOSTIN AND ITS INTERACTION WITH DDR2 IN CARDIAC FIBROSIS	473874	0	3533	477407	0	
5371	GENERAL ANESTHESIA VS SEDATION-COGNITIVE DECLINE IN ELDERLY – A RANDOMIZED CONTROLLED TRIAL IN PATIENTS WITH CHRONIC SUBDURAL HEMATOMA (GAS-CDE)	1207678	0	3977	1211655	729088	
5372	VAJRA FACULTY SCHEME	92579	0	0	92579	0	
5373	ARCHITECTURE OF PARKINSON'S	0	37507187	0	37507187	0	
5374	RISK ANALYSIS OF DEMENTIA	3642000	0	0	3642000	0	
5375	CARE IN HEART FAILURE	2814240	0	0	2814240	182280	
5376	CARE IN HEART FAILURE	4207800	0	0	4207800	851960	
5377	CARE IN HEART FAILURE	588000	0	0	588000	0	
5378	CARE IN HEART FAILURE	407500	0	0	407500	0	
5379	CARE IN HEART FAILURE	1797500	0	0	1797500	0	
5380	CARE IN HEART FAILURE	502500	0	0	502500	0	
5382	CARE IN HEART FAILURE	1658200	0	0	1658200	0	
5383	VISUAL-AUDITORY	0	320000	0	320000	34869	
5384	MAHATARI JATAN YOJANA	0	400000	0	400000	0	
5385	QUANTITATIVE EEG AND MULTI-MO	0	1719200	0	1719200	148061	
5387	INDUSTRIAL POLLUTION	0	600000	0	600000	0	
5388	EFFICIENT PORTABLE STAND	0	324500	3933	328433	177200	
5389	PEDIATRIC EPILEPSY SYNDROME	0	5131512	0	5131512	0	
5390	HUMAN GUT MICROBIOME	0	577100	0	577100	0	
5391	DISPOSABLE DEFIBRILLATOR	0	683672	0	683672	0	
5392	DNA METHYLATION IN INSULIN	0	1050000	0	1050000	0	





0	0	52800	24640	71948	149388	149388	0
0	0	549020	8120	51729	608869	608869	2072627
0	0	0	0	10934	10934	10934	85539
0	0	240000	220595	0	460595	460595	16812
0	729088	330000	0	32363	362363	1091451	120204
0	0	0	0	92579	92579	92579	0
0	0	763673	1125435	18891798	20780906	20780906	16726281
0	0	395648	0	354638	750286	750286	2891714
0	182280	1420317	0	182765	1603082	1785362	1028878
0	851960	115200	476500	50452	642152	1494112	2713688
0	0	0	128208	8000	136208	136208	451792
0	0	0	0	7500	7500	7500	400000
0	0	0	0	150044	150044	150044	1647456
0	0	0	0	2500	2500	2500	500000
0	0	0	0	1658200	1658200	1658200	0
0	34869	162000	0	4442	166442	201311	118689
0	0	0	0	0	0	0	400000
0	148061	420120	0	147414	567534	715595	1003606
0	0	59677	0	16243	75920	75920	524080
0	177200	0	0	33433	33433	210633	117800
0	0	0	0	3237072	3237072	3237072	1894440
0	0	104000	0	50218	154218	154218	422882
0	0	106880	0	62152	169032	169032	514640
0	0	0	0	0	0	0	1050000



5393	LIFESTYLE INTERVENTION	0	5512913	0	5512913	0	
5394	SKULLBASE SURGERY	0	570000	0	570000	0	
5396	ATRIAL CARDIOPATHY	0	50000	0	50000	0	
5397	SYNUCLEINOPATHY PATHOLOGY	0	1890000	0	1890000	0	
5398	INTERVENTIONAL THERAPY	0	866400	0	866400	0	
5399	STROKE CARE REGISTRY	0	500000	0	500000	0	
5400	VISUAL OUTCOME RECURRENCE	0	400000	0	400000	0	
5401	PREVENTION IN STROKE	0	1000000	0	1000000	0	
5402	CRANIOVERTEBRAL ANOMALIES	0	462000	0	462000	0	
6077	TECHNICAL ADVISORY COMMITTEE	0	233126	0	233126	0	
6080	COMPREHENSIVE PAIN CLINIC	0	29250	0	29250	0	
6105	INSTITUTE FUNDING FOR e DELIVERY	0	1800982	0	1800982	1800982	
6106	DEVELOPMENT OF AUTONOMIC FUNCTION MONITOR BASED ON COMBINED HEART RATE VARIABILITY(HRV) AND GALVANIC SKIN CONDUCTANCE	0	70403	0	70403	0	
6107	ROLE OF RESTING STATE FUNCTIONAL MRI IN PATIENTS WITH INTRACRANIAL DURAL ARTERIO VENOUS FISTULA	0	56410	0	56410	0	
6108	CEREBRAL HEMODYNAMIC	0	1940	0	1940	0	
6109	CARDIAC PLAQUE ASSESSMENT	0	35750	0	35750	0	
6110	ROLE OF INTRAVOXEL INCOHERENT	0	101520	0	101520	0	
6111	REGULATION OF PROGENITOR CELL	0	210746	0	210746	0	
6112	INTRAOPERATIVE QUANTIFICATION OF LEFT VENTRICULAR	0	26260	0	26260	0	
6113	EXOSOMAL MIRNA	0	187284	0	187284	0	
7101	ADVANCE TO P I	0	0	1138960	1138960	0	
		215529356	129669115	8228330	353426801	37545272	

	OTHER PROJECTS						
1014	NEW PENSION SCHEME	10426288		201460850	211887138		
1301	EMPLOYEES PENSION FUND	161083815		357686980	518770795		



0	0	163345	0	7833	171178	171178	5341735
0	0	47032	0	43031	90063	90063	479937
0	0	0	0	2500	2500	2500	47500
0	0	57040	64151	0	121191	121191	1768809
0	0	0	0	60000	60000	60000	806400
0	0	22581	0	0	22581	22581	477419
0	0	0	0	0	0	0	400000
0	0	0	0	0	0	0	1000000
0	0	0	0	0	0	0	462000
0	0	233126	0	0	233126	233126	0
0	0	29250	0	0	29250	29250	0
0	1800982	0	0	0	0	1800982	0
0	0	70403	0	0	70403	70403	0
0	0	0	56410	0	56410	56410	0
0	0	0	1940	0	1940	1940	0
0	0	0	35750	0	35750	35750	0
0	0	0	101520	0	101520	101520	0
0	0	0	210746	0	210746	210746	0
0	0	0	26260	0	26260	26260	0
0	0	0	187284	0	187284	187284	0
0	0	0	0	1138960	1138960	1138960	0
0	37545272	29677429	5423179	89476210	124576817	162122090	191304711

	0			203183554	203183554	203183554	8703584
	0			305857504	305857504	305857504	212913291



1075	PATIENT WELFARE FUND	10018436		1340154	11358590		
1078	DR. RICHARD A CASH & DR K MOHANDAS AWARD	253301		81661	334962		
1080	STAFF BENEVOLENT FUND	6372793		3762777	10135570		
1099	CSR GRANT - REVENUE	550000		8709704	9259704		
	TOTAL ( B )	188704633	0	573042126	761746759	0	

	BMT PROJECTS						
PROJ#	NAME OF GRANTEE/PRINCIPAL INVESTIGATOR	FUND-WISE BREAK UP			TOTAL	UTILISATION	
		OPENING BALANCE	ADDITIONS TO FUND			CAPITAL EXPENDITURE	
			GRANTS	OTHER RECEIPTS		FIXED ASSETS	
5000	PROJECT EXPENSE	5560470.58	0.00	77165453.51	82725924.09	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	MISCELLANEOUS 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.PV. 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	
7008	NMITLI, PROJECT C.S.I.R	0.90	0.00	0.00	0.90	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 VALVE	39424.00	0.00	0.00	39424.00	0.00	





	0			267913	267913	267913	11090677
	0			15000	15000	15000	319962
	0			2381651	2381651	2381651	7753919
	0			0	0	0	9259704
0	0	0	0	511705622	511705622	511705622	250041138

						TOTAL EXPENDITURE	NET BALANCE
		REVENUE EXPENDITURE					
OTHERS	TOTAL	SALARIES/ WAGES	RENT/ CONSUMABLES	OTHER ADMN EXP	TOTAL		
0.00	0.00	0.00	57704283.52	0.00	57704283.52	57704283.52	25021640.57
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	0.90	0.00	0.90	0.90	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	4761.75
0.00	0.00	0.00	0.00	0.00	0.00	0.00	213826.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	13674.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	39424.00



7016	INDO-GERMAN COMMITTEE MEETING-DST	5407.00	0.00	0.00	5407.00	0.00
7017	HINDUSTAN LATEX.EVALU:BLOOD BAG	31784.53	0.00	0.00	31784.53	0.00
7018	ALL INDIA COUNCIL FOR TECHNI:EDU:SH	591045	0.00	254333	845378.00	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
7027	STED-DR T V KUMARY-IN VITRO	5089	0.00	0.00	5089.00	0.00
7029	DONERG/LIFE SCIENCE BOARD	6876.00	0.00	0.00	6876.00	0.00
7031	DBT/DR P V MOHAN/DEVI N VITRO PYRO	79064.00	0.00	0.00	79064.00	0.00
7032	DST. DR. ANNIE/BONE REGENERATION	29166.00	0.00	0.00	29166.00	0.00
7033	BIOFUNCTIONAL EVALUATION DR UMASHANKAR	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	IN VIVO EVALUATION/ STED/DR. LISSY	6205.00	0.00	0.00	6205.00	0.00
7039	JNC/ASR/DR. MOHANAN/STUDY OF ACUTE.....	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	6844635.5	0.00	3613252	10457887.50	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



0.00	0.00	0.00	0.00	0.00	0.00	0.00	5407.00
0.00	0.00	5525	2926	0.00	8451.00	8451.00	23333.53
0.00	0.00	0.00	83816.00	0.00	83816.00	83816.00	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	5089	0.00	5089.00	5089.00	0.00
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	253742.63	0	253742.63	253742.63	10204144.87
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



7055	CSIR-NMITLI SCHEME-C.V.MURALEEDHARAN	756552.00	0.00	0.00	756552.00	0.00	
7057	DST - PROJECT.DR.JAYABALAN	14471.00	0.00	0.00	14471.00	0.00	
7059	DBT-DR. PRABHA D NAIR, ISLET IMMUN.....	67574.00	0.00	0.00	67574.00	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	
7070	CHO PROJECT - 5146 JAYASREE	-872.00	0.00	872.00	0.00	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	0.00	-86027.00	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	119649.27	0.00	0.00	119649.27	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	





0.00	0.00	0.00	0.00	0.00	0.00	0.00	756552.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	14471.00
0.00	0.00	0.00	67574.00	0.00	67574.00	67574.00	0.00
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	0.00
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	-86027.00
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	12646.00	0.00	12646.00	12646.00	107003.27
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



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	489928	0.00	0.00	489928.00	0.00	
7210	PROJ/7210/CSIR/SOMA DEY	1641.00	0.00	0.00	1641.00	0.00	
7220	COST OF ANIMAL FEED	3374136.82	0.00	443483.00	3817619.82	32120.55	
7230	PROJ/7230/CSIR/MANJU.S	12421.00	0.00	0.00	12421.00	0.00	
7250	PROJ/7250/CSIR/KIRAN.S.NAIR	15281.00	0.00	0.00	15281.00	0.00	
7260	PROJ/7260/STOX083Y09/DR.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 STERILISATION SYSTEM-	124695	0.00	40500	165195.00	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 MATIRIALS DR. P V MOHANAN	2203668	0.00	0.00	2203668.00	0.00	
7395	RAISNG ANTIBODIES IN RABITS - DR V S HARIKRISH	459533.99	0.00	238400	697933.99	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	169303	63480	0.00	232783.00	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	563762.76	0.00	0.00	563762.76	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	



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	25748	0.00	25748.00	25748.00	464180.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1641.00
0.00	32120.55	0.00	248233.30	0.00	248233.30	280353.85	3537265.97
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	9290.00	11500.00	0.00	20790.00	20790.00	144405.00
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	126812.00	13968.00	0	140780.00	140780.00	2062888.00
0.00	0.00	0.00	64854.86	0.00	64854.86	64854.86	633079.13
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	205816	0.00	0.00	205816.00	205816.00	26967.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	761369.00
0.00	0.00	0.00	50019.85	0.00	50019.85	50019.85	513742.91
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



7415	"PROJ/7415/AXONAL GUIDANCE"	18450.00	0.00	0.00	18450.00	0.00	
7416	"PROJ/7416/PULMONARY FIBROSIS"	11023	368000	0.00	379023.00	0.00	
7417	"PROJ/7417/INVITRO & INVIVO EVALUATION"	27129	407248	0.00	434377.00	0.00	
7418	"PROJ/7418/THE NATURE OF FOREIGN BODY ..."	25234	0.00	0.00	25234.00	0.00	
7419	PROJ/7419/DETERMINATION OF TOXICITY	52516.00	0.00	0.00	52516.00	0.00	
7421	PROJ/7421/FIBRIN BASED MATRIX	93942	546800.00	0.00	640742.00	0.00	
7422	PROJ/7422/HISTOPATHOLOGICAL EVALUATION	392864.74	0.00	322782	715646.74	0.00	
7423	PROJ/7423/TRACKING CARDIAC STEM	52153	20000.00	0.00	72153.00	0.00	
7424	PROJ/7424/SYNAPTIC PROTEOME	24533.00	0.00	0.00	24533.00	0.00	
7425	PROJ/7425/BIOENGINEERED SKIN GRAFT FOR ...	157500	0.00	0.00	157500.00	0.00	
7426	PROJ/7426/POLYMERIC MICRO NEEDLES	162000	20000	0.00	182000.00	0.00	
7427	PROJ/7427/ANIONIC POLYSACCHARIDE BASED .	203.05	0.00	20000	20203.05	0.00	
7428	PROJ/7428/BACTERIAL RESISTANCE	41876	472400	0.00	514276.00	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	513000	0.00	0.00	513000.00	0.00	
7431	PROJ/7431/SHELL NACRE	8333	253600	0.00	261933.00	0.00	
7432	PROJ/7432/CSIR CONTIGENCY GRANT	0.00	20000	0.00	20000.00	0.00	
7433	PROJ/7433/CSIR CONTIGENCY GRANT	0.00	20000	0.00	20000.00	0.00	
7434	PROJ/7434/CSIR CONTIGENCY GRANT	0.00	30932	0.00	30932.00	0.00	
7435	PROJ/7435/CSIR CONTIGENCY GRANT	0.00	20000.0	0.00	20000.00	0.00	
7436	PROJ/7436/CSIR CONTIGENCY GRANT	0.00	20000	0.00	20000.00	0.00	
7437	PROJ/7437/CSIR CONTIGENCY GRANT	0.00	16767	0.00	16767.00	0.00	
7438	PROJ/7438/SCTAC2010 DRUG FORMULATION	0	339471	0.00	339471.00	0.00	
7439	CSIR CONT.GRANT/MEDHASURENDRANATH	0	20000	0.00	20000.00	0.00	
7440	CSIR CONT.GRNAT/MANJULA P M	0	18356	0.00	18356.00	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	





0.00	0.00	0.00	0.00	0.00	0.00	0.00	18450.00
0.00	0.00	348000	0.00	0.00	348000.00	348000.00	31023.00
0.00	0.00	325000.00	20297.00	0.00	345297.00	345297.00	89080.00
0.00	0.00	0.00	20488	0.00	20488.00	20488.00	4746.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	52516.00
0.00	0.00	486000.00	50029.00	0.00	536029.00	536029.00	104713.00
0.00	0.00	0.00	27949.95	0.00	27949.95	27949.95	687696.79
0.00	0.00	0.00	8281	0.00	8281.00	8281.00	63872.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	24533.00
0.00	0.00	142500.00	14264.00	0.00	156764.00	156764.00	736.00
0.00	0.00	0.00	67150.25	0.00	67150.25	67150.25	114849.75
0.00	0.00	0.00	17200	0.00	17200.00	17200.00	3003.05
0.00	0.00	445440	0.00	0.00	445440.00	445440.00	68836.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	101326.00
0.00	0.00	62690.00	249240.00	0	311930.00	311930.00	201070.00
0.00	0.00	243600.00	18333	0.00	261933.00	261933.00	0.00
0.00	0.00	0.00	0	0.00	0.00	0.00	20000.00
0.00	0.00	0.00	0	0.00	0.00	0.00	20000.00
0.00	0.00	0.00	27166	0.00	27166.00	27166.00	3766.00
0.00	0.00	0.00	0	0.00	0.00	0.00	20000.00
0.00	0.00	0.00	16397	0.00	16397.00	16397.00	3603.00
0.00	0.00	0.00	0	0.00	0.00	0.00	16767.00
0.00	0.00	0.00	116233.57	0.00	116233.57	116233.57	223237.43
0.00	0.00	0.00	1129	0.00	1129.00	1129.00	18871.00
0.00	0.00	0.00	0	0.00	0.00	0.00	18356.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	-278345.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	-98722.00



8006	PROJ/8006/BIOCONJUGATION NANO MAT.	139019.00	0.00	0.00	139019.00	0.00	
8008	PROJ/8008/CSIR GRANT-PADMAJA.PNAMBI	12990.00	0.00	0.00	12990.00	0.00	
8009	PROJ/8009/DBT/DR.T.V.ANILKUMAR/DE...TISSUE	-310641.00	0.00	0.00	-310641.00	0.00	
8011	PROJ/8011/NANOFONT/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	
8014	PROJ/8014/DBT/DR.ROY JOSEPH/DEV... .V.GRAFT	-17063.00	0.00	17063.00	0.00	0.00	
8015	PROJ/8015/DR.ANOOPKUMAR/PROGRAMME...	12581.00	0.00	0.00	12581.00	0.00	
8019	PROJ/8019/STEC/DR.PRAMESH	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.PR.ANILKUMAR	2935.00	0.00	0.00	2935.00	0.00	
8026	PROJ/8026/	3339.00	0.00	0.00	3339.00	0.00	
8027	PROJ/8027/DR.PV.MOHANAN	79732.00	0.00	0.00	79732.00	0.00	
8028	PROJ/8028/DR.DIKSHA PAINULY	22332.00	0.00	0.00	22332.00	0.00	
8031	PROJ/8031	-309053.00	0.00	0.00	-309053.00	0.00	
8032	PROJ/8032/O.S.N.NAIR	128471.00	0.00	0.00	128471.00	0.00	
8033	PROJ/8033/DEV. OF IRON OXIDE- DR.R.S.JAYASREE	-7146.00	0.00	7146	0.00	0.00	
8034	PROJ/8034/FLURO PASSI...DR.ROY JOSEPH	696639.1	0.00	0.00	696639.10	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.PSHARMA	-6255.00	0.00	0.00	-6255.00	0.00	
8046	PROJ/DIFF. OF ADULT PRO - DR.ASHA.S.MATHEW	739755.00	0.00	0.00	739755.00	0.00	
8049	PROJ/NEW VISION BIOMAT-DR.C.PSHARMA	-44861.00	0.00	0.00	-44861.00	0.00	
8052	PROJ/ROLL OF TRANFORMN GROWTH-DR. ANOOP	0.47	0.00	0.00	0.47	0.00	



0.00	0.00	0.00	0.00	0.00	0.00	0.00	139019.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	12581.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	82284.00
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	0.00	0.00	0.00	0.00
0.00	0.00	0.00	17063.00	0	17063.00	17063.00	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	-6255.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	739755.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	-44861.00
0.00	0.00	0.00	0.47	0.00	0.47	0.47	0.00



8054	PROJ/MUSCULOSKELETAL STEM CELL/ DR.PDNAIR	84661.21	0.00	0.00	84661.21	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.PR.ANILKUMAR	108000.00	0.00	0.00	108000.00	0.00	
8062	PROJ/ACCELERATED AREING./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	
8067	QUANTUM DOT CONJUGATED -DR.R.S.JAYASREE	-5090.00	0.00	5090.00	0.00	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.CPS	303180.00	0.00	0.00	303180.00	0.00	
8077	HOME BASED VITAL SIGNS - DR.NIRANJAN.D.	204509.75	0.00	0.00	204509.75	0.00	
8079	DOSE RANGING STUDY FOR DES / DR.SABAREES	731710.00	0.00	0.00	731710.00	0.00	
8080	PROJ/8080/DETECTION OF ZINC IN EPILEPTIC	1.14	0.00	0.00	1.14	0.00	
8081	EXPLORING THE POTENTIALOF ISLET-DR.PRABH	241568.27	0.00	0.00	241568.27	56962.50	
8082	ASSESSMENT OF CERAMIC CONSTRUCTS 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	
8084	ROLE OF NMDA- DR.PRADEEP PUNNAKKAL- RAM	1621297.58	0.00	0.00	1621297.58	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	
8089	DO PLATELETS IN PATIENTS -DR.ANUGYABHAT	0.06	0.00	0.00	0.06	0.00	
8090	INSPIRE FELLOW PHD KEERTHI S JRF	8446	387528	0.00	395974.00	0.00	
8091	"BIORESORBABLE NANO BI- DR. H K VARMA "	0.16	0.00	0.00	0.16	0.00	





0.00	0.00	0.00	84661.00	0.00	84661.00	84661.00	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	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	3957.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	1.14	0.00	1.14	1.14	0.00
0.00	56962.50	0.00	184605.77	0.00	184605.77	241568.27	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	37118.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	8294.82
0.00	0.00	697141.00	924156.58	0.00	1621297.58	1621297.58	0.00
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	0.00	0.06	0.00	0.06	0.06	0.00
0.00	0.00	367528	0.00	0.00	367528.00	367528.00	28446.00
0.00	0.00	0.00	0.16	0.00	0.16	0.16	0.00



8092	BIOLOGICALSTRUCTURES	0.10	0.00	0.00	0.10	0.00	
8093	DR.HKVARMA-A NEW DRUG-CERAMIC MOD SUPER	0.85	0.00	0.00	0.85	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	
8096	PREP OF HYDROGEL -DR AKHILA RAJAN	0.16	0.00	0.00	0.16	0.00	
8097	MULTIFUNCN - DBT SUNITHA PREM	368177.42	0.00	0.00	368177.42	0.00	
8098	HOW ACTIN FILAMENT STRUCTUDR RENU MOH	1129.00	0.00	0.00	1129.00	0.00	
8099	INSPIRE FELLOW RESHMA S	13857	482840	0.00	496697.00	0.00	
8100	DETAILED ...CONDITIONS- ARUN ANIRUDHAN	36560.75	0.00	0.00	36560.75	0.00	
8102	"ENGINEERING BIOMIMETIC.... NICHE TARA.S"	54224.75	0.00	0.00	54224.75	0.00	
8103	"CORNEAL REGENERATIVE THERAPY...Dr.ANNIE JOHN"	523227.02	0.00	87763	610990.02	0.00	
8104	"PROJ/8104/CORNEAL REGENERATIVE THERAPY"	0.07	0.00	0.00	0.07	0.00	
8105	"PROJ/8105/STUDY IN MOLECULAR MECHANISM"	0.86	0.00	0.00	0.86	0.00	
8106	PROJ/8106/MECHANISM OF ANGIOGENESIS	20000	19150	0.00	39150.00	0.00	
8107	"PROJ/8107/DEFINING MECHANO -BIOLOGY TO HETEROGENEITY IN MUSCLE STEM -BIOLOGY"	205444.23	2430000	0.00	2635444.23	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	
8109	PROJ/8109/"EFFECTS OF VASCULAR ENDOTHELIAL GROWTH FACTOR TRASFECTED HUMAN ADMSCS IN PROMOTING ANGIOGENESIS FOR CHRONIC WOUND HEALING"	-20559.95	0.00	20560	0.05	0.00	
8110	"PROJ/8110/TO ALLEVIATE COGNITIVE DEFECTS"	162588.06	0.00	0.00	162588.06	0.00	
8111	PROJ/8111/HOW ACTIN FILAMENT STRUCTURE WITHIN THE CELL ARE AFFECTED BY CARRYING MICROTUBULE DYNAMICS	666471.99	0.00	45335.01	711807.00	0.00	
8112	"PROJ/8112/DEVELOPMENT OF A LIGHT WEIGHT, LEAD FREE, THYROID COLLAR FOR DIAGNOSTIC RADIOLOGY THYROID COLLAR"	-0.32	0.00	0.32	0.00	0.00	



0.00	0.00	0.00	0.10	0.00	0.10	0.10	0.00
0.00	0.00	0.00	0.85	0.00	0.85	0.85	0.00
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	0.16	0.00	0.16	0.16	0.00
0.00	0.00	0.00	144855.2	0.00	144855.20	144855.20	223322.22
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1129.00
0.00	0.00	462840.00	22836.00	0.00	485676.00	485676.00	11021.00
0.00	0.00	29672	6888.75	0.00	36560.75	36560.75	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	54224.75
0.00	0.00	0.00	610990.02	0.00	610990.02	610990.02	0.00
0.00	0.00	0.00	0.07	0.00	0.07	0.07	0.00
0.00	0.00	0.00	0.86	0.00	0.86	0.86	0.00
0.00	0.00	0.00	15000	0.00	15000.00	15000.00	24150.00
0.00	0.00	1623948.00	179492.71	0.00	1803440.71	1803440.71	832003.52
0.00	0.00	0.00	0.00	0.00	0.00	0.00	44556.45
0.00	0.00	0.00	0.05	0.00	0.05	0.05	0.00
0.00	0.00	115162.00	41073.00	0.00	156235.00	156235.00	6353.06
0.00	0.00	210242.00	113058.06	388506.94	711807.00	711807.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	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"	105653.65	517200	0.00	622853.65	0.00	
8115	PROJ/8115/TECHNOLOGY RESEARCH CENTRE	220188026.80	50000000.00	62863115.03	333051141.83	56996731.04	
8116	"PROJ/8116/PROGRAM SUPPORT OF TRANSLATIONAL RESEARCH ON BIO MATERIALS FOR ORTHOPAEDICS AND DENTAL APPLICATIONS SUPPORT ON TRAN..."	812733.35	524840	85811.00	1423384.35	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"	241212.8		0.00	241212.80	29449.22	
8118	PROJ/8118/THE ROLE OF NMDA & DOPAMINE RECEPTORS IN SPINAL PAIN PATHWAYS	1461965.76	0.00	0.00	1461965.76	0	
8119	PROJ/8119/DEVELOPMENT OF BIOMIMETIC STRONTIUM INCORPORATED NANOSTRUCTURED CERAMIC COATINGS ON CP-TITANIUM FOR ORTHOPAEDIC	-120336.51		120337.00	0.49		
8122	PROJ/8122/DEV. OF CENTRIFUGAL BLOOD PUMP	1279231.36	0.00	0.00	1279231.36	0.00	
8123	PROJ/8123/DEV.OF LEFT VENTRICULAR DEVICE	7297543.10	0.00	6765.00	7304308.10	10851.00	
8124	PROJ/8124/DEV. OF AORTIC STENT GRAFT	6823852.61	2817200.00	636198.00	10277250.61	621600.00	
8125	PROJ/8125/DEV. OF DEEP BRAIN STIMULATOR	7686564.74	0.00	49345.00	7735909.74	223666.13	
8126	PROJ/8126/CARDIOVERTER DEFIBRILLATOR	16029571.00	0.00	133192.00	16162763.00	88689.09	
8127	PROJ/8127/DEVELOPMENT OF LEUKODEPLETION	757947.12	1099800.00	5912.00	1863659.12	0.00	
8128	PROJ/8128/DEPT.OF ANNULOPLASTY/MITRAL VALVE CORRECTION	5739333.00	0.00	97889.00	5837222.00	0.00	
8129	PROJ/8129/DEVPT.OF BIOPROSTHETIC HEART VALVE	4209530.52	1800000.00	64273.00	6073803.52	2338963.00	
8130	"PROJ/8130/INTER VERTEBRAL SPACER"	352216.74	0.00	0.00	352216.74	0.00	
8131	PROJ/8131/BIOACTIVE MATERIAL PLATFORM	1375015.65	0.00	0.00	1375015.65	742000.00	
8132	PROJ/8132/DEV. INTRACRANIAL ELECTRODES	231641.20	0.00	0.00	231641.20	0.00	
8133	PROJ/8133/OPTICAL PERIPHERAL NERVE	1921359.13	0.00	0.00	1921359.13	489054.05	
8134	PROJ/8134/HYDROCEPHALUS SHUNT	7719011.00	0.00	10403.00	7729414.00	0.00	
8135	PROJ/8135/STANDARDIZATION OF ALBUMIN	828918.54	3038712.00	271400.36	4139030.90	0.00	





0.00	0.00	0.00	0.00	0.00	0.00	0.00	139800.00
0.00	0.00	480200.00	7431.48	0.00	487631.48	487631.48	135222.17
0.00	56996731.04	15304050.00	91065798.63	0.0	106369848.63	163366579.67	169684562.16
0.00	0.00	47669.00	624896.86	0.00	672565.86	672565.86	750818.49
0.00	29449.22	74520.00	126872.39	0.00	201392.39	230841.61	10371.19
0.00	0.00	94114.00	632371.51	0.00	726485.51	726485.51	735480.25
0.00	0.00			0.00	0.00	0.00	0.49
0.00	0.00	22211.00	100.00	0.00	22311.00	22311.00	1256920.36
0.00	10851.00	1076900.00	2347738.01	0.00	3424638.01	3435489.01	3868819.09
0.00	621600.00	1031720.00	1682820.75	0.00	2714540.75	3336140.75	6941109.86
0.00	223666.13	903426.00	1577547.97	0.00	2480973.97	2704640.10	5031269.64
0.00	88689.09	1588973.00	1049501.47	0.00	2638474.47	2727163.56	13435599.44
0.00	0.00	799691.00	273005.13	0.00	1072696.13	1072696.13	790962.99
0.00	0.00	469490.00	550912.20	3500.00	1023902.20	1023902.20	4813319.80
0.00	2338963.00	527920.00	1191159.74	0.00	1719079.74	4058042.74	2015760.78
0.00	0.00	0.00	0.00	0.00	0.00	0.00	352216.74
0.00	742000.00	0.00	344119.09	0.00	344119.09	1086119.09	288896.56
0.00	0.00	0.00	0.00	0.00	0.00	0.00	231641.20
0.00	489054.05	428206.00	256499.24	2360.00	687065.24	1176119.29	745239.84
0.00	0.00	448698.00	144794.00	0.00	593492.00	593492.00	7135922.00
0.00	0.00	0.00	2147515.00	0.00	2147515.00	2147515.00	1991515.90



8136	PROJ/8136/DEVELOPMENT OF NOVEL WOUND HEALING MATRIX COMPOSED OF HUMAN-FIBRIN	560474.71	100000.00	8174.56	668649.27	0.00	
8137	PROJ/8137/3D PRNTNG OF SKIN TISSUE CONSTRUCTS FOR IN-VIRTO TESTING&APPLICATIONS	12984078.24	520913.00	0.00	13504991.24	1244352.19	
8138	PROJ/8138/DEVLPMT OF PLATFORM TECLGY IMPLANTABLE MICRO INFUSION RECHARGING SYSTEM	6955633.00	0.00	839.00	6956472.00	498750.00	
8139	PROJ/8139/PARYLENE COATING FOR IMPLANTABLE MEDICAL DEVICES& DELIVERY SYSTEM	9337300.00	0.00	1407.00	9338707.00	0.00	
8140	PROJ/8140/REPAIR OF CARTILAGE INJURY	1089788.79	0.00	0.00	1089788.79	0.00	
8141	PROJ/8141/3D PRINTING OF LIVER TISSUE	4270953.39	0.00	0.00	4270953.39	0.00	
8142	PROJ/8142/DEVELOPMENT OF ASSAY PLATFORM	942963.67	0.00	0.00	942963.67	38270.67	
8143	PROJ/8143/POLYMERIC WOUND	846785.37	0.00	0.00	846785.37	64400.00	
8144	PROJ/8144/WOUND HEALING MATRIX	73221.12	0.00	400124.58	473345.70	0.00	
8145	PROJ/8145/LINT FREE ABSORBENT DRESSING	1626982.19	0.00	0.00	1626982.19	0.00	
8146	PROJ/8146/POINT OF CARE DETECTION	0.00	5968000.00	0.00	5968000.00	845560.00	
8147	PROJ/8147/POINT OF CARE DIAGNOSIS	2041940.71	1216000.00	0.00	3257940.71	801077.30	
8148	PROJ/8148/ALGINATE SCAFFOLD	474270.34	1259200.00	0.00	1733470.34	0.00	
8149	PROJ/8149/EVALUATION OF PLGC	3661.69	100000.00	0.00	103661.69	0.00	
8150	PROJ/8150/DEV. OF OCCLUSION DEVICE	1536212.39	1580400.00	12515.00	3129127.39	19800.00	
8151	PROJ/8151/DEV.EMBOLIZATION DEVICE	652464.79	842400.00	8475.00	1503339.79	0.00	
8152	PROJ/8152/DEVELOPMENT OF TITANIUM NITRATE COATED CORONARY STENT	5375000.00	0.00	42088.00	5417088.00	250320.00	
8153	PROJ/8153/CHARACTERISATION OF BACILLUS SPECIES-(MRSA)	5869460.77	0.00	0.00	5869460.77	625525.00	
8154	PROJ/8154/DEPT.OF BIOMATERIAL SCIENCE &TECHNOLOGY	855336.30	561512.00	0.00	1416848.30	0.00	
8155	PROJ/8155/DEVPT.OF FLOW DIVERTER TREATMENT OF ANEURYSMS	5547786.45	1258560.00	10589.00	6816935.45	0.00	
8156	PROJ/8156/RADIOPAQUE POLYMERIC MICROSPHERES OF EMBOLIZATION THERAPY	3184172.80	0.00	0.00	3184172.80	1039106.00	
8157	PROJ/8157/DEVLPMT OF PLRS&HIGH STAKE DECISION MKNG FROM CONCEPT PDT	1258000.00	0.00	0.00	1258000.00	0.00	
8158	PROJ/8158/PRIMER TECHNOLOGY TNFR TECHNICAL,MKT,FINICIAL,CL,REGLURTY INPUTS	1167082.30	0.00	0.00	1167082.30	0.00	



0.00	0.00	0.00	474112.54	0.00	474112.54	474112.54	194536.73
0.00	1244352.19	603566.00	3099255.90	2966.00	3705787.90	4950140.09	8554851.15
0.00	498750.00	949991.00	469585.53	0.00	1419576.53	1918326.53	5038145.47
0.00	0.00	429677.00	2330264.12	0.00	2759941.12	2759941.12	6578765.88
0.00	0.00	85007.00	724824.47	0.00	809831.47	809831.47	279957.32
0.00	0.00	0.00	8357.00	0.00	8357.00	8357.00	4262596.39
0.00	38270.67	303360.00	328975.47	0.00	632335.47	670606.14	272357.53
0.00	64400.00	138871.00	290251.07	0.00	429122.07	493522.07	353263.30
0.00	0.00	60000.00	25890.36	0.00	85890.36	85890.36	387455.34
0.00	0.00	105704.00	16543.80	0.00	122247.80	122247.80	1504734.39
0.00	845560.00	153922.00	384922.65	0.00	538844.65	1384404.65	4583595.35
0.00	801077.30	317986.00	639720.28	0.00	957706.28	1758783.58	1499157.13
0.00	0.00	142142.00	184110.20	0.00	326252.20	326252.20	1407218.14
0.00	0.00	0.00	11261.50	0.00	11261.50	11261.50	92400.19
0.00	19800.00	605520.00	132156.00	0.00	737676.00	757476.00	2371651.39
0.00	0.00	460800.00	196353.62	0.00	657153.62	657153.62	846186.17
0.00	250320.00	401420.00	844945.85	3500.00	1249865.85	1500185.85	3916902.15
0.00	625525.00	171562.00	783027.87	0.00	954589.87	1580114.87	4289345.90
0.00	0.00	45212.00	173550.99	0.00	218762.99	218762.99	1198085.31
0.00	0.00	1023275.00	635858.07	3500.00	1662633.07	1662633.07	5154302.38
0.00	1039106.00	364816.00	826399.50	7787.00	1199002.50	2238108.50	946064.30
0.00	0.00	360000.00	47600.00	0.00	407600.00	407600.00	850400.00
0.00	0.00	558333.00	0.00	0.00	558333.00	558333.00	608749.30



8159	PROJ/8159/ITI INFRASTRUCTURE UPGRADATION PLAN	4346715.38	0.00	0.00	4346715.38	1317019.76	
8160	PROJ/8160/TOXICOLOGICAL EVALUATION	6547623.71	1010000.00	0.00	7557623.71	55650.00	
8161	PROJ/8161/LARGE ANIMAL EVALUATION	7907143.00	1730000.00	1192.00	9638335.00	0.00	
8162	PROJ/8162/BLOOD COMPATIBILITY	1871354.40	360000.00	1800.00	2233154.40	0.00	
8163	PROJ/8163/CYTOCOMPATIBILITY	1689391.06	648000.00	0.00	2337391.06	0.00	
8164	PROJ/8164/HISTOPATHOLOGICAL EVALUATION	2110289.47	878400.00	0.00	2988689.47	0.00	
8165	PROJ/8165/MICROBIOLOGICAL EVALUATION	591721.83	360000.00	0.00	951721.83	0.00	
8166	PROJ/8166/ANALYTICAL CHARACTERISATION	1699188.00	324000.00	48367.00	2071555.00	0.00	
8167	PROJ/8167/DESIGN & PROTOTYPING	2051881.63	2000000.00	1850.60	4053732.23	364055.00	
8168	PROJ/8168/DEVPT OF EQPT FOR PCKG VALIDATION	2537800.93	0.00	13612.00	2551412.93	0.00	
8169	PROJ/8169/PREPARATION STD FOR BIOLOGICAL EVALUATION	2246303.70	666400.00	0.00	2912703.70	394587.00	
8170	PROJ/8170/DEVELOPMENT OF BIOMIMETIC STRONTIUM INCORPORATED NANOSTRUCTURED CERAMIC COATINGS ON CP-TITANIUM FOR ORTHOPAEDIC	35772.94	0.00	13968.00	49740.94	0.00	
8171	PROJ/8171/ENTERIC COATING & MICRO ENCAPSULATION OF ANTIBODIES	175589.71	0.00	0.00	175589.71	0.00	
8172	PROJ/8172/BIOACTIVE BONE CEMENT	42960.74	686503.00		729463.74	0.00	
8173	PROJ/8173/BLOOD DRAIN AREA TARGETED NANO CONSTRUCTS FOR DIAGNOSIS OF BRAIN DISEASES & DELIVERY OF THERAPEUTICS INTO THE BRAIN	82202.13	0.00	0.00	82202.13	0.00	
8174	PROJ/8174/SCAFFOLDS BASED ON SELF-ASSEMBLING PEPTIDE DENDRIMERS AND RESORBABLE CALCIUM PHOSPHATES FOR ENDODONTIC TISSUE REGENERATION	360952.05		796267.00	1157219.05	0.00	
8175	PROJ/8175/MUSTER- MUSCULOSKELETAL STEM CELL TARGETING	1531433.53	0.00	248420	1779853.53	1537505.00	
8176	PROJ/8176MUSTER- MUSCULOSKELETAL STEM CELL TARGETING	1834626.49	0.00	0.00	1834626.49	1234541.45	
8177	PROJ/8177/RADIOPAQUE LIQUID	10623.6	0.00	0.00	10623.60	0.00	
8178	PROJ/8178/PRECLINICAL EVALUATION & COMMERCIALISATION ANTI SNAKE VENOM (IGY)	345915.61	0.00	381300.00	727215.61	0.00	





0.00	1317019.76	176700.00	75705.00	0.00	252405.00	1569424.76	2777290.62
0.00	55650.00	652587.00	655750.00	0.00	1308337.00	1363987.00	6193636.71
0.00	0.00	804354.00	474756.33	0.00	1279110.33	1279110.33	8359224.67
0.00	0.00	231120.00	187074.72	0.00	418194.72	418194.72	1814959.68
0.00	0.00	533422.00	81865.59	0.00	615287.59	615287.59	1722103.47
0.00	0.00	251071.00	405765.80	0.00	656836.80	656836.80	2331852.67
0.00	0.00	221357.00	271043.90	0.00	492400.90	492400.90	459320.93
0.00	0.00	56981.00	70192.00	0.00	127173.00	127173.00	1944382.00
0.00	364055.00	797304.00	689784.55	0.00	1487088.55	1851143.55	2202588.68
0.00	0.00	420420.00	204107.75	0.00	624527.75	624527.75	1926885.18
0.00	394587.00	315076.00	25179.00	0.00	340255.00	734842.00	2177861.70
0.00	0.00	0.00	49740.94		49740.94	49740.94	0.00
0.00	0.00		16431.95	0.00	16431.95	16431.95	159157.76
0.00	0.00	8800.00	104545.00	0.00	113345.00	113345.00	616118.74
0.00	0.00	0.00	78738.90	0.00	78738.90	78738.90	3463.23
0.00	0.00	319561.00	616500.31	0.00	936061.31	936061.31	221157.74
0.00	1537505.00	120000.00	69000.00	0.00	189000.00	1726505.00	53348.53
0.00	1234541.45	201600.00	130965.86	0.00	332565.86	1567107.31	267519.18
0.00	0.00	6163.00	4460.60	0.00	10623.60	10623.60	0.00
0.00	0.00	486847	193991.71	0.00	680838.71	680838.71	46376.90



8179	PROJ/8179/DEVELOPMENT OF NOVEL PRO-TYPE MECHANICAL CLOT RETRIEVER FOR TREATMENT OF ACUTE CEREBRAL ISCHEMIC STROKE	708366	0.00	450.00	708816.00	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	32834	452812	1149	486795.00	0.00	
8181	PROJ/8181/DEVELOPMENT OF INDIGENOUS VOICE PROSTHESIS FOR REHABILITATION OF LARYNGECTOMIES	126697.13	203500	0.00	330197.13	121800	
8182	PROJ/8182/A TISSUE ENGINEERED SKIN SUBSTITUTE WITH LOCALISED HAIR FOLLICLE STEM CELLS FOR HAIR FOLLICLE AND SEBACEOUS GLAND REGENERATION	84527.04	0.00	29145	113672.04	0.00	
8183	PROJ/8183/BIO ENGINEERED CONSTRUCT WITH CARDIAC MESENCHYMAL CELLS FOR MYOCARDIAL REPAIR	519244.73	2404183	0.00	2923427.73	0.00	
8184	PROJ/8184/FABRICATION OF A HEAD PHANTOM FOR DOSIMETRIC EVALUATION OF RADIOTHERAPY TREATMENT PLANS	23632.32	0.00	0.00	23632.32	0.00	
8185	PROJ/8185/BLOOD BRAIN BARRIER PERMEABLE NANOCARRIERS FOR DIAGNOSIS & THERAPY OF NEURODEGENERATIVE DISEASES	5243584	0.00	0.00	5243584.00	627265.00	
8186	PROJ/8186/3D PRINTED CELL FREE BIPHASIC MATRICES LOADED WITH AN ADMIXTURE OF BIOMOLECULES FOR ENHANCED PROGENITOR CELL	155808	554931	0.00	710739.00	0.00	
8187	PROJ/8187/DEVELOPMENT OF HUMAN-ON-A-CHIP DEVICE TECHNOLOGY	23619480	0.00	0.00	23619480.00	5952340.85	
8188	PROJ/8188/EXPERT ADVISORY GROUP	800000.00	0.00	0.00	800000.00	0.00	
8189	PROJ/8189/CARE IN HEART FAILURE NT PRO BNP POC DEVICE	0.00	1658200	0.00	1658200.00	61231.8	
8190	PROJ/8190/MAGNETO-OPTIC SENSOR FOR CARDIAC BIOMARKER DETECTION.	0.00	373000	0.00	373000.00	0	
8191	PROJ/8191:INDO-JAPAN-ANTI -MICROBIAL PEP-TIDE(LL37) LOADED MULTIFUNCTIONAL	0.00	252000	0.00	252000.00	0	
8220	PROJ/8220/SPINAL FIXATION SYSTEM FOR THORACOLUMBAR STABILIZATION	0.00	12894960.00	0.00	12894960.00	0.00	
8221	PROJ/8221/DEVELOPMENT OF HIGH-STRENGTH TI-6AL-4V CASTINGS FOR ORTHOPAEDIC IMPLANTS	0.00	6103600.00	14169.00	6117769.00	0.00	



0.00	0.00	95226.00	257464.25	0.00	352690.25	352690.25	356125.75
0.00	0.00	374400.00	68627.00	0	443027.00	443027.00	43768.00
0.00	121800.00	0.00	112945.70	0	112945.70	234745.70	95451.43
0.00	0.00	0.00	9500	29145	38645.00	38645.00	75027.04
0.00	0.00	1879060.00	952259.26	0.00	2831319.26	2831319.26	92108.47
0.00	0.00	0.00	6431.66	0.00	6431.66	6431.66	17200.66
0.00	627265.00	691165.00	561162.00	13108.00	1265435.00	1892700.00	3350884.00
0.00	0.00	484174	0.00	0.00	484174.00	484174.00	226565.00
0.00	5952340.85	461141.00	1612039.95	0.00	2073180.95	8025521.80	15593958.20
0.00	0.00	0.00	499378.00	0.00	499378.00	499378.00	300622.00
0.00	61231.80	278710.00	578474.25	0.00	857184.25	918416.05	739783.95
0.00	0.00	0.00	144000	0.00	144000.00	144000.00	229000.00
0.00	0.00	0.00	67346	0.00	67346.00	67346.00	184654.00
0.00	0.00	90581.00	0.00	2000.00	92581.00	92581.00	12802379.00
0.00	0.00	18000.00	100781.00	0.00	118781.00	118781.00	5998988.00



8222	PROJ/8222/BIOCERAMIC CAGES WITH AXIALLY ALIGNED PORES AS A SUBSTITUTE FOR TRICORTICAL BONE GRAFT	0.00	1296000.00	0.00	1296000.00	0.00	
8223	PROJ/8223/CORNEAL EPITHELIAL CELL SHEET ENGINEERING:STANDARDIZATION & PRE-CLINICAL EVALUATION	0.00	1112000.00	0.00	1112000.00	0.00	
	TOTAL	459602318.23	115149798.00	148662574.97	723414691.20	78723243.60	

	INTERNAL PROJECTS						
6215	PROJ/6215/PROTOTYPE SAFETY SYSTEM	0.00	0.00	31755.00	31755.00	0.00	
6216	PROJ/6216/EFFICACY OF HUMAN PROTEINS	0.00	0.00	264507.41	264507.41	0.00	
6217	PROJ/6217/BIOINKS FOR 3D BIO PRINTING	0.00	0.00	252302.55	252302.55	0.00	
6218	PROJ/6218/DESIGN OF MEMBRANE OXYGENATOR.	0.00	0.00	320745.01	320745.01	0.00	
6219	PROJ/6219/A METHOD OF CELL SEEDING	0.00	0.00	458519.93	458519.93	10773	
6220	PROJ/6220/ETHYLENE OXIDE (EIO)	0.00	0.00	609570.66	609570.66	0.00	
6221	PROJ/6221/CIRCULATING TUMOR CELLS	0.00	0.00	529233.88	529233.88	0.00	
6222	PROJ/6222/MULTIMODALITY SIMULATOR	0.00	0.00	170644	170644.00	54500.00	
6223	PROJ/6223/DEVELOPMENT OF A DURAL SUB.	0.00	0.00	357814.83	357814.83	0.00	
6224	PROJ/6224/BIOCERAMIC EXTRUSIONS AND TOP.	0.00	0.00	255198.8	255198.80	189999.6	
6225	PROJ/6225/POST SURGICAL ADHESIONS	0.00	0.00	432274.84	432274.84	0.00	
6226	PROJ/6226/SKULL BASE BUTTRESS DEVICE	0.00	0.00	265714	265714.00	0.00	
6227	PROJ/6227/EMERGENCY BANDAGE	0.00	0.00	200580.46	200580.46	0.00	
6228	PROJ/6228/CEREBRAL MICRODIALYSIS DEVICE	0.00	0.00	262512	262512.00	0.00	
6229	PROJ/6229/REVERSE SUCTION DEVICE	0.00	0.00	219212	219212.00	0.00	
6230	PROJ/6230/CAVITY CONFORMABLE SSSR	0.00	0.00	21678	21678.00	0.00	
6231	PROJ/6231/AIRWAY DEVICE	0.00	0.00	14516	14516.00	0.00	
6233	PROJ/6233/EXTERNAL DEFIBRILLATOR	0.00	0.00	25000	25000.00	0.00	
6236	PROJ/6236/VASCULAR MODEL	0.00	0.00	15677	15677.00	0.00	
6300	PROJ/6300/FIBROUS MESH SHEETS	0.00	0.00	359995.34	359995.34	0.00	
6301	PROJ/6301/KNITTED POLYESTER	0.00	0.00	5100.00	5100.00	0.00	





0.00	0.00	71291.76	66271.00	0.00	137562.76	137562.76	1158437.24
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1112000.00
0.00	78723243.60	46533269.76	187636574.08	456372.94	234626216.78	313349460.38	410065230.82

0.00	0.00	31755	0.00	0.00	31755.00	31755.00	0.00
0.00	0.00	158968.00	105539.41	0.00	264507.41	264507.41	0.00
0.00	0.00	118747.00	133555.55	0.00	252302.55	252302.55	0.00
0.00	0.00	242168.00	78577.01	0.00	320745.01	320745.01	0.00
0.00	10773.00	219527.00	228219.93	0.00	447746.93	458519.93	0.00
0.00	0.00	58839.00	550731.66	0.00	609570.66	609570.66	0.00
0.00	0.00	192000.00	337233.88	0.00	529233.88	529233.88	0.00
0.00	54500.00	90000.00	26144.00	0.00	116144.00	170644.00	0.00
0.00	0.00	112258.00	245556.83	0.00	357814.83	357814.83	0.00
0.00	189999.60	0.00	65199.20	0.00	65199.20	255198.80	0.00
0.00	0.00	192000.00	240274.84	0.00	432274.84	432274.84	0.00
0.00	0.00	240000.00	25714.00	0.00	265714.00	265714.00	0.00
0.00	0.00	126837.00	73743.46	0.00	200580.46	200580.46	0.00
0.00	0.00	215400.00	47112.00	0.00	262512.00	262512.00	0.00
0.00	0.00	192033.00	27179.00	0.00	219212.00	219212.00	0.00
0.00	0.00	21678	0.00	0.00	21678.00	21678.00	0.00
0.00	0.00	14516	0.00	0.00	14516.00	14516.00	0.00
0.00	0.00	0	25000.00	0.00	25000.00	25000.00	0.00
0.00	0.00	15677	0.00	0.00	15677.00	15677.00	0.00
0.00	0.00	230400	129595.34	0.00	359995.34	359995.34	0.00
0.00	0.00	0.00	5100.00	0.00	5100.00	5100.00	0.00



6500	OHF PROJECT - DR.ANNIE JOHN	1397.00	0.00	0.00	1397.00	0.00	
6501	OHF PROJ. - DR. KALADHAR KAMALASANAN	160000.00	0.00	0.00	160000.00	0.00	
6502	OHF PROJECT DR SACHIN J SHENOY	180000.00	0.00	0.00	180000.00	0.00	
6504	DEVELOPMENT OF IRON NANO PRACTICLE	6917.72	0.00	0.00	6917.72	0.00	
6505	REM SLEEP RESTRICTION	16694.00	0.00	0.00	16694.00	0.00	
2622	OHF- FOR INNOVATIVE PROJECTS	1460000.00	0.00	365008.72	1825008.72	0.00	
2621	IIPC FUND(INDUSTRY INSTITUTE PARTNERSHIP - BMT	260769.00	0.00	0.00	260769.00	0.00	
	Total of internal projects BMT (C2)	2085778	0	5437560	7523338	255273	
C	Total of external & internal projects BMT (C1+C2)	461688096	115149798	154100135	730938029	78978516	
D	GRAND TOTAL (Hospital projects + other funds + BMT projects)	865922085	244818913	735370591	1846111589	116523789	



0.00	0.00	0.00	0.00	1397.00	1397.00	1397.00	0.00
0.00	0.00	0.00	0.00	160000.00	160000.00	160000.00	0.00
0.00	0.00	0.00	0.00	180000.00	180000.00	180000.00	0.00
0.00	0.00	0.00	0.00	6917.72	6917.72	6917.72	0.00
0.00	0.00	0.00	0.00	16694.00	16694.00	16694.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1825008.72
0.00	0.00	0.00	0.00	0.00	0.00	0.00	260769.00
0	255273	2472803	2344476	365009	5182288	5437560	2085778
0	78978516	49006073	189981050	821382	239808505	318787021	412151009
0	116523789	78683502	195404229	602003213	876090943	992614732	853496857



## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULE 4-SECURED LOANS AND BORROWINGS:		2019-2020	2018-2019
	1. Central Government	--	--
	2. State Government (Specify)	--	--
	3. Financial Institutions	--	--
	a) Term Loans	--	--
	b) Interest accrued and due	--	--
	4. Banks:	--	--
	a) Term Loans-Interest accrued and due	--	--
	b) Other Loans(specify)- Interest accrued and due-Over draft	--	--
	5. Other Institutions and Agencies	--	--
	6. Debentures and Bonds	--	--
	7. Others(Specify)	--	--
	Against OD facility- cheques issued	--	--
	<b>TOTAL</b>		
SCHEDULE 5-UNSECURED LOANS AND BORROWINGS		2019-2020	2018-2019
	1. Central Government	--	--
	2. State Government (Specify)	--	--
	3. Financial Institutions	--	--
	4. Banks:	--	--
	a) Term Loans	--	--
	b) Other Loans(specify)	--	--
	5. Other Institutions and Agencies	--	--
	6. Debentures and Bonds	--	--
	7. Fixed Deposits	--	--
	8. Others(Specify)	--	--
	<b>TOTAL</b>		
SCHEDULE 6-DEFERRED CREDIT LIABILITIES:		2019-2020	2018-2019
	a) Acceptances secured by hypothecation of capital equipment and other assets	--	--
	b) Others		
	<b>TOTAL</b>	--	--

Sd/-  
Financial Adviser

Sd/-  
Director





## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULE 7-CURRENT LIABILITIES AND PROVISIONS		2019-2020	2018-2019
	<b>A. CURRENT LIABILITIES</b>		
	1. Acceptances		
	2. Sundry Creditors:		
	a) For Goods	234394790	184711375
	b) Others	0	0
	3. Advances Received	66220276	49827131
	4. Interest accrued but not due on:	0	0
	a) Secured Loans / borrowings	0	0
	b) Unsecured Loans / borrowings	0	0
	5. Statutory Liabilities:	0	0
	a) Overdue		
	b) Others	5381621	7211579
	6. Other current Liabilities	410628264	443116146
	<b>TOTAL(A)</b>	<b>716624951</b>	<b>684866231</b>
	<b>B.PROVISIONS</b>		
	1. For Taxation	0	0
	2. Gratuity	0	0
	3. Accumulated Leave Encashment	0	0
	4. Trade Warranties/Claims	0	0
	5. Others(Specify)    Audit fee	537900	225000
	Emergency Reserve Fund contribution	0	0
	Technology Development Fund contribution	2299351	4212341
	<b>TOTAL(B)</b>	<b>2837251</b>	<b>4437341</b>
	<b>TOTAL(A+B)</b>	<b>719462202</b>	<b>689303572</b>

Sd/-  
Financial Adviser

Sd/-  
Director



## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL

## SCHEDULE 8- FIXED ASSETS

PARTICULARS	GROSS BLOCK			
	Cost/valuation as at the beginning of the year (01.04.2019)	Additions during the year 2019-20	Deductions during the year 2019-20	
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	2980054953	299180526	67385845	
B) Equipment - From Non Monetary grants	2	0	0	
4. VEHICLES	8546800	0		
5. FURNITURE, FIXTURES	85416143	7858406	213986	
6. OFFICE EQUIPMENT	1236622	0	0	
7. COMPUTER/ PERIPHERALS	9132746	0	0	
8. ELECTRIC INSTALLATIONS	173089947	0	21490	
9. LIBRARY BOOKS	206343657	16832598	3721	
10. TUBEWELLS & W. SUPPLY	301965	0		
11. OTHER FIXED ASSETS				
A) OXYGEN CYLNDRS/GAS PLANT INST	1998962	62720		
B) KITCHEN/CANTEEN EQUIPMENTS	3025767	730095	4078	
C) PAINTINGS	450216	0		
D) SURGICAL EQUIPMENTS	5226023	0	0	
Total for the year ( Total -A)	4016528372	324664346	67629119	
Total for the previous year	3915939077	144878487	44289192	
Capitla Work in Progress (B)	26598791	380110935	0	
Total for the year (A+B)	3942537868	704775281	67629119	
* Depreciation for item2(a) has been provided along with depreciation on 2(d)				

Sd/-  
Financial Adviser

Sd/-  
Director



## SCIENCE &amp; TECHNOLOGY, THIRUVANANTHAPURAM

Cost/valuation at the year end (31.03.2020)	DEPRECIATION			NET BLOCK		
	Depreciation as at the beginning of the year (01.04.2019)	Depr on items written off	During the year 2019-20	Total up to the year end (31.03.2020)	As at the end of current year end (31.03.2020)	As at the previous year end (31.03.2019)
16894606	0	0	0	0	16894606	16894606
47627608	0		0	0		
477182357	314654986	0	21015498	335670484	189139481	210154979
3211849634	2207757503	58794315	100638652	2308396155	903453478	772297450
2	2	0	0	1	1	1
8546800	7129845		212543	7342389	1204411	1416954
93060564	48216626	166179	4334832	52551458	40509105	37199517
1236622	1064583		17204	1081787	154835	172039
9132746	8302679	0	332027	8634706	498040	830067
173068457	105195753	0	6787270	111983024	61085433	67894194
223172534	200301242	0	9148517	209449759	13722775	6042415
301965	226960		7501	234460	67505	75005
2061682	1654729		162781	1817510	244172	344233
3751785	1558119	2607	217020	1775140	1976645	1467648
450216	407833		4238	412072	38144	42382
5226023	5118822	0	42880	5161702	64321	107201
4273563598	2901589682	58963101	142920964	3044510646	1229052952	1114938690
4016528372	2765109443	40163071	136480238	2901589682	1114938690	1150829634
406709726	0	0	0	0	406709726	147899863
4680273324	2901589682	58963101	142920964	3044510646	1635762678	1262838553

Sd/-  
Financial Adviser

Sd/-  
Director



## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

SCHEDULE 9 - INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS		2019-2020	2018-2019
	1. In Government Securities	47081032	56010278
	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	
	Pension & staff funds	145962696	113694398
	Project funds	532498013	640684700
	<b>TOTAL</b>	<b>731227132</b>	<b>816074767</b>
SCHEDULE 10-INVESTMENTS-OTHERS		2019-2020	2018-2019
	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	92526805	85362852
	<b>TOTAL</b>	<b>242526805</b>	<b>235362852</b>
SCHEDULE 11-CURRENT ASSETS,LOANS,ADVANCES ETC		2019-2020	2018-2019
	<b>A. CURRENT ASSETS</b>		
	1. Inventories:		
	a) Stores and Spares	0	0
	b) Instruments & Loose Tools	0	0
	c) Stock-in trade		
	Store items	140051880	70572487
		0	
	Stamps	19329	20377
	Medicine	16439845	35285480
	2. Sundry Debtors:	0	
	a) Debts Outstanding for a period exceeding six months	194079650	56994684
	b) Others	275165216	336505661
	2.1 Income tax deducted at source	32733101	20986034





3. Cash balances in hand(including cheques/ drafts and imprest)	776457	1260430
4. Bank Balances:	0	
a) With Scheduled Banks:	0	
-On Current Account	1	1
-On Deposit Accounts(L.C. margin & Commitment deposit)	1195086595	1031284284
-On Savings Accounts	114275256	303543008
b) With non-Scheduled Banks:	0	
-On Current Account	0	0
-On Deposit Accounts	0	0
-On Savings Accounts	0	0
<b>5. Post-Office-Savings Accounts</b>	0	0
<b>TOTAL(A)</b>	<b>1968627330</b>	<b>1856452446</b>
<b>B.LOANS, ADVANCES AND OTHER ASSETS</b>		
1. Loans:		
a) Staff	8193671	5588266
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	777948794	703118845
b) Prepayments	0	
c) Others	15449912	46866583
3. Income Accrued:	0	0
a) On Investments from Earmarked/ endowment Funds	11198956	22529865
b) On Investments-Others	0	0
c) On Loans and Advances	0	0
d) Others (Royalty)	566648	1291232
(includes income due unrealised)	0	0
4. Claims Receivable	0	0
From Govt of India on Grant in aid (7th CPC arrears)	417214247	417214247
<b>TOTAL(B)</b>	<b>1230572228</b>	<b>1196609038</b>
<b>TOTAL(A+B)</b>	<b>3199199558</b>	<b>3053061484</b>
Savings bank account includes Rs.15/- (GL code No.2410-Synd Bank vikas certificate)		



SCHEDULE 12- INCOME FROM SALES/SERVICES		2019-2020	2018-2019
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		1177777391	1187453016
		0	0
From Projects		6724953	7369058
Testing & Facility charges received		4114352	3874913
<b>TOTAL</b>		<b>1188616696</b>	<b>1198696987</b>
SCHEDULE 13- GRANTS/SUBSIDIES		2019-2020	2018-2019
(Irrevocable Grants & Subsidies Received)			
1. Central Government (Salary General)		1416606000	1344142000
2. State Government(s)		0	0
3. Government Agencies		0	0
4. Institution/Welfare Bodies		0	0
5. International Organisations		0	0
6. Others(Specify)		0	0
<b>TOTAL</b>		<b>1416606000</b>	<b>1344142000</b>
SCHEDULE 14-FEES/SUBSCRIPTIONS		2019-2020	2018-2019
1. Entrance Fees		2053140	1680255
2. Annual Fees/ Subscriptions		11096850	12309981
3. Seminar/Program Fees		0	0
4. Consultancy Fees		0	0
5. Examination Fees and others		2300916	1781350
<b>TOTAL</b>		<b>15450906</b>	<b>15771586</b>
SCHEDULE 15- INCOME FROM INVESTMENTS		2019-2020	2018-2019
(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)	19750795	2465497
1. Interest on Sinking Fund		
2. Withdrawal from Sinking Fund	0	0
3. Interest on Technology Fund	1002754	4210637
<b>TOTAL</b>	<b>20753549</b>	<b>6676134</b>
<b>SCHEDULE 16- INCOME FROM ROYALTY,PUBLICATION ETC</b>	<b>2019-2020</b>	<b>2018-2019</b>
1) Income from Royalty	1439767	2905743
2) Income from Publications	0	0
3) Others(Specify)	0	0
<b>TOTAL</b>	<b>1439767</b>	<b>2905743</b>
<b>SCHEDULE 17- INTEREST EARNED</b>	<b>2019-2020</b>	<b>2018-2019</b>
1) On Term Deposit		
a) With Scheduled Banks	28611483	33270859
a) 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	6050502	8276833
b) With non-scheduled Banks	0	0
c) Post Office Savings Account	0	0
d) Others(accrued)	0	16650590
3) On Loans	0	0
a) Employees/Staff	443224	764106
b) Others	0	0
4) Interest on Debtors and other Receivables	0	
<b>TOTAL</b>	<b>35105209</b>	<b>58962388</b>
<b>SCHEDULE 18- OTHER INCOME</b>	<b>2019-2020</b>	<b>2018-2019</b>
1. Profit on Sale/disposal of Assets:		
a) Owned assets	0	0
b) Assets acquired out of grants, or received free of cost	0	0
c) WIP written back from Repairs and Maintanance	0	0
2. Rent	3002243	2200725



	3. Fees for Miscellaneous Services	0	0
	4. Miscellaneous Income Rent	69200	87000
	Other Income (including grant receivable from DST for 7th CPC	14781708	212295889
	Prior period income	-721161	203675
	<b>TOTAL</b>	<b>17131990</b>	<b>214787289</b>
<b>SCHEDULE 20-ESTABLISHMENT EXPENSES</b>		<b>2019-2020</b>	<b>2018-2019</b>
	a) Salaries and Wages	1112242094	1344109453
	b) Allowances and Bonus	16296985	15539689
	c) Contribution to Provident Fund	0	0
	d) Contribution to other fund(specify)	0	0
	e) Staff Welfare Expenses	21193941	23598741
	f) Expenses on Employee's Retirement and Terminal Benefits	422462143	433086637
	g) Others(Specify) PG Training & Accademic payments	282206477	246983377
	<b>TOTAL</b>	<b>1854401640</b>	<b>2063317897</b>
<b>SCHEDULES 21- ADMINISTRATIVE EXPENSES</b>		<b>2019-2020</b>	<b>2018-2019</b>
	a) Purchases	750096625	706574427
	b) Concession to Poor patients/Labour and processing expenses	64396214	31222254
	c) Cartage and Carriage Inwards	128011	232784
	d) Electricity and power	57927882	58321750
	e) Water charges	8231352	1804222
	f) Insurance	1118301	1109729
	g) Repairs and maintenance	66667223	82503011
	h) Excise duty	0	0
	i) Rent,Rates and Taxes	0	2110568
	j) Vehicles Running and Maintenance	910393	1143962
	k) Postage,Telephone and Communication Charges	4246701	2401037
	l) Printing and Stationary	31217	20179
	m) Travelling and Conveyence Expenses	3322642	3830496
	n) Expenses on Seminar/Workshop	2069933	1680810
	o) Subscription Expenses	0	0
	p) Expenses on Fees	0	0
	q) Auditors Renumeration	1872904	225000
	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	43030333	6141549
	y) Distribution Expenses	0	0
	z) Advertisement and Publicity	3112041	5011757
	z1) Others(specify)	49720662	42773841
	<b>TOTAL</b>	<b>1056882434</b>	<b>947107375</b>
<b>SCHEDULE 23-INTEREST</b>		<b>2019-2020</b>	<b>2018-2019</b>
	a) On Fixed Loans		
	b) Bank Charges)	1276137	1115084
	c) Others(specify)	0	0
	<b>TOTAL</b>	<b>1276137</b>	<b>1115084</b>

Sd/-  
Chief Financial Adviser

Sd/-  
Director



## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

### SCHEDULE TO RECEIPTS & PAYMENTS ACCOUNTS FOR THE PERIOD FROM 01.04.2019 to 31.03.2020

RECEIPTS	2019-2020	2018-2019	Payments	2019-2020	2018-2019
	Rs.	Rs.		Rs.	Rs.
I Opening Balances			I Expenses		
a) Cash In Hand	1260430.00	2409722.00			
b) Bank Balances			a) Establishment expenses	2452401623.86	2510617945.84
i) In Current Account	1.15	1.15	b) Administrative Expenses		
ii) In deposit Account			For Purchases	18634976.00	24018448.50
iii) Savings Account *	307869506.73	180741357.94	Other expenses	92157618.16	87132531.20
			Payments made against funds for various		
II Grant Received			Projects		
From Government of India			As Per schedule	117937737.07	204772669.64
Under Object head - Creation of Capital assets	844878000.00	623349000.00	III Investments & Deposits made		
Under Object Head - Salary/General scheme	1416606000.00	1344142000.00			
			a) Out of Earmarked funds	111887222.65	102590354.00
III Receipts against Earmarked Funds			b) Out of own funds		
			IV Expenditure on Fixed Assets & Capital work		
a) Earmarked funds	285369267.00	301474476.00	-in- progress		
b) Own funds					



				a) Purchase of Fixed Assets	49334688.48	39425650.00
IV	Interest Received			b) Capital work in-progress		
	a) On Bank deposits	33344235.00	61157576.05	V Refund of Loans		
	b) Loans Advances etc	200212.00	281087.00			
	c) On NCMMR funds	0.00	156624.00			
V	Receipts from services			VI Finance Charges(Bank charges)	1275167.77	1098669.22
	Receipts from Patient services	1040808950.90	1127956440.73			
	Other receipts including Royalty	30890603.10	30188255.23	VII Other Payments		
				To Funds/ Deposit- refunds	1865915882.17	1701725374.00
VI	Other receipts			VIII Closing Balance		
	Grant received for Projects	110690375.30	140840420.39	a) Cash in hand	776457.00	1260430
	Refund of Deposits(LC Margin)			b) Bank Balances		
	Other receipts	752679064.35	1167814619.79	I) In current Account	1.15	1.15
				II) Savings Account *	114275271.22	307869506.73
	Total	4824596645.53	4980511580.28	Total	4824596645.53	4980511580.28

Sd/-  
Financial Adviser

Sd/-  
Director



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM**

**Provident Fund Account For The Year Ended 31-03-2020**

Particulars	2019-2020	2018-2019
	[Rupees]	[Rupees]
<b>LIABILITIES</b>		
MEMBERS BALANCE	137113303	163725290
MEMBERS CREDITS [ for march]	3660373	5181856
BALANCE DUE TO MEMBERS NOT IN SERVICE		
Under EPF scheme	7696198	7696198
„ GPF „	532055	532055
PENSION FUND DUES	0	0
RESERVES&SURPLUS-INTEREST	223742250	182483217
<b>TOTAL</b>	<b>372744179</b>	<b>359618616</b>
<b>ASSETS</b>		
INVESTMENT AT COST	320014126	324890331
DUES TO PF ACCOUNT		
FROM INSTITUTE	3660373	5181856
FROM PF COMMISSIONER	0	0
INTEREST ACCRUED NOT DUE	34152770	23903639
BALANCE WITH BANKS		
SBT -GPF A/C	14916910	5642790
<b>TOTAL</b>	<b>372744179</b>	<b>359618616</b>

Sd/-  
Financial Adviser

Sd/-  
Director





**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES &  
TECHNOLOGY, THIRUVANANTHAPURAM**

**NATIONAL CENTRE FOR MOLECULAR MATERIALS RESEARCH**

**Receipts & Payments Account for the period 01.04.2019 to 31.03.2020**

	2019-20	2018-19		2019-20	2018-19
Receipts	Rs.	Rs.	Payments	Rs.	Rs.
Opening Balance - Bank	4326499	4169875	Audit Fees	0	0
			Refund to DST	4486995	
Grant in aid	0	0	Bank Charges	0	0
Interest earned	160497	156624	Closing Balance - Bank	0	4326499
	4486996	4326499		4486996	4326499

**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM**

**NATIONAL CENTRE FOR MOLECULAR MATERIALS RESEARCH**

**Income & Expenditure Account for the period 01.04.2019 to 31.03.2020**

	2019-20	2018-19		2019-20	2018-19
Expenses	Rs.	Rs.	Income	Rs.	Rs.
Audit Fees	0	0	Interest	160496	156624
Bank charges	0	0			
Excess of Income over expenditure	160496	156624	Excess of Expenditure over income	0	0
	160496	156624		160496	156624

**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY,  
THIRUVANANTHAPURAM**

**NATIONAL CENTRE FOR MOLECULAR MATERIALS RESEARCH - BALANCE SHEET AS ON 31-03-2020**

Particulars	2019-2020	2018-2019
	[Rs]	[Rs]
<b>LIABILITIES</b>		
<b>CAPITAL FUND</b>		
Opening Balance	4326499	4169875
Add: Grant received	0	0
Less:- Repayment to DST	4486995	
Add/Less (-): Excess of Income over Expenditure	160496	156624
<b>TOTAL</b>	<b>0</b>	<b>4326499</b>
<b>ASSETS</b>		
<b>BANK BALANCE</b>	<b>0</b>	<b>4326499</b>
(Union Bank of India Account No.541502010002675)		
<b>TOTAL</b>	<b>0</b>	<b>4326499</b>

Sd/-  
Financial Adviser

Sd/-  
Director



# SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

## SCHEDULES FORMING PART OF ACCOUNTS AS AT 31-03-2020

### 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/-  
Financial Adviser

Sd/-  
Director



## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, THIRUVANANTHAPURAM

### SCHEDULE 25-CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS

#### 1. CONTINGENT LIABILITIES

	Rs. In lakhs	
	2019-20	2018-19
Claims against the Institute not acknowledged as debts	NIL	NIL
Bank Guarantee given by Institute 33.86 lakh+bmt 12.10	45.96	57.80
Letters of credit opened on behalf of Institute 441.45 lakh + bmt	129.89	1058.90
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	
	2019-20	2018-19
Estimated value of orders remaining to be executed on Capital Account	118.73	176.08

Construction of New Hospital block (NHB)& Hospital Equipments & Facilities for NHB	7111.98	9993.99
Completion of Combination Devices Block	2446.50	2917.00

*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	
	2019-20	2018-19
5.1 Value of Imports		
Capital Goods (284.55+99.88)	384.43	2023.77
Stores Spare & Consumables (4.84+ 22.35)	27.19	406.22
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.44.56 lakh (previous year Rs.60.85 lakh).
7. Claim for Audit fees by C&AG amounting to Rs.Nil has been paid during the year. Provision for Audit fees has been made for current year amounting to Rs.3.50 lakh.
8. Accrued Interest on Investment amounting Rs.111.99 lakh (previous year Rs. 225.30 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.2881.68 lakh has been expended over and above the sanctioned 12% Institute contribution (amounting to Rs.343.32 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. 3915.46 lakh
Present value of the pensionary liability for serving employees	Rs. 18600.00 lakh
Present value of the pensionary liability for Existing pensioners	Rs. 26000.00 lakh
Present value of the past service leave encashment	Rs. 1071.74 lakh

12. (a) Value of assets acquired from externally funded projects during the last three years has been identified as detailed below:-

FY 2016-17	Rs. 718.52 lakh
FY 2017-18	Rs. 850.68 lakh
FY 2018-19	Rs. 940.31 lakh
FY 2019-20	Rs.1165.23 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.71.64 lakh (previous year Rs.50.10 lakh) was transferred to Technology Development Fund. During the year Rs.53.33 lakh has been spent from Technology Development Fund.(Previous year Rs.24.38 lakhs)

### 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.6.87 lakh (Previous year Rs.2.28 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. National Centre for Molecular Materials Research, Thiruvananthapuram

Receipts and Payments Account, Income and Expenditure Account and Balance Sheet in respect of NCMMR has been prepared separately and annexed to the accounts. Balance amount in the fund was repaid to DST during the year 2019-20.

### 18. 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 31-03-2020, 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 the Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram for the year ended 31 March 2020

1. We have audited the Balance Sheet of the Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram as at 31 March 2020, 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 & Conditions of Service) Act, 1971 read with section 18(2) of the SCTIMST Act, 1980. These financial statements include the accounts of Bio-Medical Technology (BMT) wing of the SCTIMST. These financial statements are the responsibility of the SCTIMST's management. Our responsibility is to express an opinion on these financial statements based on our audit.
2. This 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

#### A.1 Current liabilities and provisions (Schedule -7) Rs.71.95 crore

As per Paragraph 8 of Schedule-24 Significant Accounts Policies of the annual accounts for the year 2019-20, retirement benefits are being accounted for on cash basis SCTIMST. However, the Institute has done the actuarial valuation for the year 2019-20 (Paragraph 11 of Schedule 25) and the liability towards gratuity, pension and accumulated leave encashment were Rs. 39.15 crore, Rs. 446 crore and Rs. 10.72 crore respectively.

Against the liability of Rs. 495.87 crore as on 31st March 2020 Institute has created Pension Fund (GL 1301) amounting to Rs. 21.29 crore only. This has resulted in understatement of Schedule 7: Current Liabilities and Provisions by Rs. 474.58 crore and understatement of expenses account (Schedule- 20: Establishment expenses).

#### A2 Current liabilities and provisions (schedule 7) - 71.95 crore

The un-spent portion of money received from Ministry/ Departments of the Government of India is required to be shown under 'Schedule 7-Current Liabilities and Provisions' so that the un-spent grant is either refunded in full at its request or adjusted against the subsequent releases.

SCTIMST received an amount of Rs.40 Crore from Ministry of Health & Family Welfare towards the procurement of Hospital equipment for the New Hospital Block. Out of this an amount of Rs.0.02 crore was incurred for the purpose by the institute. The unutilized portion of Rs.39.98 crore was however not shown under 'Schedule 7-Current Liabilities and Provisions'. It was instead shown under 'Schedule-1: Capital Fund'. Thus, the Current liability of the institute was understated, and Capital Fund overstated by Rs.39.98 crore.





SCTIMST replied (Aug/Sept 2020) that considering the financial position of the Institute, Governing Body decided to continue the existing practice of settling payments on cash basis and creation of funds to be considered once the financial position improves. The position of the Institute is against the directives of Ministry of Finance on the subject.

### A3 Current Liabilities - Rs.71.66 crore

As per Rule 230 (8) of General Financial Rules, 2017; all interests or other earnings against Grants in aid or advances (other than reimbursement) released to any Grantee institution should mandatorily be remitted to the Consolidated Fund of India, immediately after finalisation of the accounts.

Audit scrutiny revealed that interest received against; (i) the grant for construction of New

Hospital block amounting to Rs.4.37 crore and the grants for procurement of equipment for the new Hospital block amounting to 0.10 crore were not remitted to CFI. These amounts should be remitted to CFI immediately.

### A4 Current Assets (Schedule-11) - Rs.319.92 crore

As per the Uniform Format of Accounts prescribed for central autonomous bodies, the investments from earmarked funds in Government Securities, Shares, Debentures, Bonds, etc., are to be accounted under 'Schedule-9 — Investments from Earmarked Funds'. The fixed/Termed deposits in Scheduled/ Non-Scheduled banks are to be accounted under 'Schedule 11 - Current Assets'. Audit scrutiny however revealed that SCTIMST accounted Rs.67.85 crore deposited in Bank Account under Schedule-9 - Investments instead of Schedule 11-Current Asset. Thus Current Asset Account is understated and Investment Account is overstated by Rs.67.85 crore.

### A5 Current Assets (Schedule-11) - Rs.319.92 crore

As per the Uniform Format of Accounts prescribed for central autonomous bodies, the investments other than from earmarked funds in Government Securities, Shares, Debentures, Bonds, etc., are to be accounted under 'Schedule-10 — Investments Others'. The fixed/Termed deposits in Scheduled/ Non-Scheduled banks are to be accounted under 'Schedule 11-Current Assets'. Audit scrutiny however revealed that SCTIMST accounted Rs.24.25 crore deposited in Bank Account under Schedule-10 — Investments others instead of Schedule 11- Current Asset. Thus, Current Asset Account is understated and 'Investment others' Account is overstated by Rs.24.25 crore.

### A6 Current Assets (Schedule-11) - Rs.319.92 crore

As per Indian Accounting Standard 20 relating to accounting of Government Grants, Grants shall be recognized in accounts only when there is a 'reasonable assurance' that the Grants will be received. As per the accounting standard, Government grants shall be recognized against the grant release orders. However, the institute under Para 6 of its Significant accounting policy {Schedule 24} disclosed that all Government grants are accounted based on grant release orders, except the grant to meet seventh CPC arrears. It further disclosed that the institute accounted an amount of Rs, 41.72 crore under Current Assets (Schedule 11) towards Seventh CPC arrears grant receivable.

Audit observed that 'reasonable assurance' principle is not met in recognizing seventh CPC arrears as 'Grants receivable' under Current Asset Account as reasonable assurance was not obtained from the grantee through Grant release orders. It was also observed that the balances were receivable in the year 2018-19 and Rs.21.25 crore was received in the year 2020-21.

Further, instead of recognizing the grant receivable figure {as per estimation of SCTIMST} under Current asset account the institute, may disclose the amount under its Notes to Account (Schedule-25).

However an amount of Rs. 20.47 crore (Rs. 41.72-21.25) for the year 2018-19 without reasonable assurance has been taken into its accounts. Thus, current assets account is overstated by Rs.20.47 crore and capital fund account are also overstated by Rs.20.47 crore.

### (B) Income and Expenditure Account

#### B1 Other Income (Schedule 18) - Rs.1.71 crore

As per the notes and instructions contained in the approved Uniform Format of Accounts prescribed for central autonomous bodies, Schedule-3 earmarked / endowment funds are the amounts received as grants assistance or retained by the entity to be utilized for specific or earmarked purposes and to be expended for these purposes. This schedule should not include grants/ funds which were appropriated from the releases of the promoters of the institution.

Therefore, the funds appropriated from the grants/ income are not be kept under Schedule- 3. In-house project costs are to be expended from the income/ grant of the Institute and are direct appropriations from the Institute's Income/grant, which close to accounts and therefore would not hold any balance.



Audit scrutiny of the schedule-3 however revealed that 54 In-house projects (53 Technical Research Centre projects and project GL Code 2621 of BMT wing) were reported under schedule-3 and these projects held a balance of Rs.32.70 crore as on 31<sup>st</sup> March 2020. These balances may be credited immediately to 'Other Income'. Thus, 'Other Income' (Schedule 18) account is understated by Rs.32.70 crore and Earmarked/ Endowment Fund Account (Schedule-3) overstated.

### (C) General

#### C1 Grant in aid

SCTIMST received an amount of Rs. 186.15 crore from DST. Out of which Grant-in-aid towards Salary received from DST was Rs. 12313.01 lakh and Grant-in-aid towards General purpose received from DST was Rs. 1853.05 lakh the entire amount is spent. Grant-in-aid for creation of Capital Asset was with an opening balance of Rs. 75.72 crore and an amount of Rs. 44.49 crore grants was received during the financial year 2019-20; an amount of Rs. 59.49 crore was spent during the financial year and balance at the end of the year is Rs. 60.72 crore.

#### C2 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 (SCTIMST) 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 2020 was Rs.3807.32 lakh. The value of assets procured for the period up to the end of March 2014 (from completed projects) however was not worked out and the consent of the sponsoring agencies not obtained to include the value of these assets in the institute accounts.

#### C3. Disclosure relating to preparation of financial statements

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.

SCTIMST has one indigenous software solution to cater to the accounting requirements from indent to payment. Accounts, Purchase and Stores division are integrated into one software solution. Preparation of Trial Balance, Receipt and Payment Account and Final Accounts (Balance Sheet, Income and Expenditure account and its schedules, sub schedules) Accrued income, Dues payable are prepared in Excel through manual intervention. Inventories are managed in a different software and at the end of financial year, journal entries are proposed to transfer the transactions to trial balance.

As per the Generally Accepted Accounting Principles in India, the Creditors/ Debtors ledger accounts are two most important accounts in addition to General ledger which represent money owed to the institution by its customers and money owed by the institution to its suppliers. Audit scrutiny revealed that the institute did not have its Creditors (payables) ledger and Debtors ledger (receivable) account required as prescribed under 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.

Therefore, a comprehensive accounting software which covers activities from voucher entry till preparation of the final accounts along with Debtors/ Creditors/ General Ledger needs to be put in place. Further the solution should cover the spending aspect from the indent till acceptance and the management of inventory/ asset. Similarly, revenue aspect from services rendered, products consumed covering all customers (Patients, suppliers, contractors, creditors, debtors) needs to be in place.

The institute may therefore disclose under its notes to account the accounting system pursued by the institute and may indicate a time frame based action plan to switch over to a complete accrual system of accounting by adopting comprehensive Accounting Software which automatically generate financial statements, without any manual interventions. This includes the maintenance of Debtors/ Creditors Ledger accounts together with integration of accounting of hospital inventory to the main Accounting software.



## 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 2020.

Audit Para	Observation	Reply of the Institute
<p>A. Balance Sheet:</p> <p>A.1 Current liabilities and provisions (Schedule -7) Rs.71.95 crore</p>	<p>As per Paragraph 8 of Schedule-24 Significant Accounts Policies of the annual accounts for the year 2019-20, retirement benefits are being accounted for on cash basis SCTIMST. However, the Institute has done the actuarial valuation for the year 2019-20 (Paragraph 11 of Schedule 25) and the liability towards gratuity, pension and accumulated leave encashment were Rs. 39.15 crore, Rs. 446 crore and Rs. 10.72 crore respectively.</p> <p>Against the liability of Rs. 495.87 crore as on 31st March 2020 Institute has created Pension Fund (GL 1301) amounting to Rs. 21.29 crore only. This has resulted in understatement of Schedule 7: Current Liabilities and Provisions by Rs. 474.58 crore and understatement of expenses account (Schedule- 20: Establishment expenses).</p>	<p>Pension Fund was created in 1989. Adequate contribution to the fund could not be made as more than 50% of the pension, Gratuity and EL Encashment is paid from the internal generation of the Institute. As recommended by FC/GB, actuarial valuation was conducted from 2015-16 onwards and liability shown under Notes to account until corpus fund is created. Need to start pension fund was presented before FC meeting in February 2020. LIC of India was approached to start the pension fund and three options were suggested which leads to accumulation of Rs.511 cr. FC &amp; GB (June/July 2020) suggested for option No.2 in which Rs. 72 crore needs to be contributed annually until 2031. Request has been sent to DST seeking additional Grant-in-Aid.</p>
<p>A2 Current liabilities and provisions (schedule 7) Rs 71.95 crore</p>	<p>The un-spent portion of money received from Ministry/ Departments of the Government of India is required to be shown under 'Schedule 7-Current Liabilities and Provisions' so that the un-spent grant is either refunded in full at its request or adjusted against the subsequent releases.</p> <p>SCTIMST received an amount of Rs.40 Crore from Ministry of Health &amp; Family Welfare towards the procurement of Hospital equipment for the New Hospital Block. Out of this an amount of Rs.0.02 crore was incurred for the purpose by the institute. The unutilized portion of Rs.39.98 crore was however not shown under 'Schedule 7-Current Liabilities and Provisions'. It was instead shown under 'Schedule-1: Capital Fund'. Thus, the Current liability of the institute was understated, and Capital Fund overstated by Rs.39.98 crore.</p> <p>SCTIMST replied (Aug/Sept 2020) that considering the financial position of the Institute, Governing Body decided to continue the existing practice of settling payments on cash basis and creation of funds to be considered once the financial position improves. The position of the Institute is against the directives of Ministry of Finance on the subject.</p>	<p>Fund received from MoHFW was taken to Capital Fund in line with the Capital Grant received from DST. Unspent amount is kept in investments. Special funds of the same nature will be shown under Liabilities (Schedule 7) in future.</p>



<p>A3 Current Liabilities - Rs.71.66 crore</p>	<p>As per Rule 230 (8) of General Financial Rules, 2017; all interests or other earnings against Grants in aid or advances (other than reimbursement) released to any Grantee institution should mandatorily be remitted to the Consolidated Fund of India, immediately after finalisation of the accounts.</p> <p>Audit scrutiny revealed that interest received against; (i) the grant for construction of New Hospital block amounting to Rs.4.37 crore and the grants for procurement of equipment for the new Hospital block amounting to 0.10 crore were not remitted to CFI. These amounts should be remitted to CFI immediately</p>	<p>Interest payable to Government of India is correctly shown in the Schedule 7 - Current Liabilities. Finalization of accounts completed in June 2020. The amount will be paid to Consolidated Fund of India in the year 2020-21 after audit as being the usual practice.</p>
<p>A4 Current Assets (Schedule-11) - Rs.319.92 crore</p>	<p>As per the Uniform Format of Accounts prescribed for central autonomous bodies, the investments from earmarked funds in Government Securities, Shares, Debentures, Bonds, etc., are to be accounted under 'Schedule-9 – Investments from Earmarked Funds'. The fixed/Termed deposits in Scheduled/ Non-Scheduled banks are to be accounted under 'Schedule 11-Current Assets'. Audit scrutiny however revealed that SCTIMST accounted Rs.67.85 crore deposited in Bank Account under Schedule-9 - Investments instead of Schedule 11-Current Asset. Thus Current Asset Account is understated and Investment Account is overstated by Rs.67.85 crore.</p>	<p>Investment of earmarked funds (pension Fund, Patient Welfare Fund, Project Fund etc.) is shown under Schedule 9. Investment set aside for specific purpose. Investments for general use of the Institute are shown in Schedule 11 - Current Assets. Accounting procedure consistently been followed over the years</p>
<p>A5 Current Assets (Schedule-11) - Rs.319.92 crore</p>	<p>As per the Uniform Format of Accounts prescribed for central autonomous bodies, the investments other than from earmarked funds in Government Securities, Shares, Debentures, Bonds, etc., are to be accounted under 'Schedule-10 – Investments Others'. The fixed/ Termed deposits in Scheduled/ Non-Scheduled banks are to be accounted under 'Schedule 11-Current Assets'. Audit scrutiny however revealed that SCTIMST accounted Rs.24.25 crore deposited in Bank Account under Schedule-10 – Investments others instead of Schedule 11-Current Asset. Thus, Current Asset Account is understated and 'Investment others' Account is overstated by Rs.24.25 crore.</p>	<p>Term Deposit of Specific funds such as Emergency Reserve Fund and Technology Development Fund is shown under Schedule 10. Investment set aside for specific purpose. Investments for general use of the Institute are shown in Schedule 11 - Current Assets. Accounting procedure consistently been followed over the years</p>



<p>A6 Current Assets (Schedule-11) Rs.319.92 crore</p>	<p>As per Indian Accounting Standard 20 relating to accounting of Government Grants, Grants shall be recognized in accounts only when there is a 'reasonable assurance' that the Grants will be received. As per the accounting standard, Government grants shall be recognized against the grant release orders. However, the institute under Para 6 of its Significant accounting policy {Schedule 24} disclosed that all Government grants are accounted based on grant release orders, except the grant to meet seventh CPC arrears. It further disclosed that the institute accounted an amount of Rs, 41.72 crore under Current Assets (Schedule 11) towards Seventh CPC arrears grant receivable.</p> <p>Audit observed that 'reasonable assurance' principle is not met in recognizing seventh CPC arrears as 'Grants receivable' under Current Asset Account as reasonable assurance was not obtained from the grantee through Grant release orders. It was also observed that the balances were receivable in the year 2018-19 and Rs.21.25 crore was received in the year 2020-21.</p> <p>Further, instead of recognizing the grant receivable figure {as per estimation of SCTIMST} under Current asset account the institute, may disclose the amount under its Notes to Account (Schedule-25).</p> <p>However an amount of Rs. 20.47 crore (Rs. 41.72-21.25) for the year 2018-19 without reasonable assurance has been taken into its accounts. Thus, current assets account is overstated by Rs.20.47 crore and capital fund account are also overstated by Rs.20.47 crore.</p>	<p>No revenue recognition made in the current year under audit. Accounting standard 20 is related to Revenue Recognition of income. As per the matching principle of accounting, liability as well as revenue was accounted and was certified by C&amp;AG in 2018-19. Complied the Accounting Standard 20 based on the assurance received from DST in the year 2018-19 and was partly fulfilled in the FY 2020-21.</p>
<p>(B) Income and Expenditure Account</p> <p>B1 Other Income (Schedule 18) - Rs.1.71 crore</p>	<p>As per the notes and instructions contained in the approved Uniform Format of Accounts prescribed for central autonomous bodies, Schedule-3 earmarked / endowment funds are the amounts received as grants assistance or retained by the entity to be utilized for specific or earmarked purposes and to be expended for these purposes. This schedule should not include grants/ funds which were appropriated from the releases of the promoters of the institution. Therefore, the funds appropriated from the grants/ income are not be kept under Schedule-3. In-house project costs are to be expended from the income/ grant of the Institute and are direct appropriations from the Institute's Income/grant, which close to accounts and therefore would not hold any balance.</p> <p>Audit scrutiny of the schedule-3 however revealed that 54 In-house projects (53 Technical Research Centre projects and project GL Code 2621 of BMT wing) were reported under schedule-3 and these projects held a balance of Rs.32.70 crore as on 31% March 2020. These balances may be credited immediately to 'Other Income'. Thus, 'Other Income' (Schedule 18) account is understated by Rs.32.70 crore and Earmarked/ Endowment Fund Account (Schedule- 3) overstated.</p>	<p>No In-house projects holds balance at the end of financial year. Technical Research Centre(TRC) project is funded by DST. Audit point is about the R&amp;D projects sanctioned under the TRC fund. Hence the classification under Schedule 3 is correct. However as advised by audit, the unspent balance under IIPC project is transferred to other income of the institute in the FY 2020-21.</p>





<p>(C) General</p> <p>C1 Grant in aid</p>	<p>SCTIMST received an amount of Rs. 186.15 crore from DST. Out of which Grant-in-aid towards Salary received from DST was Rs. 12313.01 lakh and Grant-in-aid towards General purpose received from DST was Rs. 1853.05 lakh the entire amount is spent. Grant-in-aid for creation of Capital Asset was with an opening balance of Rs. 75.72 crore and an amount of Rs. 44.49 crore grants was received during the financial year 2019-20; an amount of Rs. 59.49 crore was spent during the financial year and balance at the end of the year is Rs. 60.72 crore.</p>	<p>Noted.</p>
<p>C2 General</p>	<p>As per Rule 233(ii) of GFR 2017, on completion of the projects or schemes, if the assets are allowed to be retained by the sponsoring institute/ organization, the implementing agency (SCTIMST) should include the assets at book value in their own accounts.</p> <p>As per Paragraph 12 of Schedule-25, value of assets acquired from on-going external projects from April 2014 to March 2020 was Rs.3807.32 lakh. The value of assets procured for the period up to the end of March 2014 (from completed projects) however was not worked out and the consent of the sponsoring agencies not obtained to include the value of these assets in the institute accounts.</p>	<p>Assets acquired out of sponsored projects will be taken as fixed asset at its book value (Schedule 8) on completion of the projects as specified in GFR.</p>
<p>C3. Disclosure relating to preparation of financial statements</p>	<p>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.</p> <p>SCTIMST has one indigenous software solution to cater to the accounting requirements from indent to payment. Accounts, Purchase and Stores division are integrated into one software solution. Preparation of Trial Balance, Receipt and Payment Account and Final Accounts (Balance Sheet, Income and Expenditure account and its schedules, sub schedules) Accrued income, Dues payable are prepared in Excel through manual intervention. Inventories are managed in a different software and at the end of financial year, journal entries are proposed to transfer the transactions to trial balance.</p> <p>As per the Generally Accepted Accounting Principles in India, the Creditors/ Debtors ledger accounts are two most important accounts in addition to General ledger which represent money owed to the institution by its customers and money owed by the institution to its suppliers. Audit scrutiny revealed that the institute did not have its Creditors (payables) ledger and Debtors ledger (receivable) account required as prescribed under 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.</p>	<p>SCTIMST being an Institute with multi-dimensional functionalities which includes a Hospital wing, Research wing and an Academic division. Institute has an apprehension on whether any ready software available in the India market can take care of all complex nature and functionalities of the Institute. Institute will be exploring the possibilities on whether any software can accommodate multi functionalities of the Institute. Matter will be taken up with System Manager of the Institute and renowned software providers.</p>



	<p>Therefore, a comprehensive accounting software which covers activities from voucher entry till preparation of the final accounts along with Debtors/ Creditors/ General Ledger needs to be put in place. Further the solution should cover the spending aspect from the indent till acceptance and the management of inventory/ asset. Similarly, revenue aspect from services rendered, products consumed covering all customers (Patients, suppliers, contractors, creditors, debtors) needs to be in place.</p> <p>The institute may therefore disclose under its notes to account the accounting system pursued by the institute and may indicate a time frame based action plan to switch over to a complete accrual system of accounting by adopting comprehensive Accounting Software which automatically generate financial statements, without any manual interventions. This includes the maintenance of Debtors/ Creditors Ledger accounts together with integration of accounting of hospital inventory to the main Accounting software.</p>	
(D) Management Letter	<p>Deficiencies which have not been included in the Separate Audit Report have been brought to the notice of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram through a Management letter issued separately for remedial/ corrective action.</p>	<p>The observations mentioned in the Management letter have been noted for future guidance as well as remedial/corrective action.</p>



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