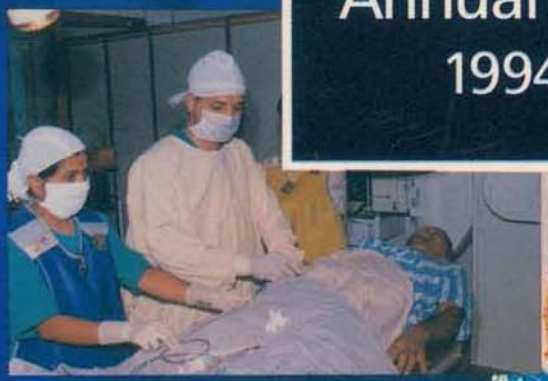
Sree Chitra Tirunal
Institute for
Medical Sciences and
Technology

Annual Report
1994-95



Annual Report
1994-95

SREE CHITRA TIRUNAL
INSTITUTE FOR
MEDICAL SCIENCES AND TECHNOLOGY
THIRUVANANTHAPURAM
KERALA, INDIA

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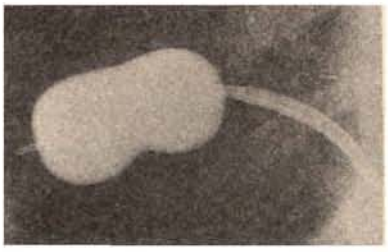
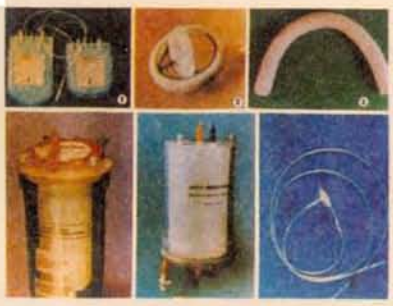


Cover

The photographs on the cover represent the increasing role of interventional cardiology, and the Institute's entry into the information super highway. The hydrogel beads in the background exemplifies our successful efforts in developing medical devices and implants.

HIGHLIGHTS OF THE YEAR

- Installation of video EEG Laboratory has brought a new insight into the diagnosis and management of intractable epilepsy and its surgical treatment.
- Vascular graft awaiting clinical trial.
- Biodegradable microspheres-based drug and protein delivery system have shown promise for sustained delivery of cyto-toxics, steroids and vaccines in initial studies.
- Biomedical technology and health economics included in the new syllabi for postdoctoral courses to bring about integration of medical sciences and related technology.
- Library enters information super highway.
- Rabbit model for endomyocardial fibrosis awaits functional evaluation.
- MRI enhances the diagnostic ability .
- Interventional cardiology offers relief without major operative treatment in selected patients.
- Development of indigenous devices brings down the cost of treatment.



Historical

THE ORIGINS of the Institute reach back to 1973 when the Royal Family of Travancore gifted a multi-storeyed building for the people and the Government of Kerala resolved to develop the gift as the Sree Chitra Tirunal Medical Centre for medical specialities.

The Medical Centre was inaugurated by Shri. P. N. Haksar in 1976 and the growth of a Biomedical Engineering and Technology Centre followed quickly at the Satelmond Palace, Thiruvananthapuram.

The concept and achievement of uniting technology and medical sciences within a single institutional framework was regarded sufficiently important by the Government of India to declare it as an Institute of National Importance by an Act of Parliament in 1980. The Act lays down the objectives of the Institute to be the promotion of biomedical engineering and technology, demonstration of high standards of patient care and the development of post-graduate training programmes of the highest quality in advanced medical specialities and biomedical engineering and technology.

Overview

DURING the decade and a half of its existence as an Institution of National Importance, the Institute notched up a significant record of achievements in all its fields of endeavour. Its efforts in developing biomedical devices and implants resulted in a number of commercially viable technologies, leading to the beginning of a credible medical devices industry in India. The Institute successfully carried out its mandate to establish and maintain high standards of patient care in advanced medical specialities. The educational and training programmes offered by the Institute gained national acceptance because of their consistently high calibre.

Poised on the threshold of the twenty-first century, the Institute is gearing up to face fresh challenges and shoulder greater responsibilities. In view of the emerging economic scenario and the change in Government policies and outlook, it has become imperative to seek the active participation of industry in R&D activities. Efforts to build linkages between the Institute and industrial houses are being pursued vigorously. Similarly the Institute is trying to forge symbiotic relationship with other R&D centres and laboratories to facilitate effective and economical development of a host of medical devices, implants and instruments. Even as the technologies for half a dozen health care products are in the final stages of development, the Institute is planning to initiate an ambitious programme for developing disposable devices like endotracheal tubes, catheters and cannulae. Market for such products is large and is growing fast due to the preoccupation of the health care professionals with contagious and potentially fatal diseases.

Patient care activities of the Institute received a new fillip with the establishment of facilities

for comprehensive medical and surgical management of epilepsy. Minimally invasive procedures for the treatment of cardiac, vascular and neurological diseases were given further emphasis in an attempt to reduce the nearly unmanageable load on surgical specialities. Hospital services are being systematically computerised in an effort to streamline patient care and make it more efficient, quicker and more economical.

The Achutha Menon Centre for Health Sciences Studies has set in motion a number of programmes including epidemiological surveys, analyses of the cost effectiveness of current health care practices and the economic burden of chronic ill-health. It is hoped that the Centre would become a nodal agency for such studies in India.

On the academic front, the major thrust is directed towards integrating medical sciences with engineering and social sciences. The existing syllabi for post-doctoral programmes are being revised to incorporate aspects of biomedical engineering and technology, as well as social sciences of relevance to health care. The revised, integrated syllabi will come into force from the academic year beginning in 1996.

To sum up, the Institute is all set to sail into the next century and continue its voyage into yet other unchartered seas.

Patient Care

DR. (MAJ) K.A. HAMEED, BSC, MBBS
Medical Superintendent

DR. D. HARIPRASAD, MD
Deputy Medical Superintendent (till 8/94)

THE NUMBER of referrals of patients for Cardiology, Neurology and Radiology Departments were on the increase. The details of the same are given in the table below.

In order to ensure the quality of patient care in the outpatient and review clinics, we have limited the number of cases to be newly registered and the appointments were given based on computerised list of registered patients. The long waiting lists of patients continue to be a problem.

Charges for various diagnostic and therapeutic procedures have been periodically reviewed in view of the escalation of prices of drugs, consumables and medical devices. A major aim in costing was to enable the hospital to partly overcome budgetary constraints for procuring expensive disposables for the low income group of patients.

A strict yet reasonable assessment of the family income of patients raised the hospital revenue to a higher proportion commensurate with the income of the patients.

An additional waiting room was made in the OPD area of the medical block and refreshment facilities for out-patients and their relations were opened in the waiting area in both the medical and surgical OPD's. These facilities were widely welcomed.

Old/unserviceable/obsolete equipment which were found unsuitable for repair were gifted to the Government Model Engineering College, Ernakulam and to the Kerala State Science and Technology Museum. Steps have been taken to replace the old Cathlab Machine with a new DSA machine which is expected to be installed during June-July 1995.

A new steriliser was installed in the CSD to meet the additional requirements. Old equipments in the laundry, kitchen and dietary, were also replaced by new ones in a phased manner.

The Hospital Management Committee met regularly and reviewed the quality of patient care. Inservice education and meetings of ward sisters were also conducted regularly as in previous years.

Seven observer trainees sponsored by various hospitals have had short term training familiarisation with the working of our dietary section and hospital administration.

Medico Social Work

Medico-Social Workers co-ordinated guidance of patients, registration and income assessment of patients, motivation of blood donors, doctor - patient correspondence/ issuing of certificates etc. and thus played a crucial role in integrating various aspects of patient care.

In the epilepsy clinic they conducted group therapy sessions for patients and their family members, counselling to patients

and a study on "Psycho-social problems of parents of epileptic children". The novel approach of family group sessions were found to be effective in dealing with psycho-social problems of epilepsy patients and improving the quality of life in the family of epileptics.

Postgraduate students specialising in medical and psychiatric social work from Loyola College of Social Sciences, Thiruvananthapuram and Master of Hospital Management [MHM] students from Madurai Kamaraj University spent short periods at the Institute for orientation and training. ■

Medical Records

SRI. P. KRISHNAMOORTHIA PILLAI, MA
Senior Medical Records Officer

This Department extended its facilities to peripheral departments by supplying scientific data and statistics. Out of 1,65,000 charts, 72,856 charts were taken out for the following purposes.

Table 1.

1.	Follow up clinics	41,990
2.	Correspondence of patients	14,222
3.	Analysis and studies	7,400
4.	Updating entries in computer	4,344
5.	Pruning of charts	4,600
6.	Cardiac surgery scrutiny	300

10,038 new registrations and 5,496 admissions were done during this year with on line computer system. All the appointments given for follow up from various special clinics were directly fed into the computer which controls the number of follow up cases also. Admission letters of cardiac catheterisation, coronary angiography and cardiac surgery were prepared by computer and mailed to the patients. Letters of postponement of appointments due to Institute holidays were prepared one month in advance and sent to patients with a new appointment date fixed through the computer. The MRD assisted doctors for sending "enquiry letters" in English and Malayalam to the patients to know their status of health. The medical records personnel visited all the wards and the ICU's to check the discharge charts.

This department presented the following statistical information to the Hospital management committee meetings.

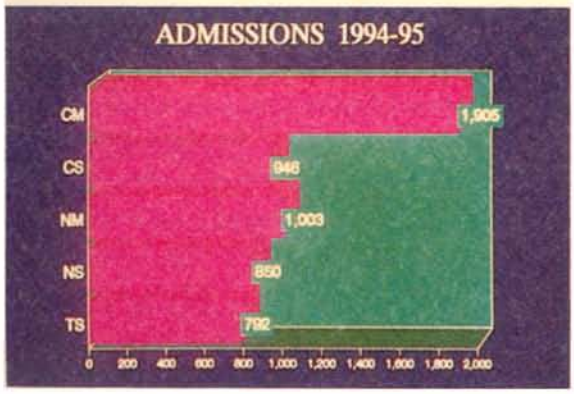
1. Out-patient statistics
2. In-patient diagnosis lists
3. Death list
4. Prolonged stay list

Other Activities

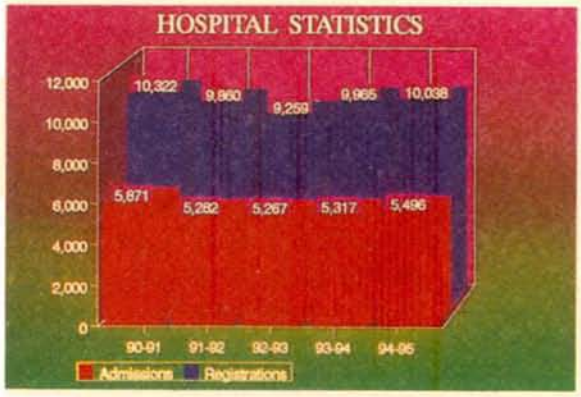
The MRD conducted a "National Conference on Health Information and Advanced Management" on 23.12.1994 at the Institute. 108 delegates attended this conference.

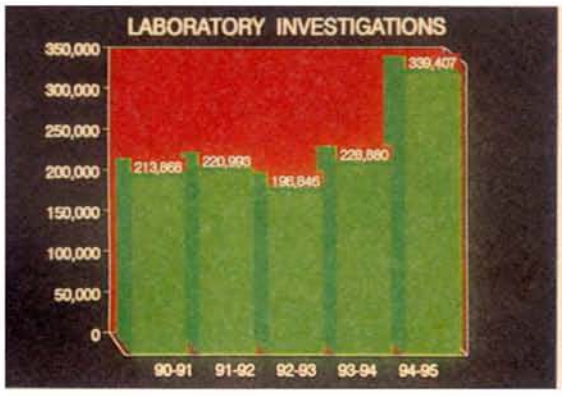
Table 2: Important Statistics

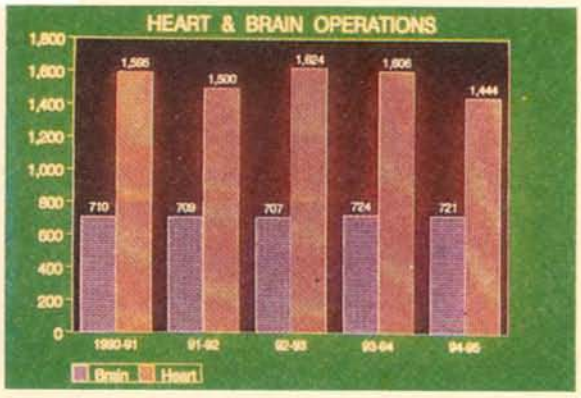
1.	New registrations	10,038
2.	Follow up	41,990
3.	Admissions	5,496
4.	Discharges	5,479
5.	Death	235
6.	Non-paying %	19
7.	Paying %	81
8.	Cardiac surgery	1,444
9.	Neuro surgery	721
10.	Lab. investigations	3,39,407
11.	X-ray	15,292
12.	Physiotherapy	18,611
13.	ECG	12,723
14.	Echo	21,738
15.	EMG	366
16.	Pacemaker	77
17.	Perfusion	749
18.	CT Scan	4,067
19.	MRI	2,190
20.	EEG	1,187
21.	TMT	1,816
22.	Cardiac Catheterisation	1,134
23.	PTCA	41
24.	Cerebral Angiogram	193
25.	Aortogram	195
26.	Angioplasty	67
27.	Myelogram	40
28.	B.P. Valvotomy	26
29.	B.M. Valvotomy	157
30.	Coarctation dilation	18



CS - CARDIAC SURGERY
CM - CARDIAC MEDICINE
NM - NEURO MEDICINE
TS - THROACIC SURGER
NS - NEURO SURGERY







Nursing Services

SMT. VIJAYAMMA HARIKRISHNAN, BSC. (NURSING), M.A.
Nursing Superintendent

SMT. ROSAMMA EDWARDS, R.N., R.M., PNA.
Deputy Nursing Superintendent

As in the previous years, the nursing services continued to provide excellent care to the patients in the Institute. In addition to the nursing activities, the senior nursing staff helped in imparting training, and helped the nursing instructress in teaching the post basic nursing course students. An orientation programme was undertaken for nurses who joined during '94-'95 as well as for students from other institutions.
A Workshop on "Nursing Process" was organised from 18-04-1994 to 20-04-1994 in the Institute. ■

Physiotherapy

The rehabilitation work undertaken by the unit aimed at achieving early independence in the daily activities of hospital in-patients. In addition, out-patients were also given physiotherapy using the special equipment available in the unit. The unit also contributed to the teaching and training of post basic nursing course students. ■

Clinical Engineering

SRI. R. MOHANDAS, M.E.
Biomedical Engineer (On leave)

SRI. K. VIJAYAKUMAR, BSC. (ENGG)
Engineer (I/C from Sept.'94)

SRI. KORUTHU P. VARGHESE, BSC. (ENGG), PG DIP (COMP)
Engineer

SRI. G. MOHANLAL, BSC. (ENGG)
Engineer

SRI. B. MADHUSOODANAN PILLAI, BSC. (ENGG) PGDCA, MBA
Junior Engineer

As in the previous years, the division was involved in the maintenance of the biomedical engineering systems as well as the procurement, installation, testing and commissioning of new diagnostic and therapeutic equipments.

Major installations during this year are the 'DANTEC' Brain Mapping System and 'NICOLET' EMG Machine in the Department of Neurology, and the TATA TELECOM Electronic telephone exchange.

The Biomedical Engineering Division has taken up the responsibility of setting up a unique Biomedical Engineering Gallery in the State Science and Technology Museum, Trivandrum. Sri. Koruthu. P. Varghese was nominated as the chief executive to the project.

Sri. Mohandas proceeded on one year leave on an assignment for setting up a new Biomedical Engineering Division in the Ministry of Health, United Arab Emirates.

Computer Division

SMT. G. GEETHA, M.TECH (Computer Science)
System Manager

Data Processing found increased applications in accounts, medical records, administration, purchase, general stores, pharmacy, microbiology, blood bank and medical illustration.

Expansion activities consisted of:

i. implementation of an on line data base with MRD, IP & OP diagnosis duly registered in acceptable formats,

ii. enhanced communication from Wards & ICU by independent terminals leading to faster data processing, and

iii. provision of independent terminals at time keeping section, despatch section and administrative office leading to decentralisation of various activities.

Hardware Expansion included procurement of:

Three 80486 machines for Hospital Information System, machine for Achutha Menon Centre, machine for library internet connectivity & library automation software and terminals & printers for Wards.

- SCO Open Server Enterprise,
- SCO Open Development System,
- Oracle 7.0.15 and
- Libsys-library automation software were the software added to the division.

System Expansion is progressing towards a closer application in different areas apart from increasing the local area network (LAN) interlinks. ■

Biomedical Technology Wing

DR. R. SIVAKUMAR, B.TECH., PHD.
Head

THE technological activities at BMT wing focussed on the devices developed and commercialised such as heart valve, hydrocephalus shunt etc. and initiating new activities based upon the requirements projected by medical practitoners and the market. In commercialised technologies, the accent was on fulfilling the gaps to ensure technology absorption by the industry. Further progress was achieved in the development of vascular graft, dental composites, glass ionomer, electrodes for neurophysiological applications, ophthalmic sponge and bioceramics. A cell culture laboratory was set up for evaluating cytotoxicity of materials and for research on material-cell interaction. Systematic work on standardising the methodologies for in-vitro blood-material interaction has been initiated. The research activities resulted in several applications for new patents with commercial potential.

In the changed context of opened up economy and free access to international technologies, the medical device industry in our country is poised for expansion and the Institute can play a vital part by offering consultancy services. Areas in which the Institute could work with the Industry have been identified. The core areas in which the Institute is in a unique position to offer consultancy services in the development of medical devices are listed below.

I. Biomaterials and Devices

a) Assessment of technologies

b) Design and prototyping

c) Quality assurance and good manufacturing practice (GMP)

d) Packaging and sterilisation

II. Biological Evaluation

a) Biocompatibility of materials and devices

b) Material tissue interaction / Material - blood interaction

c) Animal implantation

d) Multicentric clinical trials

Technology Status

a) Technologies under Commercialisation.

The multicentric trial of Chitra heart valve was completed and clearance was given for commercial production of the valve to M/s. TTK Pharma Ltd. Pilot production of the valves by TTK Pharma continued in the "Technology Proving Facility" (TPF) at BMT Wing. The "TTK - Chitra valves would be available in the market during next year". Licence for commercial production of hydrocephalus shunt was given to M/s. Hindustan Latex Ltd. this year after the completion of a sponsored pilot production of shunts at TPF. Hindustan Latex has commenced production of shunts at their new facility at Aakulam, Thiruvananthapuram.

b) Products under development.

Refinements were done in the formulation of ophthalmic sponge based on the feedback obtained from Vision Research Foundation, Madras. Detailed clinical evaluation of the newly formulated biocompatible sponge for ophthalmic applications is being planned. Vascular graft prosthesis developed jointly with SITRA, Coimbatore reached the stage of animal trials and 15 implantations were done. Based on the results, clinical trials are expected to start in the last quarter of 1995. Prototypes of concentric needle electrode are being developed and clinical evaluation planned. Hydroxyapatite based powders and porous granules were made in small batches. Toxicological studies of these materials were performed and materials were found satisfactory for application as implants in hard tissues. Animal implantation experiments will be taken up shortly. The Institute entered into a memorandum of understanding (MOU) with the Rubber Board, Kottayam for joint development of urinary catheters. This is a low-value, high volume disposable product currently being imported. Development of indigenous technology will result in substantial foreign exchange saving and give a fillip to the local rubber industry. ■

Division of Academic Affairs

DR. K.G. BALAKRISHNAN, MD, DM, FAMS, FACC
Dean

SRI. A.V. GEORGE, MA, M.PHIL
Registrar

Award of PhD degrees

The thesis entitled "Design Optimisation of the Chitra Tilting Disc Heart Valve Prosthesis" submitted by Sri. G.S. Bhuvaneshwar and the thesis entitled "Immunodiagnosis of Tubercular Meningitis" submitted by Smt. Annamma Mathai were accepted by the Institute and both the candidates were declared qualified for the award of the Degree of Doctor of Philosophy of the Institute.

Registration for PhD

A sub committee was formed to go through the various matters connected with Ph.D programme. Dr.K.Shivakumar, Scientist, Division of Cellular and Molecular Cardiology was deputed to visit various leading academic institutions to compute data and the committee went through the data so collected and submitted its report to the Academic Committee. Action has been taken and the first batch of Ph.D scholars have already been registered as per the new guidelines suggested by the Academic Committee and approved by the Governing Body whose details are as follows.

Table 3

Name	*Topic*	*Guide*
Smt. Lakshmi. S	Studies on phase transfer catalysed surface modification of plasticised polvinyl chloride to prevent plasticiser migration	Dr. A. Jayakrishnan
Smt. Preetha Nair	Developmental differences in the functional response of cardiomyocytes to sub-optimal concentrations of magnesium	Dr. Renuka Nair
Smt. Sindhu V.C.	Studies on pericardial calcification prevention via surface modifications during delivery	Dr. Thomas Chandy

Admission to Post Doctoral Courses

The nation-wide response, admissions and course-wise demand are shown in the following tables.

Table 4 : Nation-wide response and admission

State/Union Territory	*No. applied*
Andhra Pradesh	39
Assam	2
Bihar	2
Gujarat	10
Jammu & Kashmir	2
Karnataka	36
Kerala	120
Madhya Pradesh	5
Maharashtra	12
New Delhi	13
Orissa	1
Pondicherry	3
Punjab	1
Rajasthan	6
Tamil Nadu	30
West Bengal	9
Uttar Pradesh	4
Haryana	2
Tripura	2

Table 5.

Course	Applicants	Admissions
DM. Cardiology	140	4
DM. Neurology	38	3
MCh. Cardio Vascular & Thoracic Surgery	28	6
MCh. Neurosurgery	31	3
PDCC Anaesthesiology	37	6
PDCC Radiology	20	2
PDCC Vascular Surgery	5	1

The demand for short term training/observership in various departments is shown in the table below.

Table 6.

1.	Anaesthesiology	21
2.	Blood Bank	23
3.	Cardiology	11
4.	Microbiology	20
5.	CVTS	3
6.	Neurosurgery	5
7.	Neurology	42

Table 7 : Diploma courses - Course-wise demand and admissions.

Course	No. of applicants	No. of admissions
Dip. in Advanced Medical Imaging.	33	2
Dip. in Cardiac Lab. Technology.	140	2
Dip. in Neuro Technology.	75	2
Dip.in Operation Theatre Technology.	85	3
Cert. Cource in Blood Banking Technology.	156	2

Review of syllabi

The Institute has been conducting DM/MCh programmes for the past 12 years. With a view to introduce an integrated training programme as envisaged in the Sree Chitra Tirunal Institute for Medical Sciences And Technology, Thiruvananthapuram, (Act 1980), the syllabi for these courses are being revised.

National Science Day

National Science Day was celebrated on 28th February 1995 in the Institute. This year, the students invited were from the Government College of Engineering, Trivandrum and from the Rajiv Gandhi Centre for Development of Education Science and Technology, Trivandrum. About 150 students in small batches were given an overview of modern electronic equipments used in Cardiac Neuro and Radiological diagnosis.

A Group Monitoring Workshop for the young scientist projects in the area of Life Sciences funded by the Department of Science & Technology was held at our Institute during 24-25th March 1995. 26 young scientists and 12 experts along with Department of Science and Technology officials participated in the Workshop. ■

Library

SMT. R.PRASANNAKUMARI, MA, MLISC
Librarian cum Documentation Officer Gr.I

SHRI. JAYACHANDRA DAS BSC, MLISC
Librarian cum Documentation Officer Gr.II

SMT. S.JAYAPRABHA BA, BLISC
Librarian cum Documentation Officer Gr.II

The year 1994-95 saw the merger of the two libraries of the Institute to function as one Institute Library. The Library Advisory Committee was reconstituted under the chairmanship of the Dean, Academic Affairs with 8 members to represent various departments of the Institute. Being a multi-disciplinary centre, the responsibility of collection, development on topics related to biomaterials, biomedical engineering and allied sciences continues to be that of biomedical technology wing keeping in view of the needs of the scientists at biomedical technology wing.

Collection

Over the years the library has grown steadily with regard to its collection, clientele and services. Now the library has a collection of 15595 books and 14279 bound journals. Patents, standards, video cassettes, microfilms and compact discs form part of the collection to support research activities. Acquisition of books and periodicals of the library since 1978 is given as figure 6.

The library acquired 699 books and subscribed to 294 journals during the year.

Information Services

The library facilities and services are extended to the doctors, students and scientists of neighbouring institutions as well. The information services of the library showed qualitative and quantitative improvement with the introduction of NIC-SCTIMST biomedical information services to doctors and scientists of Kerala and other States engaged in biological and medical research and education. The service aimed at providing information from databases like MEDLINE, TOXLINE, AIDSLINE, Science Citation Index, Clinical Trials was received with great enthusiasm by all concerned. The number of searches during the year is given as Table 1.

Table 8

No. of Searches	-	541
No. of references retrieved	-	21469

Keeping in view of the need of scientists at BMT wing to have access to latest and critical information on technology, the library introduced online services from Dialog through GPSS and NICNET on a trial basis. The GPSS link was discontinued and it was decided to access Dialog through NICNET when INTERNET link becomes fully operational.

During the year, the library entered the Global Information Highway with the Electronic Mail facility of Internet. The facility is available on trial basis through the Research and Education Network of National Informatics Centre (RENNIC). The computer facility of the library is being upgraded to have full Internet connectivity.

Library started providing Information services from excerpta Medica Neuros-ciences on compact disk.

Library Automation

A new 80486 DX machine, 66MHz, with 8 MB RAM, 540 MB HDD 256 KB

cashe,1.44 MB FDD, 2 Serial and 1 parallel port with SCO Open Server Enterprise was installed in the library to act as a UNIX host and to enhance the information capabilities of the library and to make it available to more users on the existing LAN and UNIX networks.

The LIBSYS library Automation package was installed in the library. The conversion of the databases of books and journals of Hospital Wing from ISIS to LIBSYS was undertaken and 3 days training was given to the members of the library staff. Computerisation of library acivities like acquisition of books, subscription of journals and membership registration were started during the year.

Conferences/ Seminars/other activities

Smt. Prasanna Kumari, Librarian attended the Second National Convention for Automation of Libraries in Education and Research held from 10-2-95 to 12-2-95 at Hyderabad organised by the INFLIBNET Programme of UGC and University of Hyderabad.

Smt. Jayaprabha and Smt. Sabitha were deputed to attend a 2-day training programme on INTERNET and E-MAIL organised by National Neuroscience Information Centre, NIMHANS at Indian Institute of Science, Bangalore.

Staff and students of PG Diploma in Archives and Documentation Management and BLISc Courses of Gandhigram Rural Institute visited the library as part of their field placement programme.

Thirty-nine participants of the Refresher Course for Working Librarians and Teachers of Library and Information Science organised by the Academic Staff College of Kerala University visited the library to study the applications of information technology. ■

Nursing Education

SMT. P. P. SARAMMA MSc. (NURSING)
Nursing Tutor

The seventh batch of Post Basic Certificate students in Cadiovascular and Thoracic Nursing and the third batch of Neuro nursing students successfully completed their programme in December 1994. Currently 10 students are undergoing training in CVT nursing and 4 students in Neuro nursing programmes. Though more and more graduate nurses are enrolling for the programmes, number of applicants is below expectation. It has been decided to have a common entrance examination from 1996 onwards to enable the applicants to have their choice of specialities thus eliminating the possibility of having vacant seats in Neuro nursing programmes. During this year, students from various institutes underwent training at the Institute, the details of which are shown below.

1. MSc. (N) students from Rajkumari Amrit Kaur College of Nursing, New Delhi - one month training.
2. BSc. (N) students from College of Nursing, Thiruvananthapuram, Kottayam and Kozhikode - two weeks training.
3. MSc. (N) students from College of Nursing, Thiruvananthapuram - six weeks training. ■

Public Relations

SMT. T. V. HEMALATHA B.SC, LLB.
Public Relations Officer

Public Relations section was responsible for the publication of the quarterly in house magazine, booklets for creating public awareness and information brochures about the Institute. In addition, the section co-ordinated the visits of scientists and other eminent persons to the Institute, arranged local hospitalities for guests to the Institute and helped to maintain good public relations with the general public as well as the media. A get together of the patients with Chitra Heart Valve implants was also organised by this section. ■

Medical Illustration

SRI. P.J. GEORGE
Chief Technician

This section prepared superior quality photographs for more than eighty scientific papers published during the year, and projection slides for presentation in national and international conferences. The computer generated slides were appreciated very much in seminars. ■

Achutha Menon Centre for Health Science Studies

Dr. V.Raman Kutty, MD, MPhil, MPH (Harvard)
Associate Professor

Dr. P.Sankara Sarma, PhD
Assistant Professor

The Centre carried out research projects in Health Sciences, besides providing consultation on study design, methodology and analysis for the Institute faculty. Analysis of student and other project data were also undertaken.

Joint Collaborative Research Activity:

1. "Research into Vitamin A Status in Pre-school Children and the Effect of Raw Palm Oil" - with Regional Research Laboratory, Thiruvananthapuram.
2. Health Care Implications of Demographic Transition - a three district survey with Professor P.G.K.Panicker, Centre for Development Studies, Thiruvananthapuram, funded by UNFPA.
3. Joint project with Division of Cellular and Molecular Cardiology, SCTIMST on "Vitamin D Status and Risk Factors for Coronary Artery Disease."

To facilitate retrieval and storage of important data in connection with the research work undertaken, a personal computer with a dot matrix printer was purchased during the current year.

Dr. Raman kutty attended the meeting of international facilitators for the workshop "Problem Solving for Better Health"- organised by The Health Foundation, New York at Key West Florida, USA in July 1994. Dr. Bacete O. Bwogo, Physician from Sudan and Fellow, Institute of Current World Affairs, was an observer in the department from June 1994 to February 1995. Smt. Sarah Abraham, M.Phil student from the Centre for Development Studies, Thiruvananthapuram worked on "Health Care Technology Diffusion in Kerala" with Dr. Ramankutty. An All India Workshop on "Morbidity and Health Research in India" was held at the Institute in collaboration with the Research Programme for Strategies and Financing for Human Development. ■

Departmental Reports

Department of Anesthesiology

Dr. K. Mohandas, MD
Professor and Head (till 14.9.1994)

Dr. R.C. Rathod, MD
Professor and Head (from 15.9.1994)

Dr. (Mrs) A. Rout, MD
Additional Professor

Dr. H.D. Waikar, MD
Additional Professor

Dr. Rupa Sreedhar, MD
Associate Professor Dip N.B.

Dr. G. Suresh, MD
Assistant Professor

Dr. Pius K. Manavalan, MD
Assistant Professor

Dr. Thomas A. Koshy, MD
Assistant Professor

Shri. Ganapathy Potti
Scientific Assistant

Candidates for Post Doctoral Certificate Course.

Dr. Ratan Gupta, MD

Dr. P.S. Sathyanarayana, MD

Dr. Mahesh R. Prabhu, MD

Dr. Sathyajith V.K., MD

Dr. M. Arshad Ali, MD

Dr. Gayathri P., MD

Anaesthesia support was given to the following procedures:-

Open Heart Surgery	795
Thoracic, Vascular and Closed Heart Surgery	678
Neurosurgery	693

Besides surgical procedure, investigational & interventional radiological and cardiac procedures were also given anaesthesia cover.

Three intensive care ventilators were added to the equipment during this year.

Post-graduate students in Anaesthesiology from the University of Colombo, Sri Lanka as well as students from the Anaesthesiology Department of the Medical College of Goa, Thiruvananthapuram, Kottayam, Nagpur, Belgaum and Mangalore underwent short term training programme in the Department during the year.

An international conference on recent advances in Anaesthesiology was jointly organised with the Department of Anaesthesilogy, Medical College, Thiruvananthapuram and Research Society of Anaesthesiology and Clinical Pharmacology at Thiruvananthapuram from 28th to 30th October 1994. A CME programme on Neuroanaesthesia was also jointly organised with the Department of Anaesthsiology, Medical College, Thiruvananthapuram at the Institute on 26.2.1995.

Dr. Susmita Bhattacharya and Dr. P.K. Neema resigned to take up assignments abroad.

Division of Biochemistry

DR. K.SUBRAMONIA IYER, PHD
Additional Professor and Head

DR. N. JAYAKUMARI, PHD
Associate Professor

SMT. SANTHA A. GEORGE, MSC.
Scientist

SHRI. B.SASI KUMAR, MSC.
Scientific Assistant

The Central clinical laboratory continued to provide investigative support to the hospital on a round the clock basis. The total number of procedures in Clinical Chemistry and Pathology crossed 2.55 lakhs registering an increase of 13% over the previous year.

Research Activities

Research activities of this Division are focussed on the involvement of free radicals during ischemia and reperfusion. Free radicals can modify the amino acid residues in proteins leading to changes in conformational integrity, disruption of membrane permeability and viscosity. Damage to proteins are often more important than damage to lipids in oxidative stress situations in vivo. In order to assess the relevance of protein oxidation during post-ischaemic reperfusion, in collaboration with the Department of Cardiology, the Division evaluated the changes in protein carbonyl groups in serum along with lipid peroxides in patients with CAD who underwent PTCA. A significant rise in protein carbonyl content as well as lipid peroxide was observed within one minute of reperfusion after balloon deflation when compared to the correspo-nding levels obtained before balloon inflation. This shows that both proteins and lipids are undergoing oxidative damage during the immediate reperfusion period which confirms the importance of free radical generation and the need for therapy with free radical scavengers. A clinical trial was initiated in patients by administration of anti-oxidant vitamins to assess their protective effect against oxidative damage. The effect of combined supplementation with vitamin E and C was tested in CAD patients over a three month period. As a result of this treatment a remarkable increase was observed in the activities of free radical scavenging enzymes, super oxide dismutase and glutathione peroxide. Moreover, no further change in oxidative damage was noticed as evidenced by the levels of lipid peroxides and conjugated dienes. This indicates that anti-oxidant supplementation provides beneficial effect by enhancing the body's antioxidant capacity and preventing further oxidative injury.

Atherothrombotic brain infarction (ABI) is the most common cause of stroke syndromes throughout the world. So, in collaboration with the Department of

Neurology, the Division initiated a study on patients admitted with stroke. Because of the importance of atherosclerosis as the primary disease process causing stroke, an analysis of the levels of lipids, various lipoproteins and lipid peroxides in the serum of stroke patients was undertaken. A significantly low level of HDL-cholestrol (<35mg/dl) and a normal level of total cholestrol (~200mg/dl) were observed in most of the male and female patients. In other words, stroke patients have a high ratio(>5) of total cholestrol to HDL-cholestrol. In addition to this, these patients were found to have a significantly high level of serum lipid peroxides too. Further studies are in progress to identify the specific subclasses of HDL as risk factors in ABI.

Dr. Subramonia Iyer rejoined the Division after spending his sabbatical leave at the Albert Einstein College of Medicine, Yeshiva University, New York. He successfully completed a project on the amidation of the carbonyl of Glu 43 (B) of HBS leading to an enhancement of its solubility by 40/50%.

A powerful multi-channel, random access autoanalyser (Monarch Plus) from Instrumentation Laboratory, USA, has been installed during the current year. The system operates at a maximum analytical rate of 600 tests per hour on routine chemistries and has a wide variety of applications such as stats, special chemistries, specific proteins, therapeutic dry monitoring and drugs of abuse testing.

Division of Blood Transfusion Services

Dr. Jaisy Mathai, MBBS, DCP
Chief Blood Transfusion Officer
Dr. P. V. Sulochana, MBBS
Blood Transfusion Officer
Dr. S. Sathyabhama, MBBS
Blood Transfusion Officer

Blood donations during the year remained more or less the same as in the previous year. Blood components prepared and transferred reached an all time high of 60% and 41% respectively. Blood components were issued to outside institutions with no facilities for component separation.

Research Activities

Research activities in the Division are:

1. Study of the prevalence of serological markers for HIV and HBV infections in blood donors.
2. Blood group distribution in Kerala and
3. Preparation and standardisation of cryoprecipitate by different methods for maximal yield of factor VIII.

Apart from the small volume plasma exchange for neurology patients and blood conservation for cardiac surgical cases, collaborative work was done with Thrombosis Research Unit (TRU) of BMT Wing on platelet storage parameters. Platelet concentrates were prepared for TRU for ß Thromboglobulin Antigen preparation. The Division also helped the Division of Pathophysiology in the preparation of stroma free haemoglobin. Dr. Jaisy Mathai is a co-investigator in the project titled "Elisa for Human Serum Anti-a Galactoside Antibody and its Epitopes in Tissues" undertaken by the Division of Neurochemistry.

A Blood March was organised for the first time in the city involving different voluntary blood donor forums of Thiruvananthapuram to propagate voluntary blood donor movement on October 1st, the National Blood Donation Day.

Dr.Brento Wylie, Director, Australian Red Cross Blood Transfusion Services, Dr. Zarine Bharucha, Chief Blood Bank Officer, Tata Memorial Hospital, Dr. Dipika Mohanty, Director. Institute of Immuno-haematology, Bombay, Dr. V. Ray, Director of NPFC, Bombay, Dr. J.G. Jolly, and Dr. R.N. Makroo, Consultants, Transfusion Medicine, were the important visitors to the division. A wide range of topics were discussed during their visits.

As part of the training programme, blood bank staff, medical officers, and fourteen technicians from the Directorate of Health Services underwent a training programme of one month duration in the division. They were deputed by the State AIDS Cell. Two medical officers from private hospitals (Holy Cross Hospital, Kochi and KNS Hospital, Kottarakara) and one doctor from IMA Blood Bank, Kochi were also in this division as observers during the current year.

The Division was the organising secretariate for the XIXth National Conference of Indian Society of Blood Transfusion and Immuno haematology held from September 30th to October 2nd 1994. Dr. Jaisy Mathai was made a member of the expert group constituted by the State Government for preparing a project report for a State Level Blood Transfusion Service. The first batch of CBBT students from this Division successfully completed their course during the current year.

As a nominee-expert in the Central Drugs Standard Control Organisation, Dr. Jaisy Mathai visited the different blood banks in the State in connection with their licensing.

A Forma Scientific Deep Freezer -86°c and an incubator for platelet agitator as well as a Tube Sealer (Terumo) were acquired during the current year. ■

Department of Cardiology

DR. K.G. BALAKRISHNAN, MD, DM, FAMS, FACC
Professor and Head

DR. J. M. THARAKAN, MD, DM
Additional Professor (on leave)

DR. T. TITUS, MD, MNAMS (MEDICINE), DM
Additional Professor

DR. V. RAMAKRISHNA PILLAI, MD, DM
Associate Professor

DR. V. AJITH KUMAR, MD, DM
Associate Professor

DR. ANIL BHAT, MD, DM
Associate Professor

DR. S. SIVASANKARAN, MD, DM, DIP N.B.(CARDIOLOGY)
Assistant Professor

DR. BIMAL FRANCIS, MD, DM
Assistant Professor

SHRI. K.N. VIJAYASENAN, B.SC
Scientific Assistant

Candidates for DM.
Dr. Gopi, MD
Dr. K.R. Shyamsundar, MD
Dr. Rajpal K. Abaichand, MD
Dr. Sunil Baran Roy, MD
Dr. K. Latchumanadas, MD
Dr. T. Sudhalakshmi, MD
Dr. P. Kadermuneer, MD
Dr. P. K. Joseph, MD
Dr. Buvanesh Babu, MD
Dr. Natarajan, MD
Dr. Manoj, MD
Dr. James, MD

The out-patient statistics for the Cardiology Department shows no change in the case of new registrations. But the review of old cases in special clinics showed a 30% increase (15,180 in 1994/95 against 11,640 in 1993/94). This increase was due to the fact

that sick patients awaiting special investigations and surgery came with worsening of clinical status due to the long waiting list both in surgical intervention as well as cardiac catheterisation procedures. The latter was due to the availability of only one catheterisation laboratory which resulted in a slight decline in the number of procedures (877 in 1994/95 against 961 in 1993/94). However, the emphasis shifted to interventional procedures from diagnostic procedures as the latter only added to the surgical wait list - see table 9.

Interventional procedures	1993/94	1994/95
PTCA	32	41
BMV	19	157
BPV	23	26
Pacemaker implants	66	77
Total	961	877

Non-invasive laboratories were put to maximum use to cater to the needs of out-patients as well as inpatients.

Research Activities

1. A short experimental study on "The Status of Vaginal Mucosa in Oophorectomised Rats on Administration of ACE Inhibitors" is in progress.
2. Dobutamine Stress Studies in Coronary Artery Disease is also in progress.

Joint Collaborative Research Activities

1. Free radicals in coronary artery diseases on administration of vitamin C and E.
2. Status of free radicals in reperfusion following PTCA in patients with CAD while on vita-min C and E treatment.

Dr. V. Ajith Kumar, Associate Professor, spent seven months at West Mead Hospital, University of Sydney, Australia to get trained in cardiac electrophysiology and therapeutic radio frequency abalation for tachy-arrhythmias.

Three post-graduates (DM Cardiology) from Mahatma Gandhi University, Kottayam, Kerala and two students from the Calicut University spent three months each in cardiac catheterisation laboratory as part of DM training programme. Major Girish, Medical Specialist, Military Hospital, Thiruvananth-apuram spent 8 weeks as an observer trainee in the non-invasive laboratory.

An important addition to the existing equipments is that of two Marquette ECG machines (Model MAC - 8). ■

Department of Cardiovascular and Thoracic Surgery

DR. M.P. MOHANSINGH F.R.C.S.(ENG), F.R.C.S.(EDIN)
Professor & Head

DR. K.S.NEELAKANDHAN, M.S., M.CH.
Additional Professor

DR. R. SANKAR KUMAR, M.S., M.CH.
Additional Professor

DR. K.G.SHYAM KRISHNAN, M.S., M.CH.
Additional Professor

DR. M.UNNIKRISHNAN, M.S. M.CH.
Additional Professor

DR. Y.A.NAZER, M.S., M.CH.
Additional Professor (On Leave)

DR. KRISHNA MANOHAR, M.S., M.CH.
Associate Professor

DR. S.K.NAIR, M.S., M.CH.
Associate Professor

SHRI. THOMAS MALIAEKAL
Scientific Assistant

Candidates for M.Ch. Course in CVTS:

Dr. Ms. Rekha Matta, MS
Dr. R. Sunder, MS
Dr. Susanth Mukopadhyay, MS
Dr. Apurva Vaidya, MS
Dr. M. Akbar Bhat, MS
Dr. Ravindra Singh Rathor, MS
Dr. Sandeep Attawar, MS
Dr. Sandeep Sreevastava, MS
Dr. Shipra Gupta, MS
Dr. Joseph Xavier, M.S

Candidate for Post Doctoral Certificate Course for Vascular Surgery

Dr. P. Balachandran

Total number of surgical procedures carried out was 1444. Unit policy this year was to increase the number of open heart cases at the expense of closed heart cases that could be done elsewhere in the State. Accordingly closed case admissions were curtailed and weekly two open heart surgeries were initiated in thoracic theatres. This enabled us to do 749 open cases in place of 722 last year ie. an increase of 27 cases.

Table 10 : Open Heart Surgery Done 94-95

TYPE OF CASES	NUMBER
ASD	204
VSD	63
TOF & OTHER CYANOTICS	160
MVR	89
AVR	33
DVR	26
CABG	181
Total	**756**

Notable trend was the increase in Coronary Bypass Surgery done here, constituting 24% of all the open-heart cases.

Vascular Aneurysm constituted 46 cases and Pulmonary Resections 60. There were 337 closed heart cases.

Dr. Sankar Kumar, received the FIE Foundation award for 1994 in recognition of his contribution to the development and clinical trial of the Chitra Heart Valve Prosthesis.

Dr. Unnikrishnan completed phase III animal implantation experiments on Chitra Vascular Grafts as per recommendations of Ethics Committee. Explantation data will be available in 6 months time and human clinical trial is expected to start by the end of 1995.

Nd:YAG and CO_2 lasers were employed in more thoracic cases for endoscopic ablation of bronchial lesions, and our experience was presented at the National Laser Symposium in February 1995 by Dr.K.S.Neelakandhan.

Dr.Krishna Manohar was selected as one of Starr-Ahmed Fellows for 95-96. Dr. Nazer went on leave to take up assignment abroad. M.Ch. candidates from JIPMER, Pondicherry and Medical College, Calicut spent one month as observers in the Department. One trainee perfusionist from Baken Institute, Baroda spent 6 months in the Department as part of her practical training. ■

Division of Cellular and Molecular Cardiology

DR. C.C. KARTHA, MD
Professor and Head
DR. R. RENUKA NAIR, PHD
Scientist
DR. K. SHIVAKUMAR, PHD
Scientist
DR. JOHN T. EAPEN, PHD
Scientist

Research Activity

Significant activities during the year were related to (i) histological and biochemical characterisation of endomyocardial fibrosis

induced in rats and rabbits (ii) standardisation of techniques to measure contractile function of isolated adult cardiomycytes to assess structure - function relationship in toxic injury and (iii) initiation of a case - control study in patients to assess the relationship of serum vitamin D levels and coronary artery disease.

In both rats and rabbits which were fed a magnesium restricted and cerium adulterated diet, endocardial thickening and fibrosis resembling human disease have been observed. Quantitative estimations and phenotyping of collagen in the fibrotic lesions were done. Observations in the experiments confirm the earlier suggestion that free radical triggered mechanisms may be the major pathway of systemic oxidative injury which induces cardiac lesions. There is also evidence in support of increased lipid peroxidation in cardiac tissues from magnesium deficient animals. Other early lesions observed in magnesium deficiency include partial inhibition of mitochondrial translation and enhancement of vascular smooth-muscle proliferation which could contribute to impairment of functional integrity of blood vessels.

Structural changes in myocytes under magnesium deficient conditions and related alterations in contractile function were studied using rat papillary muscle as well as cultured myocardial cells. Histochemical studies revealed that pattern of distribution of cystoskeletal actin is not altered when magnesium levels are sub-optimal in the culture medium. Enzyme histochemical staining suggested lysosomal damage with sub-optimal levels of magnesium. Lysosomal damage is possibly mediated by free radicals since an increase in the levels of reactive oxygen species is observed in magnesium deficient conditions.

During last year, in a population based study it was observed that serum vitamin D levels are significantly higher in adult men and women in Kerala. Several workers in the past have speculated that hypervitaminosis D is a risk factor for coronary artery disease. However, the hypothesis has not been tested in patients. A case control study was initiated in pursuit of evidences for the hypothesis with the collaboration of the Department of Cardiology in the Institute.

The Division continued to extend support to the investigations on the role of lanthanides on the causation of root (wilt) disease in coconut palms, which made considerable progress at Kerala Agricultural University, Mannoothy. In collaboration with the department of Cardiovascular and Thoracic Surgery, a study has been initiated to assess the pulmonary arterial changes in patients with pulmonary hypertension secondary to rheumatic mitral valve stenosis.

Dr. G.K. Patnaik, Deputy Director, Central Drugs Research Institute, Lucknow was invited by the Institute to initiate studies on cardiac function in experimental animals. Shri. E. Jeetendra, recipient of Summer Research Fellowship of the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore and Smt. C. Nirmala, Senior Research Fellow, Central Leather Research Institute, Madras underwent training in the Division.

Dr. C.C. Kartha was elected as a Fellow of Indian Academy of Sciences, Bangalore.

A rotary microtome and a histotap plus were purchased for histological studies during the current year. ■

Division of Microbiology

DR. J. SHANMUGHAM, MSc, PHD.
Additional Professor and Head

SMT. MOLLY ANTONY, MSc, DVM
Assistant Professor

SHRI. M. RAVINDRANATH, BSc
Scientific Assistant

SMT. K. NASEEMA, MSc
Scientific Assistant

The Division continued to offer routine diagnositc services in bacteriology, immunology and virology. The bacteriological data are analysed and submitted to the Hospital Management Committee to understand the prevalence of bacterial pathogens in various wards/ICU's and the pattern of the antibiotic susceptibility of bacterial isolates at our hospital.

Research Activities

The study of staphylococcus epidemidis in relation to biomaterials is being conducted as part of the PhD programme and has yielded many interesting and important findings which are already published. Besides, a short term research project is being undertaken on the "Investigation of GB Syndrome with reference to the role of Campylobacter Jejuni in the pathogenesis" in joint collaboration with the department of Neurology and the visiting faculty from Canada, Dr. H. Hariharan. The project is being funded from the Institute's grant for research projects and will explore the possible correlation between the Campylobacter Jejuni infections and the genesis of GB Syndrome. Dr. Bright Singh, an UGC Associate Fellow from the Cochin University of Science and Technology worked in the Division and was successful in growing fish cells in vitro. ■

Department of Neurology

DR. K. RADHAKRISHNAN, MD, DM, MNAMS
Professor and Head

DR. C. SARADA, MD, DM
Associate Professor

DR. MURALEEDHARAN NAIR, MD, DM
Associate Professor

DR. SANJEEV V. THOMAS, MD, DM, DIP. NB
Associate Professor

DR. ASHA VIJAYARAGHAVAN, MD, DM
Assistant Professor (on leave)

DR. P.A. SURESH, MD, DM
Assistant Professor

DR. ABRAHAM KURUVILLA, MD, DIP. NB, (DABN, DABN (CL–NPH))
Assistant Professor

DR. B. SANTOSH KUMAR, MD, DM
Assistant Professor

Candidates for DM

Dr. S.D. Nayak, MD
Dr. Abdu Rahman, MD, Dip. NB
Dr. Gigy V. Kuruttukulam MD
Dr. Aarti Chakraborty, MD
Dr. Thomas John, MD
Dr. Reghunath, MD
Dr. Mathuranath, MD
Dr. Joseph Cheriyan, MD

As a result of improved investigative facilities, especially in clinical neurophysiology and increasing referral of patients, volume of clinical service showed an increase when compared to the previous years.

Research Projects

A number of research projects were started and continued through this academic year. These included: (1) Local intraarterial thrombolytic therapy in acute ischemic stroke in carotid territory (in collaboration with the Department of Radiology), (2) SSPE Registry for Kerala State (in collaboration with the Achutha Menon Centre for Health Science Studies), (3) "Prognosis and outcome prediction in patients under ICU care", (4) "Outcome of myasthenia gravis in thymectomised patients", (5) "CNS vasculopathy of non-atherosclerotic aetiology - A clinico pathological study", (6) "Clinical and aetiological profile of stroke in the young", (7) "Neuro Psychological problems in Epilepsy" and Psychological problems of parents of epileptic children", (8) "A comparative study of the role of free radicals in transient ischaemic attacks, completed strokes and migraine", (9) "A linguistic study of communicated disorders - an inter disciplinary study" in collaboration with ISDL and funded by the Education Department, Government of Kerala, (10) "Correlative study of structural alterations of brain anatomy in aphasic patients - A CT and MRI Study" (done in collaboration with the Department of Radiology) and (11) "Cost-effectiveness of MRI Scan of Spine in hundred consecutive patients" (with the division of Radiology), (12) "The role of BAER in the prognostic evaluation of Kernicterus" with SAT Hospital, (13) "Clinical, radiological and electrophy-siological study of OPCA with slow eye movements", (14) "Piracetam in intractable epilepsy - A double blind control study".

The projects on "Thyroid dysfunction in epilepsy" in collaboration with the Regional Cancer Centre, funded by STEC and "Neurological Manifestations of Eclampsia" were completed.

The Department organised a National Workshop on "Management of Interactable Epilepsy" on the 7th and 8th of March 1995. Dr. Herbert Silfvenius MD, PhD, Chief of Epilepsy section, University Hospital, Umea, Sweden, who has done pioneering work on monitoring and surgical treatment of intractable epilepsies was the Chief Guest. The recently installed Video-EEG laboratory, together with a high quality MRI scan of the brain and neurophysiological assessment of the systems help to locate the epileptogenic focus in the brain especially in complex partial epilepsy of temporal lobe origin. Anterior temporal lobectomy for a patient with intractable temporal lobe epilepsy was done for the first time at the Institute on March 20, 1995. Dr. K. Radhakrishnan participated in the Annual Conference of American Neurological Association, San Francisco, California, USA in October 1994. He visited the Mayo Clinic, Rochester, MN, and recieved the prestigious Mayo Clinical Research Award of 1994. He also visited the Department of Neurology, Royal London Hospital, London, UK. Dr. Sanjeev Thomas received the Epilepsy Mini-fellowship from Wakeforest University, Winston, Salem, North Carolina, USA. He attended the Epilepsy section of National Institute of Health (NINDS) from April to June 1994. He also visited the Epilepsy and EEG sections of the Mayo Clinic, Rochester, USA and the Epilepsy section at

University Hospital, Umea, Sweden. Dr. Asha Vijayaraghavan proceeded to. Neurodegenerative Disorders Centre at University Hospital, Vancouver, Canada in May 1994 on a two-year training fellowship in Movement Disorders under the guidance of Prof. D.B. Calne.

A new EMG machine (Nicolet Viking 1V) was installed on March 1995. ■

Speech Pathology and Audiology Unit

SMT. S. MAYA, MSc.
Speech Therapist

The unit undertook routine activities on speech and language evaluation, speech therapy, audiological evaluation, hearing aid trials and conducted research on speech and language disorders.

Research Activities

The unit has completed a project titled "A Linguistic Analysis of Communicative Disorders - An Inter-disciplinary Study", with the Department of Neurology, SCTIMST and ISDL on 31.3.1995. The project report is under preparation.

Joint Collaborative Research Activities

The unit has active involvement in the project "A Correlative Study of Structural Alteration of Brain Anatomy in Aphasic Patients" - an ongoing project of the Department of Neurology and the Department of Radiology.

Mrs. Edel Matzohl, Speech Therapist, Government Hospital, Bolzano, Italy visited the unit.

Sri. Mayakumar from the International School of Dravidian Linguistics recieved a three months training in speech transcription at this unit. ■

Department of Neurosurgery

DR. DAMODAR ROUT, MS, MCH, FAMS
Professor and Head

DR. BASANT K. MISRA, MS, MCH, DIP NBE
Additional Professor

DR. SURESH NAIR, MCH
Additional Professor

DR. R. KRISHNA DAS, MCH
Assistant Professor

DR. M. BHASKARA RAO, DIP NBE
Assistant Professor

DR. P.P. BISHNU, MS, MCH
Assistant Professor

DR. UMA NAMBIAR, MS, MCH
Assistant Professor

Candidates for MCh

Dr. N.I. Kurien, MS
Dr. Sumit Deb, MS
Dr. Girish Menon, MBBS
Dr. Yashesh Dalal, MS
Dr. Puduru Sai Sudarshan, MS
Dr. Dibanath Chakraborthy, MS
Dr. Sonal Thakker, MBBS
Dr. Narendra K. Das, MS

The volume of operative work remained almost the same as in the previous year (See Table 11). With the establishment of comprehensive

management protocol for epilepsy, epilepsy surgery was successfully initiated during the year. In collaboration with the Department of Neurology, a "National Workshop on Management of Intractable Epilepsy" was conducted on March 7-8, 1995.

Table No. 11: Operative Procedures

Diagnosis	Number of cases
Aneurysms	134
109 (patients)	
Vascular malformations	39
Acoustic neurinomas	31
Meningiomas	66
Pituitary adenomas	47
Craniopharyngiomas	18
Third ventricular tumours	15
Lateral ventricular tumours	9
Gliomas-(supratentorial)	55
Cerebellar tumours	19
CV junction anomalies	41
Spinal tumours	47
Other spinal lesions	57
Surgery for epilepsy	2
Miscellaneous	164

In collaboration with the Department of Neurochemistry, a new project entitled "Identification and Characterisation of Glycoconjugates containing the generally tumour related epitopes, terminal galactosides and T-antigen in normal and neoplastic human brain tissue using Jacalin" was started. Prof.Rout has been appointed a member of the Adhoc Committee on Standardisation of Terminology and Surgical Results for the World Federation of Neurosurgical Societies. Dr. B.K.Misra was deputed by the Institute for advanced training in skull base surgery under Professor M.Samii in Hannover, Germany. He was a Visiting Professor to George Washington University, Washington DC, USA in May 1994. Dr.R.Krishna Das went on research scholarship to Barrow Neurological Institute, Arizona, USA for a period of 3 months.

Dr.John Garfield, FRCS, Senior Consultant Neurosurgeon from Wessex Neurological Centre, U.K., visited the Department and delivered lectures on "Safe Neurosurgery", "Failing Vision - Neurological Options" and "Spinal Dysraphism". Dr.Herbert Silfvenius PhD, Consultant Neurosurgeon, University Hospital, Umea, Sweden visited the department in the 2nd week of March 1995. Col.Prakash Singh from Indian Army visited the Department as observer for 3 months. Post-graduate students from NIMHANS, Bangalore, K.G.Medical College, Andhra Pradesh and VHS Medical Centre, Madras visited the Department for short periods as observers. ■

Division of Neurochemistry

DR. P .S. APPUKUTTAN PH.D.
Additional Professor
MRS. K. I. ANNAMMA B.SC.
Scientific Assistant

Routine Activity

Enzyme assays in urine and serum of patients with neurological diseases due to metabolic disorders were undertaken. The enzymes included aryl sulfatases A and B and hexosaminidases A and B.

Research Activity

The main research activity was development of an ELISA procedure for human serum anti- α - galactoside antibody (Anti-Gal) which has recently been shown by experiments from this and other laboratories to play a crucial role in infection control, tumour cell surveillance and autoimmune diseases. For ELISA, BSA-melibiose was synthesized and used as substrate coated on

microtitre plates for capturing serum anti-Gal, which was detected using enzyme conjugated anti-human IgG.

Using several biochemical techniques, it was demonstrated that contrary to earlier assumption, the mammalian brain galactose-binding lectin preferred α-anomeric configuration of galactose, especially among animal glycoproteins. Since human tumour cells and invading microbes, in contrast to human tissues, are rich in the α-anomer of galactose, this observation assumes significance.

A project on detection and characterization of the tumour-specific glycocon - jugates containing T-antigen and α galactose epitopes from brain tumours was recently initiated.

Joint Collaborative Research Activity

The work on developing an ELISA for anti-Gal is being undertaken in collaboration with Dr. Jaisy Mathai, Head, Blood Transfusion Services, SCTIMST. In the work on tumour specific glycoconjugates in brain tumours. Dr. B.K.Misra and Dr. D. Rout of Neurosurgery department collaborated.

A. The following theses were submitted by students of the division of Neurochemistry for Ph.D degree of the Institute.

1. Author : P.L. Jaison
   Title : Mammalian galactose-binding proteins. Studies on human and bovine brain grey matter glycoproteins recognised by endogenous galactose-binding lectin and by human serum anti-α-galactose antibody.

2. Author : V.M. Kannan
   Title : Studies on membrane bound and soluble glycocon-jugates recognised by bovine brain ß-galactose-binding lectin; ganglioside from grey matter and glycoproteins from brain-stem.

Division of Pathology

DR. V. V. RADHAKRISHNAN MD
Professor and Head

DR. S. SANDHYAMANI MD
Additional Professor.

DR. ANNAMMA MATHAI, M.SC, PH.D
Scientific Assistant

The routine investigations carried out during the year for the hospital services are shown below:-

Table 12.

Surgical Pathology	-	894
Frozen sections	-	278
Muscle biopsies	-	45
Immunology	-	1525
Cytology	-	625
Autopsies	-	27

Studies on autopsy and surgical biopsy materials continued to show association of mucoid vasculopathy with various forms of vascular disease encountered at the Institute.

Research Activity

Research on autopsy cases and on the bonnet monkey model for mucoid vasculopathy, as part of the DST project, showed association of the vasculopathy with distinct degenerative lesions in the

pancreas. The study provided for the first time, monkey models for two forms of malnutrition related diabetes mellitus namely, protein deficiency diabetes mellitus and tropical chronic calculo pancreatopathy, common in Kerala.

Joint Collaborative Research Activity

The division is collaborating(a) with the Departament of Paediatrics, SAT hospital, Trivandrum to study the prevalence of congenital myopathy in coastal Kerala. A research project on 'Experimental induction of intracranial aneurysm, have been formulated in collaborative with the department of Neurosurgery of this Institute.

Dr. Sandhyamani delivered an invited lecture on "Mucoid vasculopathy and chronic pancreatopathy in induced malnutrition" at the Department of Oncological Pathology, Nara Medical School, Nara Japan.

Prof. C. S. Pitchumoni, Chief of Gastro-enterology and Clinical Nutrition, New York, USA, and Prof. J. S. Bajaj, Member Planning Commission, New Delhi, visited the Department. Three post graduate students from the Department of Pathology, Medical College, Kottayam were trained in the Department on Frozen Sections and muscle biopsies.

The division conducted the 35th Kerala Chapter Conference of the Indian Association of Pathologists and Microbiologists on October 8, 1994. Over 100 delegates attended the Conference.
Dr. Radhakrishnan was awarded by the Association of Physicians of India for the best original research published in the Journal of Association of Physicians of India at API Congress, Madras in January 1995.

A Leica-Research microscope-DMRB model was purchased which can be used for teaching, photomicrography as well as immunofluorescent studies. ■

Department of Radiology

DR. K. RAVIMANDALAM, MD
Additional Professor and Head (on leave)

DR. A.K. GUPTA, MD
Additional Professor

DR. SANTHOSH JOSEPH, DMRD, MD
Additional Professor

DR. MADHAVAN UNNI, DMRD, MD
Associate Professor

DR. A. SRINIVASA RAO, MD
Associate Professor

Candidates for Post Doctoral Certificate Course.

Dr. K. Murali, MD

Dr. Prasanna G. Vibhute, MD

Routine procedures done in 1994/95 are shown in the table

Table 13

Plain X-rays	-	15,292
CT Scan	-	4,067
MRI Scan	-	2,190
Invasive procedures (Diagnostic)		
Cerebral angiograms	-	193
Aortograms and peripheral arteriograms	:	195
Myelograms	-	40
Miscellaneous	-	156
Interventional procedures		
Balloon angioplasty	-	67
Pre-operative balloon occlusion embolization	:	3
Thrombolysis	-	5
CCF	-	2

Research activities in the department consist of

1. MRI study of vascular lesions of the brain.
2. MRI study in aortoarteritis.
3. Medical application of Lasers under National Laser Programme funded by Department of Atomic Energy.
4. Development of a picture archival and communication system.

Design, fabrication and evaluation of an intravascular stent in collaboration with VSSC, Thiruvananthapuram.

Dr. A.K. Gupta visited the Peoples Republic of China under the DST exchange programme to study the application of lasers in medicine. Dr. A.K.Gupta was also offered a high level French Government Fellowship for six months to study Diagnostic and Interventional Neuroradiology in Professor Picard's laboratory at NANCY, France. He also attended the 20th Congress of European Society of Neuroradiology and 22nd Congress of Societe Francaise de Neuroradiology.

Radiologists from Medical College, Thiruvananthapuram, JIPMER, Pondicherry, Medical College, Baroda, and Miraj MRI Centre, Baroda underwent short term training in the Department.

A new digital subtraction angiography system is being added to the existing equipments and will become functional by August 1995. ■

Biomedical Technology Wing

Materials Testing Laboratory

DR. R. SIVAKUMAR, B.TECH, PHD
Head

DR. A.C. FERNANDEZ, PHD
Scientist

DR. K. SRINIVASAN, PHD
Scientist

SRI. B. AJITKUMAR, M.TECH
Scientist (on leave)

DR. T. RAMACHANDRAN, PHD
Scientist

SRI. NIRANJAN D. KHAMBETE, M.TECH
Scientist

DR. P.R. HARIKRISHNA VERMA, PHD
Scientist

DR. ANNIE JOHN, PHD
Scientist

This laboratory continued work on the development. characterisation and testing of biomaterials. Analytical facilities available in the lab like IR - spectroscopy, HPLC, DTA/DSC and instron mechanical testing facility were extended to most of the research and development groups of the Institute and also to external research organisations on a chargeable basis.

Progress was made in developing methods to incorporate silver components into several polymers for medical applications with a view to impart antimicrobial properties. These efforts also led to filing of 4 patents for the processes developed. Work continued on affinity polymers, chemical sensors and biodegradable polymers. A hydrophillic polyurethane polymer having interesting properties like pH dependent swelling and susceptibility to degradation by micro organisms was developed.

The Transmission Electron Microscope (TEM) helped in studies on tissue-material interface in hard and soft tissues. The

mineral pattern of bone was examined in defraction mode of the TEM. Information on cell-material interactions were sought from the ultrastructural morphological changes to cells exposed to bio-ceramics.

The Laser group undertook studies on understanding laser-tissue interaction with the view of development of hardware and optimising clinical procedures. Nd. YAG laser induced changes in the various physical properties of animal tissues were measured and the morphological changes were analysed by electron microscopy. Effect of the laser on enamel and dentin of human teeth were also investigated for developing applications in dentistry. The laser group was also involved in the development of clinical application in interventional radiology and thoracic and cardio-vascular surgery. The project on the development of electrodes for neurophysiological applications entered its final phase. The various steps in the assembly process of an electrode were standardised and a few prototype electrodes assembled. It will be subjected to evaluation and testing shortly.

Both hydroxyapatite and tricalcium phosphate powders have been developed and characterised using scanning electron microscopy and X-ray diffraction, in order to make the powder free flowing, both the freeze drying and spray drying routes are being pursued. Various toxicological tests are being performed.

A number of glass compositions were developed to form appropriate bonding with the polyacrylic acid to obtain required properties of glass-ionomer cement for dental applications.

Research work on the development of natural products as alternatives to synthetic compounds used in pharma-ceutical and food industry was initiated. A survey of important herbal plants used in traditional medicine was done with a view to develop a herbal garden.

Dr. T. Ramachandran visited several hospitals and institutes in Beijing and Shanghai, People's Republic of China under Indo-China science and technology co-operation exchange programme in the area of "Application of Lasers in Medicine" during April-May 1994.
Dr. Richard Hodgskinson from Queen Mary Westfield College, London University, visited the Institute on an Indo-UK Scientist Exchange programme. He shared his expertise in investigating the properties of bone using TEM and presented a talk on "Cancerous bone and its replacement".

Following were the trainees from other institutes to the Division:

Dr. Bindu K. Nair	- MDS student, Dental College, Trivandrum
Dr. Dana Cherian	- MDS student, Dental College, Trivandrum
Sri. K. Sanal Kumar	- M.Tech student, Cochin University
Sri. S. Basavaraj Patil	- M. Tech student, Mysore University
Sri. K.V. Ramesh Kumar	- M. Tech student, Mysore University

A tunable UV-visible absorbance detector was added in the laboratory.

A Diamond knife for Ultramicrotome was added in the laboratory. ■

Division of Thrombosis Research

DR. M. JAMALUDDIN, PHD
Scientist

DR. LISSY K. KRISHNAN, PHD
Scientist

Thrombotic reactions consequent to interaction of materials with blood, in vitro, were studied. For screening blood compatability of materials, studies such as adsorption of proteins and adhesion of platelets to the surface were standardised. Adsorbed plasma proteins were analysed after separating them on polyacrylamide slab gels. Adhered platelets were examined under scanning electron microscope to evaluate the density of adherence, extent of morphological changes and aggregate formation. Deleterious effects of blood-material interaction on the plasma coagulation cascade and platelet functions were also studied in detail. Plasma coagulation was studied by performing tests like activated partial thromboplastin time, prothrombin time and thrombin time, whereas platelet function studies were done by assaying the rate and extent of platelet aggregation and ATP secretion, induced by adding agonists to the material-treated platelets.

Research Activity

A project titled "Mechanisms and modulations of platelet activation and aggregation" funded by the Department of Science and Technology was completed last year. Hydrogen peroxide was shown to activate platelets directly, apparently by an action on vicinal dithiols in addition to acting via the cyclooxygenase pathway. Exposure of thiols in platelet membranes as a consequence of platelet activation by hydrogen peroxide was demonstrated. Co-operativity was found to be an important mechanism of modulating platelet aggregation reactions by many agonists. Methodologies to study activation of platelet aggression by Ca^{++} ions and inhibition by other metal ions were worked out. Experiments are in progress to develop an assay for in vivo activation of platelets under clinical conditions.

A collaborative research project with the Blood Bank, SCTIMST to evaluate function of platelets stored as concentrates in PVC bags for transfusion is underway.

A Lab-line Orbit Enviorn Shaker, with shaking speed from 500 rpm and temperature range from ambient to -60°C, has been added to the existing equipments during the current year.

Dr. M. Jamaluddin has been nominated to the Scientific Committee on Antarctic Research (SCAR) to advise on Biochemistry and Biology for a period of three years. ■

Division of Artificial Internal Organs

DR. G.S. BHUVANESHWAR M.S., PH.D.
Biomedical Engineer

SHRI. C.V. MURALEEDHARAN M.TECH
Engineer

SHRI. S. VIJAYAN M.SC
Scientific Assistant

The Division extended active support to the Department of Cardiac Surgery in the data analysis and reporting of the final results of the Multi-Centric Trial (MCT) of the Chitra Heart Valve prosthesis.

Following the final meeting, the Monitoring Committee of the MCT cleared the device for commercial sale and production. This was major step forward in establishing the quality and performance of the device. The valve production facilities were leased to M/s. TTK Pharma for precommercial production. The Division co-ordinated this activity and also trained their personnel in maintaining the quality standards. A major part of the technology transfer documentation of the valve was completed.

The Division continued to interact with the TPF on the pilot production of the Hydrocephalus shunts and the technology transfer to Hindustan Latex Ltd. The control software for the computerised quality assurance system for the classification of the shunts was installed, validated and regular testing commenced.

The Division supported the Vivarium in the animal experiments of the vascular graft programme which was revived in collaboration with the South India Textile Research Association, Coimbatore. It also coordinated the qualification of new batches of yarn and graft samples.

Dr. K.B.Chandran, Prof. of Biomedical Engineering, University of IOWA, USA visited the Division on 12th and 13th December 1994. He gave a lecture on the "Dynamics of Heart valve closure" at the BMT Wing. He has been testing our valves in his study of cavitation dynamics of artificial heart valves. He proposes to carry out further cavitation studies in animals and discussions were held on this topic.

Mr. N.Krishna Murthy, final year BE (Biomedical Engg) student from the Osmania University, Hyderabad worked in the Division as visiting summer fellow of the JNCASR. During his tenure, he reviewed the current status of hearing aids for the deaf. ■

Division of Biosurface Technology

DR. CHANDRA P. SHARMA, M.TECH, MS,SCD, MEBE
Scientist

DR. THOMAS CHANDY, MSC., PHD
Scientist

SRI. P.R. HARI, BSC., AIE
Scientific Assistant

Research Activity

Calcification has limited the durability of polymeric cardiac valves, blood pumps or total artificial hearts. Basically, two types of approaches have been tried to reduce the bioprosthesis associated calcification. Surface modification and target delivery of anti-calcifying agents have been extensively studied. The earlier reports from our group have shown that certain antibiotics, anti-platelet drugs, vitamins, anaesthetics etc. can modulate the surface/ protein/cellular attachment. Presently, we investigated the role of certain commonly used antibiotics, such as ampicillin, neomycin, gentamycin and streptomycin towards mineralisation of porus polyurethane in an in vitro model system. Polyurethane films incubated in metastable solutions of calcium phosphate in presence and absence of antibiotics. The changes in calcium phosphate modulation and the diffusion profile of these minerals were evaluated using scanning electron microscopy and spectrophotometric quantitation. It appears that the antibiotics have variably inhibited the diffusion and deposition of calcium on polyurethane. Gentamycin showed the maximum inhibitory effect. It seems, that the antibiotics may interfere with the

calcium modulation sites on polyurethane, possibly via their absorption on the surface and in the reduction of calcium deposition. The exact mechanism of this inhibition due to antibiotics is not well understood, however, it is observed that certain aminoglycoside antibiotics can interfere with vascular membrane calcium binding and mobility. Thus, it may be concluded that aminoglycosidic antibiotics can inhibit the calcium deposition to bioprosthetics, in addition to their normal antibacterial action. In vivo evaluation with additional studies are being planned.

Calcium alginate microcapsules are being investigated for oral delivery of insulin, a bioactive molecule and nitrofurantoin, a commonly used urinary tract antiseptic. As a preliminary study, bovine serum albumin (BSA), insulin and nitrofurantoin are encapsulated separately using the classical alginate microencapsulation procedure. Since the release starts during the preparation of capsule, the amount of loading is very much reduced. To minimise the release during the preparation, an in situ polycationic coating is provided using an optimum concentration of chitosan solution (in 0.01 HC1). The invitro release of these encapsulated materials are observed into simulated gastric and intestinal fluids (SGM pH-1.2 and SIM pH-7.4) without any enzyme. In case of BSA and insulin, it is observed that there is no significant release into SGM, while 70-80 % of the content is released into SIM within 6 hours. Nitrofurantoin, being a small molecule, significant amount of drug occurs into SGM from the microcapsules. But the drug release is found to be very slow compared to the intestinal medium.

Hydroxyapatite microspheres developed in our laboratory (200-400 microns) with 55% porosity was coated with a thin layer of PVA and phenylalanine was immobilised onto it. This immunoadsorbent can remove IgG immunoglobulins preferentially from plasma to a greater extent. This improved solid support, affinity adsorbent is suitable for extracorporeal perfusion of plasma for the treatment of certain diseases like myesthenia gravis, etc. It may be used for direct haemoperfusion as a cheaper alternative to plasma adsorption therapy, for selective removal of antibodies belonging to immunoglobulin G class.

Hydroxyapatite granules are used as fillers for packing the cavity by the surgery for the treatment of osteomyeletis and bone tumour, with adjunct intravenous antimicrobial therapy. We have investigated the possibility of incorporating ampicillin (as a model antibiotic) into HA microspheres for sustained release. Ampicillin was released for a period of 15 days by coating the drug loaded spheres with poly (lactic acid). This may help in avoiding intravenous antimicrobial therapy which may cause adverse systemic effects. PLA coated antibiotic loaded HA microspheres may be used as infection resistant implant material (fillers) for the alloplastic augmentation and repairing of bone defects.

We have successfully developed autoclavable polyvinyl alcohol microspheres with co-valently coupled phenylalanine using epichlorohydrin as coupling agent with a size range of 200 - 400 microns. Coupling of aminoacid was stable and showed comparable results to commercial Japanese material (PH 350, ASAHI Medical Co.) This immunoadsorbent which is nontoxic, can preferentially bind 19G proteins. This may be used for preferential

removal of antibodies which belong to or consists of immunoglobulins of G class. The objective of our programme was to develop direct hemoperfusion devices. Selective removal of pathogens directly from blood provide an efficient and cheap alternative to plasma adsorption therapy. For this, adsorbents should be highly blood compatible. Preliminary studies with our improved adsorbent (heparin co immobilised) showed a decrease in selectivity of adsorption. Further studies are required to improve and optimise the selectivity of the matrix in the adsorption of immunoproteins along with their blood compatibility for the matrix to be used as direct hemoperfusion adsorbents.

Department of biotechnology funded programme on "Bioprothesis associated calcification : Prevention via surface modifications and target drug delivery", was initiated in the Division with collaboration of the divisions of Pathophysiology, Vivarium and Materials Testing Laboratory. Studies relating the process of bovine pericardial calcification due to various cross linking techniques will be undertaken. The prevention of this process due to pericardial tissue surface modifications and the target drug delivery of anticalcifying drugs will be undertaken. This collaborative programme has been initiated.

A Sartorius Electronic Balance, cost of Rs. 80,000 and a table Top High Speed Refrigerated Centrifuge, (cost of Rs. 85,000) were added to the department facility, through DBT funding.

Joint collaborative researc activity:

Smt. Nirmala Balawali and Smt. Marina Abraham PhD students from Indian Institute of Science, Bangalore has undertaken studies related to surface energy, blood compatiblity and cell/bacterial adhesion■

Division of Toxicological Screening of Materials

SRI. K. RATHINAM, MSc
Scientist

SRI. P.V. MOHANAN, MSc
Scientist

Toxicological/ Biocompatibility studies to qualify the candidate materials for the fabrication of Chitra's intra and extra corporeal devices developed by the Institute, and the mandatory biological studies such as pyrogen, sterility, safety, and microtox tests on finished devices as per international standards like ASTM, BIS, ISO and USP, is the main function of the Division. The Division is engaged in the quality control monitoring (sterility) of T.P.F. water. In addition to these tests, viability testing of B.subtilis bacteria as a part of quality control programme of TPF has been carried out. The Bacterial Colony count using blood agar for evaluating the viable micro organisms in devices was also done routinely. A large number of materials were tested during the year. The Division also completed some specific tests like primary skin irritation test on 8 samples received from M/s. Hindustan Latex Ltd., Thiruvananthapuram, LD 50 findings of a pesticide from Regional Research Laboratory, Thiruvananthapuram and intracutaneous irritation test for the catheter received from the Rubber Board, Kottayam. The

Division standardised the newly introduced bioburden test. There was a two fold increase in samples received for toxicity evaluation on materials and devices during the year when compared to the previous year. (fig 1).

The Division continued to extend its scientific/ technical support and animals management for a DST research project "Cellular basis of myocardial injury by cerium in magnesium deficiency".

Research Activity

The newly established cytotoxicity studies (cytobiocompatibility) using in vitro mast cell systems, in vivo and in vitro cytogenetic studies like chromosomal aberration, micronucleus studies and teratogenicity evaluations were carried out as per international standard (ISO) protocol, on request. It has been decided to initiate the in vitro mutagenecity test using bacteria - ie. the Ames' test.

Joint Collaborative Research Activity

In collaboration with the Division of Polymer Technology, toxicological studies such as mucous irritation, subcutaneous implantations and mast cell studies were carried out for the DST dental material project. Toxicity tests like sensitisation, subcutaneous implantations and haemolysis tests were also done for the Institute's hydroxyapatite and epoxy materials. Eye irritation, sterility and bioburden tests were conducted for the PVA hydrogel ophthalmic sponge in collaboration with the Polymer Division. Bio-availability studies were also completed in collaboration with the Polymer Chemistry Division.

Sri. T. Muthu and Smt. Girija from Hindustan Latex Ltd., Thiruvananthapuram received short term training for one and two months respectively in material toxicology. Sri. Jeedhendra, a Jawaharlal Nehru Fellowship student from Madras Veterinary College spent two days in our Division and demonstrated all the tests for evaluating biomaterials and devices.

Sri.Rathinam spent three days at Kidwai Memorial Institute of Oncology, RASHMI Division, Bangalore in connection with establishment of bioburden testing facility at BMT Wing. Further he also shared the MSRI award for the best poster presentation entitled "Bacterial resistant latex material incorporated with silver" at the Annual meeting of MSRI held at Kharagpur.

An Autoclave (Vertical) has been added to the existing equipments during the current year. ■

Division of Pathophysiology

DR. MIRA MOHANTY, MD (PATHOLOGY)
Scientist

DR. T.V. KUMARI, PHD (BIOCHEMISTRY)
Scientist

Bio-compatibility of various materials was evaluated in subcutaneous and intramuscular tissues. Materials included ceramics (Hydrooxyapatite, Tricalcium Phosphate), polymers (Latex, Silicon rubber, UHMWPE, Silicon elastomers), fabrics (Polyester), chitosan and polysaccharide beads. Histological study of different organs in short term systemic toxicity tests for light cured BIS-GMA resin was carried out. All the specimens were received from the implantation and toxicity

experiments (number 257) done in the Division of Toxicology. Pulpal response to materials implanted in canine teeth was also studied. Macroscopic and microscopic analysis was carried out in polyester vascular grafts explanted from swine model. They included a study of potency, presence and distribution of thrombic and histology of the neointima. Haematological and biochemical investigations were related to short term systemic toxicity tests for light cured BIS-GMA resin and pre and post-operative analysis of blood in pigs implanted with vascular grafts.

Research Activity

Blood Substitute: In vivo experiments were carried out to evaluate the toxicity of modified and unmodified haemoglobin solutions as per the norms of the Centre for Biological Evaluation and Research (FDA) and data obtained is being analysed. The tests included haematological and bio-chemical investigations to assess liver and kidney functions and microscopic examination of kidneys, spleen, liver, heart and lungs.

Tissue culture study: Direct and indirect contact cytotoxicity testing system was standardised according to ASTM and ISO standards. Cellular morphology of L929 cells, following contact with ceramics is being studied both by inverted phase contrast light microscopy and transmission electron microscopy. Results show good correlation with in vivo responses.

Bone implant study: Metal and carbon fibre implants with different physical surface characteristics were analysed using SEM before implantation in the long bones and muscles of dogs for different time periods. SEM was also carried out on retrieved specimens as well as of surrounding tissues. Decalcified, stained and unstained PMMA embedded ground sections were analysed microscopically. Cellular attachment and histological responses differed, depending on the surface finish of the materials.

Light microscopic studies of middle cerebral arteries were initiated in a DST sponsored animal experiment to study drugs responses in cerebral vasospasm. Tissue changes to laser ablation of cadaveric intervertebral discs was also evaluated.

A Shaker Water Bath (REMI) was purchased in an ICMR sponsored project during the current year. ■

Polymer Division

DR. M. JAYABALAN, PH.D
Scientist & Head

DR. PRABHA D NAIR PH.D
Scientist

SMT. P. P. LIZYMOL, M.SC
Scientific Assistant

Research Activity

Research and development programmes towards technology development were continued as major activities of the Division. Activities related to the development of hollow fiber haemodialyzer were the main task of the programme. Potting of Cuprophan hollow-fibres in experimental plastic cylinders such as polycarbonate and polymethylmethacrylate were taken up using castor oil based two component potting compound. Adhesive character of this potting compound was

found to be good with these plastic cylinders without separation due to ageing. Potting of hollow fibres was further investigated by varying parameters such as concentration of hardner in the potting compound, curing temperature and time before potting and speed of centrifugal rotation. The stability of cured potting compound to sterilization techniques such as autoclaving and gamma radiation was also investigated. The potting compound containing higher percentage of monomeric hardner was found to undergo cleavage resulting in low molecular weight components which can be extracted with methanol. Potting compound containing biuret of capped isocyanate as hardner was developed using castor-oil. The curing temperature of this potting compound was found to be high. Moreover the cured potted components resulted as a very hard and opaque mass. The integrity of these cured material was checked by immersing in methanol for long duration. Potting compound based on poly caprolactamtriol (PCT) and polypropylene glycol(PPG) was also developed. Various parameters such as curing temperature, setting time, concentration of hardner, solvent content and molecular weight of polyol were investigated. PCT and PPG based potting compound was found to bind hollow-fibre and hollow plastic cylinder equally well and set in a relatively shorter duration without the use of solvent for transfer. The cured compound resulted in white transparent mass. Hydroxyl value and molecular weight of component 'A' of the potting compound based on castor oil and polycaprolactum triol were determined. While efforts on the development of potting compound and process standardisation of potting were taken up, efforts to fabricate the prototype dialyser was also taken up parallely by machining suitable end caps for the potted polycarbonate-hollow-fibre component and fixing the end caps after sectioning the potted fibre at the ends of the cylinder. Flow of alcohol in the prototype device was checked using peristaltic pump. Satisfactory results on flow behaviour were obtained. The first design of the hollow-fibre haemodialyser was made and dialyser housing component and caps were machined from solid acrylic rod. Development of the first model haemodialyser is under progress. In the continuation of the programme on the development of tissue adhesives, polyurethane based adhesive and acrylate based reactive adhesives were synthesised. Polyurethane based adhesives synthesised were i) Hydrophilic polyethylene glycol/di isocyanate pre-polymer and diisocyanate hardner and ii) Hydrophobic polypropylene glycol/ diisocyanate prepolymer and di-isocyanate hardener. The acrylate based adhesive was an oligomeric copolymer of capped isocyanatoethylmethacrylate/ acrylic acid. Acrylic monomers such as HEMA and Butylmethacrylate were also used for the synthesis of the tissue adhesives. Parameters which influence the bonding of beef muscle were investigated. Comonomer ratio, polymerisation temperature, solvent effect, capping compound, decapping temperature, setting time were found to influence the bonding. The shelf life of the oligomeric acrylate based adhesive was also investigated. Capped acrylate based adhesive was found to have a good shelf life at 40°C. The bonding strength was investigated by binding beef muscle and testing the adhesive strength under tensile load. Prior to binding the muscle, the muscle was swabbed with glutaralderyde solution (5%). The bond

strength was compared with that of tissue tack adhesive (M/s. Polysciences, USA). Among all the adhesives capped, isocyanate ethylmethacrylate/acrylic acid was found to give higher bonding strength in comparison with tissue tack and polyurethane based adhesive. Further biological evaluation is to be carried out for use as surgical gloves.

Dr. Prabha D. Nair is mainly involved in the development of ophthalmic sponge. It is being evaluated for clinical performance at Shankara Netralaya, Madras. Other elements of activities carried out in this programme include formulation and faster swellability of polymeric sponge product, cutting the sponge to a desired shape and fixing to handles etc. Work on wound dressing and hemostat extended polyurethanes were prepared from polyurethane and polysaccharide. Studies related to the development of IPN membranes for encapsulating islets of langerhans were also undertaken.

Patents obtained:
Dr. Jayabalan's "A method for preparation of biostable polyurethane" complete specification filed for Indian patent. ■

Division of Polymer Chemistry

DR. A. JAYAKRISHNAN, PH.D.
Scientist

DR. P. RAMESH, PH.D.
Scientist

MR. M.C. SUNNY, A.I.C.
Scientific Assistant

The two major externally funded projects supported by DST and DBT continued to be the major activities of the Division. In the DST sponsored project on casein microspheres as drug carriers, considerable progress has been made. It was demonstrated that cross-linked casein could be used as a drug carrier for oral and parenteral delivery of many drugs in a sustained release fashion. Work has now been initiated to determine the efficacy of 5-fluorouracil and mitokantrone-loaded casein microspheres in Erlich ascites carcinoma in mice in collaboration with the Tropical Botanical Garden and Research Institute in Palode, Trivandrum. A programme for examining the duration of progesterone delivery using casein microspheres as a matrix for this steroid in a rabbit model has also been initiated.

In the DBT sponsored Technology Mission Programme on vaccine delivery, work initiated using polycaprolactone as a microsphere matrix for the sustained delivery of vaccines went into animal trials at the National Institute of Immunology in New Delhi. While the polysaccharide chitosan is still being investigated as a potential matrix for such applications, polycaprolactone as a matrix for the sustained delivery of macromolecules was investigated in a rat model using a model antigen such as bovine serum albumin encapsulated in the matrix. It was seen that the antibody response generated by a single injection of the antigen-encapsulated microspheres is equivalent to three injections of the antigen given in incomplete Freund's adjuvant at two week intervals both in terms of time kinetics as well as in magnitude in terms of antibody response for a period of 16 weeks. Subsequent to this finding,

work has been initiated for encapsulating tetanus toxoid in polycaprolactone microspheres and testing for immunogenicity in rats.

While the preparation of polymeric azides from polyvinylchloride and coating plasticized PVC using the azidated polymer followed by photocrosslinking resulted in considerable reduction in the migration of the plasticizer from the PVC matrix, a new method was discovered to surface crosslink plasticized PVC using a phase transfer catalytic process. This process was found to be extremely efficient in preventing migration of the plasticizer into potential hydrocarbon extractants.

A potentially new drug delivery matrix was prepared in the laboratory using calcium crosslinking of the bovine milk protein casein. Calcium caseinate was found to have many important characteristics as a matrix for the sustained delivery of certain oral drugs. In vitro studies have shown that the matrix has excellent potential for delivering drugs that are sensitive to the gastric pH as well as drugs that are absorbed only in the confines of the small intestine. A patent application on this invention has been prepared and assigned to the Institute.

Continuing the research efforts of the Division in the field of therapeutic embolisation, it was demonstrated that polymerisation of 2-hydroxyethyl methacrylate using redox catalysts as a balloon filling liquid in detachable balloon technique involves high exotherms. A novel balloon filling liquid without exotherms was prepared by in situ crosslinking of poly(vinyl alcohol) solutions. This method appeared to be promising for the filling of latex balloons in balloon embolisation.

Ms. S.Lakshmi joined the Division as a UGC junior research fellow and started working on the problem of plasticizer migration in PVC using phase transfer catalytic techniques.

Dr. Jayakrishnan presented three papers in the 11th European Conference on Biomaterials in Pisa, Italy in September 1994.
An ultrasonic cell disruptor/homogeniser (Cole-Parmer Model 4710) was added to the equipment facilities of the Division. ■

Division of Polymer Technology

DR. V. KALLIYANA KRISHNAN, MSC., PHD
Scientist

SRI. ROY JOSEPH, MSC., M. TECH
Scientist

Routine activity included testing of mechanical properties (tensile strength and elongation) of silicone tubing for hydrocephalus shunts before implantation and after implantation for 3 and 6 months, mechanical properties of latex rubber used for gloves (Hindustan Latex) and mechanical properties of polyurethane IPN's.

Research Activity

a) Glass ionomer cement: The project made tremendous progress during the last one year. A polyacid/glass combination which gives optimum mechanical properties has been successfully developed. Nearly 9 polyacids and 42 glass formulations were developed and tried before an optimum formulation could be developed. The material is now ready for toxicity trials. Studies conducted on

glass ionomer project also include a) effect of tartaric acid on mechanical properties and setting characteristics b) effect of mixing ratio on mechanical properties c) effect of storage temperature on the compressive strength d) standardisation of the viscosity of the resin e) effect of annealing on strength and setting characteristics f) effect of polyacid concentration on setting and strength characteristics.

b) Dental composites: The toxicity studies of the light curing composite was completed. Formulations with shades were developed for chemical curing and light curing composites. The toxicity tests on the chemical curing composite with shades were also completed. Shelf life studies at 37°C for both chemical and light curing composites and their comparison with imported control materials proved that the properties of the composite were not affected adversely even after 6 months.

A study on the marginal leakage of both chemical and light cure dental composite restoratives was conducted in association with two dental surgeons who visited our Division for nearly three weeks from the University of Liverpool, UK. A new technique based on silver staining was used for qualitative estimation. Premolar teeth were selected for the study. Meso-occlusaal dental cavities were cut and filled with Chitra chemical cure, light cure and control materials. SEM studies showed after silver staining after 48 hours that the presence of a bonding agent was found to be highly comparable to that of the imported controls; c) Development of Urinary Catheters: A joint collaborative project between Rubber Board, Kottayam and SCTIMST was initiated for development of urinary catheters based on natural rubber latex.

Patents obtained

A patent on "Improved migration resistant plasticised poly (vinyl chloride) and process for the preparation of same" was granted. Another patent on "Development of bone wax" was also granted during the year.

Sri. Roy Joseph has underwent training at Interdisciplinary research centre in biomedical materials, Queen Mary and Westfield College, University of London, UK. He gained experience in compounding, moulding characterisation of hydroxyapatite-light density polyethelene composites intended for bone replacement applications. He worked under Professor William Bonfield for three months from August 15, 1994.

Dr. Geremy Williams and Mr. Mark Entwistle, both dental surgeons from the University of Liverpool, UK visited our Division for nearly three weeks. They were involved in the study of marginal leakage of dental composite restoratives. Smt. Prasanna M.K. from Department of Polymer Science & Rubber Technology, University of Cochin carried out her M. Tech project work on "Shelf life studies of a visible light cured composite paste" and Sri. J. Sreekumar from Department of Polymer Science & Rubber Technology, University of Cochin carried out his M. Tech Project work on `Studies on some aspects of glass-ionomer cement' under the guidance of Dr. V. Kalliyanakrishnan in the Division during last year.

A data acquisition system interfaced with universal testing machine and also an ink jet printer was added to the existing equipments. ■

Technology Proving Facility

SHRI. G.S. BHUVANESHWAR M.S., PH.D.
Biomedical Engineer & in-charge

SHRI. D.S. NAGESH M.TECH.
Engineer

The pilot production of 2600 Hydrocephalus shunts under the sponsorship of Hindustan Latex Ltd. was successfully completed on time and all the devices transferred to the company for sale. This included the 600 shunts produced during the additional period of the project executed at HLL's request.

The computerised test sytem, moulds, dies, fixtures etc., specifically developed for the production and quality control of the device were transferred to HLL. The technology transfer documentation has been completed. Fabrication of a new computer controlled system for meeting the Institute's needs was initiated.

The Division extended the necessary assistance to HLL during the various stages of construction of plant, installation of equipment and trial production. HLL started trial production of the shunts on 6th September 1994.

As part of the continued R&D in this area, fabrication of moulds and dies for a paediatric sized (10 mm burr hole) flushing valve for the shunt system was completed. Other products like T&Y connectors, anti-siphon devices etc. are under development.

The Division continued to extend support for the regular maintenance of all the clean room areas of the BMT Wing and also to TTK Pharma, who has leased one half of it. ■

Technical Coordination Cell

SRI. D. RANJIT, BE (ELEC)
Engineer

The Documentation Cell was redesignated as "The Technical Coordination Cell" on 12th July 1994 with the objective of coordinating the technical activities and allied documentation of the technology transfer activity of commercialised technologies and the preparation of technology transfer documents in consultation with the concerned research teams. These were particularly related to the following technologies.

1. Hydrocephalus Shunt
2. Heart Valve Prosthesis

The patent activities (INTELLECTUAL PROPERTY RIGHTS) of the Institute were handled by this cell in coordination with the initiating investigators from various divisions of the Institute. A number of fresh patent applications were processed, which have a definite commercial prospect in the field of health care in India. These were mainly related to bioceramics, anti-bacterial coating techniques and drug delivery systems. Four of the Institute's pending patent applications have been sealed and granted as patents. The subjects are related to:

1. Bone wax
2. Hydrogel PHEMA
3. Rigid shell oxygenator
4. Anti alpha gal from outdated plasma

The present status of the Institute's Intellectual property rights is as indicated below;

Patents sealed	-	12
Designs held	-	11
Patents filed & pending	-	20

The senior patent attorney of our Institute Sri. G.S. Davar of M/s. L.S. Davar & Co., Calcutta, visited us during June 1994 and presented a talk on the status of "Intellectual Property Rights" in the light of the present Indian socio-economic scenario. He reviewed the situation of patents at SCTIMST, met the inventors and recommended measures to streamline the patent applications. The cell also co-ordinated various multi-disciplinary activities of the Institute like organising Science Expositions and arranging technical lectures related to biomedical subjects by visiting scientists both from India and abroad. The Technical Co-ordination Cell was actively involved in the generation of scientific exhibit material and technical brochure related to the biomedical R & D activities of the Institute. An exhibition was organised depicting the achievements of SCTIMST at the International Conference of "The Research Society of Anaesthesiology - Clinical Pharmacology" (RSACP), during Novenber 1994 at Thiruvananthapuram.

Mr. D. Ranjit participated in the "Lab to Man" Science Exposition at Calcutta during January 1995 as a representative of the Institute and presented an exhibition of the Institute's achievements at the science exhibition organised by the Department of Science and Technology, New Delhi and The Indian Science Congress Association, Calcutta. ■

Division of Engineering Services

SRI. O.S. NEELAKANTAN NAIR, BSC. ENGG.
Engineer

SRI. V.RAMESH BABU, B.E. (MECH.)
Engineer

SRI. K. P. R. BHAS, DIPLOMA ELEC. ENGG.
Junior Engineer

This division fabricated sample component for dialyser housing and two sets of fixtures for the concentric needle electrode. Developed a needle tip grinding technology and required fixture. Fabricated one set of mould for the paediatric shunt system for pilot production, mould for the opthalmic sponge stick and also a Teflon mould for PMMA specimen preparations. This division also extended the service tc the Blood Bank Division of the Hospital Complex to identify a suitable environmental chamber for the Blood Platelet Agitator which was developed in BMT Wing. Routine maintenance activities of this division includes electrical supplying system, air-conditioning system, sanitary system and smooth operation of the panbit, incinerator, telephone exchange and faculty hostel installations.

Sri. O.S. Neelakantan Nair was selected for the FIE Foundation Award by the Fuel Instruments & Engineers Pvt. Ltd., Pune. ■

Vivarium

DR. ARTHUR VIJAYAN LAL, BVSC.
Veterinary Scientist

The Vivarium of the Institute set high standards of laboratory animal care. The Division also provided investigative support in evaluating the safety and bio-compatability of devices and materials, which are designed for human application. A well

maintained operation theatre with equipments were provided in the facility for carrying out various experimental procedures in the field of neurosurgery and cardiovascular surgery.

Research Activity

Animal perfusion studies on animal perfusion profile were carried out through modified breeds for the specific binding and removal of immunoproteins on dogs as a project on selective removal of immunoproteins (DBT Project). Large diameter prosthetic vascular grafts were evaluated in the thoracic aorta of pigs and medium and long term follow up were carried out sacrificing the animals and studying the histology of the graft as part of phase III trials of vascular grafts.

An animal model of production of subarachoid haemorrhage and vasospasm were validated and angiographic techniques were standardised. Dr. Misra (Neurosurgery) Project No. 1505). The vivarium also standardised the techniques for implants (bone) in rabbits models.

Dr. G.K. Patnaik. Director, CDRI, Lucknow visited the Vivarium in connection with open chest cardiac monitoring in rabbits. Anaesthesia and surgical protocols were stanardised during this period.
Sri. Udayakumar,
Sri. Crispin visited the Vivarium as animal handler trainee from Hindustan Latex Limited, Thiruvananthapuram. The Division shared the Fuel Instruments and Engineers Pvt. Ltd., FIE Award (International Division) for the indigenously developed heart valve prothesis. ■

Technology Transfer Cell

SHRI. S. BALARAM, B.TECH.
Scientist

Activities pertaining to commercialisation and transfer of technologies developed by the Institute to industry were carried out. In the case of technologies already commercialised, activities like transfer of know how documents, training of personnel and testing as per the agreement were coordinated.

Monitoring of the royalties collection was also done. Drafting MOUs (Memorandum of Understanding) and agreements which the Institute entered with other institutions were done.

The licences issued this year by the Institute were:

a. Hydrocephalus Shunt to M/s. Hindustan Latex Ltd., Trivandrum.

b. Bone Wax to M/s. TTK Pharma Ltd., Madras.

A fourth licence for blood bag technology was given by M/s. NRDC to M/s. J. Mitra & Co., New Delhi.

Efforts were made to identify a suitable enterprise for transferring the Technology of Dental Composites. ■

Research Activities

Externally Funded Research Projects

1. Title
   - "Health Sector Financing in Kerala"

   Principal investigator

   Dr.V. Raman Kutty (Achuta Menon Centre for Health Science Studies)

   Funded by

   UNICEF

   Status

   Project completed in March 1995

2. Title
   - "Analysis of Morbidity Data from Kerala"

   Principal Investigator

   Dr.V. Raman Kutty (Achuta Menon Centre for Health Science Studies)

   Funded by

   Research Programme on Strategies and Financing for Human Development

   Status

   Report to be submitted

3. Title
   - "Cellular basis of myocardial damage by cerium in magnesium deficiency"

   Principal Investigator

   Dr.K. Shivakumar (Division of Cellular & Molecular Cardiology)

   Funded by

   Department of Science & Technology, Government of India

   Status

   Ongoing

4. Title
   - "Structural and functional changes in the myocardium due to sub-optimal concentration of magnesium"

   Principal Investigator

   Dr. Renuka Nair (Division of Cellular & Molecular Cardiology)

   Funded by

   Roussel Scientific Institute, LIndia.

   Duration

   4 years

   Status

   Ongoing

5. Title
   - Effect of Urokinase and Papaverine on Chronic Vasospasm in an Animal Model of Subarachnoid haemorrhage.

Principal investigators

Dr. B. K. Misra (Dept. of Neurosurgery)

Co-investigator

Dr. Santhosh Joseph, Dr.Mira Mohanty, Dr.G.Arthur Vijayan Lal, Dr.Annie John Dr. D. Rout

Funded by

Dept. of Science and Technology, Govt. of India.

Duration

3 years

Status

Ongoing

6. Title

- ELISA for human serum anti-α-galactoside antibody and its epitopes in tissues.

Principal investigator

Dr. P. S. Appukuttan (Division of Neurochemistry)

Co-investigator

Dr. Jaisy Mathai

Funded by

Dept. of Science & Technology, Government of Kerala.

Duration

3 years

Status

Ongoing

7. Title

- Identification and characterization of glycoconjugates containing the generally tumour related epitopes terminal-α-gal and T-antigen in normal and neoplastic human brain tissue using jacalin.

Principal Investigator

Dr. P. S. Appukuttan (Division of Neurochemistry)

Co-investigators

Dr. B .K. Misra and Dr. D. Rout

Funded by

C.S.I.R., New Delhi

Status

Ongoing

8. Title

- "Picture Archival & Communication System"

Principal Investigator

Dr. Santhosh Joseph (Dept. of Radiology)

Funding agency

Dept. of Electronics, Govt. of India, under the scheme Electronics for Health Care.

Duration

3 years

Status

Ongoing

9. Title

- Medical Application of Lasers under National Laser Programme

Principal Investigator

Dr. A.K.Gupta (Department of Radiology)

Co-investigator

Dr. Srinivasa Rao

Funding Agency

Department of Atomic Energy

Duration

5 years

Status

Ongoing

10. Title

Lasers in Medicine. Integrated long term planning for lasers

Principal Investigator

Dr. A. K. Gupta (Dept. of Radiology)

Funding agency

Dept. of Science & Technology

Duration

3 years

Status

Ongoing

11. Title

- Studies on the controlled release of anti-fertility vaccines using biodegradable polymeric matrices.

Principal investigator

Dr. A. Jayakrishnan (Division of Polymer Chemistry)

Funded by

Department of Biotechnology

Duration

3 years (Extended to 4 years)

Status

Ongoing

12. Title

- Preparation and evaluation of casein microspheres as drug carriers.

Principal investigator

Dr. A. Jayakrishnan (Division of Polymer Chemistry)

Funded by

Department of Science & Technology

Duration

3 years (Extended to 4 years)

Status

Ongoing

13. Name of the project

- Development of Electrode for Neurophysiological applications.

Principal investigator

Dr. R. Sivakumar (Material Testing)

Principal co-investigator

Dr. G.S. Bhuvaneshwar

Funding agency

Dept. of Science & Technology

Duration

Two years

Status

Ongoing

14. Title

- Development of blood compatible functional polymers as selective adsorbents for protein bound antigens during hemoperfusion.

Principal investigator

Dr. Chandra P. Sharma (Division of Biosurface Technology)

Principal co-investigator

Dr. Thomas Chandy

Status and duration

Completed in December 1994 (3 years).

Funding agency

Department of Biotechnology, New Delhi.

15. Title

"Bioprosthesis associated calcification: Prevention via surface modifications and target drug delivery".

Principal investigator

Dr. Thomas Chandy (Division of Biosurface Technology)

Principal co-investigator

Dr. Chandra P. Sharma

Co-investigators

Dr. Mira Mohanty and
Dr. Annie John

Status and duration

Initiated (for three years, from November 1994)

Funding agency

Department of Biotechnology, New Delhi.

16. Title

- Mechanisms and modulations of platelet activation and aggregation

Principal Investigator

Dr. M. Jamaluddin (Division of Thrombosis Research)

Funded by

Dept. of Science & Technology Govt. of India.

Status

Completed.

17. Title

- Studies on Mucoid Vasculopathy in Kerala.

Principal Investigator

Dr. S. Sandhyamani (Division of Pathology)

Funding agency

Dept. of Science & Technology, Govt. of India.

Status

Ongoing

Scientific Publications

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chitosan microspheres as carriers for prolonged delivery of macromolecular drugs. J Biomater Sci., Polym. Edn., 6: 621-632; 1994.

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Engineering in Medicine and Biology Society, Centre for Biomedical Engineering, IIT, Delhi, 1995.

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