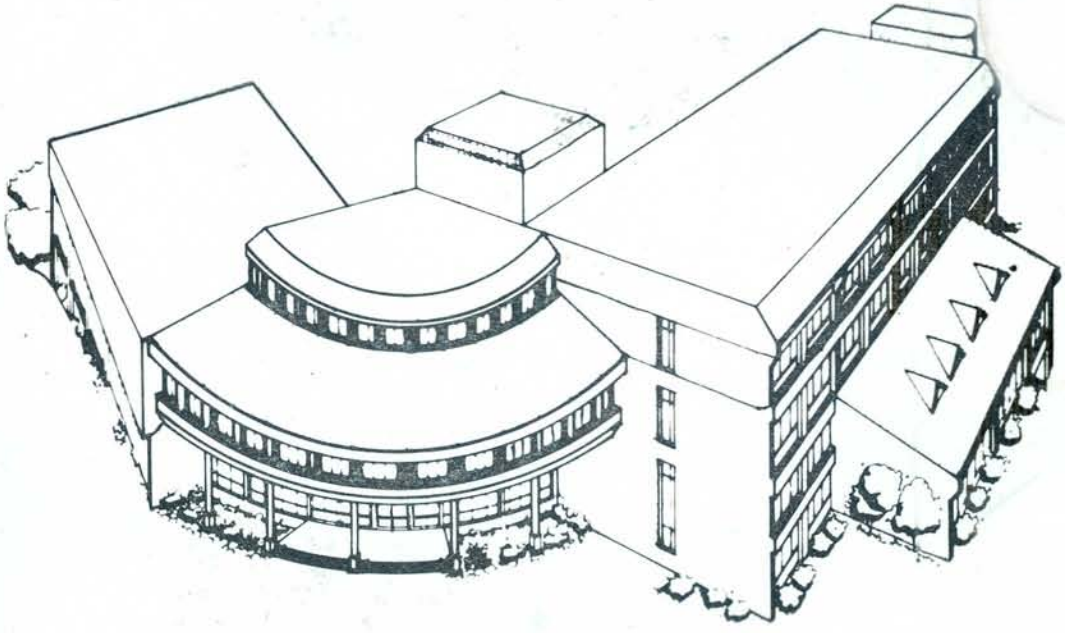
SREE CHITRA TIRUNAL
INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY
THIRUVANANTHAPURAM. INDIA



ANNUAL REPORT
1991–'92

Annual Report
1991-'92

Sree Chitra Tirunal Institute for
Medical Sciences and Technology, Thiruvananthapuram-695 011
Kerala, India

CONTENTS

COVER : View of the proposed Achutha Menon Centre for Health Science Studies.

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 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 postgraduate training programmes of the highest quality in advanced medical specialities and biomedical engineering and technology.

OVERVIEW

National Institutes function in quinquennia and the third quinquennium for the Institute began in January 1992 with the reconstitution of the Institute Body and the appointment of Shri Nani A. Palkhivala as the President. Since its transformation as an Institution of National Importance in 1981, the Institute has been fortunate in having highly distinguished Indians to head the Institute Body which provides the impulse and direction for its growth.

During the year, the Institute suffered a grievous loss in the passing away of His Highness the Maharaja Sree Chitra Tirunal and Sri C. Achutha Menon whose magnanimity and great vision were instrumental in its creation and rapid growth in the early years. No two personalities could be more different in their background or view of human destiny, yet they were strangely similar in their utter simplicity, absolute integrity and above all, their intense compassion for fellow human beings. The memory of these great men will forever inspire the endeavour of the Institute.

During the year under review, the Institute witnessed over-all progress. However, as in previous years, the hospital services continued to be under great pressure. While the volume of services reached optimum levels for a hospital with similar bed strength and facilities, the demand continued to exceed it several fold. The reduction in the percentage of free and subsidised patients and the raise in the hospital charges for other categories caused difficulties for patients who could ill afford to approach private hospitals. Even the paying patients were not free from anxiety as many sought postponement of admission for financial reasons. On the brighter side, the hospital services continued to show qualitative improvement with the introduction of newer laboratory tests and procedures for intervention and surgery. The large number of requests for training in different academic departments and hospital services bore testimony to the esteem with which the Institute was held at the national level. The civil works for the prospective installation of the Magnetic Resonance Image facility made rapid progress and promised to upgrade the diagnostic services further.

The technological programmes registered significant advances. The National Research Development Corporation which had transferred the blood bag

technology—the first to be developed by the Institute—to Peninsula Polymers Ltd, Thiruvananthapuram licensed a second unit to the Hindustan Latex, Thiruvananthapuram in view of the mounting demand for blood bags in the country. The Corporation also successfully negotiated the transfer of the blood bag technology to Egypt and signed an agreement with the TTK Pharma Ltd., Madras for the commercialisation of the Chitra valve which was undergoing multicentric trial. Apart from these arrangements, the Institute had transferred the technology of the hydrocephalus shunt to Hindustan Latex and that of the oxygenator and cardiotomy reservoir to the Southern Petrochemical Industries Corporation Ltd, Madras. The successful transfer of these technologies developed by the Institute in less than five years was surely a record in India and its positive impact was already felt in the enquiries received by the Institute from the industry for the sponsorship of R & D projects and new products. Given the right choice of technologies and sustained interdisciplinary effort, the Institute should be in a position, over a decade, to become a power-house of R&D to sustain a medical devices industry in the country. A committee consisting of Dr. S. Varadarajan and Dr. B. K. Bachhawat had, in fact, made several recommendations to give new directions and momentum for its technology programmes.

In pursuance of an earlier decision of the Governing Body, it had been decided to set up a new Centre for health science studies in the memory of Sri. C. Achutha Menon. The general neglect of important subjects such as epidemiology, health economics, biostatistics and health technology assessment has admittedly had a negative impact on the health sector in India and the concept of the Achutha Menon Centre was therefore considered timely by both health authorities as well as economists in India. Prof. K. N. Raj, National Professor and previously Chairman of the Executive Committee of the Sree Chitra Tirunal Medical Centre, agreed to write a project report for the new Centre which would be as much a pacesetter in the country as a fresh challenge for the Institute.

A major academic event during the year was an International Symposium which the Institute hosted on endomyocardial fibrosis. Clinicians and scientists who shared long experience and interest in the disease from Australia, Brazil, France, Germany, Ivory Coast, Nigeria and Uganda took part in the Symposium which became a landmark in the studies on this tropical heart disease. The proceedings of the symposium were expected to stimulate further research into the causative mechanisms, and hopefully prevention, of endomyocardial fibrosis.

SURVEY OF MAJOR PROGRAMMES

PATIENT CARE

Medical Superintendent: Dr. (Maj) K. A. Hameed, B.Sc., MBBS

Administrative Medical Officer: Dr. D. Hariprasad, MD

Compared to previous years, there was a drop in the number of specialised procedures and operations especially coronary angiography and open heart surgery during the year. Partly, this was due to the steep hike in prices for the imported items which many patients and their families were unable to afford. Overcrowding and long waiting time of new cases in the OPD were minimised by introducing a computerised appointment system. Attempts were made to extend the same system for the follow up cases as well. The hospital statistics for the year are given in Figs. 1-6

Adjacent to the old cardiac catheterisation laboratory, a new cardiac station for Echo Cardiography, Treadmill ECG etc. was installed to augment outpatient services.

The newly installed computer system, UNIX based Mini system, with its local area network, became operational and the network was gradually expanded to various locations such as Medical Records Section, Pharmacy and Cash counters. The purchase procedures for drugs, Accounts, Stores inventory and the monitoring of doctor-patient correspondence were streamlined through the computer. The Medical Superintendent was sponsored to attend a sixteen weeks' course on P. C. and Software packages with practical training in the IBM - PC conducted by LBS Centre for Science & Technology.

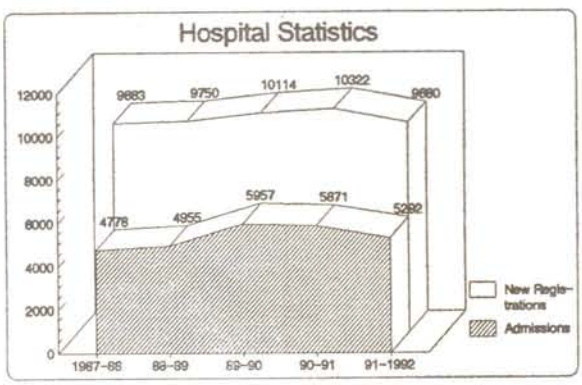


Fig. 1 Hospital Statistics

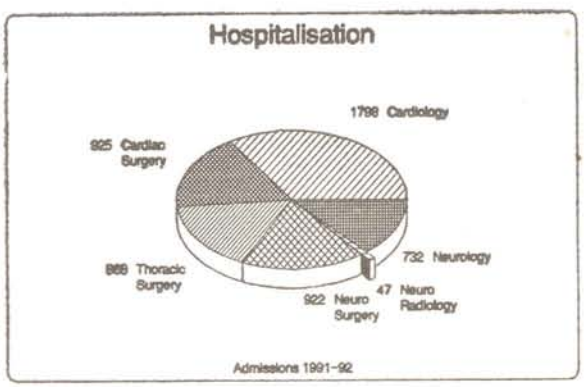


Fig. 2 Admissions

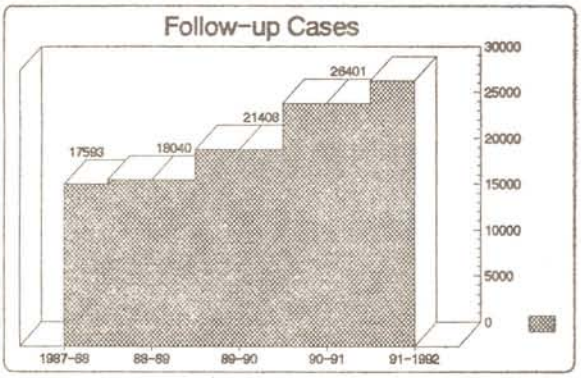


Fig. 3 Follow up Cases

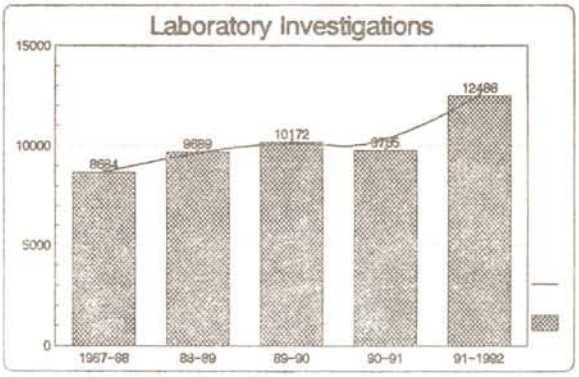


Fig. 4 Laboratory Investigations

Table 1 : Complex Investigations & Procedures

CM		Radiology		NM
TMT	2248	Aortography	240	EEG–888
Cath	1199	Barium Examination	16	EMG–277
Holter	172	Bronchography	36	
Pace Maker Implantation	54	Cerebral Angiography	324	
		Myelography	178	
		Peripheral Angiography	82	
		Venography	5	

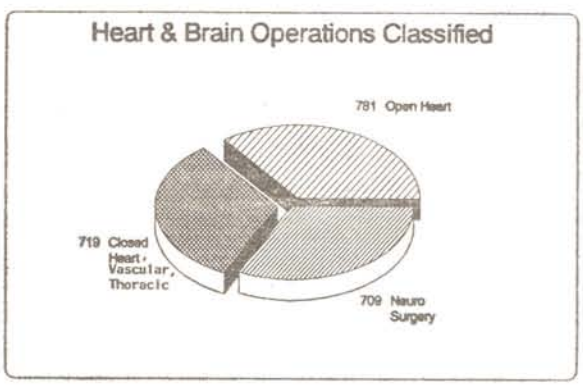


Fig. 5 Heart & Brain Operations Classified

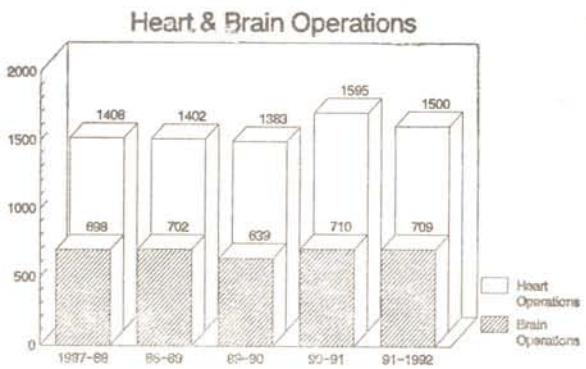


Fig. 6 Heart & Brain Operations

The supporting services such as Nursing, Medical Records, Medico Social Work, Speech and Physiotherapy, Medical Illustration, Dietary etc. contributed toward the maintenance of the high quality of patient care. Technicians, nurses and students of dietetics from various institutions within and outside Kerala were given training.

The Hospital Management Council met regularly to monitor and improve the working of the hospital services.

Hospital Economics Unit

Dr. V. Ramankutty, MD, M.Phil., MPH
Scientist

The field work and part of the analysis of the data on the project 'Study of the community prevalence of coronary artery disease' were completed during the year. Assistance in biostatistics and design was provided to several groups for their own studies.

Dr. Ramankutty served as the resource person for a workshop on 'Literacy to Health' in New Delhi and gave a lecture at the Menon Foundation Symposium, Thiruvananthapuram on 'From ultra sound to MRI Scan'.

Medico Social Work

Medico-social workers provided service to the patients and their relatives and played a cohesive role in the hospital administration. They were helpful in the effective implementation of the charging system and the fixing of appointment for new registrations and income assessment of patients. They were also responsible for co-ordinating the doctor-patient correspondence.

The medico social workers undertook a study of the functioning of the OPD-inpatient services and submitted their findings and suggestions. They provided health education through discussions and distributed health information pamphlets besides undertaking a psycho-social research programme among the epilepsy patients. One MSW student of Loyola College of Social Sciences, Trivandrum undertook a study on the "impact of hospitalisation on inpatients " under the guidance of the medico-social staff.

Mrs. Lilly Grace attended a one-day seminar organised by the Kerala Council of Social Workers on the 'role of industrial social workers'. Mrs. Usha Kandaswamy presented a paper on blood donor motivation in the National Conference of the Association of Voluntary Blood donors held at Calcutta. Mr. Jayachandran participated in the TNAI National Conference as a resource person in a panel discussion on "Women as providers of Health Care".

Medical Records

Sri. P. Krishnamoorthia Pillai, MA.
Senior Medical Records Officer

The Medical Records Section offered its services to all Sections and Depart-

ments by supplying the required data of patients. Out of 1,25,000 charts in stock, retrieval was made as shown below:–

Table 2

1. Follow up clinics	28,800
2. Correspondence of patients with physicians and appointment	13,254
3. Analytical and retrospective studies	4,302
4. Updating the list of patients awaiting surgery and sophisticated investigations	2,207

New registrations and admissions were 9680 and 5292 respectively during the year. Due to the restriction on the number of free procedures the number of admissions was lower than in the previous year.

The MRD personnel visited the wards and ICUs and rectified the deficiencies in the medical records there itself in consultation with the concerned doctors and sisters. This enabled the direct transfer of the medical records to the filing areas without being detained in the main MRD. Fifty percent of the death charts were deactivated and filed in a new room.

Patients from other States were classified separately and called for surgery at the rate of 1 per week. The waiting lists for open heart surgery and cardiac catheterisation were computerised. The list supplied by the computer was used for calling patients for surgery and tests upto December 1992.

The section provided the monthly statistical reports generated by the computer to the hospital council for its monthly meetings.

With the microfilm reader-cum-printer received during the year, pruning of the medical records was expected to be taken up shortly.

Mr. P. J. Varghese, Assistant MRO and Mr. G. Mohan Kumar, MRA (SG), were deputed to attend the Management Seminar on medical records.

Table 3

New Registrations	9680
Follow up	28880
Admissions	5292
Discharges	5301
Deaths	299
Cardiac catheterisation	1199
CT Scan	5595
Open heart surgery	781
Closed heart surgery	719
Neurosurgery	709

Medical Illustration

Medical illustration section provided audio-visual support for the publication of scientific papers and material for presentation in seminars, both national and international. Messrs. George and Joy Abraham prepared photographs and

artwork of high quality for over 75 scientific papers published in different journals in India and abroad during the year. They illustrated a series of medical educational pamphlets for the public.

The Medical illustration group also extended their interest to the field of animated film making. Animation, by its plasticity, can be utilised in educational and research fields effectively even though special attention, craft and skill are required to prepare easy and relevant communications. In the field of mass communication the role of animated films is higher than in any other medium. The areas of current interest in animation films were: functioning of the human heart (normal and abnormal), surgical procedures, functioning of prosthetic heart valves, cardiac catheterisation and balloon angioplasty.

Nursing services

Mrs. Chandini Tyagi, B.Sc. (Nursing)
Nursing Superintendent

The nursing staff worked as a good team and contributed their best services even under challenging conditions caused by the continual emigration of nurses. While the authorised strength of staff nurses increased from 186 to 196, 10 staff nurses resigned and 12 new nurses joined service. Most of the staff nurses who resigned left for West Asian countries.

In-service education was conducted by nursing supervisors, ward sisters and staff nurses on various topics every fortnight. Post-basic Certificate (CVTS) course was conducted by the Nursing Instructor. In addition to this post-basic certificate course in Cardiovascular nursing, a Neuro nursing Course of 10 months duration was also started from January 1992 with an intake of 5 students.

M. Sc. nursing students from RAK College of Nursing, New Delhi and Christian Medical College, Vellore, Tamil Nadu came to the Institute for field visit for short periods. Undergraduate students (B.Sc. Nursing) from the College of Nursing, Kottayam, Calicut, Thiruvananthapuram, Father Muller's College of Nursing, Mangalore, Karnataka, All India Institute of Medical Sciences, New Delhi and Christian Fellowship Community Health Centre, Ambilikai, Tamil Nadu, visited the hospital for observation and training purposes. Students from School of Nursing, Catherine Booth Hospital, Nagercoil, Tamil Nadu and Upasna Hospital, Quilon also visited the Institute. Sr. Albeena F. C. C. from Samaritan Hospital, Iduki, Staff Nurse Sosamma Baby from Banaras Hindu University, Varanasi and staff nurse Sreekala from Sree Uthradom Tirunal Hospital Thiruvananthapuram obtained practical experience for 3 months in the Intensive Care Units and Operation theatres.

Smt. A. K. Bhargavi, Nursing Superintendent from Tata Memorial Hospital, Bombay visited the hospital.

Smt. P. P. Saramma, Instructor in Nursing attended the Biennial conference of the Trained Nurses Association of India at Ernakulam in November 1991.

Ward sister Smt. Rosamma Sebastian and OPD supervisor Smt. Anandavally Amma attended a refresher course on "Management Skill Development" for Ward Sisters and Head Nurses conducted by the TNAI at Caritas School of Nursing, Kottayam from 26.5.1991 to 1–6–1991. O. T. Supervisor Smt. Aleyamma Cherian and two O.T. staff nurses, Smt. Vimala-Kumari and Philo, participated in a seminar on Johnson & Johnson Products - Ethicon from 17–9–1991 to 20–9–1992 at their manufacturing plant at Bombay.

Staff Nurses Smt. Maria Jose who was awarded a P.N. Berry Scholarship joined the Queen Elizabeth Hospital for Children, London for training.

Rehabilitation Unit

Thanks to the support of the Travancore Charitable Medical Trust of the Royal Family of Travancore, the unit could expand and improve its activities which included physiotherapy, speech therapy and audiometry. Physiotherapy services continued at the same level, but plans were made for adding cardiac rehabilitation following the visit of Prof. S. K. Verma of the All India Institute of Medical Sciences.

The growth in the newly established areas of speech therapy and audiometry was considerable. Patients with specific speech and language disorders due to neurological disorders, hearing loss and cleft palate attended the clinic in increasing numbers (Figs. 7, 8, 9).

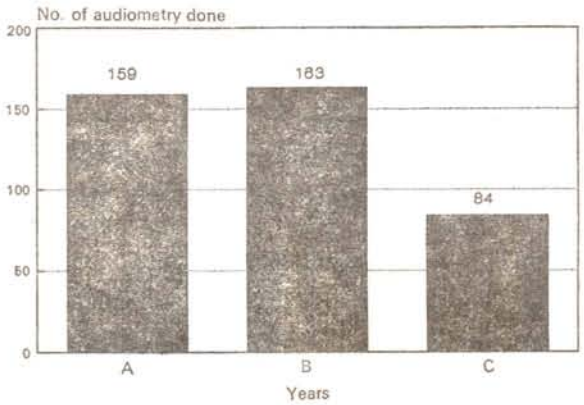


Fig. 7

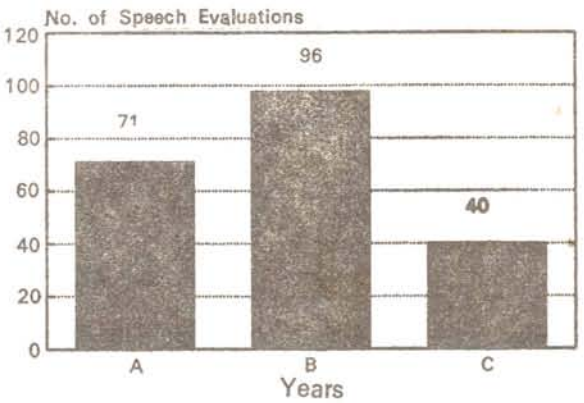


Fig. 8

Group A - 15/6/90 to 31/12/91
Group B - 1/1/91 to 30/6/91
Group C - 1/7/91 to 31/12/91

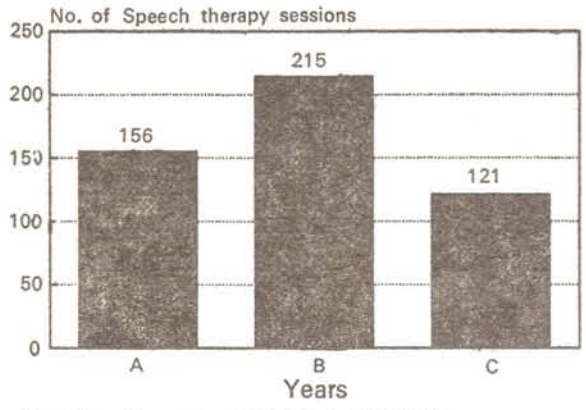


Fig. 9 Group A - 15/6/90 to 31/12/90
Group B - 1/1/91 to 30/6/91
Group C - 1/7/91 to 31/12/91

These services were made available not only to the patients of the Institute but also to others referred from elsewhere.

Clinical Engineering

Mr. R. Mohandas, ME
Biomedical Engineer
Mr. K. Vijayakumar, B. Sc., B. Sc. (Eng.)
Asst. Biomedical Engineer
Mr. Korathu P. Varughese, B.Sc., (Eng.) PGDEDT
Asst. Biomedical Engineer
Mr. G. Mohanlal, B. Sc. (Eng.)
Asst. Engineer

Apart from routine activities relating to the maintenance of equipment, the staff were fully involved in the planning and civil works for the installation of the MRI system. Mr. Mohandas with Dr. VRK Rao collaborated with Electronics Research and Development Centre and CDAC (Centre for Advanced Computer Technics) in the project on Image Archiving.

Under the sponsorship of the Department of Vocational Higher Secondary Education, Mr. Mohandas took up the preparation of a Manual for the operation and maintenance of biomedical equipments. IEEE, Kerala elected Mr. Mohandas as Vice-chairman and Mr. Koruthu Varghese as General Secretary.

The Division co-sponsored an international seminar on "Systems, Services and Support for the physically handicapped."

Computer Division

Mrs. G. Geetha, M. Tech (Comp. Sc.)
Systems Manager

The Computer Division made remarkable progress and the expansion of system environments was initiated as follows:

* Installation and commissioning of 80486 EISA with 8 terminals and their allocation to user locations apart from commissioning of CD ROM Net in Library.

* Software addition of CD ROM Medicine (1966–1992) for the library and statistical package SPSS as well as Applause Graphics package for the Hospital Economics Unit.

* Processing of 2 Nos. of additional PCs one at each cash counter, purchase of an UPS and integration of the Telex to the PC 486 for better utilisation.

System support was also provided to the Medical Records for the computerisation of old patient's addresses and the entry of new registrations. Patient-hospital correspondence was duly indexed to avoid hardships. X-ray library information was updated and surgery scheduling was greatly improved by the allocation of dates and their computerised communication to the patients. Similarly development of payroll package, capability to maintain financial accounting, provident fund statement and income tax calculation with Form 16 print out-were provided to the account section. For the general store and pharmacy, inventory management package included the preparation of purchase orders and maintenance of unit-wise cost factors inclusive of tax and incidentals. The pharmacy was also provided with means to scrutinize and compare supply against indented quantity.

System familiarization was provided to the end-users and the development of capability encouraged within the group to manage respective data processing independently.

BIOMEDICAL ENGINEERING AND TECHNOLOGY: BIOMEDICAL TECHNOLOGY CENTRE

Dr. R. Sivakumar, B.Tech., Ph.D (Mat.Sci.)
Head

The overall progress of the Biomedical Technology Centre was excellent during the year. The completion of the pilot production of the blood oxygenator and cardiotomy reservors, and progress in the pilot production of hydrocephalus shunt, chitra heart valve and smaller devices such as mediastinal drainage system, custom pack, blood filter and humidifier showed the healthy status of technology development and transfer. The technologies in the pipeline included those of BIS-GMA dental composite, bone wax and vascular graft.

New activities included the development of biomedical sensors and needle and surface electrodes for neurological applications. A project was also under way to develop base metal-Ni alloys and titanium implants for dental applications in collaboration with the Defence Research and Development Organisation.

The Varadarajan Committee which studied the performance of the Biomedical Technology Centre and its interaction with the Hospital Wing had made far-reaching recommendations on the choice of new areas for research and development, linkages between basic science and technology and between medicine and technology, technology transfer and several other facets of the Institute's activities. The report provided a blue print for technology development during the next two decades which would witness dramatic changes in the techno-economic scenario in the country.

Dr. Sivakumar, formerly Deputy Director, Defence Metallurgical Research Laboratory, Hyderabad took over as the Head following the departure of Mr. Ramani who joined the industry.

Library

Mrs. Jayasree Thankom, MA, MLI Sc.
Librarian-cum-documentation Officer

The routine activities consisted of document acquisition, technical processing, documentation including bibliography compilation and reprography. Cataloguing was completed and bibliography services computerised. The programme for computerised SDI service was taken up during the year.

The students attending the refresher course organised by the Kerala Library Association and NISSAT visited the Library to watch a demonstration of the computerisation activities. A student of the Department of Library Science, Kerala University, Mr. Venu, carried out a project on a bibliography compilation on 'Artificial heart'.

Mrs. Jayasree Thankom attended a conference sponsored by National Informatics Centre, New Delhi which considered the recognition of the Institute as one of its nodal points to have access to Medlars data base. Mr. N. Suresh, Library Assistant, attended a Library computerisation course in the Kerala University Library.

The collection in the Library exceeded 6000 books, 3000 back volumes and over 1500 national and international standards on devices. The Library subscribed for 130 current periodicals in the area of science and biomedical engineering.

POSTGRADUATE TRAINING PROGRAMMES

Prof. G. N. Ambikatmajan Nayar,
MD (Biochem), MD (Biophy.)
Registrar

Ph.D Programme

The list of candidates who were awarded the degree of Ph. D. of this Institute, showing the titles of their theses and names of Guides is given in Table 4.

Table 4

Name	*Title*	*Guide*
Mr. K. Sreenivasan Scientific Officer Dvn. of Techn. Evaluation.	Studies on the diffusion of physiological fluid molecules in polyurethanes	Dr. K. V. C. Rao ABR Organics Ltd. Hyderabad
Mr. Bobby Zacharia Division of Neurochemistry	Physicochemical studies on cell surface glyco-conjugates of neuron from developing human brains	Prof. D. K. Basu Division of Neurochemistry SCTIMST
Ms. Yasmin Marikar Division of Neurochemistry	Biochemical studies on cell surface glycoproteins of glial cells in developing human brain	Prof. D. K. Basu Division of Neurochemistry SCTIMST
Mrs. Prabha D. Nair Scientific Offr. Division of Technical Evaluation	Polyurethane interpenetrating polymer networks for biomedical applications.	Dr. V. N. Krishnamoorthy, VSSC Thiruvananthapuram
Mr. S. N. Pal Chemical Engineer Division of Polymer Technology BMT Wing	Studies on polymer blends for medical applications	Dr. N. Subramonian Professor, Dept. of Chemical Engg., IIT, Madras

Sri. N. Shanmuga Kumar submitted his thesis titled "Studies on the stability of polyurethane materials and their interaction with tissues". The thesis which was guided by Dr. Jayabalan is under evaluation.

Dr. S. Bhaskara Rao, Veterinary Scientist, registered for Ph. D. under Dr. Chandra P. Sharma of BMT Wing. The title of the thesis is "Studies on the haemostatic potential of chitosan".

Admissions to post-doctoral courses

The Nation-wide response, State-wise admissions and Course-wise demand are shown in Tables 5, 6 & 7 respectively.

Table 5. Nation-wide response

State/Union Territories	*Number applied*
Andhra Pradesh ..	35
Bihar ..	2
New Delhi ..	6
Goa ..	1
Gujarat ..	7
Kerala ..	55
Karnataka ..	30
Maharashtra ..	28
Madhya Pradesh ..	16
Orissa ..	4
Uttar Pradesh ..	3
Tamil Nadu ..	26
Rajasthan ..	2
Punjab ..	1

Table 6. Admission 1992 (State-wise)

State	*No. of candidates*
Andhra Pradesh	2
Karnataka	5
Kerala	5
Maharashtra	3
Tamil Nadu	1
Rajasthan	1
Madhya Pradesh	1
Uttar Pradesh	1
West Bengal	1

Table 7. Course-wise demand

Course	*No. of applicants*	*No. of applicants selected*
DM Cardiology	115	5
DM Neurology	18	2
MCh CVTS	48	3
MCh Neurosurgery	5	3
PDCC-Anaesthesiology	19	6
PDCC-Radiology	11	2
Total	216	21

Examinations

Table 8 lists the names of candidates who were successful in the DM and MCh Examinations held during 1991–1992.

Table 8

Names of candidates	*Degree*	*Speciality*
Dr. K. Sunithakumari Dr. Debanu Ghosh Ray Dr. M. K. Shah	DM	Cardiology
Dr. Zachariah Philip	M.Ch	Cardiovascular and thoracic surgery
Dr. Mathew Alexander Dr. Gracykutty Mathew Dr. Anoop Ranjan Varma	DM	Neurology
Dr. Adil S. Chagla Dr. S. S. Praharaj	M.Ch	Neurosurgery

Table 9 lists the candidates who successfully completed the Post Doctoral Certificate Course.

Table 9

Names of candidates	*Speciality*
Dr. Saroj B. Kulkarni Dr. Mathew Kuncheria Dr. BGR Prasad Dr. BVS Murthy	Cardiovascular and Neuro Anaesthesiology
Dr. Pandit Sameer Arvind Dr. Manish Goyal Dr. T. R. Kapilamoorthy Dr. Kantilal Chakraborti	Cardiovascular and Neuroradiology

Short term training/observership

The demand for short term training/ observership in procedures, techniques and management was again on the increase as shown in Table 10. The Institute was constrained to put certain restrictions, due to the inordinately high demand in some areas. However, no fees were charged for offering its training facilities.

Table 10

Department/Division	*No. of candidates*
Anaesthesiology	15
Biomedical Technology	3
Blood Bank	8
Cardiology	13
Cardiovascular and Thoracic Surgery	3
Microbiology	12
Neurology	8
Neurosurgery	5
Neurochemistry	1
Radiology	48

Nursing Education

Mrs. P. P. Saramma, M.Sc. (Nursing)
Nursing Tutor

The Post Basic Nursing Course in Neuro Nursing commenced in January 1992, in addition to the regular Cardiac Nursing Course. There were 67 applicants for the Courses. Out of 11 candidates admitted for Cardiac Nursing, one was from Jammu and Kashmir and out of the 5 candidates admitted for Neuro Nursing, one was from Goa. The list of successful candidates for the Post Basic Nursing Course in cardiac nursing is listed in Table 11.

Table 11

1. Sr. Devotia MSJ
2. Ms. Geetha N
3. Ms. Grace George
4. Ms. Louja R S
5. Mrs. Saliamma Daniel
6. Ms. Shanthi Suguna S
7. Ms. Subha Abraham
8. Mrs. Sunithakumari V S
9. Mrs. Susan John

The list of candidates admitted to the Post Basic Course in cardiac nursing and neuro nursing is shown in table 12.

Table 12

Cardiac nursing	*Neuro nursing*
Ms. Anitha Philip	Ms. Jayasree A
Ms. Saly John	Ms. Maya G
Ms. Sheela KK	Ms. Saleena Joseph
Bro. Thomas James	Ms. Mini L
Ms. Shiby CK	Ms. Shamal S Teli
Ms. Sreedevi S	
Ms. Maya Damodaran	
Ms. Beena Rani R S	
Ms. Lizzy George	
Ms. Lincy PJ	
Ms. Nimi Braroo	

Diploma in Cardiac Laboratory Technology

There were 63 applicants for one seat. Ms. Suja George was selected for the course.

Diploma in Operation Theatre Technology

This new course of one year duration was started in January 1992. There were 68 applicants for 2 seats. Ms. A Bindu and Sri G.S. Manoj were selected for the course.

National Science Day

National Science Day was celebrated on the 28th of February. This year students of the Thiruvananthapuram Medical College, numbering 200, were taken on a study-cum-exhibition tour of the Institute, on the 28th and 29th of February. All the Departments/Divisions of the hospital complex and the entire Biomedical Technology Centre gave full and enthusiastic support to make the programme successful.

Library

Mrs. R. Prasanna Kumari, MA., MLISc
Librarian

Mrs. S. Jayaprabha, BA., BLISc
Librarian-cum-Documentation Officer

The library has acquired, over the years, a good collection of books and journals on cardiovascular sciences, neurosciences and related disciplines. Among the subjects prominently represented are cardiology, cardiovascular and thoracic surgery, neurology, neurosurgery, anaesthesiology, pathology, microbiology, biochemistry and radiology.

The library services functioned satisfactorily to support the academic and research programmes of the Institute and extended its services to the faculty, postgraduate students and research workers including those from other institutions as shown in table 13.

Table 13

Total members	..	351
Faculty	..	70
Postgraduate students/ Research Scholars	..	64
Paramedical staff		202
Others	..	15

Collection

The library satistics and the distribution of expenditure are shown in figs. (10, 11). The library has 7425 books and 9120 bound volumes.

The information services of the Library functioned with a view to disseminate quickly and effectively the current literature resources available in the library. Circulation of computer based monthly bulletin of publications

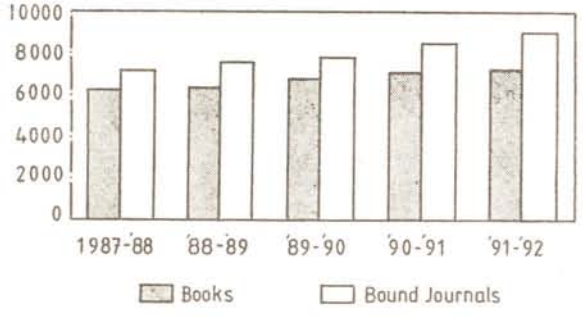


Fig. 10 Library Collection

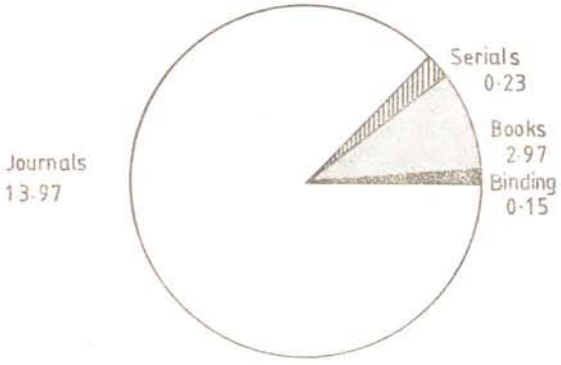


Fig. 11 Distribution of Expenditure Library (Rs. in Lakhs)

added to the library, and routing of contents page of journals which are most relevant to the interested users, formed part of the activity of the library. The library continued to provide in-house services like retrospective literature searches and reprographic services. During the year, the library experienced a heavy demand for the photocopy of articles from journals available in the library, from other institutions in the locality and outside the State. Photocopy of 344 articles were supplied to various institutions on request.

British library documents supply centre pre-paid coupon system facilitated the acquisition of xerox copies of documents, serving the urgent need of users of the Institute to a limited extent.

The audio-visual unit which was added to the library during 1990–91, became operational with the acquisition of video cassettes on surgical and investigative techniques. The unit organised the screening of video films on medical topics received from the Embassy of France on loan.

The seven-year-old reprographic facility of the library received a major fillip with the addition of a heavy duty photocopy machine HCL Finesse 5210 ZOOM. The new addition helped the library to cope with the demand for photocopying of articles and facilitated the extension of the service to the faculty and research scholars of the neighbouring institutions too.

Library Automation

The work connected with the creation of retrospective and current machine readable catalogue of books and periodicals, which was undertaken with Micro ISIS software version 2.3 was completed during the year. As part of the plans for total library automation, the system

requirements of the library were identified and the PC in the library was upgraded to a LAN server with three terminals and two CD ROM drive attached.

Subscription to Medline on compact disk was made during the year to cover the period from 1966 to date which will give a major impetus to the information services like CAS, SDI services and retrospective literature searches undertaken by the library.

On the conversion of the existing data bases from Micro/ISIS to LAN based system after suitable additions and modifications, the library will be able to computerise all house-keeping operations like acquisitions, periodicals subscriptions, circulation of books and periodicals and serve more expeditiously the research and teaching departments.

Effort was also made to conduct short term courses on library automation and current trends in information technology to familiarise the library staff on the best utilisation of the PC and the software.

Conferences / Seminars

The library organised a two-day workshop on MEDLARS conducted by the National Informatics Centre in association with the Institute. It aimed at increasing the awareness among the users of medical information of the possibility of online information retrieval facility offered by Medlars through the National Informatics Centre. Seventy-four delegates from the Medical College, Regional Cancer Centre, Dental College and the Institute particiapted in the Programme. A demonstation of the Online service through NICNET and NICMAIL was held at the NIC State Centre.

Prospects

The Institute Library is being designated as one of the twentyone centres in the country to be linked with the Medical Literature Analysis and Retrieval System through the National Informatics Centre.

The library also formulated plans to collaborate with INFLIBNET, an information library network programme of the University Grants Commission.

DEPARTMENTAL REPORTS

HOSPITAL WING

DEPARTMENT OF ANAESTHESIOLOGY

Dr. K. Mohandas, MD	Professor & Head of the Department
Dr. Mrs. A. Rout, MD	Additional Professor
Dr. R. C. Rathod, MD	Additional Professor
Dr. H. D. Waikar, MD	Additional Professor
Dr. Rupa Sreedhar, MD	Assistant Professor
Dr. Raman Chaddha, MD	Assistant Professor
Dr. Samir Girotra, MBBS, DA., DIP. NB	Assistant Professor
Dr. Gopakumar, MD	Assistant Professor

Candidates for Post doctoral certificate

Dr. Susmita Bhattacharya, MD
Dr. A. M. Kuttappa, MD
Dr. Shrinivas V. Gadhinglajkar, MD
Dr. Narendra Menon, MD
Dr. Jain Sunilkumar, MD
Dr. Ravi Taneja, MD

Anaesthetic and post-operative intensive care support were provided for the following procedures during the year.

Cardiac Surgery - 781,
Thoracic and Vascular surgery - 719,
Neurosurgery - 709.

In addition to the above list, anaesthetic coverage was given for over 200 investigational and interventional procedures in radiology.

Dr. Mohandas gave an invited lecture on the 'Development of biomedical technology in a developing country–the Chitra model'-at the College of Anaesthesiology, Sree Lanka and also addressed the post-graduate students of the University of Colombo. Dr. Mohandas took part in an Indo-US workshop at Chandigarh and an International Workshop on critical care in Bombay.

Dr. H. D. Waikar proceeded to the Hospital for Sick Children, Great Ormond Street, London for training in neonatal anaesthesia and intensive care.

Post - graduate students from the Medical Colleges in Goa, Belgaum, Kottayam and Thiruvananthapuram spent 4–6 weeks in the Department to gain additional experience.

DIVISION OF BIOCHEMISTRY

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

The Central Clinical Laboratory provided investigative support to the hospital on a round-the-clock basis and the number of procedures in clinical chemistry and clinical pathology exceeded 2.06 lakhs. Installation of the automatic electronic blood cell counter, Coulter T-540, enhanced the quality and promptness of the hematological services.

The thrust of research activity was on free radical mediated lipid peroxidation in relation to atherosclerotic heart disease. Lipid peroxides and conjugated dienes were found to be elevated in patients with both stable and unstable angina. Studies on the antioxidant status revealed that in stable angina the erythrocytes expressed low levels of superoxide dismutase and normal levels of catalase and glutathione peroxidase whereas in unstable angina enhanced activities of both superoxide dismutase and normal levels of catalase and glutathione peroxidase appeared to be characteristic features. A significant increase was also noticed in the levels of ceruloplasmin and vitamin E during both types of angina. Further, coronary artery disease (CAD) patients with diabetes showed maximum levels of lipid peroxides compared to smokers and hypertensives. In CAD patients an increase in lipid peroxides was noticed as the disease advanced to three vessel diseasee which indicates that free radicals may contribute to the development as well as exacerbation of atherosclerotic heart disease.

In collaboration with the departments of Cardiology and Cardiac surgery, free radical activity was studied in patients who underwent coronary artery bypass grafting. A highly significant rise in the concentration of lipid peroxides was observed immediately after the release of the aortic side clamp and peak levels were attained on the sixth day. By logistic regression analysis no statistically significant correlation could be observed between the aortic occlusion time or total cardiopulmonary bypass time and the levels of peroxides. However a positive correlation was found to be present between the increasing number of grafts and the increasing concentration of lipid peroxides.

Mr. B. Sasikumar attended a workshop on "Affinity chromatography" sponsored by the Department of Biotechnology and arranged at the Indian Institute of Science, Bangalore.

DIVISION OF BLOOD TRANSFUSION SERVICE

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

The annual statistics of the blood transfusion service is given in Tables-14 to 16.

Table 14

Blood donation	..	7043
Whole blood transfusion	..	5071
Components transfused (packed cells, FFP, PRP, SDP, buffy coat preparation)	..	682
Compatibility tests Alb Saline	..	9519
Albumin	..	9519
Anti Human Globulin	..	3256
Blood grouping- Patients	..	7346
Donors	..	8275

Table 15

HBs Ag Screening (ELISA)	6366
Anti HIV Screening (ELISA)	6128
RPP test for syphilis	6012
Irregular antibody screening	4607
Therapeutic plasmapheresis	458
Washed concentrated cells for autologous transfusion	512

Table 16

Components prepared :	Packed cells ..	454
	FFP ..	236
	PRP ..	215
	Buffy coat ..	22
Frozen single donor plasma	..	199
Plasma separated	..	467
Components issued to other institutions (FFP, PRP, SDP, Buffy coat and Platelet concentrate)	..	448

A RC 3C Sorvall Refrigerated centrifuge with accessories was added to the laboratory which enabled the standardisation of platelet rich plasma by adjusting incubation time, speed and rpm. Other projects related to the detection of cold aggultinins in surgical patients, survey for HBs Ag, ABO, MNS and Rh genotype among the blood donors.

Preparation of blood components was on the increase and 20 - 25% of the blood collected was used for component separation every month. As blood donor panel got computerised, newer

blood forums were initiated in various institutions and at community level.

The blood conservation project succeeded in bringing down the use of bank blood in open heart surgery. As in the previous years, small volume plasma exchange was carried out for neurological patients with GBS, myasthenia gravis and chronic inflamatory demyelinating polyneuropathy (CIDP). The blood filter developed in the Biomedical Technology Wing underwent clinical evaluation. In a collaborative study with the Department of Gastroenterology, Medical College, Thiruvananthapuram, the efficacy of fresh frozen plasma was studied in subacute hepatic failure.

Important visitors included Dr. Z. S. Bharucha, Tata Memorial Hospital, Bombay, Dr. R. K. Panigrahi, Berhampur, Dr. R. N. Makroo, WHO National Consultant in Transfusion Medicine, New Delhi and Dr. J. G. Jolly, Chandigarh.

Six technicians and a medical officer from Kottayam Medical College received short term training in blood transfusion techniques. Three doctors from the National Institute of Mental Health, Bangalore and the area managers and hospital sales representatives of M/s TTK Pharma came to the Division as observers.

The staff organised the first Kerala Chapter meeting of the Indian Society for Blood Transfusion and Immunohaematology which attracted 40 delegates. Dr. P. V. Sulochana presented a paper at the Annual Conference of the Indian Society for Blood Transfusion.

DEPARTMENT OF CARDIOLOGY

Dr. K.G. Balakrishnan, MD, DM., FACC, FAMS	Professor and Head of the Department
Dr. C.G. Venkitachalam, MD., DM	Professor
Dr. Jaganmohan Tharakan, MD., DM	Additional Professor
Dr. Thomas Titus, MD, MNAMS., DM	Associate Professor
Dr. M. V. Joseph Joy, MD., DM	Associate Professor
Dr. V. K. Ajith Kumar, MD., DM	Assistant Professor
Dr. Anil Bhat, MD., DM	Assistant Professor
Mr. K. N. Vijayasenan, B.Sc., DCCT	Scientific Assistant

Candidates for DM

Dr. Aravinda Saha, MD
Dr. O. Mohammed Najeeb, MD
Dr. Promodkumar Jaiswal, MD
Dr. (Mrs.) Sudha Mani, MD
Dr. Francis Bimal, MD
Dr. P. Jyothi, MD
Dr. J.S. Bhuvaneswaran, MD
Dr. Ravi Narayan, MD
Dr. Zulfikar Ahmed, MD
Dr. N. P. Padmaja, MD
Dr. Rajassegar, MD

With the appointment system for new registrations in cardiac clinic with a ceiling of 25 per day, the waiting period for new appointments gradually increased to three months. In the special follow up clinics, the number of patients without appointment showed an increase partly because of the reluctance of referring doctors to look after chronic problems like rheumatic heart disease and the inevitable delay in surgical treatment.

Two of the faculty members Dr. R. Subramoniam, Additional Professor and Dr. Rajeev Gupta, Assistant Professor left the Institute. The number of special investigations like exercise stress testing, echocardiography and cardiac catheterization procedures reached a plateau of the maximum possible with the existing staff strength and facilities. However, there was an increase in the therapeutic interventional procedures like balloon valvoplasty and PTCA. A new therapeutic interventional procedure, namely catheter ablation of accessory pathway in the heart using radiofrequency energy was performed for certain tachyarrhythmias. In very sick paients with critical obstruction of cardiac valves, balloon valvoplasty was performed with partial cardiopulmonary bypass support.

The following collaborative and other research projects were carried out:

* Estimation of free radicals and anti-oxidant enzyme levels in patient with coronary artery disease. (Bio-chemistry).

* Estimation of CK and CKMB enzymes in patients undergoing open heart surgery - Atrial septal defect, Tetralogy of Fallot and coronary artery disease (Biochemistry and Cardiothoracic surgery)

* Pilot study of the prevalence of coronary artery disease in the rural population of Kerala (Hospital Economics).

* Shunt quantification and reversi-bility of PAH in L-R shunt with severe PAH - Echo Doppler assess-ment and correlation with hemody-namic study (Cardiothoracic Surgery).

* Patency of coronary bypass grafts-its correlation with postoperative patient status-a study of 100 patients (Cardio thoracic Surgery).

* Electrophysiologic studies in endo-myocardial fibrosis.

* Pulmonary capillary blood sample for cytodiagnosis of pulmonary neoplasms - a new diagnostic test (Cardiothoracic surgery and Patho-logy)

The DM (Cardiology) students of the Medical College, Thiruvananthapuram received training in invasive cardiology for three months and M. D (Paediatrics) students spent a fortnight in the Depart-ment as observers. Dr. Deshpande from Nagpur visited the Department for a month to learn Echocardiography.

Jointly with Medical College, Thiru-vananthapuram, the Department orga-nised the Kerala Chapter meeting of the Cardiological Society of India.

DIVISION OF CARDIOMYOPATHY

Prof. M. S. Valiathan	Head of the Division
Dr. C. C. Kartha, M.D	Additional Professor, Pathology
Dr. R. Renuka Nair, Ph.D	Scientist
Dr. K. Shivakumar, Ph.D	Scientist
Dr. John T. Eapen, Ph.D	Scientist
Dr. Annie John, Ph.D	Senior Research Fellow (CSIR)
Ms. S. Rajasree, M. Sc.	Senior Research Fellow (ICMR)

Research activities of the Division centred on the evaluation of the hypothesis that magnesium deficiency associated with cerium toxicity could be a causative factor for endomyocardial fibrosis. Magnesium deficiency was produced in rats through dietary means and the effects of cerium supplementation was studied. Though an animal model for the disease could not be produced, many of the findings were in support of the hypothesis. Preferential accumulation of cerium in the cardiac tissue compared to skeletal muscle, enhanced accumulation of cerium in the tissues in the presence of magnesium deficiency and synergistic effects of magnesium deficiency and cerium accumulation on calcium levels in the heart were some of the important observations. Myocardial lesions (Fig. 12) were more severe when the hypomagnesemic rats were fed a cerium adulterated diet.

As collagen accumulation in the endomyocardium is central to the pathophysiology of endomyocardial fibrosis, a study was undertakn to examine the effect of cerium on collagen synthesis at levels at which the element is found in the cardiac tissue of patients. Interestingly, the element was found to have a stimulatory effect on the synthesis of both collagen and non-collagen proteins. While enhancement of collagen synthesis is particularly significant, the stimulation of non-collagen protein synthesis raises the question whether cerium could effect a disproportionate stimulation of certain proteins like those of the extracellular matrix. From the standpoint of the suspected involvement of cerium in the pathogenesis of endomyocardial fibrosis, it would be important

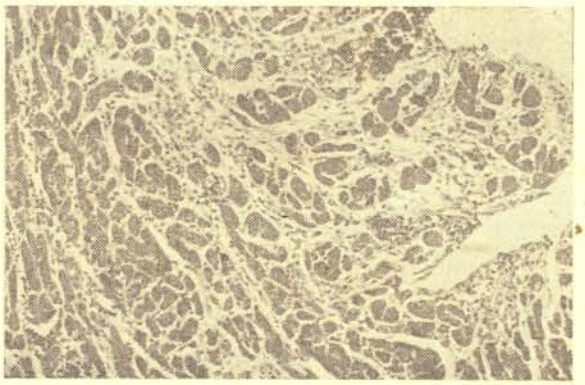


Fig. 12 Photomicrograph of myocardium of a rat on magnesium restricted and cerium adulterated diet.

to quantify the relative levels of expression of genes encoding collagens and intracellular and extracellular matrix proteins. Recent investigations reveal that cerium acts at nanomolar levels to stimulate RNA synthesis suggesting that the stimulation of protein synthesis by the element is a transcriptional event.

The stimulatory effect of cerium on cell proliferation was also studied using cardiac fibroblasts from new born rats. An increase in cell number was observed on treatment with cerium, significantly at low concentrations(1uM). A significant increase in the incorporation of radio-labelled thymidine was also observed on, treatment with 1uM cerium suggesting a stimulation of DNA synthesis leading to the proliferation of cardiac fibroblasts.

Analysis of magnesium levels in blood samples of school children showed that the mean serum magnesium level in children of the low socio-economic group was significantly lower than that of the higher socio-economic group.

Project	Determination of magnesium levels in a population sample from Kerala.
Principal Investigator	Dr. Renuka Nair
Co-investigator	Dr. John T. Eapen
Funded by	Roussel Scientific Institute, Bombay
Status	Ended on 29th February 1992

The requirement for magnesium is higher during the phase of rapid growth and also during pregnancy and lactation. This corresponds to the age group at which patients first report to the hospital with symptoms of endomyocardial fibrosis. Blood samples from pregnant women are being analysed.

Ms. S. Rajasree joined the Division as a Senior Research Fellow in an ICMR sponsored project titled 'Vitamin D status in the population of Kerala'. The study aims to explore the possible relationship between Vitamin D status as well as magnesium deficiency and the prevalence of restrictive cardiomyopathies, chronic pancreatitis and urinary calculi. It is based on the hypothesis that an increased Vitamin D synthesis due to excessive exposure to sunlight and consumption of tubers containing sterols, convertible to Vitamin D precursor compounds, could lead to dystrophic calcification and calcium induced cellular hyperplasia in the tissues. A research project on the molecular mechanism of endomyocardial damage induced by Ce in a context of Mg deficiency has just been initiated in the Division with financial support from the DST.

Project	Cellular basis of myocardial damage by cerium in magnesium deficiency.	
Principal Investigator	Dr. K. Shivakumar	
Co-Investigators	Dr. C. C. Kartha Mr. K. Rathinam Dr. John T. Eapen	SCTIMST
	Dr. P. T. Manoharan	IIT Madras
Funded by	DST	
Duration	3 years	
Status	Ongoing	

Dr. Annie John received training in Electron Microscopy at the Department of Neuropathology and Applied Biology; Medical Research Centre, Bombay Hospital under the guidance of Prof. D. K. Dastur.

Ms. Deepa Krishnaswamy worked in the Division for 2 months as a trainee on a Fellowship from the Jawaharlal Nehru Centre for Advanced Research, Bangalore. A veterinary graduate, she had the opportunity to interact with the scientists in the Division and to familiarise herself with techniques such as cell fractionation, cell culture and radioisotope labelling of macromolecules to study their rates of synthesis.

An International symposium on Endomyocardial Fibrosis was hosted by the Institute in December 1991. Distinguished scientists in the field from all parts of the globe participated in the symposium which was also attended by research workers in the field and selected students from postgraduate Institutions. Papers were presented by the scientists of the Division at the symposium.

Dr. C. C. Kartha participated in the Basic Cardiology Symposium organized by the Jawaharlal Nehru Centre for Advanced Research, Indian Institute of Science, Bangalore and presented a paper on 'Pathogenesis of Cardiomyopathies'.

An important addition of equipment to the Division was an Oscilloscope with a Bioamplifier and Force Transducer.

DEPARTMENT OF CARDIOVASCULAR AND THORACIC SURGERY

Prof. M. S. Valiathan	Professor and Head of the Department.
Dr. M.P. Mohan Singh, FRCS (Eng) FRCS (Edin)	Professor
Dr. R. Sankarkumar, MS., MCh	Additional Professor
Dr. K. S. Neelakandhan, MS., MCh	Additional Professor
Dr. K. G. Shyamkrishnan, MS., MCh	Additional Professor
Dr. M. Unnikrishnan, MS., MCh	Associate Professor
Dr. Aruna Kashyap, MS., MCh	Associate Professor
Dr. Y. Nazer, MS., MCh	Associate Professor
Dr. Krishna Manohar, MS., MCh	Assistant Professor
Dr. Shiv Kumar Nair, MS., MCh	Assistant Professor

Candidates for M.Ch. Course

Dr. B. Neelakantan, MS
Dr. Mrinal Bindu Das, MS
Dr. Sushil Chandran, MS
Dr. R. Jagannathan, MS
Dr. Usha Parvathy, MS
Dr. Avinash Dal, MS
Dr. T. Rameshwara, MS
Dr. T. M. Babu, MS
Dr. N. R. Ravisankar, MS

Thanks to the revision in hospital charges and the reduction in the percentage of free patients, the number of operative procedures showed a decline towards the second half of the year. The open heart procedures totalled 781, closed heart and vascular and thoracic procedures 719 each during the entire year. With the assistance of Medical Records and the Computer Division, a concerted effort was made to reschedule the large number of patients on the surgical list on the basis of the new charging system and communicate the revised dates to those whose turn would come within 18 months. Among the surgical procedures performed, the percentages of pediatric, valve replacement, coronary artery bypass and vascular operations remained substantially unchanged.

The sharp rise in the prices of cardiovascular devices such as oxygenator, valve, cardiotomy reservoir etc., was another reason for the curtailment of the number of surgical procedures. As the Institute saved about 8 lakhs by using oxygenators, cardiotomy reservoirs, and valves developed at the Biomedical Technology Wing instead of importing them over the preceding 18 months, it was estimated that the previous yearly record of operations could be

restored without any increase in the Departmental allocation with the increasing use of Chitra technology during 1992–93.

The clinical trial of the Chitra valve made excellent progress and more than 50 valves had been implanted in the mitral and aortic positions at the time of the report. The results of the trial which were reported at the Annual Meeting of the Indian Association of Cardiovascular and Thoracic surgeons at Calcutta and the valve exhibits by the TTK Pharma evoked great interest for the clinical use of the valve. A protocol for the multicentric trial of the valve was approved at a meeting of the panel of Principal Investigators and Monitoring Committee on 22–11–91 in the Institute. The names of the members for the panel and their affiliations are given below:

Principal Investigators	*Institution*
Prof. R. Magotra	KEM Hospital, Bombay
Dr. M. Muralidharan	Kuppuswamy Naidu Memorial Hospital, Coimbatore
Col. R. S. Rajan	Military Hospital, Armed Forces Medical College, Pune
Prof. D. Saha	Postgraduate Institute of Medical Research, Calcutta
Prof. K.S.V.K. Subba Rao	JIPMER, Pondicherry
Prof. Karan Singh Yadav	SMS Medical College Hospital, Jaipur

MONITORING COMMITTEE

Professor K. G. Balakrishnan	Prof. & Head of the Department of Cardiology Sree Chitra Tirunal Institute, Trivandrum.
Prof. P. S. Bidwai	Chief Cardiologist Central India Institute of Medical Sciences, Nagpur.
Dr. S. Radhakrishna	Institute for Research in (ICMR) Madras-31.
Prof. S. M. Sengupta	Consultant Thoracic and Cardiovascular Surgeon, Calcutta.
Prof. M. S. Valiathan	Professor & Head of the Department of Cardiac Surgery, Sree Chitra Tirunal Institute Trivandrum.

The transfer of technology of the Chitra valve and the consequent reduction in the pressure on the laboratory enabled the Department to revive its old project on the vascular graft. As the selection and characterisation of the yarn, weaving of a seamless crimped graft, tests for porosity, and long term patency studies in 50 pigs had been completed more than 2 years ago it was estimated that the graft could be brought to the stage of clinical trial in less than a year. The presently available models were expected to be used as straight grafts, preclotted patches for right ventricular outflow reconstruction and valved conduits.

Col. R. S. Rajan, Head of the Department of Cardiothoracic Surgery, Armed Forces Medical College, Pune, spent a week as a visiting Professor. Dr. Ashok Bhoyar from the Central India Institute of Medical Sciences, Nagpur spent 3 months to gain additional experience in coronary artery surgery.

Dr. Shiv Kumar Nair was deputed to spend four months in the Department of Dr. Antunes at Coimbra, Portugal to learn the techniques for valve conservation which have a potentially important role in India. Dr. Jyotirmoye Chanda of Bangladesh joined the Department on a Fellowship offered by the Government of India to work on the development of a bioprosthetic valve.

Dr. D. Metras of Marseilles visited the Department and presented lectures to the staff and postgraduate students. Prof. Valiathan delivered the C. V. Raman Memorial lecture at the Indian Institute of Science, Bangalore.

DIVISION OF MICROBIOLOGY

Dr. J. Shanmugham, MSc, MD (Hon) Ph.D FABMS, FIMSA	Additional Professor.
Ms. Molly Thomas, M.Sc., DMV MABMS	Assistant Professor.
Mr. M. Raveendranath, B.Sc.	Scientific Assistant.
Mrs. K. Naseema, B.Sc., M.Sc. (MLT), MABMS	Scientific Assistant.

The laboratory services registered further improvement by the introduction of a new differential medium CLED (Cysteine Lactose Electrolyte Deficient) and ELISA test for the specific detection of IgM antibody against T. gondii. Group A streptococcal isolates were sent to the WHO Reference Centre in Delhi for M-typing and T-typing. The equipment and facilities added to the laboratory included a binocular NiKON microscope and Laminar Flow Biohood.

Research activities related to the work of Mr. Rathinam and Mr. Shanmugha Kumar who had registered for the Ph.D course. The staff also collaborated with other scientists in areas of mutual interest. Ms. Molly Thomas contributed to the studies of Dr. Radhakrishnan in the Division of Pathology on the rapid diagnosis of tuberculosis and Dr. Shanmugham and Mr. Ravindranath collaborated with Dr. Jayabalan of the Biomedical Technology Wing on evaluating the microtoxicity of certain candidate polymers in a new cell line.

A patent was registered for a CO2 incubator which was developed by Mr. Raveendranath, Mr. Koruthu P. Varughese and Dr. Shanmugham and work was taken in hand for developing an improved model.

The Division organised the 2nd Chapter meeting of the International Medical Science Academy which was attended by 50 delegates. The visitors to the laboratories included Dr. K.B. Sharma from the South East Asia Regional Office, WHO, New Delhi and Prof. S. C. Agarwal from Lucknow. Dr. Shanmugham delivered two lectures at the annual conference of the Sri Lanka College of Microbiologists and was conferred the degree of Doctor of Medicine by the Free International University of Complementary Medicine. He was elected to the membership of the Executive Council of the Indian Association of Biomedical Scientists. Miss. Molly Thomas received an Award from the Association of Commonwealth Universities to learn rapid diagnostic techniques at the University of Sains, Malaysia. She became a member of the Indian Association of Biomedical Scientists.

DEPARTMENT OF NEUROLOGY

Dr. P. K. Mohan, MD, DM.	Additional Professor.
Dr. C. Sarada, MD, DM.	Associate Professor.
Dr. Muralidharan Nair, MD, DM.	Associate Professor.
Dr. Sanjeev Thomas, MD, DM.	Assistant Professor.

Candidates for DM.

Dr. J. B. Agadi, MD.
Dr. V. K. Radhakrishna, MD.
Dr. Sreekantaswamy, MD.
Dr. A. Rajaram Bhat, MD.
Dr. G. Shivnarayana, MD.
Dr. Sunil Narayanan, MD.
Dr. B. Santhosh Kumar, MD.

The department continued to provide patient services as before. There was increased demand for neuro-electrophysiological investigations from other departments during the year. Because of the large number of follow-up cases, Department introduced, on a trial basis, correspondence follow-up on a structured letter format for epilepsy cases. As before, the regular academic programmes were conducted for the D.M trainees.

A clinical research project on thyroid function abnormalities in epileptic was initiated.

Project	Thyroid function abnormalities in epilepsy —its impact on seizure control and neurophysiological performance.
Principal Investigator	Dr. Sanjeev Thomas
Funding	State Committee on Science and Technology, Government of Kerala
Duration	2 years
Status	Ongoing

Dr. Mohan continued his studies on the linguistic aspects of aphasia in association with the Institute for Dravidian linguistics.

Project	An interdisciplinary study of linguistic aspects of aphasia
Principal Investigator	Dr. P. K. Mohan
Funding	Govt. of Kerala
Duration	5 years
Status	Ongoing

Dr. Asha Vijayaraghavan completed a study of peripheral nerve regeneration in the silicon chamber model using human amniotic membrane matrix as substratum during her postdoctoral Fellowship.

Postgraduate students in pediatrics from the Medical College, Thiruvananthapuram visited the Department as observers.

DEPARTMENT OF NEUROSURGERY

Dr. Damodar Rout, MS., M.Ch., FAMS.	Professor and Head of the Department.
Dr. B.K. Misra, MS., M.Ch., Dip. NBE.	Additional Professor.
Dr. Rajeev Sharma, MS., M.Ch.	Associate Professor.
Dr. Suresh Nair, M.Ch.	Associate Professor.
Dr. Vijay Iyer, MS., M.Ch.	Assistant Professor (On leave).
Dr. Satish Krishnan, M.Ch., Dip. NBE.	Assistant Professor.
Dr. Ajay Gehlot, M.Ch.	Assistant Professor.

Candidates for M.Ch.

Dr. Sunil M. Pandit, MS.
Dr. K. Uma Nambiar, MS.
Dr. Rajesh Shishoo, MS.
Dr. Rajneesh Kachhara, MS.
Dr. Moni K. Vinod, MBBS.
Dr. Dilnavaz B. Bhiladvala, MS.
Dr. Muralidhar Pai K., MS.

The clinical workload and the variety of operative procedures remained more or less as in the previous year. (Table 17). However, there was a significant increase in the number of cases of intracranial aneurysms. Infact, over the last five years, there has been a two-fold increase in the number of cases undergoing direct surgical obliteration of aneurysms with excellent results (Fig. 13). The bulk of intracranial surgery was for deep and inaccessible tumours. For the first time there was no mortality this year for the surgery of acoustic neurinomas. A number of complicated skull base tumours, one of the major thrust areas, were managed surgically in a satisfactory manner.

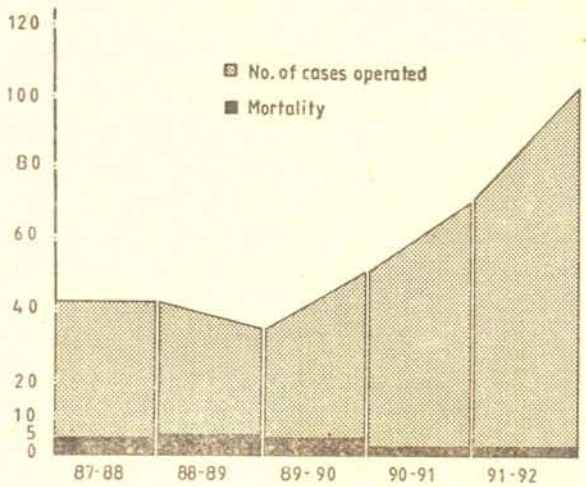


Fig. 13 Rising incidents of intracranial Aneurysms

Table 17

Aneurysms	113 (104 pats)
Arteriovenous mal-formations	23
Acoustic Neurinomas	37
Other Cranial N. Neurinomas	5
I.C. meningiomas	74
3rd ventricular tumours	19
Lateral ventricular tumours	7

4th ventricular tumours	4
Pituitary tumours	48
Craniopharyngiomas	25
I.C.gliomas	71
Epidermoids	5
CSF rhinorrhoea	6
C.V. Junction anomaly	40
Spinal tumours	43
Other spinal lesions	53
Miscellaneous	149

Following the successful completion of the preliminary clinical trial of the Chitra hydrocephalus shunt system in the Department, a multicentric trial was launched. The participating institutes included AIIMS, New Delhi; CMC, Vellore, KEM Hospital, Bombay; NIMHANS, Bangalore; NIMS, Hyderabad and PGIMER, Chandigarh.

Project	Multicentric trial of Hydrocephalus shunt for clinical evaluation
Principal Investigator :	Dr. D. Rout
Funded by :	DST
Status	Ongoing

The collaborative projects, with the divisions of Vivarium and Pathology by the postgraduates included control of experimentally induced raised ICP in a canine model and immunohistochemical demonstration of mycobacterial antigens in intracranial tuberculomas.

Dr. Vijay Iyer went on leave to U. K. for one year on a Commonwealth Scholarship. Dr. Suresh Nair attended the Eighth Asian Australasian Congress of Neurological Surgery at Seoul and presented a paper on "Adult Chiari malformation: surgical experience". Dr. Misra served as a visiting faculty to AIIMS, New Delhi in March 1992. Prof. Rout and Dr. Misra delivered invited lectures at the annual meeting of the International Medical Sciences Academy (Kerala Chapter) at Thiruvananthapuram.

Dr. S. N. Mathuriya, Associate Professor of Neurosurgery, P G I M E R, Chandigarh and Dr. Subodh Hiran, Consultant Neurosurgeon, JLN Hospital and Research Centre, Bhilai visited the Department as observers. Drs. Anil P. Lal, Alok Ranjanand George Kavoor from CMC, Vellore, Drs. Ravikumar C and Baliga SP from NIMHANS, Bangalore and Dr. Krishna Sastry from K. G. Medical College, Visakhapatnam attended the Department as observer trainees. Prof. Rout was elected a Fellow of the National Academy of Medical Sciences.

DIVISION OF NEUROCHEMISTRY

Dr. Debkumar Basu, Ph.D.	Professor
Dr. P. S. Appukuttan, Ph.D.	Additional Professor
Mrs. K. I. Annamma, B.Sc.	Scientific Assistant

Candidates for Ph.D.

P. L. Jaison, M.Sc.
V. M. Kannan, M.Sc.

In view of recent evidence suggesting the involvement of mammalian galactose-binding proteins (lectins) in tissue sociology, attempts were made as part of an ongoing project to identify endogenous glycoprotein molecules that interact with mammalian brain galactose-binding lectin. Using bovine brain lectin molecules immobilized under non-denaturing conditions, several lectin-binding endogenous glycoproteins in the molecular mass range 45 kDa - 186 kDa were obtained. These results were independently verified after electro-blotting of electrophoretically separated brain glycoproteins to nitrocellulose membrane, and probing with active lectin-peroxidase conjugate prepared by glutaraldehyde conjugation. Attempts are on to isolate individual glycoproteins by immunoaffinity chromatography.

Two α-galactoside-binding proteins isolated in this laboratory (jacalin from jack fruit seed and anti-α galactoside antibody from human serum) were demonstrated to be convenient biochemical tools to specifically detect terminal α-galactoside groups in glycoproteins (including those from bovine brain), glycolipids and polysaccharides. Possible presence of such groups in human brain glycoconjugates that may be relevant in autoimmune disorders, is presently under investigation.

Project		Galactose-binding lectins and endogenous lectin-binding glycoconjugates (receptors) of mammalian brain : their structure and interactions in normal and tumour-affected tissue.
Principal Investigator	:	Dr. P.S. Appukuttan
Co-Investigator	:	Dr. D. K. Basu
Funded by	:	DST
Duration	:	3 years
Status	:	Ongoing

A process patent was filed for the preparation of antigalactoside antibody from outdated human plasma by Dr. Appukuttan and Mr. Jaison.

DEPARTMENT OF PATHOLOGY

Dr. V. V. Radhakrishnan, MD.,	Additional Professor
Dr. C. C. Kartha, MD.,	Additional Professor
Dr. Mrs. Sandhyamani, MD.,	Additional Professor
Mrs. Annamma Mathai, M.Sc.	Scientific Assistant

The investigations carried out during the year for the hospital services are listed below:

Table 18

Histopathology	—	950
Cytology	—	450
Immunologic tests	—	2010
Frozen section	—	340
Autopsies	—	59

The accuracy obtained in the frozen section diagnosis on the basis of subsequent confirmation by histopathology was 93%. Two new tests were introduced and standardised. These related to Argyrophilic nucleolar organiser region as a useful marker for assessing the biological behaviour of brain tumour and the 'western blot' method to detect mycobacterial antigen in CSF samples.

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

Detailed histopathological and histochemical studies on mucoid vasculopathy showed the association of this disorder with coronary artery disease, cerebrovascular and peripheral vascular disease in some of the autopsies conducted at the Institute and in surgical biopsy material. Animal experiments demonstrated that a generalized mucopolysaccharidosis and vasculopathy of similar nature, with some associated cardiomyopathy changes could be induced experimentally in bonnet monkeys fed 3–5 months a low protein-high carbohydrate tapioca (cassava) based diet. Studies indicated the induction of

similar cardio-vascular lesions by protein-deficient corn-starch based diets as well. The experiments emphasized the central role played by protein-deficiency and the enhancement of the cardiovascular changes by increased consumption of carbohydrate in such a state. As recommended by the Monitoring Committee of the Department of Science and Technology, an intensive research programme for studies on the other aspects of mucoid vasculopathy, including biochemical, ultrastructural aspects and the reversibility of changes in the animal model, was being undertaken.

Dr. C. C. Kartha joined the Editorial Board of Current Science.

DEPARTMENT OF RADIOLOGY

Dr. V.R.K. Rao, MD, DMRD, MNAMS	Professor and Head
Dr. K. Ravimandalam, MD	Additional Professor
Dr. A. K. Gupta, MD	Associate Professor
Dr. Santhosh Joseph, MD, DMRD	Associate Professor
Dr. Madhavan Unni, MD	Associate Professor
Dr. A. Srinivasa Rao, MD	Associate Professor

Candidate for Postdoctoral Certificate Course

Dr. (Ms) Swatee Halbe M.D
Dr. Easwaravaraprasad Rao M.D

The diagnostic and intervention procedures carried out during the year are indicated in Tables 19 and 20.

Table 19

Diagnostic procedures		
Outpatient X-rays	:	17528
Special investigations	:	
Aortography		240
Peripheral Angiography		82
Venography		5
Bronchography		36
Barium examinations		16
Cerebral Angiography		324
Myelography		178
CT Scan: Registered patients		2276
Outside patients		2806

Table 20

Interventional Procedures	
Angiography :	
Aorta	9
Iliac	25
Femoropopliteal	43
Renal	7
Subclavian	4
Carotid	2
IVC	2
	92
Laser in oesophageal occlusion	4
Embolizations:	
Intracranial	19
Cranio-facial	7
Spinal / Paraspinal	3
Carotid-cavernous fistulae	6
Peripheral	9
	44
Total	140

Satisfactory progress was made in the design and development of a balloon expandable stent in collaboration with the Vikram Sarabhai Space Centre and the prototype was expected to be available shortly. Simultaneously a joint project with the Biomedical Technology Wing was begun to develop a polyurethane - polymethyl methacrylate spiral stent (Figs. 15,16,17,18). In a project sponsored by the Department of Electronics, the Department collaborated with the Electronics Research and Development Centre, Thiruvananthapuram on the development of digital archival and networking of medical images.

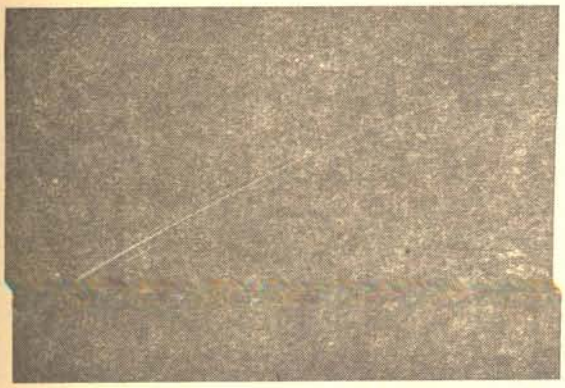


Fig. 15 Hydrogel coated stainless wire (stent)

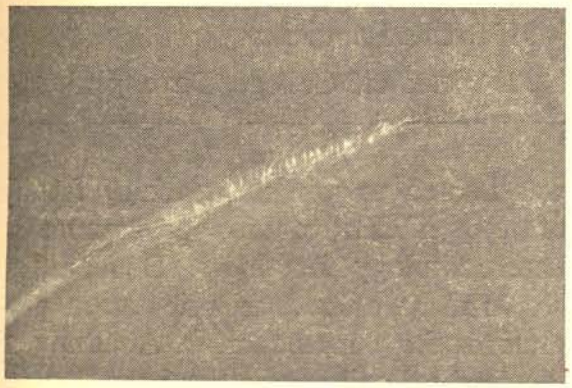


Fig. 16 Coated stent wound tightly over an uninflated angioplasty balloon

Fig. 17 Balloon is inflated and the stent expands

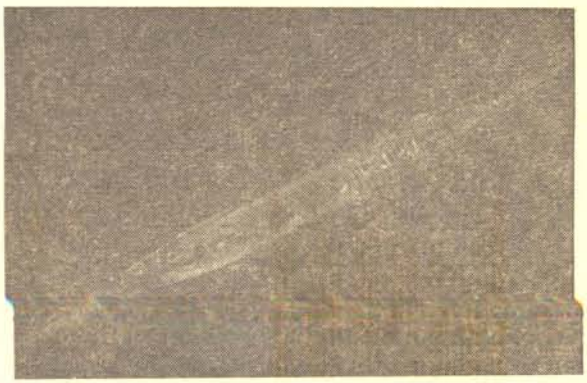


Fig. 18 Balloon is deflated. The stent remains in the expanded state

The variety and quality of the radiological procedures drew a steadily increasing number of physicians to the Department as observers and trainees. Their names and affiliations are listed in Table 21.

Table 21

List of observer trainees from other institutions

	Name and Designation	*Sponsored by*
1.	Dr. Ashok Kapoor Senior Specialist	Dept. of Radiology Tata Main Hospital, Tata Iron and Steel Co. Ltd. Jamshedpur
2.	Dr. K. Mohanan	MCH, Thiruvananthapuram
3.	Dr. Remla Beevi, Tutor	MCH, Thiruvananthapuram.
4.	Dr. Malan Shankar Kamble	KEM Hospital, Bombay
5.	Dr. J. Venkateswarlu Assistant Professor	Nizam's Institute of Medical Sciences, Hyderabad
6.	Dr. C. Daniala	JIPMER, Pondicherry
7.	Sheela M.S. CRA student Sheeba U. P. ,, ,, Ambily Govind K. ,, ,, Sreelatha B. ,, ,, Sivaprasad T. ,, ,, Suresh Babu ,, ,, Prasad V ,, ,, V. G. Vivekanandan ,, ,,	Medical College, Thiruvananthapuram
8.	Dr. Ravi Hoisala, Asst.Professor	St. John's Medical College, Bangalore
9.	Dr. S. S. Shreeram, II year resident	JIPMER, Pondicherry
10.	Dr. Abraham Sebastian, P.G. Student	JJM Medical College, Davangere

Prof. Henry Dirk Sostman, Director academic affairs, Dept. of Radiology of the Duke University Medical Centre, USA and Dr. Harold Coons, Sharp, Memorial Hospital, San Diego visited the Department and delivered lectures on MR angiography. Dr. VRK Rao was invited to join the teaching faculty of the NICER course programme in neuroradiology in New Delhi. The Department offered an orientation programme for the teachers in Anatomy of the medical colleges in the State.

BIOMEDICAL ENGINEERING & TECHNOLOGY CENTRE

Head: Dr. R. Sivakumar, B.Tech, Ph.D. (Mat. Sci.)

Division of Technical Evaluation of Biomaterials

Dr. M. Jayabalan, Ph.D.	Scientist
Dr. K. Sreenivasan, Ph.D.	Scientist
Dr. Prabha D. Nair, Ph.D.	Scientist

Physicochemical characterization of polymeric materials was carried out during the year as shown in Table-22.

Table 22

Test	*No. of samples*
Liquid chromatographic analyses	730
Mechanical tests	3025

The research activities of the Division centred on the evaluation of biomaterials and biomaterial performance under physiological conditions **in vitro.**

One of the major causes of failure of devices during long term use is biodegradation which is a cumulative effect of water, enzyme and environmental stress. The involvement of lysosomal enzymes in inducing biodegradation by hydrolysis and oxidation during the initiation of microcracks was studied by a new technique, the dynamic stimulus response (DSR). The interaction of trypsin, a hydrolytic enzyme, with pellathane, a biomedical grade polyurethane, was studied to detect the initial event at the material-enzyme interface which leads to enzymatic attack on the material. The DSR apparatus consists of a bed-column flow. Pellathane spherical beads (2mm diameter) were loaded into a flow cell column which was equilibrated with flowing denoized water. Under a constant flow, radioactive 99 TC-pertechnetate tracer (concentration 1 ml) was injected as stimulant through the inlet tube. The deionized water was collected through the outlet at different intervals and the radioactivity determined using a gamma scintillation counter. The relation between radioactivity and time was plotted and 'C' curve was obtained. The area under the response 'C' curve for 99 TC-pertechnetate was considered to be equivalent to 1, numerically indicating no adsorption of 99 TC on pellathane. Trypsin was radiolabelled using 99 TC-pertechnetate. The percentage of 99 TC bound to the enzyme was determined by thin layer chromatographic technique.

The radiolabelled trypsin was injected as an impulse in another set of experiments. The eluant was collected and radioactivity determined. The area under the response 'C' curve for 99 TC-pertechnetate trypsin was calculated and the degree of adsorption of the radiolabelled trypsin on pellathane determined. The hydrolytic cleavage of urethane bond by enzyme adsorption was elucidated. The studies on microstructural changes on polyurethane have paved the way for further studies on the interaction of the enzyme with the material.

Polyurethane interpenetrating polymer networks: (CIPN)

Polyurethane IPN offers biocompatibility as well as biostability. Some of the polyurethane IPNS based on MDI were found to exhibit such characteristics. In order to evaluate tissue and cell response to the material, surface characterization of IPNS was carried out using analytical techniques such as SEM, ESCA and Wilhelmy technique. Cytotoxic assays were carried out using L929 fibroblasts to understand the material-cell interaction. The studies were supplemented with HPLC analyses. Studies on material-tissue interaction were carried out after intramuscular implantation by histopathology and image analysis. The effect of the material composition on tissue response was also analysed.

Diffusion of model compounds in polymers

As the diffusion of biological molecules in biomedical materials and devices leads to catastrophic failure, diffusion of binary mixtures of organic solvents was studied with graft copolymers of polyurethane. The WAXD and diffusion data revealed the possibility of diffusion of specific molecules in the grafted polymer. Diffusion studies and solution properties were also used to understand the morphology and composition of the grafted polyurethane. Diffusion of lipids and leaching of plasticizer in polyvinyl chloride, one of the most needed polymers for extracorporeal applications, were also studied.

Chemical modification of polyvinyl chloride

Chemical modification of polyvinyl chloride to prevent the leaching of DEHP plasticizer into blood was attempted. Chemical modification was carried out by reacting a highly reactive modified polymer with PVC sheet in the presence of a catalyst. The studies were carried out with Chitra PVC, and commercially available PVC sheets. Early results suggested that the plasticizer migration could be reduced to zero level. Studies on the systemic toxicity and haemolysis of the modified PVC are planned.

Collaborative research

The Division carried out studies on the evaluation of multiwell culture

dishes and the effect of radiation sterilisation of culture dishes on cell growth to explore the reuse of these dishes. The investigation was done in collaboration with Dr. Shunmugam and Mr. Raveendranath, Division of Microbiology. Chemical modification of polystyrene sheets and the development of tissue culture grade polystyrene were also initiated.

Dr. Jayabalan visited the Department of Chemical Engineering, Hacettepe University, Ankara, Turkey with a Fellowship of the Third World Academy of Sciences for 2 months. He participated in the EUROBIOMAT Workshop on 'Biological modification of biomaterials' held at Antalya, Turkey and presented a paper on 'Experimental soft tissue implants-material morphology and tissue compatibility'.

Dr. Jayabalan attended the National Conference on Biomaterials and Artificial Organs held at CLRI, Madras and presented a paper on "Studies on cellular interaction with solid crosslinked polyurethane biomaterials".

Dr. Prabha D. Nair visited the Department of Dental and Bioengineering, University of Liverpool, under a BOYSCAST fellowship of the Department of Science and Technology, New Delhi for 6 months. She attended the conference of the European Society of Biomaterials held at Chester, UK and the workshop of the European Polymer Federation at the University of Liverpool.

Sri. K. Sreenivasan was awarded the Ph.D degree for his studies on 'the diffusion of biological molecules in polyurethanes'. Ms. Prabha D. Nair was awarded the Ph.D. degree for her 'studies on polyurethane interpenetrating network polymers for biomedical applications'.

Mr. N. Shunmugha Kumar completed his doctoral work under the guidance of Dr. Jayabalan and submitted his Ph.D thesis on 'Studies on the stability of polyurethanes and their interaction with tissues.'

DIVISION OF THROMBOSIS

Dr. M. Jamaluddin, Ph.D.	Scientist
Dr. Lizzy Kalliyanakrishnan, Ph.D.	Scientific Assistant (on leave)

Aggregation of blood platelets could trigger life - threatening thrombotic reactions the prevention of which demands better understanding of the mechanisms of aggregation. Work in this laboratory indicated the involvement of stimulus-induced, energy-dependent creation of heterogeneous platelet species which sort out partners by long-range, possibly hydrophobic, attractive forces.

Prof. Gundu H. R. Rao, University of Minnesota (U. S. A) visited the laboratory and gave lectures on "Current understanding of Blood-Material Interaction" and "The Aspirin Dilemma".

A paper by Dr. Jamaluddin entitled "Aspirin accelerates H_2O_2 induced platelet aggregation by causing inhibition of catalase" was accepted for presentation at the International Conference on Thrombosis, Buenos Aires, Argentina.

DIVISION OF ARTIFICIAL INTERNAL ORGANS

Mr. G. S. Bhuvaneshwar, B.Tech., M.S. (Bio Eng.)	Biomedical Engineer
Mr. C. V. Muralidharan, M.Tech. (Control Sys.)	Engineer
Mr. R. Sreekumar, B.Sc.	Scientific Assistant

The infrastructure for the pilot production of clinically usable valves under funding from National Research Development Corporation was organised with the help of Engineering Services and Technology Transfer Division. During this year about 50 valves in sizes 23 and 25 were supplied to the Department of Cardiac Surgery for the first phase of clinical trials. Project staff were systematically trained in the various processes involved in the polishing of both the valve cages and discs. About 100 cages and discs were readied for assembly at the year-end despite a high staff turnover in the project. The division actively interacted with TTK Pharma group for the transfer of technology of this device.

The staff were actively involved with the Technology Transfer Division for the transfer of the Chitra Humidifier to M/s. Peninsula Polymers Ltd., Thiruvananthapuram.

Active cooperation was extended to the Department of Neurosurgery, and Divisions of Polymer Technology and Technology Transfer in the pilot production of the first batch of hydrocephalus shunts for multi-centric trials.

DIVISION OF BIOMATERIALS TECHNOLOGY

Dr. R. Sivakumar, Ph.D.	Head, BMT Centre
Mr. B. Ajith Kumar, M.Tech.	Scientist
Mr. S. Vijayan, B.Sc.	Scientific Assistant

The Activities of the Division temporarily slowed down between the departure of Mr. Ramani and the assumption of charge by Dr. Sivakumar.

The staff took the initiative in relocating the transmission electron microscope from the hospital centre in the Biomedical Technology Centre and organising a composite unit for ultra structural studies with a new scanning electron microscope (Fig. 19). Other supportive activities included the preparation and supply of stainless steel (316 L) stents for trial in the Department of Radiology.

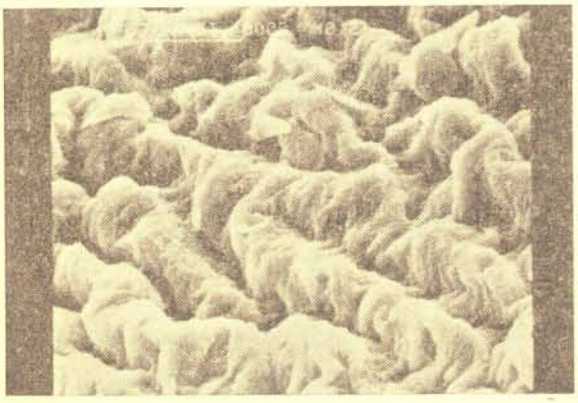


Fig. 19 Glutaraldehyde treated bovine pericardium. SEM of epicardial surface (smooth) X 2000

Mr. Ajith Kumar completed his M.Tech in metallurgical engineering in the IIT, Kharagpur and submitted a thesis on 'biocompatibility evaluation of laser glazed stainless steel'.

The Division continued to support the multicentric trial of the Oxygenator and Cardiotomy reservoir by providing inputs as necessary to the industry.

Dr. Sivakumar formally took charge of the Division in June 1991.

Dr. Sivakumar gave the following invited lectures:

i) "Standardisation in biomedical materials and devices", at the National Workshop organized by TIFAC, DST, Bureau of Indian Standards and CEI, Delhi.

ii) "Use of Lasers in Surface Modification" at the National Seminar on "Materials for National Technology and Industrial Economy" organized by Indian National Academy of Engineering, Hyderabad.

iii) "Design of Coatings for Gas Turbine Blades" MRSI Medal Lecture, at the 3rd Annual General Meeting of MRSI, Bangalore.

DIVISION OF BIOSURFACE TECHNOLOGY

Dr. Chandra P. Sharma, M.Tech, M.S., Sc.D.MEBE — Scientist
Dr. Thomas Chandy, Ph.D — Scientist
Mr. P. R. Hari, B.Sc. — Scientific Assistant

Hyperbilirubinemia is common among new-born infants and hemoperfusion using synthetic resins as sorbents has been used to reduce the bilirubin level. Beads were fabricated from chitosan, a natural polysaccharide from prawn shells, and tested for bilirubin binding. Several layers of poly-L-lysine were coated covalently onto chitosan beads using N plasma and carbodiimide treatments. Such surface modified chitosan beads exhibited high binding affinities for bilirubin in aqueous phosphate buffer solutions at 4°C. Since albumin is a natural bilirubin binder, the polylysine coated substrates were compared with albuminated surfaces for bilirubin binding. The surface immobilized polylysine showed better binding capacity for bilirubin than albuminated substrates.

Recently an effort was made to employ cheap raw materials and simplify the formulations for controlled release therapies. Nifedipine is one of the most potent calcium antagonists used extensively to treat angina and hypertension. Since the half-life of the drug is short, prolonged release of drug from chitosan matrix was tested. The in-vitro release profile of nifedipine from beads and micro granules of chitosan was monitored, as a function of time, using a U. V. spectrophotometer. The release studies were performed in a rotating shaker at 100 rpm, containing 0.1 M HCl buffer, pH 2.0 (gastric solution) or 0.1 M phosphate buffer, pH 7.4 (intestine solution), and the comparison made between drug loaded microbeads and granules. It was found that the amount and percentage of drug release were much higher in HCl compared to phosphate solution, probably due to the salt formation of the matrix (chitosan hydrochloride) at acid pH. In the in vitro studies the release rate of nifedipine from chitosan matrix was slower for the beads than for the granules. This may have therapeutic implications.

A technique was developed to encapsulate activated charcoal within a polymer matrix for hemoperfusion in liver failure. Activated charcoal was encapsulated within chitosan matrix (ACCB) in different concentrations and used as support for perfusion of a mixture of solutes having molecular weight ranges from 60 to 69,000 under a flow rate of 80 ml/mt. It was found that the ACCB may be a good adsorbent

system for .the removal of toxic uric acid, creatinine, bilirubin etc. from their solutions, while larger molecules like albumin are less adsorbed. The encapsulated charcoal did not leak out from the matrix during perfusion and the system may be useful for the detoxification of blood.

Attempts were made to modify the surface of plasticized polyvinyl chloride by gelatin using nitrogen gas discharge plasma treatment and a coupling agent, 1-ethyl-3-(3-dimethylaminepropyl) carbodiimide hydrochloride to enhance its blood compatibility and retard the migration of plasticizer without affecting the bulk properties of the polymer sheet. Accelerated leaching studies in polyethylene glycol-400 and cotton seed oil at 70°C demonstrated a reduction of leaching by 69% and 53% to the respective media.

In continuing the studies on blood-material interface events, the effect of protein adsorption onto polymer surfaces due to the presence of external lubricants like calcium stearate and silicone fluid coating was examined. It was observed that fibrinogen adsorption increased with the reduction in albumin at the surface.

In another study, acetyl salicylic acid (Aspirin) was blended with PVA for developing an improved blood compatible membrane for hemodialysis. It was found that aspirin-blended membranes were more hydrophilic and provided higher passage to solutes. Although the membranes became hydrophilic, the platelet and RBC adhesion were significantly reduced. It was felt that membranes with 0.768 mg of aspirin/ cm^2 may be used for application as dialysis membrane with enhanced blood compatibility and improved solute permeability.

Work related to PVA-polyether urethane urea was initiated for future applications in the area of oxygenator membranes, hemodialysis membranes, artificial skin and transdermal delivery systems. The preliminary studies showed that the mechanical strength of PEUU-b-PVA (90:10) membrane was comparable to the standard cellulose acetate membrane. The permeability of solutes is the same as that in PAN-b-PVA(8713) membrane. Further studies are in progress.

Hydroxy-apatite was prepared in the laboratory with particle size less than 45 microns. The characterisation of the samples is in progress.

An attempt was also made to develop chitosan-bonded hydroxy-apatite, bone filling paste with a very low setting time. The sample with CaO 1.8%, ZnO 6.0% and 92.2% of Hydroxy-apatite when bonded with chitosan had a minimum setting time of 2 min- 46 sec. The compressive strength of the dried mixture was 30 +/– 4 kg/cm.

PVA beads were developed and studies on the specific binding of low density lipoproteins (LDL) onto the modified PVA beads are in progress.

Patents applied for:

1. PVA + PA based membrane for insulin release.
2. Chitosan and activated charcoal encapsulated matrix for controlled release of drugs and other biomedical applications.
3. Polyvinyl (alcohol) and polyacrylonitrile blended membranes for haemodialysis.
4. Surface modification of plasticized polyvinyl chloride towards resistance to the migration of plasticizer.

Collaborative research

A collaborative project was initiated for the study of specific binding of low density lipoproteins (LDL) on polymer supports with the help of Dr. T.V. Kumari of the Division of Pathophysiology. Chitosan beads were modified with heparin, polyelectrolyte, and chondroitin sulphate and the ability of these substrates to bind LDL was investigated using electrophoretic techniques.

Miss. Nirmala Balwalli, Research Fellow of Indian Institute of Science, Bangalore, visited the laboratory to carry out blood compatibility studies of her polymer samples.

Dr. Thomas Chandy presented a paper entitled "Surface modified chitosan matrix as adsorbents for bilirubin", at the Vth National Conference of the Society for Biomaterials and Artificial Organs - India at CLRI, Madras.

Dr. Sharma continued to be the Editor of Trends in Biomaterials and Artificial Organs. He delivered the Presidential address of the Vth National Conference of Society for Biomaterials and Artificial Organs - India and became the First recipient of the Society's "Best Scientist Award – 91". He also delivered an invited lecture on Biomaterials on the occasion of 125th Anniversary of University College, Thiruvananthapuram. He was elected a member of the National Advisory Committee of the Vth National Conference on Surfactants, Emulsions and Biocolloids at University of Baroda. He has also been invited to join the Editorial Board of a Russian Journal "Biomaterials-Living Systems Interactions".

Project		Development of blood compatible functional polymers as selective adsorbents for protein-bound antigens during hemoperfusion.
Principal Investigator	:	Dr. C. P. Sharma
Co-investigator	:	Dr. Thomas Chandy
Status and duration	:	3 years – ongoing
Funding agency	:	Department of Biotechnology

DIVISION OF RESEARCH TOXICOLOGY

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

Standardisation work on the primary cell culture of macrophages, lymphocytes and cardiac cells was completed during the year. These cell culture systems have to be validated by running parallel experiments in animals and primary cell culture test system to establish a correlation.

The studies on the possible serum protein changes when implant materials are exposed to rabbit serum in-vitro made progress. The necessary infrastructure for carrying out the immunogenicity test was set up. Work was initiated to prepare amboceptor, antigen etc. necessary for the planned immunogenicity experiments.

Dr. P. V. Vedanarayanan participated in a brain-storming session on "Recent trends in laboratory animal science technology–an Indian perspective" held at National Institute of Nutrition, Hyderabad on 21 and 22 February 1992. Dr. Vedanarayanan inaugurated the scientific session of the annual convention of the Veterinary faculty association of Kerala Agricultural University.

DIVISION OF TOXICOLOGICAL SCREENING OF MATERIALS

Sri. K. Rathinam, M.Sc., FABMS, MIMSA — Scientist
Sri. P. V. Mohanan, M.Sc. — Scientific Assistant

Toxicological and biocompatibility studies of candidate materials intended for the fabrication of devices continued to be the main activity. The major effort during the year consisted of mandatory biological tests which are indicated in (Figs. 20, 21). The tests related to devices such as SPICTRA Oxygenator and they conformed to internationally accepted protocols.

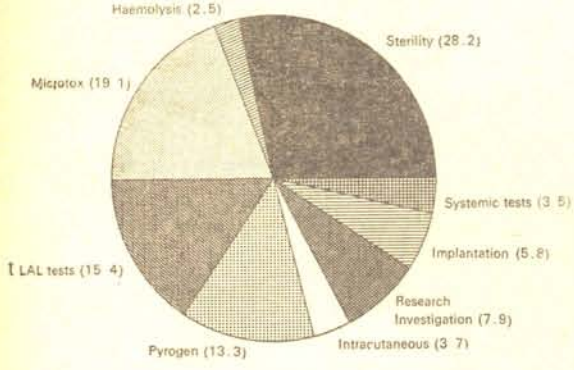


Fig. 20 Experiments conducted during 1992*

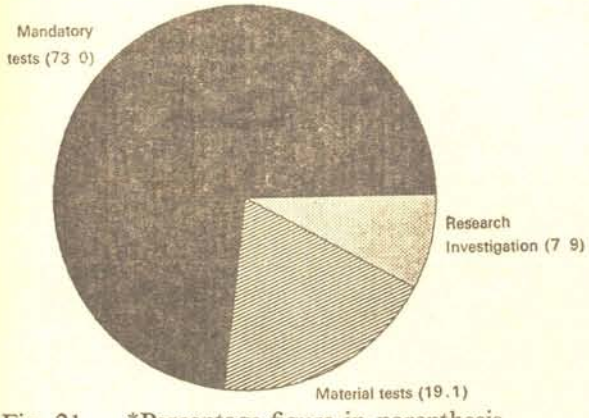


Fig. 21 *Percentage figure in parenthesis

Besides the above tests, a number of acute and sub-acute tests such as systemic toxicity, intracutaneous irritation, haemolysis, intramuscular/subcutaneous implantation, sensitisation etc. were also carried out (Figs. 22, 23)

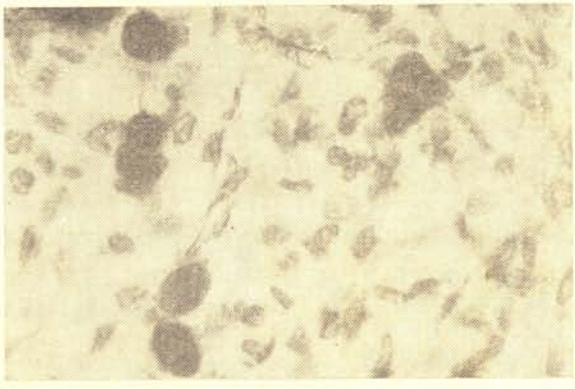


Fig. 22 Granulated (intact) mast cells of rat mesenteric tissue.

Fig. 23 Degranulated (as a result of exposure to toxic material extract) mast cells of rat mesenteric tissue.

Technical support and care of laboratory animals were also provided to the Cardiomyopathy group in their experimental studies on endomyocardial fibrosis.

A significant result obtained was the positive correlation between the in vivo pyrogen, in vitro LAL and in vitro Microtox tests in ongoing studies on 64 finished devices of Chitra technology. The attempt to standardise cytotoxicity studies using in vitro mast cell systems attracted the attention of investigators in India and abroad. A Crompton computer with colour monitor was added to the laboratory for enhancing the quality of Microtox analysis.

Mr. Rathinam received an Incentive Award for his important contributions to the development of medical devices and was elected a Fellow of the Indian Association of Biomedical Scientists. He also became a Member of the International Medical Sciences Academy. He gave lectures on various aspects of materials toxicology at the 11th Congress of Toxicology in Developing Countries in New Delhi, 12th Annual Conference of the Indian Association of Biomedical scientists and the meeting of the staff of Peninsula Polymers. Mr. Mohanan presented a paper at the 11th Congress of Toxicology in Developing countries.

Prof. A. Seidel of Germany visited the laboratory and held discussions on the in vitro test protocol for screening biomaterials.

DIVISION OF PATHOPHYSIOLOGY

Dr. Mira Mohanty, MD. Scientist
Dr. T. V. Kumari, Ph.D. Scientific Officer

As in previous years, the histopathological response to a variety of candidate materials was studied. The materials included laser-glazed stainless steel discs, silicone rubber, ultra-high-molecular-weight polyethylene, delrin and sapphire. Techniques for processing hard tissues were also standardised in view of the growing importance of studying their response to materials.

The research effort centred on the mechanisms of cell-biomaterial interactions. The study basically involved tissue culture technique using macrophages and evaluating their response to materials by analysing their secretory products on activation. The project on the preparation of a safe and non-toxic hemoglobin solution as a possible blood substitute was continued. Collaborative support was given to the projects of other Departments and Divisions as shown in Table 23.

Table 23

	Project	*Department/Division*
1.	Adsorption of lipoprotein on chitosan beads	Biosurface Technology
2.	Pulpal response to dental restorative material	Polymer Technology
3.	Histopathological evaluation of experimentally induced peripheral nerve regeneration	Neurology
4.	Histopathological study of myocardial revascularisation by transmyocardial laser puncture	Cardiac Surgery
5.	Histological study of artificial skin	Biosurface Technology

Dr. Arnulf Siedel of Karlsrube, Germany visited the laboratory and discussed the technique of macrophage culture with the scientific staff. Dr. Mira Mohanty gave an invited lecture on biomaterials-host tissue interactions at the Indo-Japanese discussion meeting sponsored by the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore. Dr. Indulekha Warrier, Medical College, Thiruvananthapuram worked in the Division under the supervision of Dr. Kumary on the hemoglobin solution project.

DIVISION OF POLYMER CHEMISTRY

Dr. A. Jayakrishnan, Ph.D	Scientist
Dr. B. Chithambara Thanoo, Ph.D (on leave)	Scientist
Mr. M. C. Sunny, B.Sc., A.I.C.	Scientific Assistant

The main activity of the Division was concerned with the development of controlled-release polymeric formulations. Presently, the activity is focussed on the controlled release of cytotoxic drugs from biodegradable protein matrices, sustained release of oral drugs from non-biodegradable polymeric matrices and the controlled release of anti-fertility vaccines from biodegradable synthetic polymer matrices.

The Division is also engaged in the surface modification of polymers for improved blood and tissue compatibility. In this area, the activity is presently concentrated on the surface modification of the polyester sewing ring of the heart valve prothesis by grafting hydrophilic polymers using ultra violet radiation. Work is also in progress on the surface modification of plasticised polyvinyl choride to retard or prevent plasticizer migration.

Another area of research the Division presently pursues is the preparation and characterization of water absorbing polymeric microspheres for therapeutic embolization in continuation of the work which had already been initiated. Work on the preparation of a fluid

Project		Controlled release of anti-fertility vaccines from biodegradable polymeric matrices.
Principal Investigator	:	Dr. A. Jayakrishnan
Co-investigator	:	Dr. B. C. Thanoo Dr. K. Sreenivasan
Funding Agency	:	Department of Biotechnology
Duration		Three years
Status		Ongoing

embolization-material is also being pursued along with the synthesis and characterization of radiopaque monomers and polymers for biomedical applications.

Dr. B. C. Thanoo left for the Department of Pharmacy, University of Kentucky, USA on extraordinary leave for 18 months to accept a post doctoral assignment.

Dr. A. Jayakrishnan joined the division after spending a year as a Visiting Scientist at the Department of Materials Science and Engineering, University of Florida, USA.

DIVISION OF POLYMER TECHNOLOGY

Dr. S.N. Pal, B.Tech., M.Sc. (Tech), Ph.D	Scientist
Sri. V. Kalliyanakrishnan, M.Sc.	Scientist (on leave)
Mr. Roy Joseph, M.Sc., M.Tech.	Scientist

As part of routine activity, 1700 chest drainage tubing systems were fabricated and supplied to the hospital wing. Training was imparted to the project staff (TPF) for the hydrocephalus shunt and nearly 4000 components for hydrocephalus shunt were made by them in the Division.

In the field of research and development the clinical trial of the blood transfusion microfilter was completed during the year. A requirement for the development of bonewax came as a result of the problems faced by the hospital in getting regular supplies. After standardization of the processes and formulation, the material was characterized for its physico-chemical behaviour and potential for toxicity. More than 750 foils were made for clinical trial. The newly developed bonewax was used in more than 200 open heart and neurosurgical operations with satisfactory results.

A major project related to the development of composite dental restorative materials.

After completion of the work related to physico-chemical characterization, materials toxicology and in-vivo trial with animal model, the two component

Project	:	Development of indigenous composite dental restorative materials
Principal Investigator	:	Dr. S. N. Pal
Co-investigators	:	Dr. Mira Mohanty Mr. K. Rathinam Dr. Arthur Vijayan Lal Dr. M. Jayabalan
Consultant	:	Dr. (Mrs.) A. Valiathan
Funding	:	DST
Status	:	Ongoing

Bis-GMA based dental composite was cleared for clinical trial. The materials developed were employed as cavity filling material, for direct bonding of brackets and for aesthetic repair. Results obtained so far indicate that the Chitra materials perform as good as any established imported brand. Further clinical trials are continuing.

The development work related to visible light-curing type Bis-GMA based composite was also initiated and the development of the formulation is nearing completion.

Consultancy was extended to M/s. Hindustan Latex Ltd. (HLL) in preparing an uptodate project report on the manufacture of blood bags.

One visible light source was procured from the funds available under the DST sponsored project on dental materials.

A patent application for Bis-GMA based composite was filed.

Sri. V. Kalliyanakrishnan spent one year from April 1991 at the Institute of Medical and Dental Bio-engineering, Liverpool with a fellowship under the Colombo Plan.

One B. Tech and one M. Sc. student from Cochin University of Science and Technology were guided for their research project.

Staff under the HLL sponsored project for the pilot production of hydrocephalus shunt received training in the Division.

DIVISION OF TECHNOLOGY TRANSFER

Mr. H. Vijayakumar, BE, MS, PGDBA — Scientist
Mr. D. Ranjit, BE — Scientist
Mr. D. S. Nagesh, BE — Scientist

The activities of the Division were many sided involving as they did tie-ups for commercialisation, batch production, technology training and documentation, and engineering consultancy. The transfer of the Chitra valve technology by the National Research Development Corporation to M/s. TTK Pharma and the signing of an agreement by the Corporation with an Egyptian company for the transfer of the blood bag technology were important landmarks in the technological endeavour of the Institute.

Medical devices production

The Technoprove facility was utilised fully to produce clinical grade devices shown below which account for a foreign exchange saving of Rs. 50 lakhs.

Table 24

Blood oxygenator	1000
Cardiotomy reservoir	600
CSF shunts	120
Custom packs	700
Mediastinal drainage sets	350

SPIC sponsored projects on oxygenators and cardiotomy reservoirs

The user feedbacks obtained from multi-centric trials were successfully incorporated in the pilot production of blood oxygenators and cardiotomy reservoirs which improved functionally and aesthetically as a consequence. A team consisting of an engineer and three technicians were trained and three volumes of documents consisting of component drawings, assembly procedures were completed. Engineering consultancy was also provided on a continuing basis to the manufacturing facility of SPIC which was expected to enter production shortly.

Hindusthan Latex sponsored project on CSF shunt

The Technoprove facility was expanded by the addition of 2000 sq. feet to meet the demand for pilot production. Plant and equipment were commissioned, production fixtures and dies fabricated, manpower trained and unit processes streamlined on schedule with the support of the Division of Artificial Internal Organs and Polymer Technology. Assistance was also provided to the

company in the preparation of the detailed project report which was technically defended before the funding institution. The plant layout as prepared was designed for an installed capacity of 5000 shunts and a monitoring committee met regularly to watch the progress of the project.

The equipment added to the facility included a two-day--light compression press, electronic balance for quality, guillotine type shear for cutting and indexing surgical tubings.

Custom Packs

The complete knowhow document was sent to South India Petrochemical Industries Corporation (SPIC) and Peninsula Polymers Ltd, who had taken the technology. The SPIC Employees were also trained in the fabrication procedures.

Ethylene oxide Sterilisation technology

M/s Madhavi Mandiram Trust, Neyyattinkara which seeks to promote small scale industries for the uplift of rural women was given assistance in setting up and running their ethylene oxide sterilisation unit. Two of their technical staff were also given hands-on training in the process stages of the Technoprove facility.

Mediastinal drainage system

Following the transfer of technology, detailed technology documentation was handed over to M/s. Peninsula Polymers, Thiruvananthapuram and batch production begun with a group of four technical staff from the Company.

Status Report on Intellectual property Rights

The current status is shown below

Table 25

Patents sealed	6
Design held	9
Patent applications filed	8
Designs filed	1

Mr. Ranjit coordinated the participation of the Institute in the Science Exhibition, Baroda. Mr. Nagesh rejoined after completing his M.Tech course from IIT, Bombay.

DIVISION OF TOOL ROOM ENGINEERING

Mr. O.S. Neelakantan Nair, B.Sc. (Engg.) Engineer

Apart from meeting the demands for overall maintenance of electrical, sanitary and airconditioning systems, the staff were also responsible for the smooth operation of the Panbit, Incinerator, telephone exchange and the faculty hostel installations. These activities did not interrupt the R & D programmes which related to the pilot production of Chitra valve housing for the multi-centric trial, fabrication of valve holders and leak testers, development of cryo-machining facility and high pressure syringes.

A refrigerated cooling system for the cryomachining of ultra high molecular weight polyethylene discs and a precision model LZ300 G-Gedee Weiler lathe were added to the Tool Room during the year.

DIVISION OF VIVARIUM

Dr. G. Arthur Vijayan Lal, BVSc. — Veterinary Scientist
Dr. S. Bhaskara Rao, MVSc., LLB FVPHAI — Veterinary Surgeon.

Apart from maintaining the vivarium, the Division provided support to various other groups in experimental studies listed in Table 26.

Table 26

Project	*Department/Division*
Experimental model for myocardial infarction and laser revascularisation of myocardium	Cardiovascular and Thoracic Surgery
Development of BIS-GMA based composite dental materials	Polymer Technology
Mannitol administrations in the control of experimental hydrocephalus	Neurosurgery
Mitral valve replacement with Chitra valve	Cardiovascular and Thoracic surgery
Nerve regeneration through synthetic biodegradable nerve guide	Neurology
Large diameter vascular graft	Cardiovascular and Thoracic surgery

The Division also met the experimental requirements of various other groups such as Toxicological screening, Pathology, Thrombosis, Neurochemistry, Cardiomyopathy and Microbiology for tissue samples and small animals. The Vivarium housed sheep, dogs, rabbits, rats, guinea pigs and mice for the studies.

Dr. Arthur Vijayan Lal was selected for the Institute Award for his contribution to the development of devices technology. Dr. Bhaskar Rao was elected President of the Veterinary Public Health Association. He took part in the brain storming meeting on laboratory animal management sponsored by the Indian Council of Medical Research.

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ADMINISTRATIVE BODIES (1991 - 96)

INSTITUTE BODY

President — Sri Nani A Palkhivala

1. Sri. Anil Bordia, (Ex-officio)
Secretary to the Government of India,
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3. Prof. R. N. Chakravarti,
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4. Sri. G. Gopalakrishna Pillai (Ex-officio)
Commissioner & Secretary to the Government of Kerala,
Department of Health and Family Welfare,
Thiruvananthapuram.

5. Prof. Indira Nath,
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7. Sri. R. L. Misra (Ex-officio)
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8. Dr. P. Rama Rao, (Ex-officio)
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Ministry of Science and Technology,
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15. Dr. J. V. Vilanilam, (Ex-officio)
Vice Chancellor,
Kerala University,
Thiruvananthapuram

16. Dr. M. S. Valiathan, (Ex-officio)
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Sree Chitra Tirunal Institute,
Thiruvananthapuram–695 011.

17. Dr. G. K. Viswakarma, (Ex-officio)
Director-General of Health Services,
Government of India, Nirman Bhavan,
New Delhi–110 011.

18. Dr. N. H. Wadia,
Director of Neurology,Jaslok Hospital,
Consultant Neurologist,
J. J. Group of Hospitals, Bombay-
(Ben Nevis, B. Desai Road,
Bombay–400 036).

19. Dr. B. N. S. Walia,
Director,
Postgraduate Institute of Medical
Education and Research,
Chandigarh – 160 012.

20. Member of Parliament } To be nominated
21. Member of Parliament }

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Secretary to the Government of India,
Ministry of Science and Technology,
(Department of Science and Technology
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2. Prof. C. G. Ramachandran Nair (Ex-officio)
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Government of Kerala, Thiruvananthapuram.

3. Prof. D. V. Singh,
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4. Dr. R. Sivakumar, (Ex-officio)
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Thiruvananthapuram–695 012.

5. Dr. M. S. Valiathan, (Ex-officio)
Director,
Sree Chitra Tirunal Institute,
Thiruvananthapuram–695 011.

6. Dr. C. G. Venkitachalam
Professor of Cardiology,
Sree Chitra Tirunal Institute
Thiruvananthapuram–695 011.

7. Dr. G. K. Viswakarma, (Ex-officio)
Director-General of Health Services,
Government of India, New Delhi-110 011.

8. Dr. N. H. Wadia,
Director of Neurology, Jaslok Hospital,
Consultant Neurologist,
JJ Group of Hospitals, Bombay

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Sree Chitra Tirunal Institute, Thiruvananthapuram.

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Sree Chitra Tirunal Institute,
Thiruvananthapuram–695 012.

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Thumba, Thiruvananthapuram.

Head, Biomedical Engineering & Technology Centre
Sree Chitra Tirunal Institute,
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Financial Adviser & Chief Accounts Officer,
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Thiruvananthapuram (Ex-officio Convener).

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(Shri S. B. Krishnan).

Prof. R. N. Chakravarti,
Viswaskhand–III, 3/261,
Gomati Nagar, Lucknow-226 015.

Financial Advisor and Chief Accounts Officer,
Sree Chitra Tirunal Institute
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Junior Staff Selection Committee

Medical Superintendent
Sree Chitra Tirunal Institute,
Thiruvananthapuram.

Head, BMT Centre,
Sree Chitra Tirunal Institute,
Thiruvananthapuram.

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Biomedical Technology Wing,
Sree Chitra Tirunal Institute,
Thiruvananthapuram.

Nursing Superintendent,
Sree Chitra Tirunal Institute,
Thiruvananthapuram.

A Representative of the Academic Staff of the Institute nominated by the Director.

Senior Staff Selection Committee

Director of the Institute (Chairman)

Head,
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An expert from outside the Institute nominated by the President.

A Professor from the Institute.

Technology Development Committee

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Sree Chitra Tirunal Institute,
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Technology Transfer Committee

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Mr. A. K. Nair,
Kerala State Industrial Development Corporation,
Thiruvananthapuram.

Head,
Division of the Technology Transfer,
Sree Chitra Tirunal Institute

Expert Nominee
(in case of devices)

Principal Investigator,
(for specific devices)

FA & CAO of the Institute.

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