ANNUAL REPORT
1990-91

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, THIRUVANANTHAPURAM

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FOR

MEDICAL SCIENCES AND TECHNOLOGY

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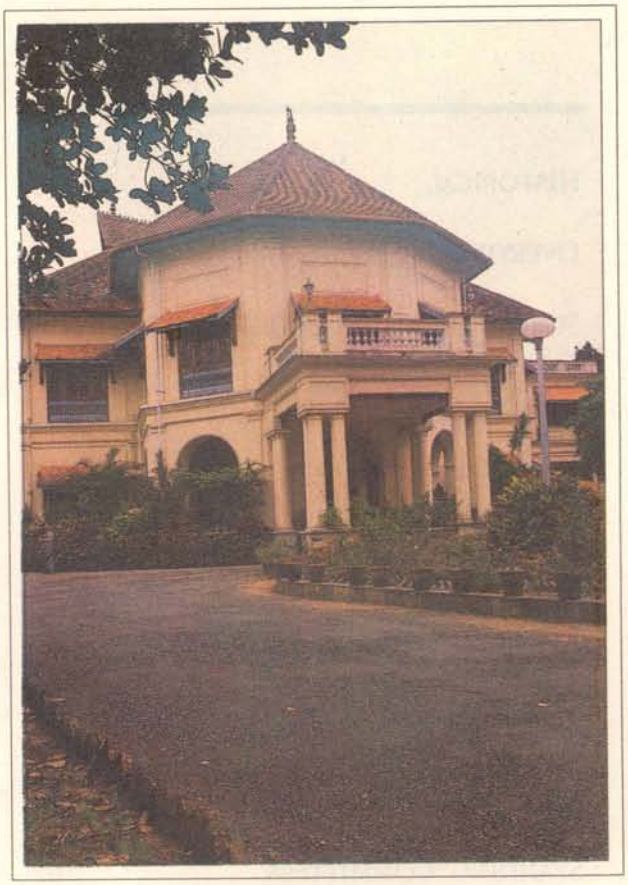
Contents

Cover *Chitra Heart Valve: Stages of development from cryo machining to use in patients.*



SATELMOND PALACE

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 Wing 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 1981. 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.

Annual Report 1990-91

Overview

YEAR after year the Annual Reports had highlighted the increase in the volume of patient services and the continuing emphasis on free or subsidised care for the low income groups at the Institute. To no one's surprise, the gap between supply and demand was not small to begin with, but it reached disturbing proportions during the year. The problem of supply-demand mismatch never needed aggravation; but it was aggravated further by the escalation in prices of drugs, devices, spares and other hospital items which made further inroads into the budgetary resources of the Institute. Given the minimal growth in cardiac and other specialised services elsewhere, especially for the poor, the prospects for a reduction in the pressure on the Institute's services did not however seem bright. Be that as it may, the notable development during the year was the commencement of the clinical trial of the Chitra heart valve. Claiming a long decade and the tireless effort of a multidisciplinary team, the story of the Chitra valve is a study in miniature of the travails of technology development in India. It is an index of the complexity of the device that inputs and assistance for its development had to be sought from experts outside the Institute and the names of Prof. S. Ramaseshan of Raman Research Institute, Dr. C. G. Krishnadas Nair, Managing Director, Hindustan Aeronautics Ltd. and Dr. A. Parthasarathy, Director, Government Tool Room and Training Centre, Bangalore are particularly noteworthy.

A decade after its declaration as an Institute of National Importance, the Institute is poised now to forge ahead and build on the technological foundations which have been laid so far. The heart valve, blood bag, hydrocephalus shunt, oxygenator and other technologies proclaim in no uncertain terms the ability of the Institute to conceive, develop and successfully transfer for production medical devices which are

manufactured in no more than a handful of countries in the world. They have also shown that while the time scales and priorities may bar the development of a particular item in medical technology, the Institute can accomplish any job in its areas of interest if and when society demands, no matter whether the challenge relates to an implantable lens, cochlear implants or an artificial heart. It is a truism that the practice of modern medicine is impossible in a village dispensary or in a tertiary hospital without technological support. What is less obvious is that the technological support for the medical care of India's millions cannot be maintained as long as the country is obliged to import the whole range of products and technologies which sustain the hospital services of the nation. The recurrent crises in hard currency resources and the enormous domestic demand for medical care make it imperative that science and technology are harnessed to the fullest extent in establishing a self reliant base for medicine in instrumentation, diagnostics, drugs, devices and biological products.

From the nineteenth century, the history of western medicine made it clear that major advances in medicine invariably result from the impact of discoveries in science. Nitrous Oxide, Roentgen rays, radioisotopes, penicillin and a long list of shining discoveries illustrate the powerful influence of chemistry, physics, microbiology and other sciences on the practice of medicine. In the second half of the present century, engineering and modern biology began to mould medicine as never before. This trend will continue and incorporate increasingly higher levels of science and technology in the practice of medicine. The life and work of the Institute are cast on the dynamic frontier between medicine and technology and to the extent its endeavour succeeds in building a self-regenerating, technological base for medicine, it shall have fulfilled its national mandate.

Survey of Major Programmes

Hospital Services

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

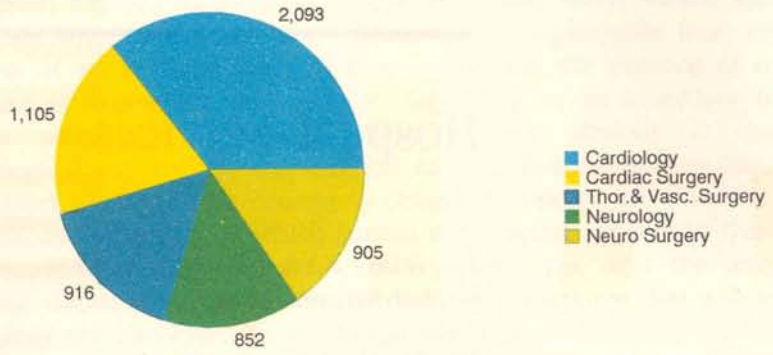
DR. D. HARIPRASAD, MD
Administrative Medical Officer

THE increase in the volume, range and quality of patient services was instrumental in putting the referral system under considerable strain. In the interest of the satisfactory management of patients in the out patient clinic, the Institute had been obliged to insist on limits to daily registrations and admissions, which tended to lengthen the waiting period for patients. The problem was compounded by the fact that a good percentage of patients were referred by clinics and physicians without even carrying out primary investigations. While this led to a scrutiny of the present practice of referral on the one hand, the sharp increase in the price of imported devices and hospital disposables necessitated an ongoing review of the hospital rates which could no longer be subsidised at the current level.

Fig. 1 Hospital Statistics

The hospital statistics and the distribution of expenditure are given in Fig. 1 to 8. In spite of restrictions, the number of new registrations and admissions continued to show a modest increase (Fig. 1, 2 & 3) whereas the corresponding

Fig. 2 Hospitalisation



increase in laboratory investigations (Fig. 4) complex diagnostic procedures (Fig. 5) and surgical operations (Fig. 6, 7) was notably higher. The pattern of expenditure for the Institute as a whole and for the hospital wing alone (Fig. 8) showed little change from the previous year even though the expenditure increased in absolute terms thanks to the enhanced payments to staff and the increase in the price of goods and services in every aspect of hospital care.

Fig. 3 Follow-up Cases

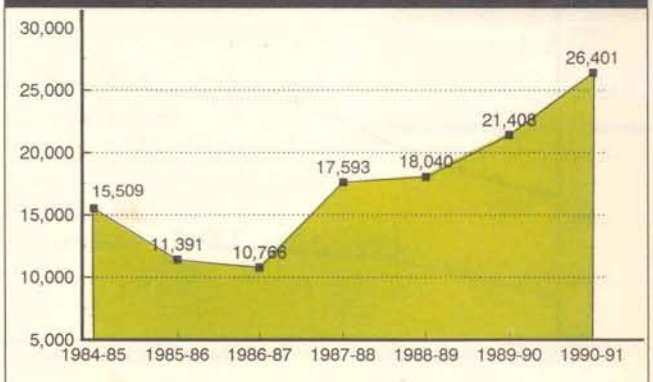


Fig. 4 Laboratory Investigations

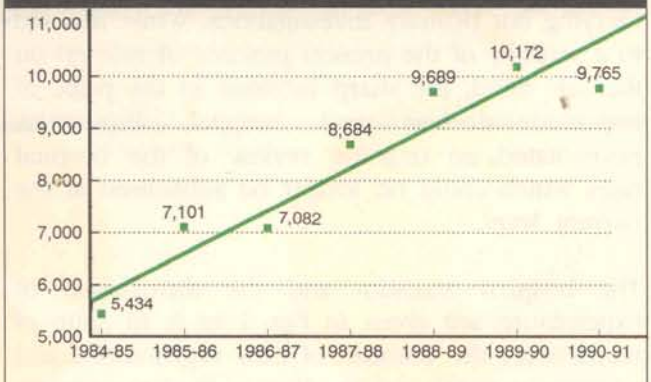


Fig. 5 Complex Investigations & Procedures

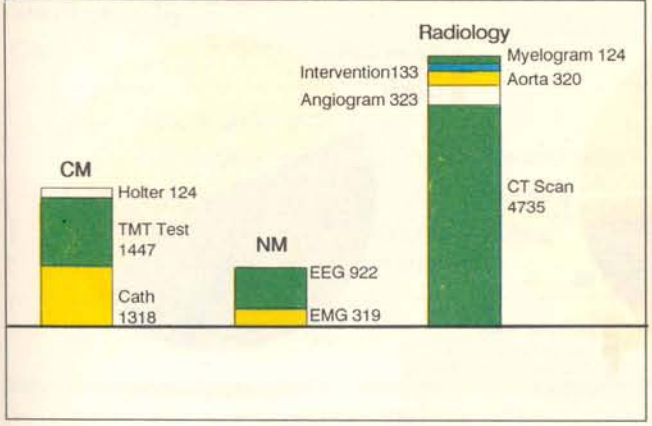
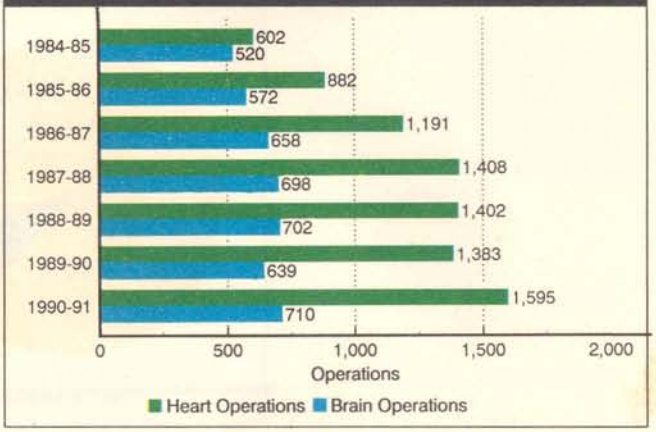


Fig. 6 Heart & Brain Operations



The Central clinical laboratory was relocated in the space vacated by the administrative divisions after extensive modifications and the addition of new facilities. The new location was superior to the earlier one in so far as it was more spacious and was situated equidistantly from the medical and surgical blocks of the hospital. The space vacated by the Central clinical laboratory underwent modifications for the use of the cardiac clinic which needed additional room for computerised treadmill test, echocardiography and other outpatient procedures.

Fig. 7 Surgical Operations

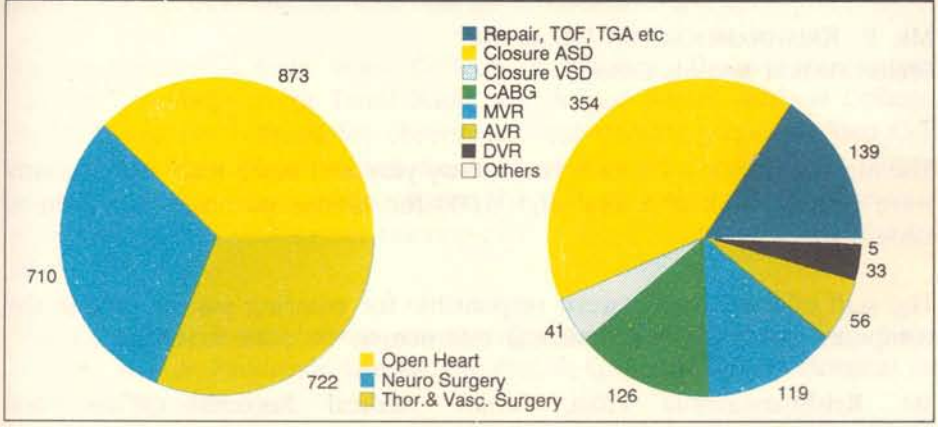
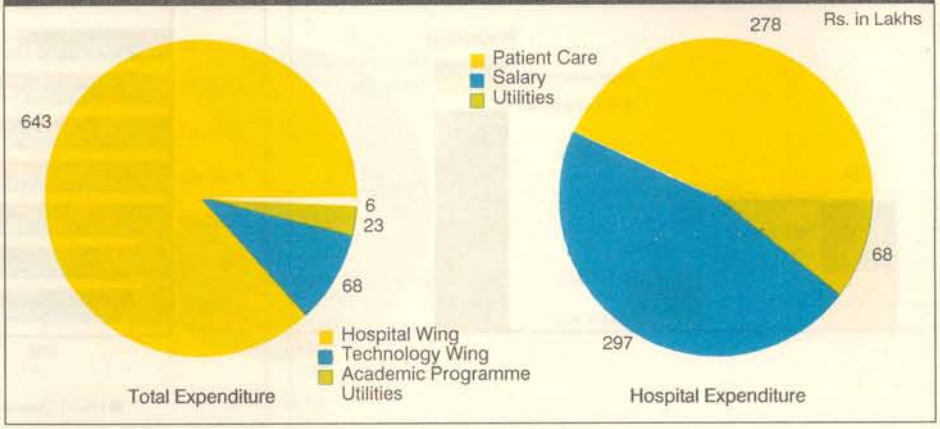


Fig. 8 Distribution of Expenditure



The Hospital audit committee which included the Heads of Clinical Departments, Nursing Superintendent and Administrative Medical Officer met every month under the Chairmanship of the Medical Superintendent to review matters relating to patient care and make recommendations for improvement or corrective action. The reports of the Committee did serve to tone up the hospital administration.

Medical Records

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

The Medical Records Division had a busy year and more than 40,000 charts were retrieved out of a total of 100,000 for various purposes as shown in table 1.

The staff of the Division were responsible for entering patient data in the computer and preparing statistical information on patient services.

Mr. Krishnamoorthia Pillai, Senior Medical Records Officer and

Mrs. Ramavathy, Medical Record Assistant, attended the National Seminar on Health Records Management and the former presented a paper on 'computer applications in medical records'.

Table 1.

1.	Follow up clinics	26,400
2.	Correspondence with Physicians and patients	10,300
3.	Analytical and retrospective studies	3,800
4.	Updating the list of patients awaiting valve replacement	2,900

Nursing Services

MRS. CHANDINI TYAGI, B.Sc (Nursing)
Nursing Superintendent

The nursing services functioned satisfactorily and the postbasic course and in-service educational programmes were conducted by Mrs. P.P.Saramma, Instructor in Nursing. Mrs.Chandini Tyagi joined as Nursing Superintendent.

As in previous years, staff movements were considerable and 24 new staff nurses joined and 22 staff nurses resigned during the year. Inservice education programme continued; but the annual conference for Nurses could not be held due to unavoidable circumstances.

Undergraduate students from College of Nursing, Thiruvananthapuram, Kottayam, Ambiliki from Tamil Nadu, and Armed Forces Medical College, Pune, visited the hospital for observation and training purposes. Two O.T. Supervisors from Bhilai visited the Institute for observation for 2 weeks. Four nun sisters from Trichur Heart Hospital gained practical experience in cardiac and cardiothoracic nursing care in the hospital for a total period of 8 months.

The P. N. Berry's scholarship was awarded to Mrs. Maria Jose, Staff nurse for one year in Paediatric Cardiac Nursing, at Queen Elizabeth Hospital for Children, London.

Mrs. Thankamma Chacko, staff nurse, thoracic surgery ward was awarded a certificate and Rs.100/- for her resourcefulness and timely revival of a patient from cardiac arrest.

Hospital Economic Unit

DR. V. RAMANKUTTY, MD, M.Phil., MPH
Scientist

The major activity of the unit during the year related to the project on a "study of the community prevalence of coronary artery disease" which was started in the Thiruvananthapuram district. A study team consisting of one doctor (Research Associate), a social scientist (Research Assistant), an ECG technician and a helper was recruited in April 1990. From the entire rural population of Thiruvananthapuram district, a sample of five villages was drawn by appropriate techniques. The selected villages were Nemom, Pallichal, Kulathoor, Manambur and Peringammala. The survey was completed in three villages, and partial results from two villages are appended in table 2. This study was partially funded by the Kerala State Committee on Science and Technology and is continuing in the current year.

Table 2- Results of Survey on Coronary Artery Disease (Interim)

	Panchayat	Total No.		No. Examined	ECG Abnormalities
1.	Nemom	M	123	113	15
		F	133	133	10
		Total	**256**	**246**	**25(10.2%)**
	Response Rate = 96.1%				
2.	Pallichal	M	118	100	7
		F	138	131	6
		Total	**256**	**231**	**13(5.6%)**
	Response rate = 90.2%				

Apart from this, the unit helped in the production of a booklet on coronary artery disease in Malayalam which was brought out by the Institute as part of a new health education programme. Dr. Ramankutty also collaborated with the academic divisions of the Institute and other institutions in various research projects.

Clinical Engineering

MR. R. MOHANDAS, ME
Biomedical Engineer

MR. KORUTHU P. VARUGHESE, B.Sc.(Engg) PGDEDT
Assistant Biomedical Engineer

MR. G. MOHAN LAL, B.Sc.(Engg)
Assistant Engineer

The activities covered the routine maintenance of electromedical equipment and utilities with the reduction of down time to the minimum. The division was actively involved in fixing the specifications for a Magnetic Resonance Imaging system (MRI) to be purchased by the Institute.

Mr. Mohan Das visited the Sanjay Gandhi Postgraduate Institute of Medical Education, Lucknow, on invitation. He organised with Mr. Koruthu Varughese, the IEEE International Conference on 'Frontiers in Imaging'. He was appointed a member of the Board of Studies in the Cochin University and the Medical Equipment sub-committee of the Bureau of Indian Standards.

Computer Section

MRS. G. GEETHA, M.Tech.(Comp. Science)
Systems Manager

MR. K. VIJAYAKUMAR, B.Sc., B.Sc.(Engg)
Assistant Biomedical Engineer

Mrs. G. Geetha joined the Division as the first Systems Manager.

The routine activities were the preparation of software for medical records, inventory processing for pharmacy, and general stores, financial accounting and pay roll. In the Medical records division, programme development and modification were carried out in FOX BASE to suit the PC environment while maintaining the characters. FOX BASE programme was devised for donor's data in the blood bank and for processing frequent and sundry tenders for pharmaceutical items.

As part of the plans for upgrading the Division, the systems requirement of the Institute was identified and procurement advanced to the final stage of a UNIX based MINI SYSTEM (486-EISA) with eight terminals. The upgradation of the PC in the library to a Lanserver with CD ROM drive attached was also planned. Two PC-AT 386 SX units were purchased during the year.

On conversion of all remaining softwares (Store/pharmacy inventory and financial accounting) from PSI Omni system to a UNIX BASED SYSTEM after suitable additions / modifications, the Division will interact more closely with various research departments and tailor-make softwares to the specific needs of faculty members. Effort will also be made to familiarize the faculty and staff on the best utilisation of the machine and softwares.

Biomedical Technology Wing

MR. A. V. RAMANI, BSc(Chem. Tech.)
Head

THE convergence of medicine and technology which inspires the activities of the Biomedical Technology Wing found triumphant expression in the clinical trial of the Chitra heart valve during the year. Primarily developed by the Division of Artificial Internal Organs, scarcely had any single technology owed more to so many Divisions and Departments in the Institute as a whole. The pilot production of 300 valves was financed by the National Research and Development Corporation and the first batch was slated for use on a multicentric basis for establishing the safety and efficacy of the device during its premarket evaluation.

The 'technoprove experiment' proved itself by strengthening the link between the research effort of the Institute and the industry. The pilot production of over 1000 SPICTRA Oxygenators and cardiotomy reservoirs for the Southern Drugs and Devices made progress and was due to end in the last quarter of 1991 when the factory was expected to start commercial production of the devices in Madras. The Technoprove facility was expanded to meet the concurrent demand for the pilot production of the hydrocephalus shunt.

The Indo-UK link programme which had made it possible to hold two Indo-UK Symposia in Thiruvananthapuram and for several young scientists to exchange visits during a three year period was extended by the British Council for further period of three years. A detailed plan of activities for the extended period is under preparation which will lay greater emphasis on the joint execution of projects than on the exchange of visits.

Library

MRS. JAYASREE THANKOM, MA, B.Lib.Sc
Assistant Librarian

The Library at the Biomedical Technology Wing continued to support research and development activities with the addition of 187 new books.

The six-year-old computerisation activity of the library received a major fillip with the acquisition of a PC-AT compatible computer under the library computerisation programme. The computerised bibliography database started in 1984 in a small way grew to cover 26 subjects of research interest with over 6000 entries in all. They were regularly updated and new topics added on request.

Educational Programmes

MR. V. NARASIMHAN, MSc, MIMS
Registrar (upto 24.6.1990)

PROF. G. N. AMBIKATMAJAN NAIR, MD (Biochem.), MD (Biophy.)
Registrar (from 1.11.1990)

Ph.D programme

Miss. Jyothi V. Nair and Mr. Madhusoodana Nambiar who had registered for Ph.D in Biochemistry under Prof. Debkumar Basu, submitted their theses, which were accepted after evaluation and defence, during the year 1989.

The lists of candidates registered for Ph.D and those who have submitted their theses, are shown in Tables 3 and 4 respectively.

Table 3 - Candidates registered for Ph.D

Name	Area	Guide
1. Mr. V.M. Kannan, JRF, Division of Neurochemistry	Identification and characterisation of endogenous glycolipid brain galactose binding lectins.	Dr. P.S. Appukuttan, Asst. Professor, Division of Neurochemistry.
2. Mr. P.L. Jaison, SRF, Division of Neurochemistry	Functional and Physicochemical characterisation of endogenous glycoprotein receptors of mammalian brain galactose binding lectins.	Dr. P.S. Appukuttan, Asst. Professor, Division of Neurochemistry.

Table 3 - Candidates registered for Ph.D (Continued)

Name	Area	Guide
3. Mr. K. Rathinam, Scientist, Division of Toxicological Screening of Materials, BMT Wing.	Studies on interactions between polymer biomaterials and staph. epidermid strains.	Dr. J. Shanmugham, Addl. Professor. Division of Microbiology.
4. Mrs. K. Naseema, Scientific Assistant, Division of Microbiology.	Role of adherence in the Pathogenesis of Rheumatic fever due to Group A streptococci.	Dr. M. Jamaluddin, Scientist, Division of Thrombosis.

Table 4 - Candidates who have submitted their theses for Ph.D

Name	Area	Guide
1. Mr. V. Kalliyanakrishnan, Scientific Assistant, Division of Polymer Technology.	Studies on the radiation grafting of hydrophilic monomers onto plasticized polyvinyl chloride to prevent plasticizer migration.	Prof. Joseph Francis, Head of the Dept. of Polymer Science and Technology, Cochin.
2. Mr. K. Sreenivasan, Scientific Officer, Division of Technical Evaluation of Biomaterials, BMT Wing.	Studies on the diffusion of physiological fluid molecules in polyurethanes.	Dr. K. V. C. Rao. ABR Organics Ltd. Hyderabad.
3. Mr. Bobby Zachariah, Division of Neurochemistry.	Physicochemical studies on cell surface glyco-conjugates of neuron from developing human brains.	Prof. Debkumar Basu, Division of Neurochemistry.
4. Ms. Yasmin Marikar, Division of Neurochemistry.	Biochemical studies on cell surface glycoproteins of glial cell in developing human brain.	Prof. Debkumar Basu, Division of Neurochemistry.

Table 4 - Candidates who have submitted their theses for Ph.D (Continued)

Name	Area	Guide
5. Mrs. Prabha D. Nair, Scientific Officer, Division of Technical Evaluation of Biomaterials, BMT Wing.	Polyurethane interpenetrating polymer networks for biomedical applications.	Dr. V. N. Krishnamoorthy, VSSC, Thiruvananthapuram.
6. 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., Indian Institute of Technology, Madras 600 036.

Admission

The nation-wide appeal of the academic programmes of the Institute rose considerably as evident from the pattern of applications shown in Table 5. The course-wise demand in various disciplines revealed no substantial change (Table 6). The State-wise list of admissions is given in Table 7.

Table 5 - Nation-wide Response

State/Union Territories	Number applied	State/Union Territories	Number applied
Andhra Pradesh	22	Madhya Pradesh	3
Bihar	2	Orissa	8
Delhi	3	Pondicherry	6
Gujarat	6	Punjab	2
Jammu and Kashmir	2	Tamil Nadu	26
Kerala	46	Tripura	1
Karnataka	18	Uttar Pradesh	8
Maharashtra	22	West Bengal	6

Table 6 - Course-wise demand

Course	No. of applicants	No. selected and joined	
DM Cardiology	89	4	
DM Neurology	19	2	
M.Ch CVTS	29	3	+ 1 sponsored
M.Ch Neurosurgery	20	3	
PDCC - Anaesthesia	13	4	
PDCC - Radiology	6	2	
Total	**176**	**19**	

Table 7 - Admission 1991 (State Wise)

State	No. of Candidates	State	No. of Candidates
Andhra Pradesh	1	Maharashtra	5
Delhi	1	Tamil Nadu	2
Karnataka	3	Tripura	1
Kerala	6	West Bengal	1

Examinations

Table 8 lists the names of successful candidates for D.M. and M.Ch examinations held in 1990.

Table 8 - List of Successful Candidates for DM/MCh

Name of the Candidates	Degree	Speciality
Dr. K. Raghu	DM	Cardiology
Dr. Siddhartha Mukhopadhyay Dr. Murtaza Ahmed Chesti	MCh	Cardiovascular and Thoracic Surgery
Dr. Asha Vijayaraghavan	DM	Neurology
Dr. A. K. Chand Dr. R. S. Diwanji	MCh	Neurosurgery

Post-doctoral certificate course

Table 9 shows the successful candidates for post doctoral courses.

Table 9 - List of Successful Candidates for Post Doctoral Courses

Name of the Candidates	Speciality
Dr. N. Chandrasekhar Dr. T. Chandrasekhar Dr. P. V. Agnihotri Dr. S. S. Dhole	Cardiovascular and Neuro anaesthesiology
Dr. Mathew Cherian Dr. Rajiv Bapuraj Dr. S. K. Bajaj	Cardiovascular and Neuroradiology

Short term training / observership

The demand for short term training/observership, in procedures, techniques and management was notably high as shown in Table 10. The Institute responded readily and positively to all valid requests, with no fees charged for offering its training facilities.

Table 10

Department	No. of Candidates	Department	No. of Candidates
Anaesthesiology	8	Dietetics	54
Biomedical Engineering	13	Medical Records	2
Biomedical Technology	2	Microbiology	27
Blood Bank	2	Neurology	7
Cardiology	13	Neurosurgery	4
Cardiovascular and Thoracic Surgery	3	Nursing	4
		Radiology	9

Continuing Medical Education Programme

Dr. P. K. Mohan, Head of the Department of Neurology, organised a programme for the Medical practitioners in the region, during the month of October 1990, on "Recent advances in the management of vascular disorders".

Nursing Education

MRS. P. P. SARAMMA, M.Sc. (Nursing)
Nursing Tutor

The curriculum of the Post Basic Certificate Programme in cardiovascular and thoracic nursing was restructured with greater emphasis on hands-on experience and the number of seats was increased from eight to ten. Fifty six applications were received and all the ten seats were filled by selection. In addition, one candidate was admitted under sponsorship.

Third year B.Sc. nursing students from the College of Nursing,

Thiruvananthapuram and Kottayam received two weeks' clinical experience in the Institute as part of their educational programme. Three post-graduate students from the College of Nursing, Thiruvananthapuram also had one week's clinical posting in the intensive care units. Observational visits were made by nursing students of other institutions as well.

The list of successful candidates for the Post Basic Certificate Programme in cardiovascular and thoracic nursing is shown as Table.11.

Table 11 - List of Successful Candidates for Post Basic Nursing Course Programme in Cardiovascular and Thoracic Nursing.

1. Ms. Alice Mathew
2. Sr. Elsy M.S.J.
3. Ms. Janambika K.R
4. Mrs. L. Kalyani
5. Ms. Saramma C.V
6. Ms. Shashibala Lee
7. Mrs. Silvy George

Course in Cardiac Laboratory Technology

The two year course which was offered last year for the first time had attracted 25 applicants, whereas this year the number of applicants rose to 62, for one seat.

Training in Perfusion Techniques

Two candidates from Central India Institute of Medical Sciences, Nagpur and Saviour Clinic, Calcutta, joined for training in perfusion techniques in the Department of Cardiovascular and Thoracic Surgery for a period of six months from January 1990.

Training in Dietetics and Dietary Internship

Several candidates underwent training in dietetics after receiving their Master's degree in Home Science/Nutrition. Students from Avinashilingam Institute for Home Sciences and Higher Education for Women, Coimbatore, the Gandhigram Institute of Rural Health and Family Welfare Trust, Tamil Nadu, and PSG College of Arts and Science, Coimbatore had their dietary internship in the Institute as part of their degree/diploma course requirements in Dietetics/Nutrition/Home Science.

Fellowship in Vascular Surgery

A Fellowship in Vascular Surgery of one year duration was offered from Ist January 1991. There were 12 applicants for the Fellowship.

National Science Day

For the second year, February 28th was celebrated as the National Science Day. A medical science exhibition in tune with the theme of the Year, "Learning and doing Science can be full of fun and joy" was organised for local high school children. The exhibition was spread over for three days from 28th. The Director opened the exhibition and the Principal of Arya Central School was the Chief Guest.

All the Departments enthusiastically participated and were successful in giving the children an insight into the latest technological developments in the medical field in addition to the basic concepts of healthy living. Live demonstrations, do-it-yourself techniques and video films were helpful in the transfer of information to the highly receptive visitors. The cooperation extended by the Thiruvananthapuram Medical College was invaluable in the effective organisation of the exhibition.

Hospital Library

MRS. PRASANNA KUMARI, MA, M.Lib.Sc
Librarian

The Library continued 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. The services included selective dissemination of information, retrospective literature searches, reprography and the issue of a monthly bulletin on the addition of books monographs and reports. The library had 7134 books and 8612 bound volumes of periodicals. The number of journals totalled 228.

A new unit was added to the library which procured videocassettes on surgical and investigative techniques for instructional purposes. Computerisation made progress with the installation of a PC/AT and the

creation of a machine readable catalogue under taken with Micro/ISIS software version 2.3.

Smt. Prasanna Kumari presented a paper at the International Congress on Medical Librarianship in Delhi and attended a national seminar on bioinformatics organised by the National Informatics Centre and ICMR. Smt. Jayaprabha, Asst. Librarian attended the IX Annual convention of the Society of Information Scientists in Thiruvananthapuram.

The students and faculty from the Department of Library and Information Science, Karnataka University visited the Library as part of their learning experience.

Special Research Scheme

Medical and Surgical Application of Lasers

(Sponsored by the Department of Science & Technology)

Principal Investigators	Dr. M. S. Valiathan Sree Chitra Tirunal Institute	
	Dr. D. D. Bhawalkar Centre for Advanced Technology Department of Atomic Energy Indore	
Co-Investigators	Dr. K. Ravimandalam	
	Dr. Arthur Vijayan Lal	
	Dr. K. S. Neelakandhan	SCTI
	Dr. Meera Mohanty	
	Dr. V. R. K. Rao	
	Dr. V. K. Chatterji	
	Dr. T. P. S. Nathan	BARC
	Dr. L. M. Kukhreja	
Project Scientist	Dr. T. Ramachandran	
Duration	Three years - ended on 31.3.91	

THE principal activity related to the evaluation of the laser delivery system developed at the Institute. Using the experimental animal model of vascular occlusion, in vivo evaluation was done which revealed certain problems in the design of the contact probes requiring further modifications. Most of the problems were associated with significant lateral heat transfer from the probe causing thermal damage and perforation of

the vessel wall. Hence, the tip was modified to give it an additional stainless steel sleeve and a final outer protective covering of thin teflon tubing. This system was successfully tested in animal experiments and found to be safe and effective.

Clinical laser angioplasty made modest progress with 14 more patients being treated with Nd-YAG laser system for occlusions in the femoral and popliteal arteries. A beginning was made in laser endobronchial surgery by using the system for laser ablation of a malignant tumour in the left main bronchus of a 55-year old female patient.

The following scientists visited the Institute and delivered talks on laser applications in medicine:

Dr. Chireskin and Dr. Masedkin of First Moscow Medical Institute, Moscow

Dr. Strekalovsky and Dr. Berdikyan of Vishnevski Institute of Surgery, Moscow

Dr. Ambartzumian and Dr. Korogodov from Lebedev Physical Institute, Moscow visited the Institute and installed a mid-infra-red range Erbium YAG laser for experimental evaluation in angioplasty applications.

Hospital Wing

Department of Anaesthesiology

DR. K. MOHANDAS, MD
Professor & Head of the Department

DR. V. PADMANABHAN, MD
Professor

DR. MRS. A. ROUT, MD
Additional Professor

DR. J. M. SHAHANI, MD
Associate Professor

DR. RUPA SREEDHAR, MD
Assistant Professor

DR. SAMIR GIROTRA, MBBS, DA, DIP.NB
Assistant Professor

DR. R. C. RATHOD, MD
Additional Professor

DR. H. D. WAIKAR, MD
Associate Professor

DR. RAMAN CHADDHA, MD
Assistant Professor

DR. GOPAKUMAR, MD
Assistant Professor

Candidates for Postdoctoral Certificate
DR. SAROJ B. KULKARNI, MD
DR. B. V. S. MOORTHY, MD
DR. B. G. R. PRASAD, MD
DR. MATHEW KUNCHERIA, MD

ANAESTHETIC service provided for the following procedures during the year is given in Table 12, which clearly shows the overwhelming priority of departmental activities which were focused on clinical services.

DEPARTMENT OF ANAESTHESIOLOGY

It is satisfying to note that anaesthetic services could match the increasing complexity of cardiac, vascular, neurosurgical and interventional procedures during the year. In addition to meeting the demand for elective procedures, arrangements were made to cover the needs for emergencies which too tended to increase in number.

Turning to research, two important projects related to blood conservation which were carried out in collaboration with the Division of Blood Transfusion Service and the Department of Cardiovascular and Thoracic Surgery. As part of one project, a mediastinal drainage system developed by the Institute was evaluated successfully for safety and efficacy.

Table 12 - Clinical Services

Cardiac surgery	985
Thoracic and Vascular surgery	719
Neurosurgery	527
Cardiac and Neuroradiological Procedures (Investigation and Interventional)	130
Pulmonary function tests	67

The monitoring system in the cardiac intensive care unit was updated and several new ventilators and infusion pumps added to the range of supportive equipment. The replenishment of critical care equipment and the addition of post-basic nursing trainees substantially enhanced the efficiency of the intensive care unit.

Dr. Shahani presented a guest lecture at the Third International Anaesthesia Conference at Peshawar. Dr. Mohandas was appointed Chairman of the Anaesthesia, Resuscitation and Allied Equipment Committee of the Bureau of Indian Standards.

In addition to MD Students from the Medical College Thiruvananthapuram and Goa, the following anaesthetists spent several weeks as observers in the Department:

Dr. Mathew George, Lisie Hospital, Cochin
Dr. Balan, Trichur Heart Centre, Trichur
Dr. Vijay Mehta, Anaesthetist, Govt. Hospital, Rajkot.

Division of Biochemistry

DR. K. SUBRAMONIA IYER, Ph.D
Additional Professor

DR. N. JAYAKUMARI, Ph.D
Assistant Professor

MRS. SHANTHA A. GEORGE, M.Sc
Scientist

MR. B. SASIKUMAR, M.Sc
Scientific Assistant

THE central clinical laboratory continued to provide round-the-clock service to the hospital. The total number of the investigations in clinical chemistry and pathology crossed 2.23 lakhs registering a sharp increase of 20% over the previous year. A binocular microscope was imported to facilitate prompt and accurate reporting on slides. In order to meet the increasing work load in hematology, an order was placed for Coulter T-540 automatic electronic blood cell counter capable of determining WBC, RBC, platelets, lymphocyte percentage, hemoglobin and hematocrit at the rate of 40 samples per hour. The laboratory moved to a more spacious location in the central block of the hospital complex.

Efforts were continued on the study of atherogenic risk factors and antiatherogenic determinants especially in a Kerala backdrop. Fractionation of high density lipoprotein (HDL) into its sub-classes clearly demonstrated that the low level of HDL cholesterol observed in male CAD patients was due to the significant reduction of cholesterol in both HDL2 and HDL3 sub classes. But the percentage of reduction of cholesterol was much higher in the HDL subclass. In the case of female CAD patients the reduction of cholesterol was solely in the HDL2 subclass whereas HDL3 cholesterol was

DIVISION OF BIOCHEMISTRY

least altered. When the HDL sub classes were analysed in young male CAD patients having normal levels of triglycerides, cholesterol and LDL cholesterol, a significant reduction of cholesterol was observed in the total HDL and HDL2 subclass. The study of the inter-relationship of lipoproteins showed that the negative correlation existing between triglycerides and HDL2-C in control subject was less pronounced in CAD patients. It was clear from the study that HDL2-C is the major antiatherogenic determinant but it is not an indicator of the severity of coronary artery disease.

A procedure for the separation of apolipoprotein AI, AII and B was standardised. This consists of isoelectric focussing followed by electrophoresis in the second dimension on a slab gel. The diagnostic significance of this technique is being evaluated.

Division of Blood Transfusion Services

DR. JAISY MATHAI, MBBS, DCP
Chief Blood Transfusion Officer

DR. P. V. SULOCHANA, MBBS
Blood Transfusion Officer

DR. C. R. USHA, MBBS
Blood Transfusion Officer

THE Blood Transfusion Service responded effectively to the mounting demand from the clinical departments as well as from neighbouring institutions for specialised services. Table 13 lists the number of procedures carried out which indicate an increase of approximately 30% over the previous year's level of performance.

Progress was made in computerising donor data for a voluntary donor panel which was further expanded. Maximal, if not total, support was given for patients from far-away locations and emergencies. Predeposit phlebotomy was carried out for a neurosurgical patient with multiple allo-antibodies among other novel techniques introduced during the year.

The heavy commitment to blood transfusion services did not slow down research effort which sought collaboration with other departments. A project on blood conservation by the administration of washed, concentrated autologous blood was carried out successfully in collaboration with the Department of Cardiothoracic Surgery and the plasmapharesis project was continued for neurological disorders. A new project was initiated to study the role of fresh frozen plasma in the management of subacute hepatic failure jointly with the Department of Gastroenterology of the Medical College and support was extended to the

DIVISION OF BLOOD TRANSFUSION SERVICES

Division of Polymer Technology in the evaluation of a new microaggregate blood filter. Other studies related to the sensitivity of two third-generation tests for HBs Ag screening, Rh genotyping and MNS groups among donors.

Table 13

Blood donation		..	6615
Whole blood transfusion		..	5987
Components (Packed cells, Plasma YYP, PRP, buffycoat)		..	419
Compatibility tests:	Saline	..	10692
	Albumin	..	10692
	Anti Human Globulin	..	3292
Blood grouping:	Patients	..	8084
	Donors	..	9041
HBsAg. Screening:	Donors (ELISA)	..	4436
	RPHA method	..	2446
Anti HIV Screening Donors (ELISA)		..	7335
RPR test for syphilis		..	6510
Antibody screening of donors by Enzyme technique		..	4462
Therapeutic plasma pheresis		..	316
Washed concentrated cells for autologous transfusion(units)		..	766
Components prepared:	Packed cells	..	380
	FFP	..	287
	PRP	..	191
	Buffycoat	..	32
Plasma separated		..	575
Components issued to MCH/RCC (FFP, PRP, Plasma, buffy coat, platelet concentrate)		..	288

Prof. Richard Hughes visited the Division and showed keen interest in the plasmapheresis technique in use for Guillain Barre syndrome. Medical officers and technicians from various medical college blood banks in the State visited the division and a medical officer and technician from the PSG Institute of Medical Sciences and Research, Coimbatore received training in blood transfusion technology. Dr. Jaisy Mathai and Dr. P.V. Sulochana presented papers at the Annual Meeting of the Indian Society for Blood Transfusion at Madurai.

Department of Cardiology

DR. K. G. BALAKRISHNAN, MD, DM, FACC, MNAMS
Professor & Head of the Department

DR. C. G. VENKITACHALAM, MD, DM
Professor

DR. R. SUBRAMANYAN, MD, DM
Additional Professor

DR. THOMAS TITUS, MD, DM, MNAMS
Associate Professor

DR. JAGAMOHAN THARAKAN, MD, DM
Associate Professor

DR. M. V. JOSEPH JOY, MD, DM
Assistant Professor

DR. RAJIV GUPTA, MD, DM
Assistant Professor

DR. SHYAM SUNDER, MD, DM
Assistant Professor

DR. V. K. AJITH KUMAR, MD, DM
Assistant Professor

DR. ANIL BHAT, MD, DM
Assistant Professor

Candidates for DM

DR. SUNITHA KUMARI, MD, DM

DR. MAHESH KUMAR SHAHA, MD

DR. DEBANU GHOSH RAY, MD

DR. PRAMOD KUMAR JAISWAL, MD

DR. ARAVINDA SAHA, MD

DR. J. S. BHUVANESWARAN, MD

DR. FRANCIS BIMAL, MD

DR. ZULFIKAR AHMED, MD

As ever increasing demand for registration had obliged the Department to limit the number of new patients to 25 per day, the outpatient attendance showed only a marginal increase during the year. However the follow up clinic showed an increase of 20% in attendance, a significant proportion of whom were patients who were on the waiting list for various surgical procedures.

DEPARTMENT OF CARDIOLOGY

While cardiac catheterisation seemed to level off at 1318, interventional procedures increased by 20% and included balloon mitral valvotomy, PTCA, pulmonary and aortic valvotomy, atrial septostomy and dilatation of coarctation of aorta. Similarly the number of electrophysiological studies and pacemaker implantation rose by 20%. The volume of invasive procedures was large enough to keep both catheterisation laboratories fully occupied.

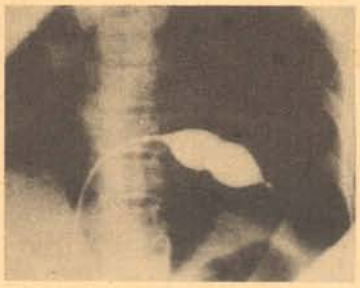


Figure 9
Partially inflated balloon across mitral valve showing the waist caused by the stenotic mitral valve.

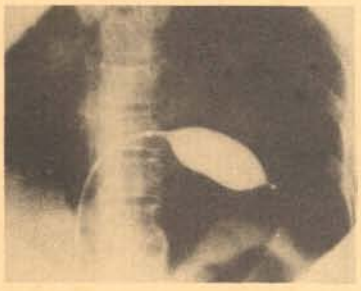


Figure 10
Full inflation of the balloon showing disappearance of the waist.

Clinical research studies were carried out by members of the faculty on the natural history of aortoarteritis and endomyocardial fibrosis, risk factors in patients under forty with coronary artery disease, follow up of patients who had undergone interventional procedures, effect of new cardioselective beta blocker, Bisoprolol, on patients with stable angina and the use of ACE inhibitor, Lisinopril, in the management of essential hypertension. Collaborative support was provided for the ongoing epidemiological study on coronary artery disease in an urban and rural populations of Kerala and the estimation of myocardial isoenzyme levels following cardiac operations for tetralogy of Fallot and coronary artery disease.

The number of postgraduate admission was raised to 4 in view of the substantial increase in the volume of cardiac procedures. Postgraduate students for DM from the Medical College, Thiruvananthapuram and Calicut and Dr. Ravi Narayanan from Ramiah Medical College, Bangalore visited the Department as observer trainees. Prof.S.Baligadoo, Director of SSR Centre for Medical Studies and Research, Mauritius visited the Department and gave a guest lecture on 'Coronary risk factors in Mauritians of Indian origin under 40 years'.

Following the visit of Prof. Balligadoo, an Indo-Mauritian collaborative study for the risk profile of patients of coronary artery disease under the age of 40 years in India and people of Indian Origin in Mauritius was started and patients from Mauritius began coming to the Institute for invasive investigation and surgical intervention if needed.

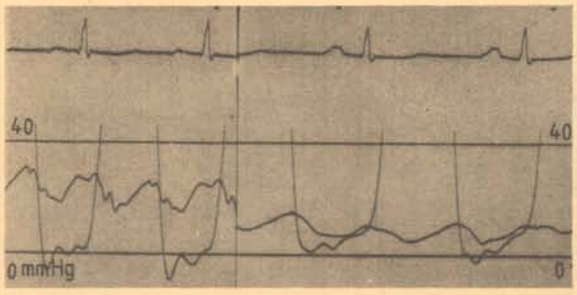


Figure 11
simultaneous left atrial and left ventricular pressure tracing before dilatation of the mitral valve (initial part) and after dilatation (later part). The large transmitral gradient has been significantly reduced.

Division of Cardiomyopathy

PROF. M. S. VALIATHAN
Head of the Division

DR. C. C. KARTHA, MD
Additional Professor

DR. R. RENUKA NAIR, Ph.D
Assistant Professor

DR. K. SHIVAKUMAR, Ph.D
Scientist

DR. JOHN T. EAPEN, Ph.D
Scientist

DR. JOSE JACOB, MD
Research Associate (Till December 31st 1990)

MRS. ANNIE JOHN, M.Sc
Senior Research Fellow (CSIR)

IN July 1990, the staff and the programme of the Centre for Advanced Research in Cardiomyopathy sponsored by the ICMR were absorbed by the Institute, in keeping with the agreement with the ICMR, and a successor Division of Cardiomyopathy came into existence. The Division continued the work on endomyocardial fibrosis (EMF), probing the possible role of Ce and Mg deficiency in the causation of the disease.

The experiments on non-human primates, designed to see if a combination of Ce toxicity and Mg deficiency produces changes similar to EMF in the heart, were terminated in July 1990. Two years after the commencement of

DIVISION OF CARDIOMYOPATHY

the study, cardiac and other tissues were collected for histopathologic examination and metal analysis. While gross fibrotic changes were not observed in the cardiac tissue of the experimental animals, one of the test animals on a low Mg diet which had been administered cerium sulphate showed myofibre atrophy, interfibre fibrosis and small areas of subendocardial fibrosis. Most of the other animals, including those in the control groups, showed non-specific changes like focal increase in interstitial cellularity in the cardiac tissue. Significantly, however, Mg deficiency was found to enhance the concentration of Ce in the cardiac tissue, an observation of considerable biological significance. Encouraged by the results of earlier experiments, long-term experiments on rats to test the hypothesis were initiated and are in progress.

The suspected involvement of Ce in the pathogenesis of EMF had earlier suggested a probe into the mechanism(s) of cardiac toxicity of Ce. Experiments were carried out to determine whether the element has an effect on collagen biosynthesis at low concentrations comparable with those in the cardiac tissue of patients. Interestingly, it was found that at 100 nM, a level comparable with that in question, the element has a stimulatory effect on collagen and non-collagen protein synthesis while at concentrations 10 $\geq \mu$ M, it is inhibitory. These results indicate that Ce is biologically active on collagen synthesis and could produce a fibrogenic effect at low concentrations, consistent with the speculation on its involvement in the pathogenesis of the disease. In preliminary studies, it was found that human fetal lung fibroblasts grown in a medium containing different concentrations of Mg show an increase in cell number on the addition of Ce, the increase being more marked at lower concentrations of

Mg. The stimulatory effect of Ce, enhanced in Mg deficiency, was also evident in fetal myocardial explant cultures (Fig. 12-A, B, C). Experiments to confirm these observations using 3 H-thymidine were initiated.

Investigations carried out in the Institute and in the laboratory of Dr. Joseph, Central Leather Research Institute, Madras, revealed that among the cardiac collagens, Types I and III are predominant in EMF. Collagen typing did not reveal other striking differences between the test and control samples.

Two Post-graduate students from the University of Pune spent a brief period in the laboratory to learn biological techniques.

Dr. Kartha presented a paper entitled "Causation of EMF" at the International Symposium on Preventive Cardiology and Cardiovascular Epidemiology held at the AIIMS, New Delhi, in January 1991. Dr. Shivakumar presented a poster entitled "Mg deficiency enhances the inhibitory effect of Ce on protein biosynthesis" at the DST-sponsored Workshop on Bioinorganic chemistry at the IIT, Madras, in December 1990.

Dr. Kadenbach, Professor of Biochemistry from the Philips University, Marburg, Germany and Dr. Seidel, toxicologist, also from Germany, visited the laboratory and had discussions with the scientists.

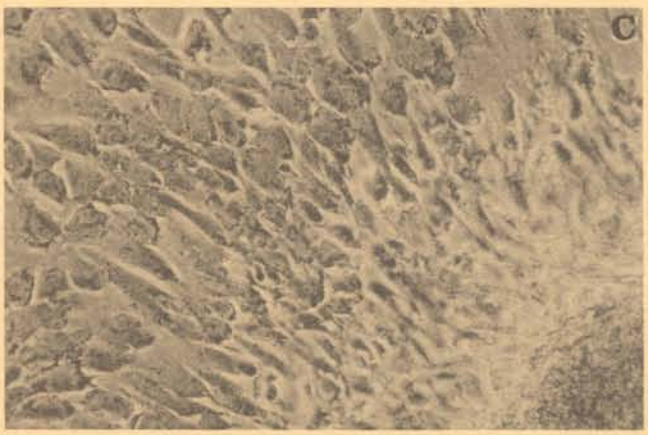


Figure 12
Human fetal Cardiac explant cultures after 7 days of treatment:

A. Normal medium
B. Low magnesium
C. Low magnesium + cerium.

(The stimulatory effect of cerium may be noted)

Department of Cardiovascular & Thoracic Surgery

DR. M. S. VALIATHAN, Ch.M (L. Pool) FRCS (Edin.), FRCS (Eng.), FRCS (C), FACC, FAMS, FASc, FNA
Professor & Head of the Department

DR. M. P. MOHAN SINGH, FRCS (Eng.), FRCS(Edin.)
Professor

DR. K. S. NEELAKANDHAN, MS, M.Ch
Associate Professor

DR. R. SANKARKUMAR, MS, M.Ch
Associate Professor

DR. K. G. SHYAMKRISHNAN, MS, MCh
Associate Professor

DR. M. UNNIKRISHNAN, MS, M.Ch
Assistant Professor

DR. ARUNA KASHYAP, MS, M.Ch
Assistant Professor

DR. Y. NAZER, MS, M.Ch
Assistant Professor

DR. KRISHNA MANOHAR, MS, M.Ch
Assistant Professor

DR. SHIV KUMAR NAIR, MS, M.Ch
Assistant Professor

Candidates for M.Ch

DR. V. RAJAGOPALAN, MS
DR. B. NEELAKANTAN, MS
DR. MRINAL BINDHU DAS, MS
DR. SUSHIL CHANDRAN, MS
DR. ZACHARIAH PHILIP, MS
DR. R. JAGANATHAN MS,
DR. N. R. RAVISANKAR, MS
DR. USHA PARVATHY, MS

DR. A. K. JOHN, MS
Post doctoral Fellow in Vascular surgery.

THE Department carried out approximately the same number of cardiovascular and thoracic procedures as in the previous year as the

DEPARTMENT OF CARDIOVASCULAR & THORACIC SURGERY

volume of operative work had more or less reached a plateau. Out of a total of 1700 procedures, closed, vascular and thoracic procedures accounted for 720 and the remainder consisted of open heart operations. The subspecialties of pediatric, coronary and thoracic and vascular surgery became more crystallised and made further progress. (Fig. 13 a & b)

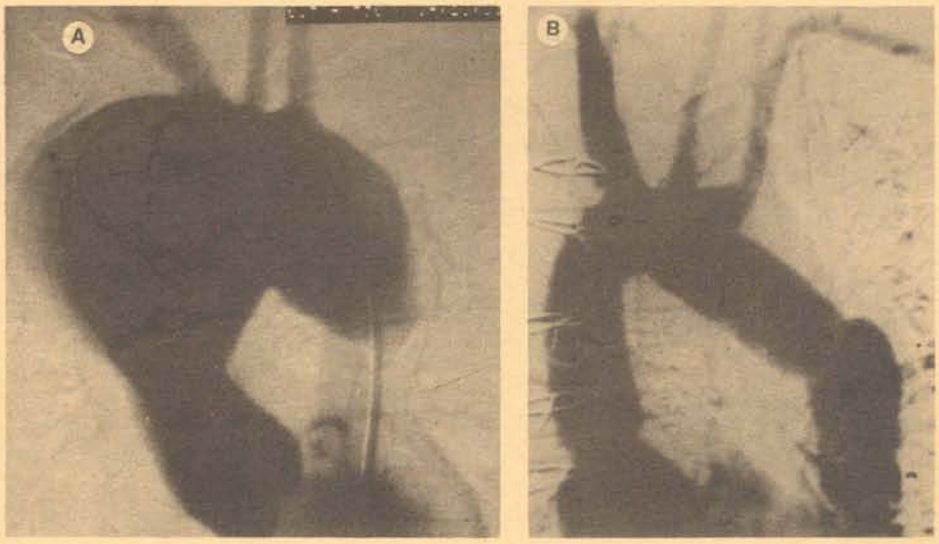


Figure 13 A, B
Aneurysm of the aortic arch before and after repair under total circulatory arrest.

Given the existing facilities, staff and soci-economic conditions of patients, it was not considered feasible to expand the surgical volume significantly beyond the present level. It was clear that the acute and evergrowing problem of waiting lists for cardiac operations could not be solved except by the emergence of other cardiac surgical centres in the public sector.

The rapid growth and maturation of vascular surgery encouraged the creation of a training programme at the post-doctoral level on the stipulation that those receiving the benefit of training would return to their parent institution and set up units for vascular surgery. As this was the first experiment in the country for postgraduate training in vascular surgery, the enthusiastic response to the notification from sponsored candidates was highly encouraging. The first post doctoral Fellow joined during the year.

From the stage of inception, the Department had taken the initiative for the development of technologies for cardiac surgery and interaction with bioengineering groups of the Institute. Thanks to this policy, the

DEPARTMENT OF CARDIOVASCULAR & THORACIC SURGERY

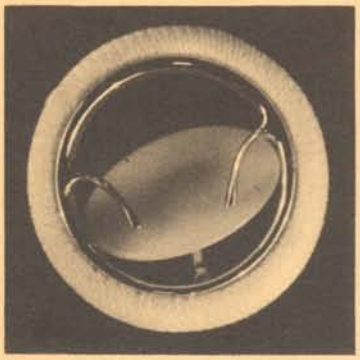


Figure 14
Chitra heart valve

cardiotomy reservoir established its safety and efficacy after nearly 200 pieces had been successfully used at the Institute and other major Centres. Similarly SPICTRA Oxygenators demonstrated excellent performance in clinical use and its trial in four or five other Centres got under way during the year.

The major achievement during the year was the initiation of the clinical trial of the Chitra valve which had been under development and public gaze for almost ten years. (Fig. 14). At the time of the report, 23 valves had been implanted and all patients were being followed up on the basis of a well accepted protocol. The successful clinical trial of the valve would not have been possible without the utmost cooperation and effort of the surgeons, engineers, scientists and other workers of the Institute.

In terms of clinical research, the Department completed a study on the long term results of mitral valve replacement which not only estimated the mortality and rate of occurrence of various postoperative events but also considered the impact of the public health indicators of Kerala on the morbidity and mortality patterns of patients undergoing valve replacement. Another detailed study on similar lines was completed for patients with tetralogy of Fallot following repair.

Dr. Sankarkumar rejoined the Department after his extended visit to the Department of Cardiac surgery of the Hospital for Sick children, London. At the request of the Bhilai Steel Plant Hospital, Bhilai, Dr. Aruna Kashyap assisted their Department of Cardiothoracic surgery by paying two visits and carrying out several open heart procedures.

Dr. Valiathan was awarded the Dhanwantari prize by the Indian National Science Academy.

Division of Microbiology

DR. J. SHANMUGHAM, Ph.D, FABMS, FIMSA
Additional Professor

DR. ARUNA SHAHANI, MD
Assistant Professor

MS. MOLLY THOMAS, M.Sc DMV
Assistant Professor

MR. M. RAVEENDRANATH, B.Sc
Scientific Assistant

MRS. K. NASEEMA, B.Sc, M.Sc(MLT)
Scientific Assistant

As in previous years, hospital services dominated the activities of the Division which covered bacteriology, immunology, mycology and virology. The number of immunological tests increased by 25% and three new ELISA tests were introduced for the detection of Ig G measles antibody, Ig M HSV antibody and HSV antigen in the CSF of encephalitis patients. Screening of the sera of all in patients was started and a package of measures instituted for ensuring protection against Hepatitis B viral infections among the hospital personnel.

A new research study was initiated by Dr. Aruna Shahani during the year.

Mrs. Naseema began a study on the role of adherence in the pathogensis of rheumatic fever due to Group A streptococci under the guidance of Dr. Jamaluddin for her part time Ph.D course. Dr. Shanmugham became the guide for Mr. Rathinam for his part time Ph.D. study on "Interactions between polymer materials and staphylococcus epidermidis strains".

DIVISION OF MICROBIOLOGY

Project title	Study of Epidemiology of nosocomial infections caused by glucose non-fermenting gram negative bacilli
Principal Investigator	Dr. Aruna Shahani
Co-Investigators	Dr. Aruna Kashyap (Cardiac Surgery) Dr. Suresh Nair (Neurosurgery)
Funding Agency	Dept. of Science and Technology & Environment, Government of Kerala.
Duration	3 years
Status	just started

Dr. Aruna Shahani presented a paper at the International Congress for Infectious diseases at Montreal. She also attended the 3rd International Decennial Congress on Nosocomial Infections at Atlanta, USA. Dr. Shanmugham participated in a WHO workshop on quality control at Pondicherry and chaired a session during the XIV National Congress of Medical Microbiologists at Vellore. Miss. Molly Thomas attended a National Workshop on 'Nucleic acid probes in infectious diseases' at Calcutta.

Dr. P. Venugopal, Asst. Professor of Diabetology at Stanley Medical College, Madras underwent one month's training in tissue culture and virology. Technicians from the Priyadarshini Institute of Basic Medical Sciences and the Regional Cancer Centre, Thiruvananthapuram spent short periods for training in speical techniques in Microbiology. The division organised the 5th Bi-Annual Conference of the Kerala Chapter of the Indian Association of Medical Microbiologists and joined hands with the Division of Pathology in holding the Kerala Chapter meeting of the Indian Association of Pathologists and Microbiologists.

Dr. Shanmugham was elected a Fellow of the Indian Association of Biomedical scientists and a member of the Editorial Board of a newly started journal *'Laboratory Diagnosis'*.

Department of Neurology

DR. P. K. MOHAN, MD, DM
Additional Professor

DR. JOHN THARAKAN, MD, DM
Associate Professor

DR. C. SARADA, MD, DM
Assistant Professor

DR. MURALIDHARAN NAIR, MD, DM
Assistant Professor

DR. SANJEEV THOMAS, MD, DM
Assistant Professor

Postgraduate Students
DR. ANOOP RANJAN VARMA, MD
DR. GRACYKUTTY MATHEW, MD
DR. MATHEW ALEXANDER, MD
DR. J. B. AGADI, MD
DR. SHIVANARAYANA, MD
DR. V. K. RADHAKRISHNA, MD
DR. SUNIL NARAYANAN, MD
DR. SREEKANTA SWAMY, MD

DR. ASHA VIJAYARAGHAVAN, MD, DM
Post Doctoral Fellow

BESIDES running a busy service for outpatients and inpatients, counselling was introduced for patients with epilepsy with the assistance of the medicosocial workers. Introduction of the new service as well as the audiometry and speech therapy services produced excellent response from patients. Another activity which increased substantially in number was investigations in clinical neurophysiology.

DEPARTMENT OF NEUROLOGY

The research carried out by faculty members was collaborative and related to different aspects of neurology. Vasculopathy of the intracranial vessels in non-atherosclerotic conditions, a test battery for speech and language analysis in regional languages and linguistic aspects of communication disorders were projects which were jointly studied with the faculty of the Division of Pathology and the International School of Dravidian languages.

Department of Neurosurgery

DR. DAMODAR ROUT, MS, M.Ch
Professor and Head of the Department

DR. B. K. MISRA, MS, M.Ch
Associate Professor

DR. RAJEEV SHARMA, MS, M.Ch
Associate Professor

DR. SURESH NAIR, M.Ch
Assistant Professor

DR. VIJAY IYER, MS, M.Ch
Assistant Professor

DR. SATISH KRISHNAN, M.Ch, Dip NBE
Assistant Professor

DR. AJAY K. GEHLOT M.Ch
Assistant Professor

Candidates for M.Ch

DR. S. S. PRAHARAJ, MS
DR. ADIL S. CHAGLA, MS
DR. SUNIL M. PANDIT, MS
DR. MONI K. VINOD, MBBS
DR. K. UMA NAMBIAR, MS
DR. DILNAVAZ B. BHILADVALA, MS

THERE was a significant increase in the number of operative procedures, the bulk of which was claimed by surgery for complex procedures as listed in Table 14.

Given its largest experience in the direct surgical management of

DEPARTMENT OF NEUROSURGERY

intracranial aneurysms in the country, it was not surprising that difficult cases and lesions deemed 'inaccessible' were referred to the Department by several other centres for corrective surgery. Apart from establishing a high rate of success in tackling such lesions, the faculty achieved a 'first' in the country by successfully operating on a giant basilar trunk aneurysm under cardiopulmonary bypass. (Fig. 15 & 16)

Table 14

Aneurysms	98	(72 patients)
Arteriovenous malformations	27	
Acoustic Neurinomas	38	
Other cranial N. Neurinomas	8	
I.C. Meningiomas	73	
3rd Ventricular tumours	12	
Lateral Ventricular tumours	8	
4th Ventricular tumours	5	
Pituitary tumours	46	
Craniopharyngiomas	25	
I.C. Gliomas	81	
Epidermoids	7	
C.S.F.rhinorrhoea	7	
C.V.Junction anomalies	44	
Spinal tumours	30	
Other spinal lesions	58	
Miscellaneous	177	

The clinical trial of the Chitra hydrocephalus shunt system was initiated by the Department following its approval by the Ethics Committee. The trial made good progress and advanced the date for the multicentric trial of the device. As in previous years, research effort by postgraduates was encouraged and one project in collaboration with the Division of Vivarium and Pathology related to the role of streptokinase and urokinase in the resolution of experimental intraventricular and intracerebral hematomas.

Prof. Rout presented papers at the First Annual Conference of the Indian Society for Pediatric Neurosurgery at Bombay and the National Symposium on 'CP angle tumours' at SMS Medical College, Jaipur as an invited speaker.

DEPARTMENT OF NEUROSURGERY

Figure 15

Figure 16

Giant Basilar trunk aneurysm operated under cardiopulmonary bypass (pre and post operative angiograms).

Dr. K. M. John, Consultant Neurosurgeon, Lizzie Hospital, Cochin and Dr. P. D. Kulkarni, Lecturer in Neurosurgery, Lokamanya Tilak Medical College, Bombay visited the Department as observers. Drs. M. B. Chitare, P. Dey and H. B. Mishra, final year post graduates from CMC, Vellore attended the Departmental activities as observer trainees.

Dr. Satish Krishnan passed the National Board examination in neurosurgery.

Division of Neurochemistry

PROF. DEBKUMAR BASU, Ph.D
Professor

DR. P. S. APPUKUTTAN, Ph.D
Associate Professor

MRS. K. I. ANNAMMA, B.Sc
Scientific Assistant.

MR. P. L. JAISON, M.Sc
Candidate for Ph.D

MR. V. M. KANNAN, M.S
Candidate for Ph.D

THE project on the identification and characterization of endogenous glycoprotein and glycolipid receptors for mammalian brain galactose - specific lectin received major emphasis because lectin-glycoconjugate interactions are increasingly implicated in cell sociology both in normal and tumour tissues. Presence of endogenous glycoproteins interacting with bovine brain lectin was verified by two observations: i) endogenous glycoproteins immobilized on matrices could retain in lectin sugar - specifically and ii) plant lectin-binding endogenous glycoproteins could inhibit the brain lectin-mediated agglutination of trypsinized rabbit erythrocytes. Interaction of endogenous gangliosides with bovine brain lectin was also confirmed by the following results.

i) Gangliosides, both native and desialated, could inhibit lectin-mediated agglutination of red cells.

ii) Ganglioside-containing liposomes (artificial lipid bilayers) could be

aggregated with brain lectin and this phenomenon was reversed by specific sugars.

iii) In a novel approach to affinity electrophoresis of lectins in ganglioside - containing gels, retention of the lectin in gel and its reversal by the specific sugar only was noted. Efforts were made to identify the individual glycoproteins and gangliosides that interact with the brain lectin.

Optimal physicochemical conditions for the isolation of anti-α-galactoside antibody, present exclusively in human plasma, were established using a polysaccharide matrix prepared in this laboratory. Work was initiated towards using this antibody for the localization as well as isolation of α-galactosyl groups in tissues.

Project	:	Galactose - binding lectins and endogenous lectin-binding glycoconjugates (receptors) of mammalian brain : their structure and interactions in normal and tumor-affected tissue.
Principal Investigator	:	P. S. Appukuttan
Funded by	:	Dept. of Science and Technology, Govt. of India
Duration	:	3 years
Status	:	Ongoing

Division of Pathology

DR. V. V. RADHAKRISHNAN, M.D
Additional Professor

DR. C. C. KARTHA, MD
Additional Professor

DR. MRS. S. SANDHYAMANI, MD
Associate Professor

DR. MRS. R. RENUKA NAIR, Ph.D
Assistant Professor

DR. MRS. ANNAMMA MATHAI, M.Sc
Scientific Assistant

DURING the year, the laboratories analysed 930 surgical pathology specimens, 375 cytology specimens and carried out 2545 investigations in immunology. Frozen section for rapid diagnosis during operations was performed in 297 cases. There was an overall increase of 24 percent in the number of diagnostic investigations over the previous years. The Division also performed 64 autopsies in cardiac and neurological cases which provided valuable material for research projects like endomyocardial fibrosis and mucoid vasculopathy.

Two relevant diagnostic techniques were introduced for the rapid diagnosis of tuberculosis particularly in smear negative and culture negative patients of tuberculosis (A) a dot-immuno binding Assay (DOT-IBA) in body fluids like CSF and serum. This assay is inexpensive and the results can be made available within 4 hours after the receipt of clinical specimens. (B) demonstration of mycobacterial antigens by immunohistochemical method. This has several advantages over the

conventional Zeihl-Nielsen method including higher sensitivity and little danger of false positivity.

Another research project related to the "Determination of magnesium levels in a population sample from Kerala". This project was funded by Roussel Scientific Research Institute India, Bombay and had Dr. (Mrs.) Renuka Nair and Dr. John Eapen as the Principal Investigator and Co-investigator. The project made progress and provided useful information on the magnesium levels in a population sample and its possible role in the genesis of cardiomyopathy.

Project	:	Determination of magnesium levels in a population sample from Kerala
Principal Investigator	:	Dr. Renuka Nair
Co-investigator	:	Dr. Eapen
Funded by	:	Roussel Scientific Institute, Bombay
Status	:	Ongoing

Cytocompatibility of prosthetic vascular graft material fabricated in the division of Biosurface Technology of BMT Wing was evaluated in - vitro. To a culture of rat lung fibroblasts, (Fig. 15), prosthetic vascular graft materials and siliastic materials (Fig. 16) were incorporated. Seven days later the plates showed comparable growth patterns. The results of this invitro study suggested that the prosthetic vascular graft material fabricated in BMT Wing is cytocompatible and inert.

Two postgraduate students in Pathology from Medical College, Calicut received training in techniques of rapid diagnosis with cryostat and techniques in cardiac pathology and morbid anatomy.

The Division conducted a 2-day Biannual conference of Kerala Chapter of Indian Association of Pathologists and Microbiologists in January 1991. Over 70 members of IAPM from all the State Medical Colleges participated in the conference.

Dr. V. V. Radhakrishnan was elected as a member of the executive committee of Neurological Society of India.

Department of Radiology

DR. V. R. K. RAO, MD, DMRD, MNAMS
Professor & Head

DR. K. RAVIMANDALAM, MD
Additional Professor

DR. A. K. GUPTA, MD
Associate Professor

DR. SANTHOSH JOSEPH, MD
Assistant Professor

DR. MADHAVAN UNNI, MD
Assistant Professor

DR. A. SRINIVASA RAO, MD
Assistant Professor

Candidates for Post Doctoral Certificates
DR. PANDIT SAMEER ARVIND, MD
DR. MANISH GOYAL, MD
DR. T. KAPILAMOORTHY, MD
DR. KANTI LAL CHAKRABORTI, MD

THE diagnostic and intervention procedures (Tables 15, 16) showed some interesting trends. Among diagnostic procedures, the drop of 2000 in the number of plain x-rays over the previous year in spite of no decrease in the number of patients showed that greater judgement was being used in ordering the investigation and the efforts to avoid the waste of plain x-rays was beginning to have an impact on actual practice. The reduction in the number of CT Scans by over 2600 in previous year, on the other hand, was caused by the emergence of several scan centres in the region and patients coming to the Institute with scan pictures done elsewhere. Inspite of the reduction in the total number, 70% of the scans carried out

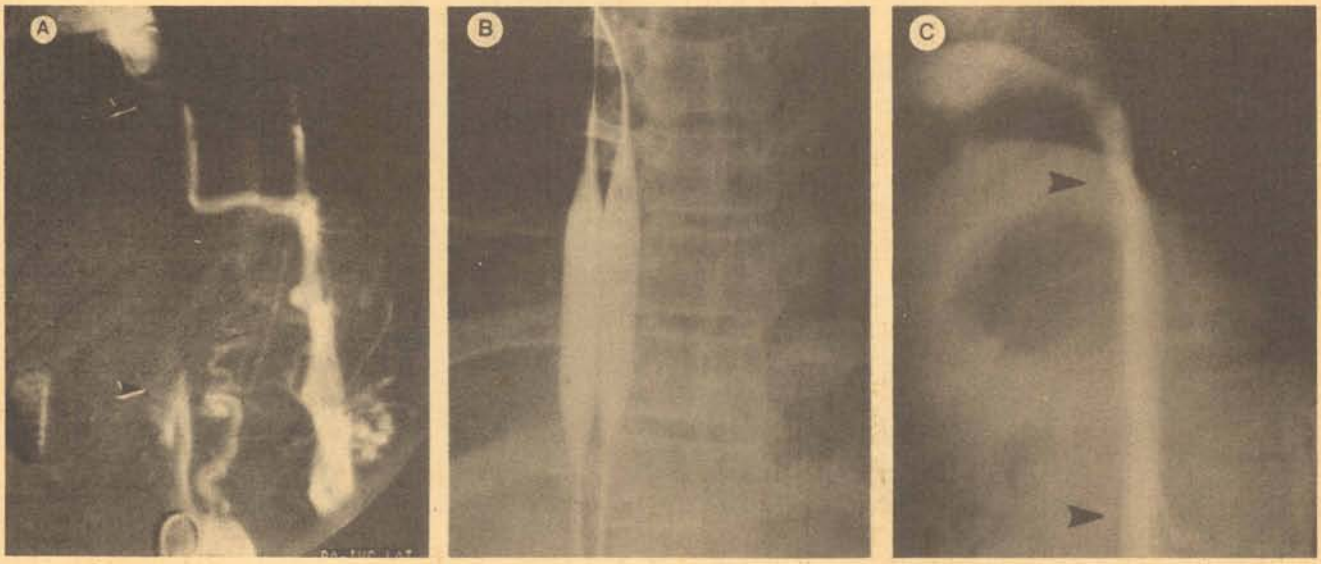


Fig. 17 **A.** Long occlusion (arrow heads) of a major abdominal blood vessel (Vena cava) in a young patient having intestinal bleeding. **B.** Two elongated balloons introduced through a skin hole, opening the obstruction (Percutaneous Balloon Angioplasty - a new application). **C.** End result shows re-established lumen (arrow heads) of the Vena cava, without operation.

were accounted by patients referred from other institutions.

Intervention procedures and angioplasty, in particular, continued to grow in number and importance. Laser angioplasty for the occlusion of leg vessels and therapeutic embolisation for intracranial vascular lesions gave encouraging results.

Collaborative efforts were continued with other groups in the Institute for the fabrication of intravascular stents and tissue adhesives for application within detachable balloons. The material for vascular stents was produced by MIDHANI and supplied for investigational use by the Defence Metallurgical Research Laboratory, Hyderabad.

Dr. R. Enzmann, Professor of Neuroradiology, Stanford University, California and Dr. V. Cruze, Medical Director, MRI Medical Centre, Barbara, California visited the Department and gave lectures on different aspects of magnetic resonance imaging. The Department hosted a seminar organised by the Indian Radiological and Imaging Association on 'Frontiers in Imaging'. The following physicians visited as observers during the year:

Table 15
Interventional Procedures

Plain X-rays	12275
Cerebral angiograms	323
Myelograms	124
C.T.Scan	4735
Cardiac angiograms	1158
Vascular (Aorta and Peripheral vascular)	320

Table 16
Other Procedures

Transluminal Balloon Angioplasty	102
Laser angioplasty	14
Therapeutic embolisation	17

Fig. 18

A. Obstructed segment of asynthetic bypass graft in a 50-year old patient (arrow heads)

B. Recanalization of the obstructed graft following local intra arterial Urokinase injection and balloon dilation (arrow heads)

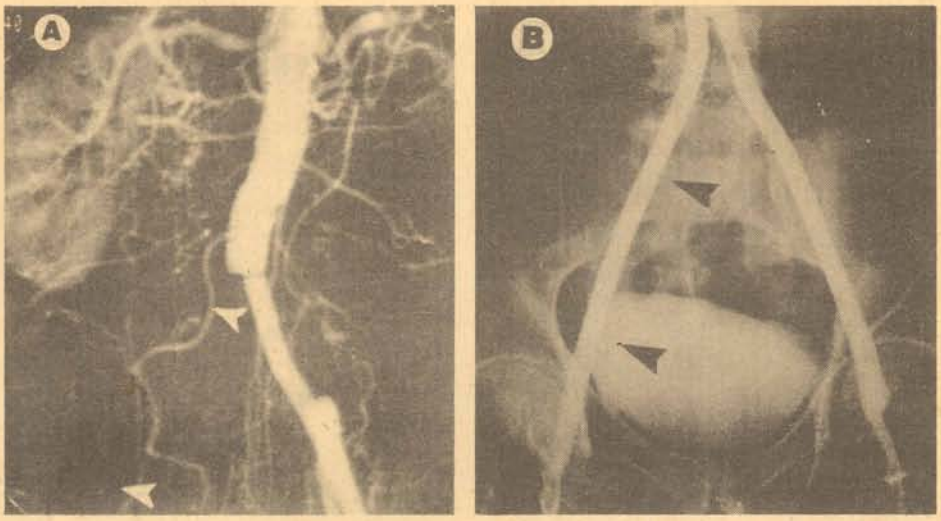


Fig. 19

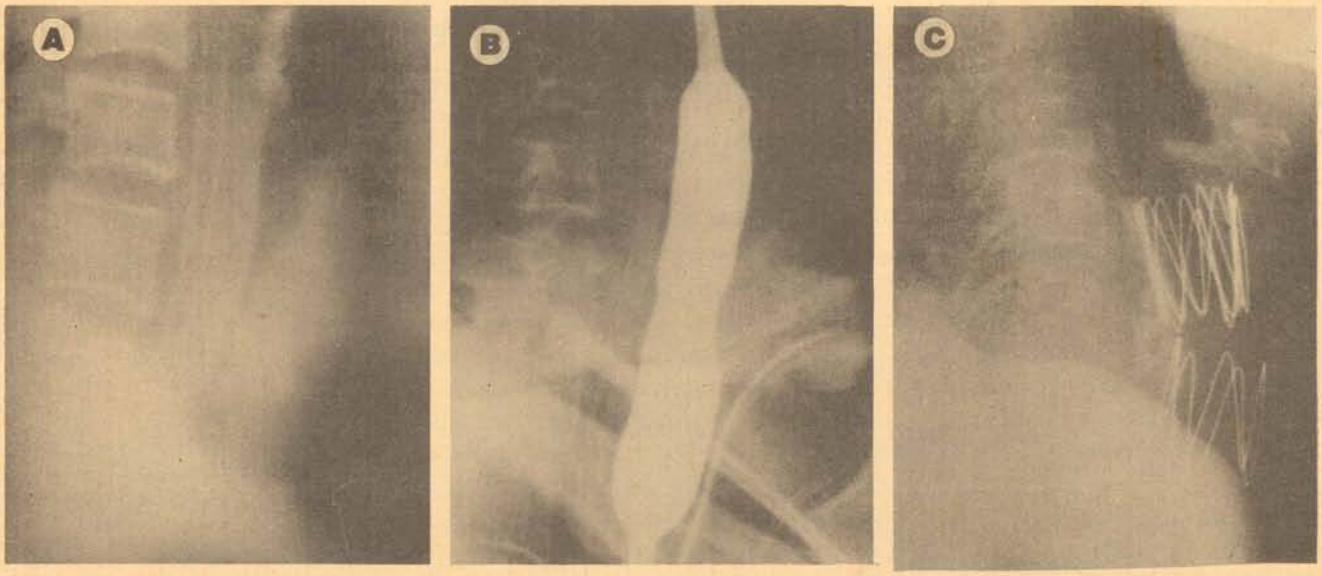
A. Narrowing of the tracheal lumen.

B. Balloon in the narrow segment.

C. Self expandable metallic stents released to reinforce the tracheal lumen.

Dr. Patil, Kasturba Medical College, Manipal, Dr. Jayant Yadav, State service, Bhopal, Dr. Sanjay Sallooja, Dr. Sateesh, JIPMER, Pondicherry, Dr. Sravankumar, Dr Uday Bhaskar, Osmania Medical College, Hyderabad.

Dr. Rao was nominated as a senior member of the World Federation of Interventional and Therapeutic Neuroradiology and a member of the Europa-India Foundation in Neurosciences.



Biomedical Technology Wing

MR. A. V. RAMANI, B.Sc.(Hon).Chem.Tech
Head

Department of Biomaterials Science

Division of Technical Evaluation of Biomaterials

DR. M. JAYABALAN, Ph.D
Scientist

MR. K. SREENIVASAN, M.Sc
Scientist

MRS. PRABHA D. NAIR, M.Sc
Scientist

MR. N. SHANMUGHAKUMAR, M.Sc
Candidate for Ph.D

THE characterisation tests carried out for other Divisions during the year are listed in table 17.

The research activities aimed at the evaluation of newer biomaterials

DEPARTMENT OF BIOMATERIALS SCIENCE

intended for biomedical applications. The effect of stress on the calcification of crosslinked polyurethanes was studied using an in-house, invitro model. A new pressure built-in system was developed with nitrogen gas for studying calcification. The candidate, crosslinked polyurethanes were exposed to blood plasma containing antibiotics at 37°C. The samples were kept under a pressure of 400 mm of Hg. The experiment was continued for 4 weeks with changing of plasma at the end of each week. At the end of 4 weeks the surface was cleaned. The polymers were extracted with a known quantity of 0.1 M HCl at 60°C for 16 hrs. The extracted solutions were analysed for calcium ions using atomic absorption spectrophotomer. The experiment was also repeated without applying pressure. A biomedical grade polyurethane (Tecoflex 5 A) was used as the control. A polyurethane system based on isophorone disocyanate (IPDI) and another based on hydrogenated MDI (SMDI) were used for this study. Calcification in IPDI polymers was linear with the increase of soft segment (PTMG) content whereas in SMDI polymers a reverse trend was observed. Increased phase mixing with increased soft segment content was attributed to the decreased calcification in SMDI based polyurethanes.

Table 17

Test	No.of samples
IR spectral analyses	145
Thermal analyses	80
Liquid chromatographic analysis	125
Mechanical tests using INSTRON	1790

Conventional sterilization methods, though they eliminate harmful micro-organisms, are not guaranteed to safeguard an implant from subsequent attack of micro-organisms. An implant loaded with a suitable component capable of killing a wide spectrum of organisms seems to be an alternative to keep the implant always sterile. A new programme of studies on 'self sterilization' was initiated in the laboratory. The preliminary results using biocide and antibiotic loaded polyurethane were encouraging.

In a new study on the lubricating characteristics of pericardial fluid, pericardial fluid was collected from pigs with a view to analysing the composition of pericardial fluid. The lipids were extracted using conventional methods and efforts begun to estimate the lipid profile of the fluid.

DEPARTMENT OF BIOMATERIALS SCIENCE

In the joint research project "Development of indigenous composite dental restorative materials" under the Division of Polymer Technology of BMT Wing, mechanical tests such as tensile, diameterial tensile and compression tests on dental composites were carried out.

Mr. K. Sreenivasan submitted his thesis on "Studies on the diffusion of physiological fluid molecules in polyurethane" for the award of Ph.D degree. Mrs. Prabha D. Nair also submitted her thesis on "Polyurethane interpenetrating polymer networks for biomedical applications" for the award of Ph.D. degree. Mr. N. Shanmugakumar CSIR, SRF submitted the synopsis of his Ph.D thesis on "Studies on stability of polyurethane and their interaction with tissues" and completed its oral-presentation before the external examiners.

Division of Thrombosis

DEPARTMENT OF
BIOMATERIALS SCIENCE

DR. M. JAMALUDDIN, Ph.D
Scientist

DR. LIZZY KALLIYANAKRISHNAN, Ph.D
Scientific Assistant (on leave)

THE use of chemical agents having specific biological effects contributed to the current notions about the biochemical mechanisms of platelet activation. Thus the use of the calcium ionophores A 23187 and ionomycin helped to delineate the role of intracellular Ca^{2+} ions in cell stimulation. Similarly the use of tumor-promoter phorbol esters led to the realization of the importance of protein kinases C. In a similar fashion H_2O_2 was used. Evidence is now available to show that it functions as an analogue of PGH_2/Tx A_2 and that it functions by the oxidation of platelet SH groups. This is of therapeutic significance.

A Hewlett Packard UV-visible spectrophotometer was added to the laboratory.

Dr. Lissy K. Krishnan joined the School of Dentistry, Department of Preventive Sciences, University of Minnesota, U.S.A. on a post-doctoral fellowship.

Prof. Gundu H. R. Rao, University of Minnesota Medical School was a guest of the laboratory from 3.1.91 to 5.1.91. He delivered a lecture on "Aspirin, prostaglandins and thrombosis."

Department of Biomedical Engineering

Division of Artificial Internal Organs

MR. G. S. BHUVANESHWAR, B.Tech, M.S (Bio Engg)
Biomedical Engineer

MR. C. V. MURALIDHARAN, M.Tech (Control Systems)
Engineer

MR. R. SREEKUMAR, B.Sc
Scientific Assistant

Chitra Heart Valve Prosthesis

THE development of the Chitra valve prosthesis reached a major milestone this year. Following the successful outcome of trials in sheep, the valve was cleared by the Ethics Committee for clinical use in October '90 and the evaluation started in December '90.

Eventhough the vendor for the UHMW-PE disc did not come through successfully, in collaboration with the Tool Room, the Division was successful in fabricating the necessary quality discs for clinical use. The Haynes-25 alloy blanks were machined in the Tool room of the Institute and finish-machined at the Government Tool Room and Training Centre, Bangalore to produce valve cages. These were polished to prosthetic quality, assembled, inspected and sterile packed before handing over to the Department of Cardiovascular and Thoracic surgery for clinical trials. With

DEPARTMENT OF BIOMEDICAL ENGINEERING

funding from the NRDC, the pilot production of 300 clinically usable valves was taken up during 1991-92.

In bringing the device to this advanced stage of development, the Division received support and inputs from several groups in the Institute and Mr. Ramani, in particular, over several years. Its own contributions to the project are listed below:

A. Design of the valve prosthesis, its packaging system for sterile supply and accessories.

B. Design and development of in-vitro test systems and evaluation of the valves and its components.

   a. Pulse duplicator
   b. Accelerated durability tester
   c. Wear test systems for material qualification: Pin-on-wheel and abrasive testing.

C. Development of the technology for the fabrication of:

   a. Sewing Rings
   b. UHMW-PE DISCS
   c. Polishing of metal alloy cages to prosthetic quality
   d. Assembly, inspection, packaging and sterilisation.

D. Co-ordinating other areas of fabrication and testing:

   a. Alloy cage machining with the Institute's Toolroom and Government Tool Room and Training Centre, Bangalore.

   b. Animal evaluation - Vivarium and Department of Cardiovascular and Thoracic surgery.

Chitra Humidifier

Following the successful completion of the clinical evaluation last year, the patenting and technology transfer of this device was taken up with the Technology Transfer Division.

Hydrocephalus Shunt Project

DEPARTMENT OF
BIOMEDICAL ENGINEERING

Active cooperation was extended to the Department of Neurosurgery, Division of Polymer Technology and Technology Transfer Cell in the setting up of its pilot production following the signing of an agreement with Hindustan Latex Limited.

Under the Indo-UK link programme, collaboration was established with Dr. T. V. How of the Institute of Medical and Dental Bioengineering, University of Liverpool, UK. for setting up a pulsed Doppler Ultrasonic Velocimeter system. This system was to be primarily used for the measurement of three dimensional velocity profiles of prosthetic heart valves in pulse duplicator studies.

Dr. How visited the laboratory during October 1990 for a fortnight. The work planned for the visits was the characterisation of the ultrasound probe beam and the measurement of velocity profiles in a straight tube as well as downstream of a Chitra valve under steady flow. The objectives were mostly met during his short stay, despite problems in the doppler module. The use of the doppler and the fine tuning of the system was greatly facilitated by the considerable experience of Dr.How in this field of ultrasonic instrumentation. He delivered a lecture on the 'Engineering design of a compliant polyurethane arterial graft' and 'fluid mechanics of arterial grafts.'

Two B.Tech students from the Department of Electronics & Telecommunications, College of Engineering, Thiruvananthapuram, did their final year projects during February to December 1990 on "Interchangeable temperature sensor for biomedical applications". The aim of the project was to develop methods of screening standard silicon diodes for use as interchangeable temperature sensors. The results of the project were encouraging and would form the basis of further developmental work.

Another batch of three B.Tech students from the Department of Electronics of the same college successfully carried out their B. Tech. Project on 'PC based Micro-infusion Pump Controller". This would be used in the computerised test system for the quality assurance testing of the hydrocephalus, shunt valves.

Division of Biomaterials Technology

DEPARTMENT OF
BIOMEDICAL ENGINEERING

MR. A. V. RAMANI, B.Sc.(Hons.)Chem.Tech
Scientist (till 11/90)

MR. B. AJITH KUMAR, B.Tech
Scientific Officer

MR. D. S. NAGESH, BE
Scientific Officer

MR. S. VIJAYAN, M.Sc
Scientific Assistant

THE main activity related to the pilot production and clinical trial of the SPICTRA Oxygenator and Cardiotomy reservoir. The inputs from the group and the participation of Mr. Vijayan in the clinical trial in particular proved highly useful in the pilot production of the devices. Application of a hydrophilic coating in the cardiotomy reservoir, redesigning of prefilters and simpler assembly procedures were significant improvements which occurred during the phase of pilot production.

Another extracorporeal device to be developed and introduced for application in the intensive care unit during the year was mediastinal drainage system with 20 cm. vacuum control and collection system for the readministration of shed blood. This device was being taken up by the Division of Technology Transfer for transfer to industry.

Dr. Misra completed the project on the development of a zinc phosphate cement conforming to ISO specifications.

Mr. Ramani left the Institute to take up a senior assignment in industry. Mr. Sreenivasan rejoined the Division after completing his M.Tech. in Applied Optics at the IIT, Delhi.

Division of Biosurface Technology

DEPARTMENT OF
BIOMEDICAL ENGINEERING

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

AN attempt was made to develop a polymeric membrane to control the delivery of insulin at rates dependent on the external glucose concentration. Membranes were prepared from polyacrylamide and poly-vinyl-alcohol blends and such membranes containing amine groups and entrapped glucose oxidase were found to alter insulin permeability in response to external glucose concentration. It would appear that the production of gluconic acid catalyzed by the entrapped glucose oxidase altered the pH of the microenvironment within the membrane, thereby causing swelling or deswelling and consequent changes in permeability. The blending of poly-vinyl-alcohol with polyacrylamide was found to improve the wet strength without altering their insulin transport properties and this could alleviate the problem of membrane rupture reported with polyacrylamide alone.

In continuing the studies of the effects of trace mediators for the changes in protein-surface binding, the kinetics of protein polymer interaction in the presence of certain antihypertensive drugs and steroid hormones was studied. Apart from increased albumin or decreased fibrinogen concentration with certain antihypertensive drugs, kinetics of protein absorption studies also showed that steroids reduced the surface-albumin concentration from a mixture of proteins but enhanced the fibrinogen surface concentration. Earlier, it had been reported that certain antihypertensive drugs inhibit platelet-surface attachment, which was

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BIOMEDICAL ENGINEERING

reversed with steroid hormones. It is possible that the changes in platelet attachment due to various drugs are dependent on the availability of fibrinogen receptors at the polymer interface.

The poly-vinyl-alcohol-blended chitosan membranes were prepared with improved mechanical properties without altering their permeability functions for low molecular weight compounds. Nonthrombogenic membranes were derived from them immobilizing bioactive molecules like PGE1 on heparin modified membranes via free radical mechanisms using N2 plasma. Such novel membranes demonstrated good permeability properties for small molecules and showed an increase in albumin surface attachment with a reduction in fibrinogen binding and subsequent reduction in platelet adhesion. The study suggested that it is not the total water content of the membrane, but the amount of solutes dissolved in bound water and the status of water in the polymer matrix, which control the permeability of solutes through the swollen membranes.

The adhesion and stability of blood cells under various flow rates and due to glow discharge had been reported earlier from this laboratory. Further studies of cell adhesion and their stability to various polymers like PMMA, polyacrylonitrile and chitosan were also carried out in protein containing and protein free media due to plasma glow (GDT) and under various shear rates. A significant amount of cell detachment was observed with the bare and the proteinated substrates under various shear conditions. However, the cell detachment did not occur until a critical value of shear stress was exceeded. The GDT-Immobilized cells were highly stable when compared with the untreated cells under shear rates upto 300 rpm on proteinated or bare substrates.

Protein interaction towards polymer surfaces having the same surface energy but different characteristics was studied. Hydrogels like (HEMA), Polyacrylamide, Polyacrilonitrile and polyethylene glycol were grafted onto a siliastic-polyurethane surfaces using ^{60}Co - γ - irradiation method and optimised to similar surface energy. Protein interaction studies were conducted by tracer technique. It was observed that a relative change in behaviour occurred due to the difference in chemical nature.

In another study, the effect of cod liver oil on the protein adsorption and adhesion of blood cells on an artificial surface (polycarbonate) was investigated. Results indicated that the presence of cod liver oil reduces the adsorption of albumin and fibrinogen, with significant reduction in fibrinogen adsorption. In the presence of cod liver oil, stability of albumin

was also found to be more. Adhesion of red blood cells and platelets to the surface decreased significantly in the presence of cod liver oil.

Tantalum is a biocompatible metal and is completely inert to body fluids and tissues. Oxide layers of different thickness were coated on tantalum by anodization. Hydroxyapatite was also applied on tantalum by electrophoretic coating. The competitive adsorption of albumin and fibrinogen on to these surfaces were investigated. It was noted that albumin and fibrinogen adsoprtion increased with increase in oxide layer thickness.

Polyacrylonitrile blended polyvinyl alcohol (PVA : PAN = 87:13) membranes were developed with good mechanical strength in water swollen state, comparable with that of cellulose acetate membranes, without affecting the permeabilities of urea, creatinine and uric acid. This was thought to have possibilities of application as a dialysis membrane.

A collaborative project was initiated for the study of fibroblast cell culture (adhesion and proliferation) on a variety of biologically modified polymer substrates (Heparin, PGE_1, albumin, synthetic polyelectrolyte etc.), with the help of Dr. R. Renuka Nair of the Division of Pathology. The studies are in progress.

Dr. P. J. Doherty, Institute of Medical and Dental Bioengineering, University of Liverpool, paid a visit under the Indo-UK link programme during October 1990. He attempted an explant procedure to establish the effect of substrate property on cell adhesion with the collaboration of Dr.Renuka Nair. He delivered two lectures on "Biocompatibility evaluation by in-vitro and in-vivo test methods."

Dr. C. P. Sharma chaired a session and delivered an invited talk on "Protein-platelet adhesion onto artificial substrates" at the National Conference on Chemical and Physical aspects of Organised Biological Assemblies at Jadavpur University, Calcutta.

Dr. Thomas Chandy Co-chaired a session and presented a paper entitled "Biodegradable chitosan matrix for the controlled release of steroids" in the 4th National Conference of the Society for Biomaterials and Artificial Organs at Hyderabad.

Dr. Sharma presided over the inauguration of the Vth Anniversary of the Society for Biomaterials and Artificial Organs. He served as an external examiner at IIT, Delhi.

Division of Research Toxicology

DEPARTMENT OF
BIOMEDICAL ENGINEERING

DR. P. V. VEDANARAYANAN, B.V.Sc., Ph.D
Senior Materials Toxicologist

DR. A. C. FERNANDEZ, Ph.D
Scientist

EVENTHOUGH progress could not be made in performing extended immunological studies on the reduction of gamma globulin observed in rabbits with polymeric implants, a study was initiated to elucidate the serum protein changes under in-vitro conditions when polymeric materials were exposed to rabbit serum.

Standardisation of primary cell cultures of macrophages and lymphocytes was continued.

Division of Toxicological Screening of Materials

DEPARTMENT OF
BIOMEDICAL ENGINEERING

SRI. K. RATHINAM, M.Sc
Scientist

SRI. S. BHASKARA RAO, M.V.Sc, LLB
Verterinary Surgeon

MR. P. V. MOHANAN, M.Sc
Scientific Assistant

THE major activity during the year centered on the mandatory biological tests, such as pyrogen, Limulus amebocyte lysate (LAL) and sterility tests for the finished products like SPICTRA cardiotomy reservoir, oxygenators etc. as per USP. The systemic toxicity, intracutaneous irritation, heamolysis and implantation tests reached the peak during the year. The Division was also responsible for the management of the small animal research facility involving the breeding and care of guinea pigs, rabbits, rats, mice, and hamsters required for toxicological experiments. The animals were supplied to other scientists of the Institute for experiments. Technical support and animal care were provided for investigating cardiomyopathies and for other studies for the Pathology, Microbiology, Thrombosis, and Material Toxicology Divisions. In vitro toxicity studies of standard phenol, barium methacrylate (monomer), and extracts of oxygenators and cardiotomy reservoirs using Microtox systems were also standardised and established. This showed a positive correlation between in-vivo animal test and in-vitro Microtox systems.

An important research activity related to the new in-vitro cyto-biocompatibility test using mast cell systems. The mast cell collection from the peritoneal lavage of rats and tests for the effects of toxic substances on peritoneal mast cell were standardised and established. The teratological effects of barium methacrylate (monomer) was established and

DEPARTMENT OF BIOMEDICAL ENGINEERING

standardisation of mutagenicity test taken up.

In a collaborative project with Division of polymer technology, the toxicological tests such as systemic toxicity, intracutaneous irritation, haemolysis, subcutaneous implantation, sensitization and dermal toxicity studies on a new dental composite were carried out.

Dr. S. Bhaskara Rao served as Visiting Scientist for a year in the University of Health Sciences, Vijayawada. He presented papers at the 10th Congress of Indian Veterinary Society at Srinagar and the 9th Annual Symposium of Indian Veterinarians Association at Guwahati.

Division of Pathophysiology

DEPARTMENT OF
BIOMEDICAL ENGINEERING

DR. MIRA MOHANTY, MD
Scientist

DR. T. V. KUMARI, Ph.D
Scientific Officer

As in previous years, service activities consisted of the histopathological evaluation of tissue response to implant materials such as polyurethanes, sillicone and titanium. Histopathological studies were also carried out on Chitra valves and prosthetic shunts removed from animals, on laser induced lesions in tissues and on an experimental model in rats for endomyocardial fibrosis. Hematologic and biochemical tests were carried out as before for various experimental studies in animals.

Dr. Mira Mohanty collaborated as a co-investigator in the following projects:

1. Studies on material-tissue interface of experimental prosthesis for reconstructive surgery. (Laboratory for technical evaluation)

2. Medical and surgical application of Lasers. (Radiology and Cardiothoracic surgery)

3. Development of Indigenous, composite dental restorative materials. (Polymer Technology)

Dr. Mohanty rejoined the Division after spending a year in the Institute of Medical and Dental Bioengineering, Liverpool where she worked on tissue-material interactions under the guidance of Prof. David Williams.

Division of Polymer Chemistry

DEPARTMENT OF
BIOMEDICAL ENGINEERING

DR. A. JAYAKRISHNAN, M.Sc, Ph.D
Scientist (On sabbatical leave)

DR. B. CHITAMBARA THANOO, M.Sc, Ph.D
Scientist

DR. M. C. SUNNY, B.Sc, AIC
Scientific Assistant

THE hydrogel microsopheres developed in the laboratory for endovascular embolization were prepared and supplied to the Department of Radiology as and when required for clinical procedures. Materials were also supplied to a few other clinical centers upon request. The application of this hydrogel microsphere as a space filling material in the eye was tested at the University of Liverpool, UK in an experimental model and found suitable for the successful treatment of retinal detachment.

The microsphere technology developed in the laboratory was extended to the microencapsulation of pharmaceutical agents. Polyvinyl alcohol microspheres containing upto 80% drug was prepared in a suspension crosslinking process. Drugs such as theophyllin, aspirin, gresiofulvin and nicotinic acid were successfully incorporated and very good control over the release pattern of these drugs was achieved by changing the crosslinking density. Chitosan microspheres having various rates of swelling were developed and the possibility of using these microspheres in a drug delivery system was explored.

A polymerizable vinyl monomer was synthesised from iothalmic acid, a clinically used contrast material, and successfully copolymerized with 2-hydroxyethyl methacrylate towards the achievement of a radiopaque polymer for medical applications. They were prepared in the form of microspheres for application as particulate emboli.

DEPARTMENT OF BIOMEDICAL ENGINEERING

A new fluid embolizing agent based on polyvinyl alcohol was developed. The solidification of the fluid was achieved by the crosslinking process initiated by a catalyst and the process lacked any exotherm. The viscosity of the fluid is low till solidification and the time for this could be controlled by the catalyst concentration. Methods were developed and standardised to make the gel radiopaque. Another fluid embolizing system which consists of both 2-hydroxyethyl methacrylate and polyvinyl alcohol was devloped which resulted in a mechanically strong and rubber gel. The fluid accommodates a wide variety of radiopaque substance without much increase in viscosity.

Particle size analyser, GALAI Model CIS-1 was purchased under a DST Project and installed. A data acquisition system for the particle size analyser, HCL Busybee AT Plus Computer was also added to the laboratory.

Dr. Jayakrishnan left to join the Department of Materials Science and Engineering, University of Florida for a year as a Visiting Scientist.

Division of Polymer Technology

DEPARTMENT OF
BIOMEDICAL ENGINEERING

SRI. S. N. PAL, B.Tech, M.Sc(Tech)
Scientist/Engineer

SRI. V. KALLIYANAKRISHNAN, M.Sc
Scientist

SRI. M. MURALEEDHARAN
Scientist/Engineer (resigned during the year)

As a clinical service, about 2000 chest drainage tubing systems were supplied to the Hospital Wing. Fabrication of components required for blood filter and hydrocephalus shunt also continued in close collaboration with the scientists belonging to other disciplines. It was gratifying that the knowhow for the blood bag technology, developed by the division, was re-licensed for commercial exploitation. Preparation of a modified knowhow document and the extension of consultancy to the second licensee were accordingly taken up.

Blood Filter

Following the approval of the Ethics Committee, fabrication of 100 blood filters was nearly completed for clinical trial. The technology transfer of this device made progress and the documentation for the transfer of knowhow was also made ready.

The development of modified graft and blend PVC materials was completed by Sri. Kalliyanakrishnan and Sri. S. N. Pal as part of their Ph.D programmes.

DEPARTMENT OF
BIOMEDICAL ENGINEERING

Composite Dental Restorative Materials

Project Title	Development of Indigenous Composite Dental Restorative Materials
Principal Investigator	S. N. Pal
Principal Co-Investigator	V. Kalliyanakrishnan
Co-Investigators	K. Rathinam Arthur Vijayan Lal M. Jayabalan Mira Mohanty
Consultant	Dr. (Mrs.) A. Valiathan
Funding	Dept. of Science and Technology
Status	Ongoing

Good progress was made in the development of two component chemical curing BIS-GMA based dental composites. The studies on the role of formulation variables on end properties were the main emphasis of the work carried out during the year. Investigation of physico-chemical characterization, materials toxicology and in-vivo experiment with animal model are currently in progress. The need to develop visible light curing dental composite along with chemical curing system was identified and a proposal for this development work was approved recently by the Department of Science and Technology. Work on the light curing system was to commence shortly. A patent application was forwarded on chemical curing dental composites.

Sri. S. N. Pal attended the Task Force meeting of the Department of Biotechnology on Collagen Biotechnology at Central Leather Research Institute, Madras. He served as a member of the National Organising Committee for the Symposium on "Polymers-91" held at the National Chemical Laboratory, Pune in January 1991 where he presented a paper entitled "Physico-chemical characterisation of composite materials for dental applications".

Division of Technology Transfer

DEPARTMENT OF
BIOMEDICAL ENGINEERING

MR. H. VIJAYAKUMAR, BE, MS, PGDBA
Scientist

MR. D. RANJIT, BE
Scientist

MR. D. S. NAGESH, BE
Scientist

Technological

CUSTOMPACKS, which started as an engineering support to the cardiac theatre went through constructive refinements, became a viable technology and attracted Southern Petrochemical Industrial Corporation Ltd., Madras and Peninsula Polymers Ltd., Thiruvananthapuram as licencees for commercialisation. The mediastinal drainage system went through batch production in close consultation with the Division of Biomaterial Technology and the device is currently under clinical evaluation. A spin off from these, the Ethylene oxide sterilisation process, also attracted industrial attention.

Planning and running industry-sponsored projects for proving technologies with strict time and cost factors continued to be a challenging task. This concept of integrating Industry, R & D and pilot production groups expanded within a year into multiproduct, multi-organisational effort detailed in the following table.

About 700 Cardiotomy reservoirs produced in the Technoprove facility were distributed for clinical use by SPIC Science Foundation (SPICF), Madras. Creative feedback and commitment towards continuous

improvement contributed to backward integration. As a result, better models emerged and led SPICF to seek the extension of the sponsored production by 500 devices more.

Device	Sponsor	Project Cost
Oxygenator and Cardiotomy Reservoir	SPICF, Madras	Rs. 25.00 lakhs
CSF Shunt	Hindustan Latex Limited, Thiruvananthapuram	Rs.25.00 lakhs
Custom packs	Peninsula Polymers Ltd. Thiruvananthapuram	Approximately Rs.1.00 lakh.
Mediastinal drainage system		
Blood Filter		
Humidifier		

The successful experience of cardiotomy reservoir led to a similar exercise for SPICTRA oxygenators. About 100 oxygenators for inhouse clinical evaluation were made with highly encouraging results. About 150 additional oxygenators were produced and sent for distribution by SPICF. The multicentric trial commenced with the clinical participation of the Department of Cardiothoracic surgery and engineering assistance from Technoprove facility. This development not only signalled the birth of a proven high-tech indigenous technology but also yielded foreign exchange saving to the tune of Rs.15 lakhs in the technology generation stage itself.

Preparation of the knowhow documentation for SPICF commenced with a user-attractive document on plant and machinery designed and configured for an installed capacity of twenty devices a day. For the commercial plant, the company was assisted in its efforts for securing venture capital funds from the Industrial Development Bank of India.

The pilot production of the CSF shunt commenced with the initial target being the commissioning of a class 10000 clean room facility.

DEPARTMENT OF
BIOMEDICAL ENGINEERING

Techno-administrative

The technology transfer activities reached a peak wherein a major technology related to an implantable device, minor technologies related to five devices and one process entered the commercialisation stage.

Preparation of project profiles, communication with prospective industries, monitoring their responses, coordinating visits, meetings and discussions were some of the activities organised for the identification of industries who could successfully take up commercialisation of the knowhow. Hindustan Latex Limited (HLL) for the hydrocephalus shunt, Southern Petrochemical Corporation (SPIC) for custompacks and Peninsula Polymers Ltd. (PPL) for a package of minor technologies consisting of custompacks, mediastinal drainage system, blood filter, and humidifier were the licencees identified by the Technology Transfer Committee. Subsequently agreements for pilot production and implementation of the knowhow transfer were taken up for consideration for the following projects.

i. Pilot production of CSF shunt with HLL.

ii. Technology Transfer with SPICF, Madras for Blood Oxygenator and Cardiotomy Reservoir.

iii Technology transfer with SPICF and PPL for minor technologies.

iv. MOU with PPL for pilot production of the devices included in the minor technologies package.

v. Process knowhow transfer related to Ethylene oxide sterilisation to Madhavi Mandiram, a Gandhigram Lok Seva unit.

vi. Pilot production of heart valve with National Research Development Corporation, New Delhi.

vii. Consultancy for implementing National Research Development Corporation's second licensee on blood bag and soft shell devices.

Techno-legal

The patenting activity too grew in volume. As the development of heart valve moved towards newer and better materials and processing methods, the Japan and European Patent Office (EPO) applications filed on the earlier models were withdrawn. Fresh applications are also being filed in the application areas related to dental materials, CSF shunt, micro beads for embolisation and PVC with resistance towards plasticizer migration. A summary of the status is as follows.

Sealed Indian Patents	5
Sealed Foreign Patents	1
Indian design registrations	9
Indian Patent applications under examination	2
Applications under filing stage.	3

Mr. Vijayakumar served as a member in the Board for undergraduate engineering programmes of the Cochin University of Science and Technology. He also guided one student of Kerala University for M.Tech thesis work. He continued as a member of the committee on GMP related to Medical Devices of the Bureau of Indian Standards.

Mr. Prajithkumar, Project Engineer posted by SPICF joined TPF for training in oxygenator and CR production. Mr. D. Ranjit coordinated the clean Room activities. The computer facilities were maintained by the Division and Mr. D. S. Nagesh played a key role in the product improvement activities of Cardiotomy Reservoir and Oxygenator.

Division of Tool Room and Engineering Services

DEPARTMENT OF
BIOMEDICAL ENGINEERING

MR. O. S. NEELAKANTAN NAIR, B.Sc.(Engg)
Engineer

THE Division with its team of skilled personnel was responsible for operating the Tool Room, panoramic batch irradiation unit and maintaining the general engineering services at the Biomedical Technology Wing. Its activities varied therefore from precision jobs such as the cryomachining of a valve disc to general duties like the maintenance of airconditioning equipment.

The Division was assigned a major role in producing 300 Chitra valves for the premarket evaluation of safety and efficacy. Three hundred Haynes blanks of different sizes were fabricated using optical profile grinding tools and a similar number of UHMW polyethylene blanks were made in a clean room using liquid nitrogen. A new clean room machining facility was set up with a high precision lathe in a filtered and controlled environment. This facility was meant to be used for the fabrication of components for the valve and medical laser project.

Division of Vivarium

DEPARTMENT OF
BIOMEDICAL ENGINEERING

DR. G. ARTHUR VIJAYAN LAL, B.V.Sc.
Veterinary Scientist

THE services of the Division were used by several clinical Departments and the well equipped operating room with X-ray, angiography, blood gas analysis and other facilities continued to be in demand. A new Medilas - 4060 N Nd: Yag laser unit was added to the laboratory for experimental work.

In the laser medical project, several studies were carried out on laser - tissue interaction and the development of an experimental model for chronic arterial occlusion. In-vivo evaluation of the Chitra valve was also carried out in sheep as a preclinical exercise. Other experiments related to the evaluation of new dental filling materials in dogs and tissue response in pigs to newly developed polyurethanes for reconstructive applications.

Dr. Arthur Vijayan Lal presented a paper on the animal evaluation of the Chitra hydrocephalus shunt at the Annual Conference of the Neurological Society at Indore. Facilities were provided to three postgraduates from the Department of Neurosurgery for this project work.

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A senior officer of the DST
nominated by the Secretary.

Mr. C. Venugopal,
Technology Transfer Division,
VSSC, Thiruvananthapuram.

A nominee of the KSIDC,
Thiruvananthapuram.

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

Director's Nominee
(in the case of devices) expert.

Principal Investigator,
(the corresponding person for each device to be called at the appropriate time).

FA & CAO of the Institute.

Alumni

1. Dr. M. V. Joseph Joy (DM 1985)
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2. Dr. K. Suresh (DM 1985)
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5. Dr. S. Gobisankar (DM 1985),
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