



Sree Chitra Tirunal Institute for Medical Sciences & Technology
TRIVANDRUM - 695011 · KERALA

ANNUAL REPORT 1986 - 1987



annual report 1986-'87

Sree Chitra Tirunal
Institute for Medical Sciences & Technology
Trivandrum, Kerala

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Cover : Human myocardial cells in culture

Overview

During 1986-'87, the Institute witnessed the emergence of new administrative bodies whose term of office had been limited to five years by the Act, Rules and Regulations. Mr. G. Parthasarathi was renominated as the President and Chairman of the Institute and Governing Bodies whose first meetings were held in November 1986. The membership of the reconstituted Institute Body, Governing Body and standing committees is listed in Schedule.

The hospital services continued to grow in volume and quality. The increase in the volume of patient services over the previous year's level was matched by the regular use of innovative procedures such as balloon angioplasty and embolisation as well as a series of administrative measures including the organisation of a Central Clinical

Laboratory. The annual figures for admissions, investigations and operations recorded an all time high and the utilisation of hospital equipment and facilities reached near maximal levels. Most importantly the excellence of the hospital services remained readily accessible to low or middle income groups as the charging policy of the Institute was unchanged and great care had been taken to ensure that 42.3% of the revenue expenditure was directly utilised for patient care.

The total expenditure of the Institute for the year 1986-'87 was Rs. 622 lakhs which was met from grant received from the Government of India for the year (Rs. 491 lakhs), receipts of the Institute (Rs. 78 lakhs) and unspent grant carried over from previous year. Distribution of the expenditure for

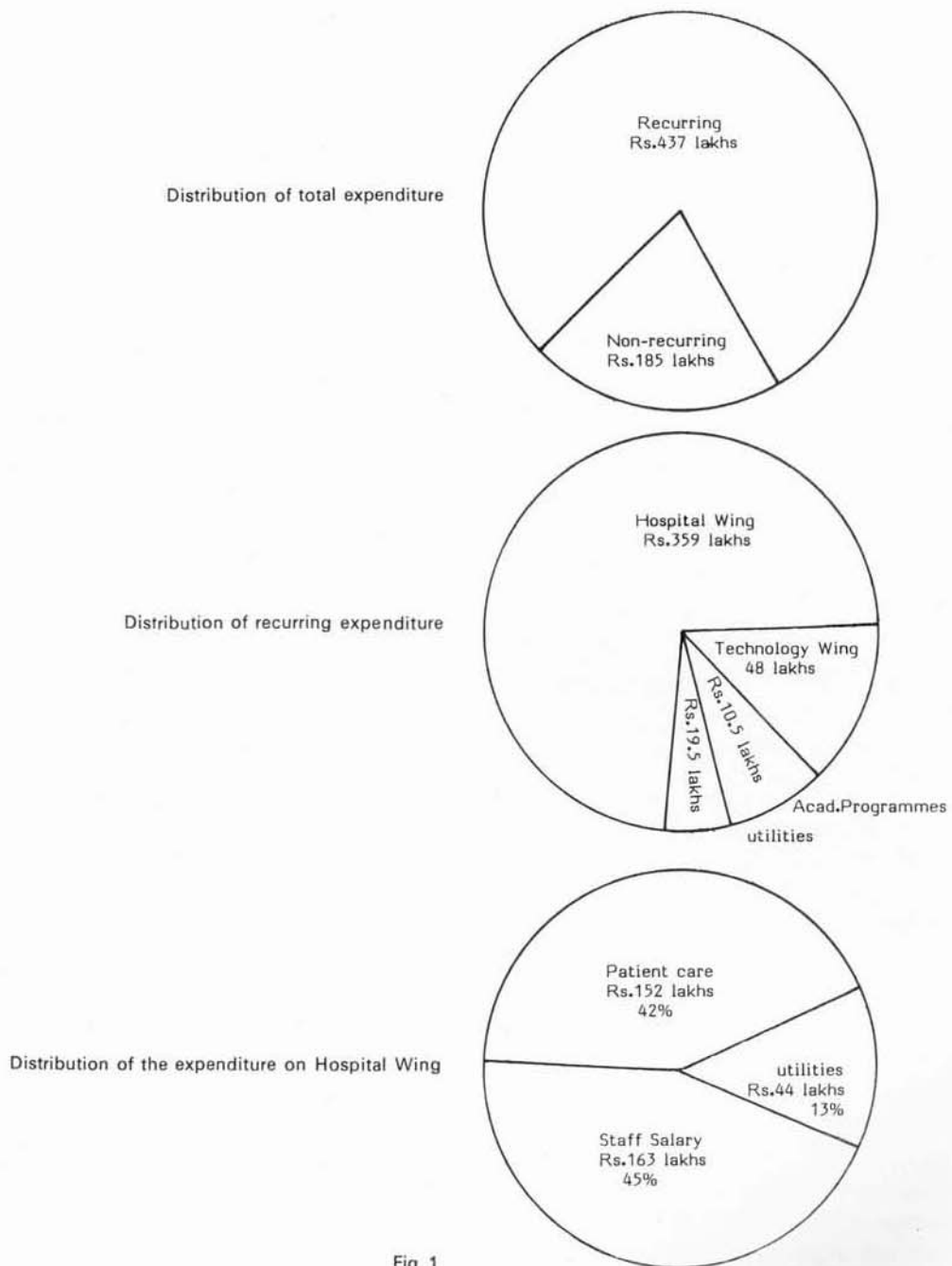


Fig 1

various purposes is indicated in Fig. 1. The hospital receipts during the year was Rs. 74 lakhs which worked out to 21 per cent of the expenditure.

While the record in hospital services won public esteem over the years and attracted favourable attention from within the country and abroad, the prospect for continued excellence faced two hazards which were socio-economic and administrative in nature. The socio-economic problem was all too familiar in so far as the hospital was attempting to provide specialised services for more than 20 million people whereas a specialised centre is optimally recommended for 2 million. Regardless of efficient management of resources and dedicated work on the part of staff, the hospital services were bound to face severe strain if the demand continued to mount at the present rate. The administrative hazard arose from the obligation to adopt pay hikes from time to time on the basis of national recommendations with no definite assurance of total reimbursement of the additional expenditure involved. This could only lead to the gradual erosion of the allocation for actual patient care and the impairment of services for those who are too poor to pay. The gross inadequacy of specialised services in the country as well as the mounting budgetary burdens were matters of grave concern which tended to complicate the longterm plans of the Institute.

Turning to the field of devices development, the Institute could rightly claim to have anticipated international interest in devices technology by several years. This became obvious at the First International

Conference on 'Medical Device Regulatory Authorities' which was jointly sponsored during 1986 by the World Health Organisation and by the Food and Drug Administration of the United States in Washington, DC. Attended by the Director of the Institute on behalf of the Ministry of Health, Government of India, the conference attracted delegates from over 50 countries and dealt with a variety of issues in relation to biomedical devices ranging from standards and safety evaluation to export regulations all of which had been of intense interest to the Institute from 1976 when a national seminar on biomaterials and medical devices technology was organised in Trivandrum. The Conference of the Medical Device Regulatory Authorities which will be a triennial feature underscored the worldwide interest in devices technology and opened up possibilities for the Institute to share its considerable experience with other countries.

Dr. David Annis from the University of Liverpool visited the Institute during the year and closely interacted with the scientists of the Biomedical Technology Wing by holding discussions and giving lectures on the ongoing projects at the University of Liverpool. An important outcome of his visit was the formulation of a plan to hold an Indo-UK symposium on biomaterials in January 1988 which would coincide with the beginning of the Raman Centenary Year. The high quality of the invited presentations and the participation of young scientists from Indian Universities in the symposium were expected to inspire biomaterials research in other Indian centres in the years ahead.

SURVEY OF MAJOR PROGRAMMES

i. HOSPITAL SERVICES

Medical Superintendent:

Dr. (Maj.) K. A. Hameed, MBBS

Dr. D. Hariprasad, MBBS, Asst. Administrative Medical Officer

Outpatient & Inpatient services

The dominant trend continued to be expansion in services at various levels as indicated in Fig. 2-3.

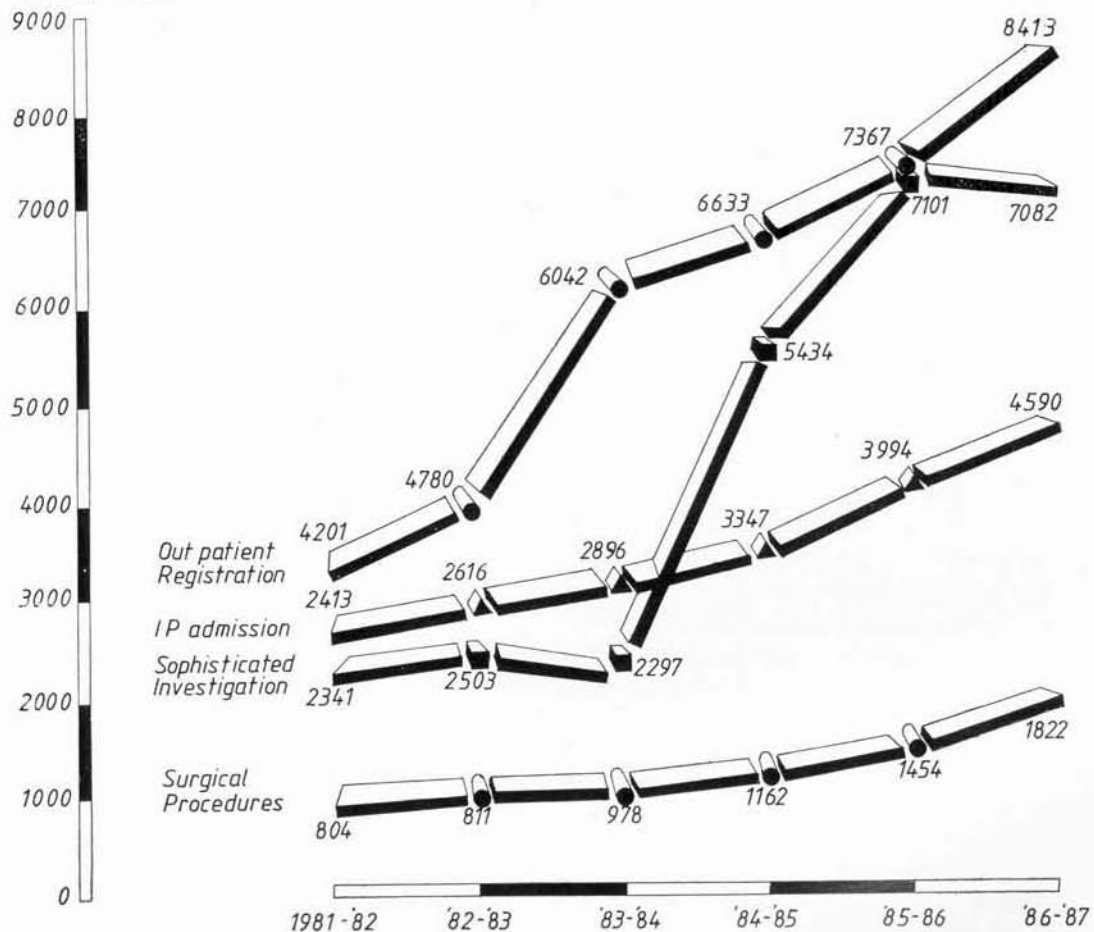


Fig. 2

The hospital administration made efforts to cope with the process of continuing growth by introducing several measures the most important among them being a series of reforms in the outpatient services. These included the commissioning of a Central Clinical Laboratory integrating clinical chemistry and clinical pathology under Dr. Subramonia Iyer, relocation of the laboratory for Echocardiography in the cardiac outpatient section, redistribution of the timings and location of various other special clinics including those of neurology, opening of new counters for registration and income assessment and expansion of

seating capacity for waiting patients. While these steps did streamline and greatly improve the outpatient services, they were no more than palliatives for the basic problem of a gross mis-match between supply and demand for specialised services in the country.

Medical Records

The thinning and microfilming of the voluminous charts of patients were completed for a five year period in accordance with the decision to transfer essential data to microfilm after five years of the original admission of patients. Progress was also

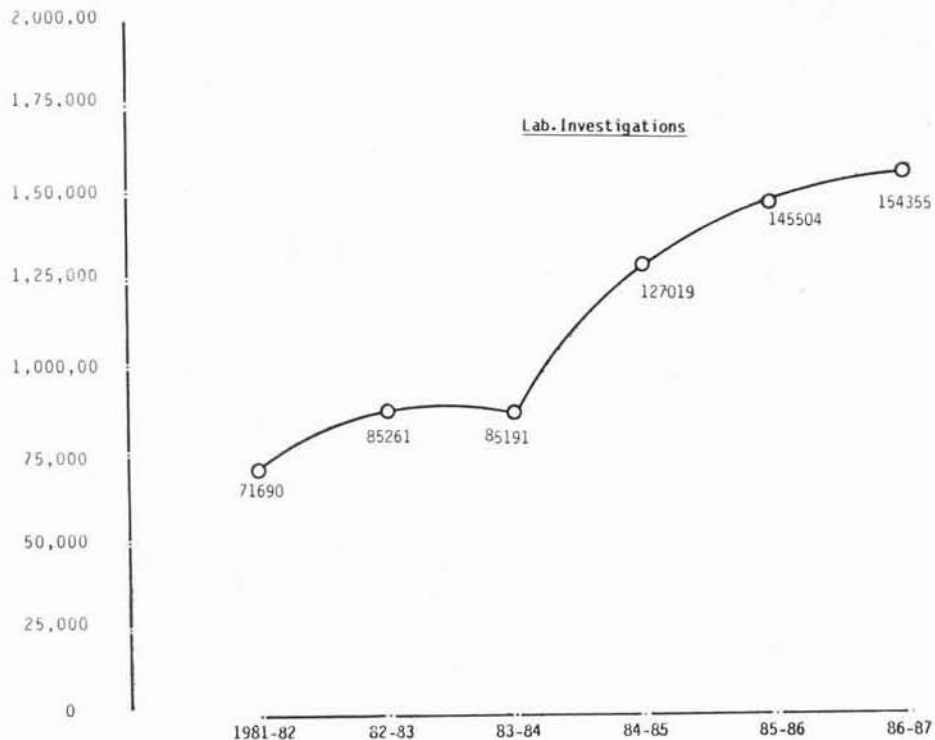


Fig. 3

made in the development of a patient data base in collaboration with the Department, of Computer Science, Cochin University of Science & Technology. Toward the end of 1986-87, the data base was being used to generate statistical reports on patient services which had been done manually earlier. With the development and operation of the patient data base, the computer applications at the Institute came to cover patient data, billing, accounts and inventory control. The computer committee therefore took up the next phase of extended application to the management of library services for which potential and capacity exist.

Electron Microscopy Laboratory

The small animal house in the hospital block was transferred to the Biomedical Technology Wing during the year and the area remodelled for locating the new laboratory for electron microscopy.

Nursing Services

Eighteen nurses left during the year to take up employment abroad and maintained the emigration rate of previous years. The resulting vacancies were filled by fresh recruitment and fall in nursing standards prevented by regular in-service education programmes. The educational activities received the support of the staff nurses and doctors and included demonstration of nursing procedures, case and topic discussions and a course in cardiopulmonary resuscitation using a CPR stimulator.

A two day Conference was organised by the nursing staff in November 1986 which

was attended by nearly 60 nursing delegates from the southern region. The conference covered common clinical problems in Cardiology as well as Neurology and was appreciated by the participants.

Two postgraduate nursing students from the Raj Kumari Amrit Kaur College of Nursing, New Delhi visited the hospital for summer field experience. Five staff nurses attended the Satellite conference of Neuro nurses in Delhi in December 1986 and presented a symposium on brain tumours in pediatric age group. Mrs. Lyla Mathew received the first prize for the best poster presentation and much appreciation for organising a quiz programme in neuro anatomy and physiology.

Clinical Engineering

Support was provided mainly for the installation and commissioning of new equipment and the maintenance of existing equipment. The new equipment covered a wide range and included DISA - Evomatic 4000, UMF Echocardiograph, OPMI-6 operating microscope, Holter system and laboratory instruments such as spectrophotometer, spectrofluorimeter and CO₂ incubator. Adequate steps were taken to ensure that the level of maintenance of existing systems such as cardiac catheterisation laboratory, CT Scanner, Diagnost 73 and other major equipment was satisfactory throughout the year. The staff were also responsible for the smooth operation of the electrical and airconditioning systems which called for several corrective measures in view of the vagaries in power supply.

ii. BIOMEDICAL TECHNOLOGY WING

Head: Shri A. V. Ramani,
B. Sc. (Chem. Tech)

1986-87 was a satisfactory year for the Biomedical Wing which made progress in achieving its diverse goals. Research in biomaterials science which had previously been confined to characterisation and surface modifications acquired a new dimension with the development of a new class of hydrophilic polymers which had potential applications for eye implants and drug delivery systems. On the other hand experience on the devices front illustrated the truism that the course of medical device development seldom runs smooth. Whereas the Variflo oxygenator with its novel design features emerged successful in the clinical trials, it faced difficulties in scaling up for manufacture as the very design features tended to raise the cost of production and ultimately the unit price. Accordingly a new exercise was undertaken to redesign the device with the specific aim of easing commercial production and reducing unit cost. If the phase of production became the bottleneck for the oxygenator project, the tilting disc valve was obliged to undergo a major change in so far as its material for housing became a chromecobalt alloy instead of titanium which proved itself to be a mismatch for sapphire discs in long-term animal experiments. While such experiences would be regarded as setbacks in project management charts, they are, in the technological world, the best instructors and the stimuli for the generation of new ideas and better techniques. Thanks

to the demand for redesign, the technology for the Chitra devices was assured of reaching the patients ultimately at lower costs and superior quality.

In opting for the development of laser for angioplasty in collaboration with the Bhabha Atomic Research Centre, Bombay, the technology programmes of the Institute broke new ground as they had been confined to biomaterials and devices earlier. Given the promise of lasers for reopening arteries and reducing the need for reconstructive operations, the Institute welcomed the prospect of entering the exciting field of lasers in partnership with the Bhabha Atomic Research Centre. The project envisaged the development of the laser source by BARC and that of the delivery system by the Institute over a three year period for recanalising occluded arteries which constitute a distressingly common clinical problem.

As a central objective of the Institute was the development of a joint culture of medical science and technology, the Biomedical Technology Wing contributed to the process of integration in several ways. The formulation of collaborative research projects with the clinical faculty, provision of experimental facilities for postgraduate students of clinical disciplines, development of 'low technology' disposable devices for upgrading patient care and the offering of an introductory course on 'measurement in medicine' for the postgraduate medical students were some of the steadily growing list of measures which were likely to bridge the gap between the best in medical sciences and technology before the dawn of the new century.

iii. EDUCATIONAL PROGRAMMES

Registrar: Shri V. Narasimhan, M.Sc.

Broadly speaking the course of educational programmes during the year paralleled the growth of medical specialities and technology development which together constituted the three central objectives of the Institute. While the formal degree and Postdoctoral certificate courses gained stability and national acceptance as indicated by the formal membership of the Institute in the Association of Indian Universities, new stirrings in educational programmes appeared in the moves for initiating a specialised training course for nurses, rethinking on the status and content of Ph.D. programmes and the technological orientation of the medical curriculum.

Postgraduate Courses

Whereas the number of applications for various courses continued to remain impressive (Fig. 4), the Statewise break up of the applications confirmed the nationwide appeal of the educational programmes (Table 1). The coursewise distribution of the number of applicants and those who joined is given in Table 2.

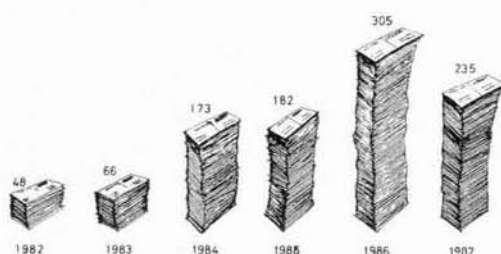


Fig. 4. Yearwise applications for PG Courses

Table-1

<i>State/Union Territories</i>	<i>Number applied</i>
Andhra Pradesh	20
Assam	2
Bihar	5
Delhi	25
Gujarat	3
Haryana	5
Himachal Pradesh	1
Jammu Kashmir	3
Karnataka	22
Kerala	29
Madhya Pradesh	32
Maharashtra	15
Orissa	2
Punjab	14
Rajasthan	11
Tamil Nadu	30
Uttar Pradesh	10
West Bengal	6

Table-2

<i>Course</i>	<i>No. of applicants</i>	<i>No. selected & joined</i>
DM Cardiology	98	2
DM Neurology	19	2
M.Ch. Cardiovascular thoracic surgery	37	2
M.Ch. Neurosurgery		
3 year	22	2
5 year	24	nil
Postdoctoral certificate in Anaesthesiology	24	2+1*
Postdoctoral certificate in Radiology	11	2

* One candidate sponsored by the Government of India.

In view of the increasing demand for admission to the postdoctoral certificate course in anaesthesiology, improved facilities for training and the ready employment opportunities for trained anaesthesiologists the Institute decided to raise the number of annual admissions to the course to four.

Postgraduate Examinations

All the candidates who had appeared for DM/M.Ch. examinations during 1986 were declared successful. They are listed in Table 3.

Table-3

<i>Name of candidates</i>	<i>Degree</i>	<i>Speciality</i>
Dr. Geevar Zachariah Dr. K. Suresh	DM	Cardiology
Dr. B. K. Sharma Dr. A. B. Bhoyar	M.Ch.	Cardiovascular and Thoracic surgery
Dr. K. Venkateswarlu Dr. Chetan Trivedi Dr. G. M. Wali	DM	Neurology

All the candidates for the postdoctoral certificate courses completed their training programme satisfactorily in December 1986 and the details are given in Table 4.

Table-4

<i>Name of the candidates</i>	<i>Speciality</i>
Dr. S. Bhanumurthy Dr. Deshpande	Cardiovascular and Neurosurgical Anaesthesiology
Dr. A. Balathimmiah Dr. Sunil Kumar*	Cardiovascular and Neuroradiology.

* joined late completed on 9-3-87

Ph. D. programme

Mrs. Annamma Mathai of the Department of Pathology registered for Ph.D. with Prof. Mrs. Shobha Saigal of the Institute of Postgraduate Medical Education and Research, Chandigarh as her guide under the external teachers scheme. The subject of her investigation is 'immunodiagnosis of tuberculous meningitis'.

Specialised training programmes abroad for academic staff

Prof. K. G. Balakrishnan was deputed for training in balloon angioplasty for coronary artery disease at the New York University Medical School as the procedure was

scheduled to be introduced at the Institute during 1988 when the new cardiac catheterisation laboratory would be commissioned. Prof. Debkumar Basu proceeded to the National Institute of Health, Bethesda for four months on a training award from the National Biotechnology Board. Dr. P. S. Appukuttan of the Division of Neurochemistry left for a year to accept a Post-doctoral Fellowship at the Uniformed Services University of the Health Sciences, Bethesda, USA.

**Training facilities
for staff from other
institutions**

As in previous years, the Institute accepted staff members and students from several institutions for short term training in various departments and disciplines which are mentioned in the departmental reports.

**Continuing Medical
Education programme**

The faculty organised a continuing education programme for the general practitioners in the region on 'clinical electro Cardiography' and 'epilepsy' during September 1986.

Nursing education

The annual two day conferences which the nursing staff of the Institute had been organising successfully had evoked excellent response from the nursing community and led to the formulation of a proposal for starting a post basic course in cardiovascular nursing which was approved by the Institute. The course was scheduled to be offered on an experimental basis initially for a period of three years when its level of national acceptance, demand and employment potential for the successful trainees would be reviewed for appropriate modification of course content.

Departmental Reports

HOSPITAL WING

Advanced Centre for the Study of Endomyocardial fibrosis (Sponsored by the Indian Council of Medical Research)

Prof. M. S. Valiathan, Ch.M., FRCS., (Edin & Eng) FRCS.(C), FACC., FAMS., FASc., FNA.	Head of the Centre
Dr. C. C. Kartha, MD.	Assistant Prof. of Pathology
Dr. Renuka Nair, Ph.D.	Lecturer in Pathology
Dr. K. Shivakumar, Ph.D.	Senior Research Officer
Dr. Prabha Nini Gupta, MD.	Research Officer

Dating back its birth to 1-7-1985, the Centre grew precociously and commissioned two fullfledged laboratories for tissue culture and analytical biochemistry during the year. The equipment installed and used in the laboratories covered a wide range and included CO₂ incubator, inverted microscope with stage incubator, atomic absorption spectrophotometer, electrophoretic unit, scanning densitometer, spectrophotometer and other instruments.

Within a year of the establishment of the tissue culture laboratory, the technique for explant culture was standardised. The cardiac tissue from human embryos obtained by suction termination of pregnancy was successfully cultured and maintained in an active stage for upto 75 days. The explant and the surrounding cells showed rhythmic contractions at the rate of 60-80 per minute and offered an experi-

mental cardiac model for studying its morphological, physiological and biochemical, response to given stimuli. An immediate application of the model related to the study of agents which have been suspected to have a role in the causation of endomyocardial fibrosis. The myocardial response to such agents at the cellular and subcellular levels might lead to a clearer understanding of the causation and pathogenetic mechanisms of the disease which has defied investigative skill for many years. As the explant culture technique became standardised, a serious attempt was made to isolate and separately grow the myocardial and non-myocardial cells of the heart.

In parallel with the biochemical changes of the treated cells in culture, the changes associated with endomyocardial fibrosis were also studied using cardiac tissues obtained at autopsy. Work on the isolation and purification of the cardiac base-

ment membrane was begun and a PAS positive, hematoxylin negative preparation which was obtained was taken up for characterisation. As intracardiac thrombi are frequently seen in endomyocardial fibrosis, a beginning was made in investigating platelet function in patients. To evaluate the significance of magnesium deficiency and the presence of thorium which had been reported in the endomyocardium of patients earlier, a longterm experimental study was undertaken in rats to induce the disease by the elemental manipulation of diet. Approval was also obtained to carryout a parallel study in primates at the Indian Institute of Science, Bangalore.

The Government of Kerala gave a special grant to the Institute for the purchase of an electron microscope in view of the essentiality of cardiac ultra-structural studies at the present stage of research on endomyocardial fibrosis. The equipment was shipped from Japan at the time of the present report and was expected to become operational during 1987.

The Advisory Committee of the Indian Council of Medical Research under Prof. Usha K. Luthra visited the Centre in November 1986 to observe its work and progress.

Department of Anaesthesiology:

Dr. K. Mohandas, MD	Professor
Dr. V. Padmanabhan, MD	Associate Professor
Dr. R. C. Rathod, MD	Associate Professor
Dr. Mrs. A. Rout, MD	Assistant Professor
Dr. J. M. Shahani, MD	Assistant Professor
Dr. D. K. Saxena, MD	Assistant Professor
Dr. Rupa Sreedhar, MD	Candidate for postdoctoral Certificate Course
Dr. Madhavi Purohit, MD	-do-
Dr. Raman Chadha, MD	-do-

For the Department of Anaesthesia, the intra and postoperative management of patients undergoing surgical and other interventions remained the principal responsibility which grew in volume to include nearly 1500 cardiothoracic, 650 neurosurgical and 60 radiologic intervention procedures. The staff and postdoctoral students of the department not only responded to the demands of the operating rooms and laboratories but also provided round the clock coverage for postoperative management of the patients. The high standards of patient care maintained by the department were the main basis for the recommendation of the Review Committee to entrust the overall responsibility for the management of intensive care units of the Institute to the Department of Anaesthesia. During the year the department took the initiative in preparing a working manual for the cardiac surgical intensive care unit in consultation with the departments of Cardiology and Cardiothoracic surgery.

Dr. Mohandas rejoined the department after completing his year of Commonwealth

fellowship at the Guy's Hospital, London. He presented a paper on the 'Effect of histamine receptor blockade on the hemodynamic changes after protamine administration' at the conference of cardiothoracic anaesthetists at Cambridge in June, 1986. He also gave the annual oration at the Nagpur branch of the Indian Society of Anaesthetists.

Wing Cdr. A. Joseph joined on deputation for training for a year and the postgraduate students in anaesthesia from the Trivandrum Medical College were received by rotation for training in the department.

Dr. Omar Prakash of the department of Anaesthesia, Thorax Center Erasmus University, Rotterdam visited the department.

The new equipment added in recent months were CPU ventilators (2), infant ventilator (1), ultrasonic nebuliser (1) and intravenous infusion pumps(2). Short and long term plans for the acquisition of critical equipment were prepared to meet the projected growth in the volume of cardiac and other branches of surgery.

Division of Biochemistry

Dr. K. Subramonia Iyer, Ph.D. Associate Professor
Mrs. Santha A. George, M.Sc. Scientist
Dr. N. Jayakumari, Ph.D. Lecturer

Service activities

A major reorganisation took place in laboratory services with the opening of the Central Clinical Laboratory in a new location. The new facility incorporated the laboratories for clinical chemistry and clinical pathology and streamlined investigations for the benefit of patients. The number of tests carried out by the Central Laboratory totalled 1.15 lakhs which was 26% higher than the tests performed by the clinical biochemistry laboratory in the previous year. To provide reports on bloodgas analysis during operations, a satellite laboratory was also opened on the cardiac operating room floor.

Research

The main research effort related to the conformational alteration of proteins in res-

ponse to contact with foreign surfaces. Preliminary observation of enhanced dye binding by the serum lipoproteins was suggestive of conformational alteration. Spectrophotometric titration of aromatic amino acid residues on the isolated human serum high density lipoproteins clearly showed that lipoproteins undergo unfolding on contact with artificial surfaces.

A binocular research microscope was added to the Division.

Dr. Subramonia Iyer rejoined the Division after spending his sabbatical leave at the Rockefeller University, New York, USA where he worked on Haemoglobin S. Mr. Sasikumar, laboratory technician, returned from the Institute of Postgraduate Medical Education and Research, Chandigarh after completing M.Sc. in clinical chemistry.

Division of Blood Transfusion Services:

Dr. P. A. Jayaprakash, MBBS, DIBT
Dr. Jaisy Mathai, MBBS, DCP
Dr. P. V. Sulochana, MBBS

Chief Blood Transfusion Officer
Junior Blood Transfusion Officer
Junior Blood Transfusion Officer

Service Activities

Blood transfusion services grew by 10% over the level of the previous year. The current level of services are summarised in Table.

Table 5

1. Blood donation	5650
2. Whole blood transfusions	4142
3. Component transfusions	706
4. Compatibility tests	
i. Saline	7510
ii. Albumin	7510
iii. Coombs	2191
5. Blood grouping	14034
6. HBsAg screening	6165
7. Therapeutic plasmapheresis	153

Research

While the blood transfusion services claimed greater emphasis and the larger percentage of the time of staff members, research activities continued to receive active attention. These consisted of joint efforts with the Division of Pathophysiology for the preparation and standardisation of a stable hemoglobin solution and the establishment of manual plasma exchange as

a therapeutic approach to Landry Guillain Barre Syndrome in collaboration with the Department of Neurology.

Dr. Jayaprakash presented a paper on 'Recent developments in blood bag technology' at the Joint Congress of the International Society of Haematology and International Society of Blood Transfusion in Sydney, Australia in May 1986. He delivered two guest lectures at the Regional Seminar on Blood Banking organised by the WHO and Ministry of Health at Shillong in November 86. He was presented the first award for outstanding contribution in the field of Blood Transfusion by the Indian Society of Blood Transfusion and Immuno-haematology.

Dr. Golubeva of the Institute of Blood Transfusion Moscow and Dr. Serova of the Institute of Haematology and Blood Transfusion, Leningrad visited the division as part of the Indo-USSR programme of collaboration in haematology and blood transfusion. Dr. Theifelder of the Institute of Haematology, Munchen was another esteemed visitor to the division.

Five batches of drug inspectors deputed by the State Drug Controller were given orientation to modern blood banking practices. The National Service Scheme of the University Centre made a 15 minute feature film on voluntary blood donation collaboration with the division. The film was telecast by the local station of Doordarshan.

Department of Cardiology:

Dr. K. G. Balakrishnan, MD, DM, FACC, MNAMS	Professor
Dr. C. G. Venkitachalam, MD, DM	Associate Professor
Dr. R. Subramaniam, MD, DM	Assistant Professor
Dr. Thomas Titus, MD, DM, MNAMS	Assistant Professor
Dr. Jagmohan Tharakan, MD, DM	Lecturer
Dr. M. V. Joseph Joy, MD, DM	Lecturer
Dr. M. Srinivasan, MD	Candidate for DM
Dr. M. F. Gopinath, MD	-do-
Dr. Shilendra Singh, MD	-do-
Dr. Nageswara Rao, MD	-do-
Dr. Asha Rajan, MD	-do-
Dr. K. K. Haridas, MD	-do-
Dr. Tiny Nair, MD	-do-
Dr. Y. R. Yellury, MD	-do-

The cardiac services exceeded the previous year's level as shown by the following table.

Table 6

<i>Procedures</i>	<i>1985-86</i>	<i>1986-87</i>
New registrations	3633	4323
Repeat visits	6733	8928
Treadmill tests	654	1170
Echocardiograms	3057	2593
Cardiac catheterisations including aortograms	817	901
Balloon dilatation procedures, septostomies	not done	46

The special clinics for pacemaker, hypertension, coronary artery disease, rheumatic

heart disease and congenital heart disease came into regular operation and streamlined the follow up care of patients.

A number of clinical studies were undertaken during the year by the staff and students of the Department. These included experimental correlation of intraoesophageal and left atrial pressures, assessment of aortic valve gradient and RV pressure by Doppler echocardiography, clinical and echocardiographic evaluation of the safety and efficacy of balloon dilatation procedures for coarctation and pulmonary stenosis, long term assessment of the efficacy of antiplatelet drugs for the prevention of emboli in mitral valve disease and atrial fibrillation and observation of the natural history of endomyocardial fibrosis, aortoarteritis, primary pulmonary hypertension and ventricular septal defect with aortic regurgitation. Collaborative studies with the Division of Pathology were carried out

for the correlation of haemodynamic and histopathologic features in the pulmonary vascular changes of congenital heart disease and right ventricular outflow tract in tetralogy of Fallot. The Division of Microbiology provided support for an analysis of the viral and serological findings in patients with acute carditis, mitralvalve prolapse and mitral regurgitation.

Prof. K. G. Balakrishnan was deputed for special training in coronary angioplasty to the New York University Medical Centre from February to May 1987. The guest doctors who received training in echocardiography included Dr. S. Maralihalli,

Associate Professor of Cardiology, Davangere Medical College, Dr. Raja Paul of the Catherine Booth Hospital, Nagercoil and Dr. Mrs. Suresh of the Ultrasound Scan Centre of Madras.

Ultra Mark 8 Mechanical Sector Scanner with Doppler echomodule, Holter ECG recorder and analyser and a programmable stimulator were added to the equipment range of the Department. Purchase procedures were also expedited for the acquisition of a new cardiac catheterisation laboratory with upto date accessories including a DSA system.

Department of Cardiothoracic Surgery:

Dr. M. S. Valiathan, Ch.M. (L.Pool) FRCS (Edin), FRCS (Eng), FRCS (C) FACC, FAMS, FNA, FASc.	Professor and Head of the department
Dr. M. P. Mohan Singh, FRCS(Eng) FRCS(Edin)	Professor (on sabbatical leave)
Dr. K.S. Neelakandhan, MS, M.Ch.	Assistant Professor
Dr. R. Sankarkumar, MS, M.Ch.	Assistant Professor
Dr. K. G. Shyamakrishnan, MS, M.Ch.	Lecturer
Dr. M. Unnikrishnan, MS, M.Ch.	Lecturer
Dr. Aruna Kashyap, MS, M.Ch.	Lecturer
Dr. Y. Nazer, MS, M.Ch.	Lecturer (on study leave)
Dr. Prakash, MS	Candidate for M.Ch.
Dr. Suresh G. Rao, MS	-do-
Dr. J. T. Tolia, MS	-do-
Dr. Rajendra Prasad, MS	-do-
Dr. S. R. Krishna Manohar, MS	-do-
Dr. V. M. Kurien, MS	-do-
Dr. Shekar Rao, MS	-do-

The year saw an impressive rate of growth in the volume and variety of patient services in the context of ever increasing demand. This was clearly shown by the combined figures for cardiothoracic procedures which rose to 1170 from the previous year's record of 880 and included 600 open heart operations. The number of babies and children for corrective operations for complex anomalies and adults for thoracic and vascular procedures also increased substantially. On the basis of existing trends it was therefore felt reasonable to plan for an increase in the annual total to 2000 procedures over a 2-3 year period including 900 open heart operations. Given the global advances in cardiac surgery, the demand for subspecialisation in paediatric, coronary, vascular and thoracic surgery assumed importance and received

the earnest consideration of the department.

In terms of research programmes, the central emphasis continued to be laid on the development of cardiovascular devices. The clinical evaluation of the variflo oxygenator was successfully completed and the perfusion data used as the major input for revising the design with a view to easier manufacture. The implantation of the chitra valve in the mitral position of sheep for longterm study became routinely successful and brought the long awaited date for its clinical trial closer.

The approval of an interdisciplinary project for the development of laser for angioplasty in collaboration with Dr. Bhawalkar's group of the Bhabha Atomic Research Centre

and the sister Divisions of Extracorporeal Devices, Pathophysiology and Radiology marked a new direction in research which was as contemporary as it was potentially beneficial to large numbers of patients with arterial occlusions.

Prof. Mohan Singh proceeded for a year to the Queens University of Belfast on sabbatical leave and Dr. Y. Nazer was granted study leave for two years to obtain training in coronary and arrhythmia surgery at the Westmead Hospital, Australia.

Prof. J. S. Gujral of the Postgraduate Institute of Medical Education and Research, Chandigarh served as a Visiting Professor during the year. Dr. Krishnan, Assistant Professor of Cardiothoracic Surgery of the Kasturba Medical College Manipal and

Dr. A. M. Patwardhan Reader in Cardiothoracic Surgery of Lokmanya Tilak Municipal Medical College, Bombay visited the department as Reeve H Betts Fellows of the Association of Thoracic and cardiovascular surgeons during 1986. Mr. Shivaji Gupta of Indore was accepted for a six month period of training in cardiopulmonary bypass techniques.

Prof. Valiathan accepted Visiting Professorships at the Jawaharlal Institute of Medical Education & Research, Pondicherry and Postgraduate Institute of Medical Education & Research, Chandigarh during the year. He was elected a corresponding member of the Association of Thoracic and Cardiovascular Surgeons of U.K. and Ireland and was awarded the Om Prakash Bhasin National Award in medical sciences.

Division of Microbiology

Dr. J. Shanmugham, Ph.D. Associate Professor
Mr. M. Ravindranath, B.Sc. Scientific Assistant
Miss Molly Thomas, M.Sc., DMV. —do—

Service Activities

The increase in the volume of patient services was reflected in the diagnostic tests in bacteriology which grew in number and variety. Introduction of Ogawa's medium for improving the yield for myobacterium tuberculosis in culture and treponema pallidum haemagglutination test were two new additions to the laboratory procedures. ELISA test which had been standardised was expected to be introduced soon for detecting viral and bacterial antigens and antibodies in serum and CSF.

Research

In a search for a simple, economical test which is specific and sensitive for detecting

viral antibodies, the SRHG technique was studied in a project funded by the Indian Council of Medical Research. The technique was shown to be highly specific and sensitive in detecting antibodies against influenza and mumps but not against coxsackie B or measles viruses. The Technique was currently being compared with other techniques such as CFT, HAI and NT in Vero Cell lines.

In another project funded by the State Committee on Science and Technology, the bacteriology of urinary tract infections was taken up for study including the emergence of antibiotic resistant strains.

A bionocular microscope was added to the equipment of the laboratory.

Project	— Study of Urinary Tract Infections in patients undergoing cardiac and neurosurgery
Principal Investigator	— J. Shanmugham
Co-Investigators	— R. N. Bhattacharya K. G. Shyamkrishnan
Funding	— State Committee on Science & Technology, Government of Kerala
Duration	— Two years
Status	— Ongoing

Dr. Roger Dean Smith, Director of Pathology and Laboratory medicine, University of Cincinnati, USA visited the division and gave a lecture on the rapid diagnosis of viral infections. Other visitors included Dr. K. Prakash, Director of WHO Regional Reference Centre for Streptococcal studies, New Delhi and Dr. U. C. Chaturvedi, Head of the Department of Microbiology, KG Medical College, Lucknow.

Dr. Shanmugham was elected a Fellow of the International Medical Sciences Academy, New Delhi in 1987. He was

appointed a member of the Board of Studies in Microbiology in University of Madras and invited by the University to deliver the IAPM endowment lecture for the year 85-86.

Miss Molly Thomas underwent a short-term training course in mycoplasmaology at LTM Medical College, Bombay as part of her Ph.D. programme. Mrs. Nazeema rejoined the division after obtaining M.Sc. in medical laboratory technology with a silver medal for first rank from the Institute of Postgraduate Medical Education and Research, Chandigarh.

Department of Neurology

Dr. P.K. Mohan, MD, DM	Associate Professor
Dr. John Tharakan, MD, DM	Assistant Professor
Dr. C. Sarada, MD, DM	Lecturer
Dr. Muralidharan Nair, MD, DM	Lecturer
Dr. Abdul Majeed, MD	Candidate for DM
Dr. K. S. Sunil Kumar, MD	-do-
Dr. T. A. Subramanian, MD	-do-
Dr. Sanjeev Thomas, MD	-do-
Dr. Lekha Bhaskaran, MD	-do-
Dr. S. Venugopal, MD	-do-
Dr. Jacob Daniel, MD	-do-

There was a marginal increase in the out-patient registration and the number of electrophysiological investigations during the year. After initial troubles following installation, the Evoked Potential equipment became regularly operational. It was used intensively for the standardisation of normal data from healthy individuals and for patient investigations.

The joint study with the Blood Transfusion Service on plasmapheresis for patients

with Landry – Gullain – Barre Syndrome made progress. A joint project was initiated on speech and language disorders in neurologically disabled patients in collaboration with the International School of Dravidian linguistics.

The postgraduate students in medicine from the Medical College, Trivandrum visited the department as observers. The staff played an active role in organising a continuing medical education programme.

Department of Neurosurgery

Dr. Damodar Rout, MS, M.Ch.	Professor
Dr. R. N. Bhattacharya, MS, M.Ch.	Associate Professor
Dr. B. K. Mishra, MS, M.Ch., MNAMS	Assistant Professor
Dr. Rajeev Sharma, MS, M.Ch.	Lecturer
Dr. Suresh Nair, M.Ch.	Lecturer
Dr. A. K. Gehlot, MBBS	Candidate for M.Ch.
Dr. K. N. Krishna, MBBS	-do-
Dr. A. K. Purohit, MS	-do-
Dr. M. P. Haroon, MBBS	-do-
Dr. Sarala Menon, MS	-do-
Dr. Satish Krishnan, MBBS	-do-
Dr. Subodh Darbari, MS	-do-
Dr. Dilip Paniker, MS	-do-

The increase in the number of surgical procedures to 650 was marked by considerable growth in experience with cerebral vascular lesions. By the end of the year, the department had accumulated the largest surgical series of cerebral angiomatous malformations in the country. Other fields where the surgical experience was notably large related to craniovertebral anomalies which were approached transorally and microvascular decompression in the management of trigeminal neuralgia and facial myoclonus. The department also collaborated with the department of Radiology in carrying out therapeutic embolisation procedures for inoperable cerebral vascular lesions.

The main research project on the development of an indigenous hydrocephalus shunt was carried out in collaboration with the division of Artificial Internal organs and Polymer Technology and the progress was noted to be on schedule. In a study of experimental subarachnoidal haemorrhage, ultra structural changes were found

in the basal vessels and this vasculopathy was thought to be the basis of the phenomenon of cerebral vasospasm. The projects of postgraduate students included a study on experimental hydrocephalus.

Dr. R. N. Bhattacharya was appointed to the post of Associate Professor and Dr. B. K. Mishra rejoined the department after a two year stay at the University Department of Neurosurgery, Edinburgh as a Commonwealth Fellow.

Dr. Alan Crockard, Consultant Neurosurgeon, The National Hospital for Nervous Diseases, Queen Square, London visited the department and gave a lecture on the transoral approach to the base of the skull and craniovertebral region. Dr. A. M. Bhole, Professor of Surgery, Indira Gandhi Medical College, Nagpur spent two months for short term training in neurosurgery and Dr. Sanjiv Bhatia, Senior Resident in Neurosurgery of All India Institute of Medical Sciences, New Delhi paid a visit as an observer.

Dr. Rout was appointed as a member of the Board of Studies of the Aligarh Muslim University and Dr. K. N. Krishna, candidate for M.Ch was awarded the E. Merck Gold Medal for the best scientific paper in Neuro- surgery at the Annual Conference of the Neurological Society for his work on the vasculopathy in experimental subarachnoidal haemorrhage.

Project — Development of an indigenous viable hydrocephalic shunt system

Principal Investigator — D. Rout

Co-Investigators — G. S. Bhuvaneshwar
S. N. Pal

Funded by — Department of Science and Technology

Status — Ongoing

Division of Neurochemistry

Dr. Debkumar Basu, Ph.D.	Professor
Dr. P. S. Appukuttan, Ph.D.	Lecturer (on study leave)
Mrs. K. I. Annamma, B.Sc.	Scientific Assistant
Miss Jyoti V. Nair, M.Sc.	Candidate for Ph.D.
Mr. Madhusudhanan Nambiar, M.Sc.	-do-

In structural studies on glycoproteins and their interaction with lectins, the soluble and membrane-bound galactose-binding lectins from bovine heart were studied in detail. This lectin, extracted with Triton X-100 or with lactose and purified by affinity chromatography, contained a tetrameric protein of 8 kDa subunit. It also contained high molecular oligomer in low percentage in the detergent - extracted samples. SDS-PAGE showed a single subunit of 8 kDa which was also confirmed after affinity electrophoresis at different

pH values in gel containing galactomannan. The inhibition studies with various mono-saccharides showed marked preference for α -galactoside anomers.

The placental galactose-binding lectin was studied in further detail. The chemical modification of various amino acid residues showed that histidine, arginine and lysine residues at the saccharide-binding site. The lone cysteine residue of the protein is also involved in the saccharide-binding.

Project	— Structure of enzymes, the role of their carbohydrate side chains and their interaction with lectins.
Principal Investigator	— Debkumar Basu
Co-Investigator	— P. S. Appukuttan
Funding	— Department of Science & Technology, New Delhi.
Duration	— 3 year 9 months
Status	— Ongoing

CSIR sponsored project on cell surface markers of developing brain was initiated in August. Preliminary studies were made to isolate at least 90-95% homogenous

population of neurons and glial cells from developing and adult brains. Further work on the characterization of cell surface marker glycoconjugates are in progress.

Project	— Cell surface Glycoproteins of Developing Brain.
Principal Investigator	— Debkumar Basu
Funding	— Council of Scientific & Industrial Research, New Delhi
Duration	— 3 years
Status	— just started

A Shimadzu Spectrofluorometer RF – 540 and Kinematic polytron were added to the laboratories. Dr. Richard Joseph, Scientist from Central Food Technological Research Institute Mysore gave a series of 3 lectures on (1) Genetic Engineering and its relevance in Indian economy (2) Molecular biology techniques used in recombinant DNA and (3) Site-directed mutagenesis technique and application in December 1986.

Dr. Molly Thomas and Smt. N. Usha Nair from Rubber Research Institute of India, visited the division for training in HPLC Technique and Dr. P. Ambika from Trivandrum Medical College obtained training in ultracentrifugation techniques.

Prof. D. Basu was awarded a short-term Foreign Associateship from Department of Biotechnology, Government of India to work at National Institute, of Health, USA.

Prof. D. Basu was an Organiser and chairperson of scientific sessions at the International Symposium on 'Biochemical roles of Eukaryotic Cell Surface Macromolecules' held at New Delhi in January 12–16, 1987.

Dr. P. S. Appukuttan proceeded on leave to accept a postdoctoral fellowship at Uniformed Services University of the Health Sciences, USA.

Division of Pathology

Dr. V. V. Radhakrishnan, MD	Associate Professor
Dr. C. C. Kartha, MD	Assistant Professor
Dr. S. Sandhyamani, MD	Assistant Professor
Dr. Renuka Nair, Ph.D.	Lecturer
Mrs. Annamma Mathai, M.Sc.	Scientific Assistant

Service activities

With the transfer of clinical pathology tests to the Central Clinical Laboratory, the main activities were confined to reporting on frozen sections (204), surgical pathology specimens (676) and carrying out autopsies (76). The material obtained from these studies became an invaluable resource for teaching postgraduate students from cardiac and neurologic disciplines. Other techniques which were offered included histochemical study of muscle biopsies, single nerve fibre preparation and semi-thin sections of peripheral nerves and ELISA

test for the diagnosis of tuberculous meningitis.

Research Projects

The Division housed the Advanced Centre for Endomyocardial fibrosis which is reported separately. Dr. Sandhyamani was awarded a project on a study of the cardiovascular changes in induced malnutrition as her preliminary observations had sought to link various arterial occlusions of the young in Kerala with nutritional deficiencies.

Project	— Cardiovascular changes in Induced malnutrition
Principal Investigator	— S. Sandhyamani
Principal Co-Investigator	— M. S. Valiathan
Funding	— DST
Status	— Ongoing

In a collaborative project, joint study was carried out with the Pediatric Neurology unit of SAT Hospital on muscle biopsies in muscular disorders with special reference to congenital myopathies.

Mr. N. S. Radhakrishnan rejoined after obtaining M.Sc. in medical laboratory – technology (in cytology) with a silver medal for first rank from the Postgraduate Institute of Medical Education and Research, Chandigarh.

Department of Radiology

Dr. V. R. K. Rao, MD	Professor
Dr. Ravimandalam, MD	Associate Professor
Dr. Arunkumar Gupta, MD	Assistant Professor
Dr. Sunilkumar, MD	Assistant Professor
Dr. Santhosh Joseph, MD	Lecturer
Dr. R. V. Phadke, MD	Candidate for Postdoctoral Certificate
Dr. NLN Moorthy, MD	-do-

The conventional and special investigations done during the year are given in the following table.

Table 7

Vascular studies	240
Cardiac catheterisation & angiography	758
Bronchogram	30
Myelogram	146
Ventriculogram	21
Air Myelogram	6
Plain X-ray: Cardiac	10328
Neuro	2108
CT Scan – Head	4076
Body	386

The clinical project on the application of balloon catheter techniques in intracranial arteriovenous malformations and peripheral occlusive lesions was actively pursued.

The results in a series of over 60 patients were encouraging and the volume of intervention procedures was expected to grow particularly for balloon detachments and super selective embolotherapy using isobutyl 2 cyanoacrylate, for which patients were already being referred to the Institute from as far away as Madras and Bombay. A programme for the computerisation of radiological data and reports was also taken up for development.

Interventional Procedures in Radiology during 1986–87

Table 8

1. Superselective embolization of intracranial arteriovenous malformations	7
2. Superselective embolisation of extracranial vascular malformations including spine & extremities	11
3. Vascular Occlusions detachable balloon techniques	10
4. Percutaneous transluminal angioplasty of aortoiliac and other peripheral vascular lesions	28
5. Thrombolytic therapy for occlusive vascular lesions	10

Figs. 5-8 NON-SURGICAL OBLITERATION OF AN INTRACRANIAL AV FISTULA



Fig. 5 Carotid - cavernous fistula

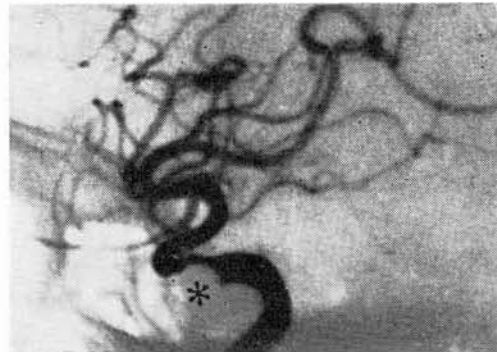


Fig. 6 Fistula completely obliterated (*Balloons)

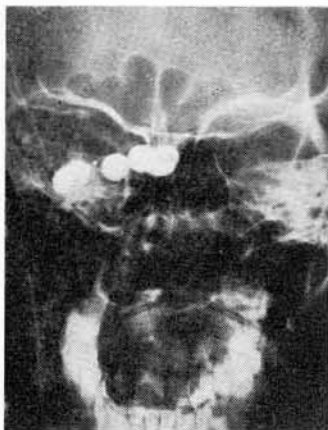


Fig. 7 Front view of skull shows 4 balloons deep in the skull



Fig. 8 Side view showing the balloons in position (Arrowhead)

Three research projects were continued during the year in collaboration with other organisations. The development of a hydroxyethyl methacrylate was taken up by the chemicals group of the Vikram Sarabhai Space Centre and that of latex-mini-balloons by the London Rubber Company of Madras with clinical inputs from

the department. The collaborative study on chronic calcific pancreatitis by CT imaging made progress in collaboration with the department of Gastroenterology of the Medical College, Trivandrum.

Dr. V. R. K. Rao was appointed Professor of Radiology.

Figs. 9-10 RECANALISATION OF PERIPHERAL ARTERY

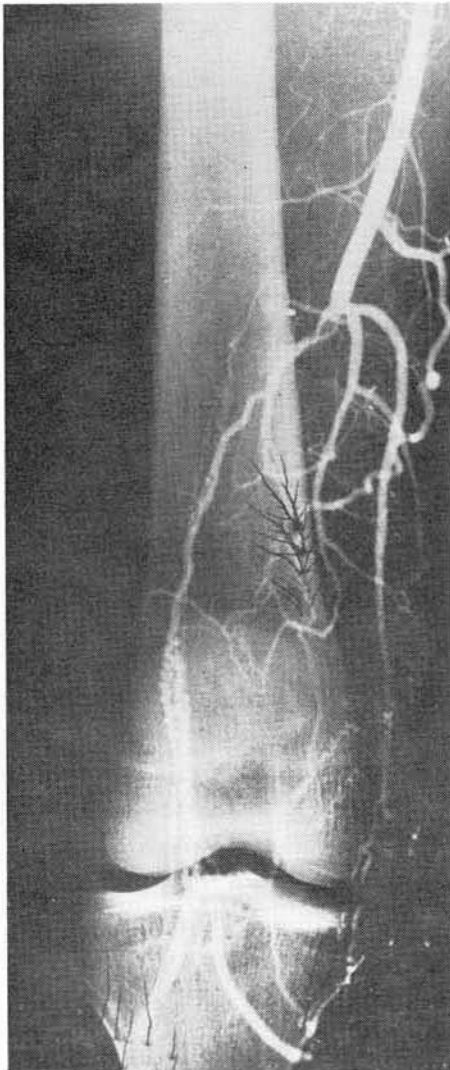


Fig. 9
15 cm occlusion of the femoropopliteal artery

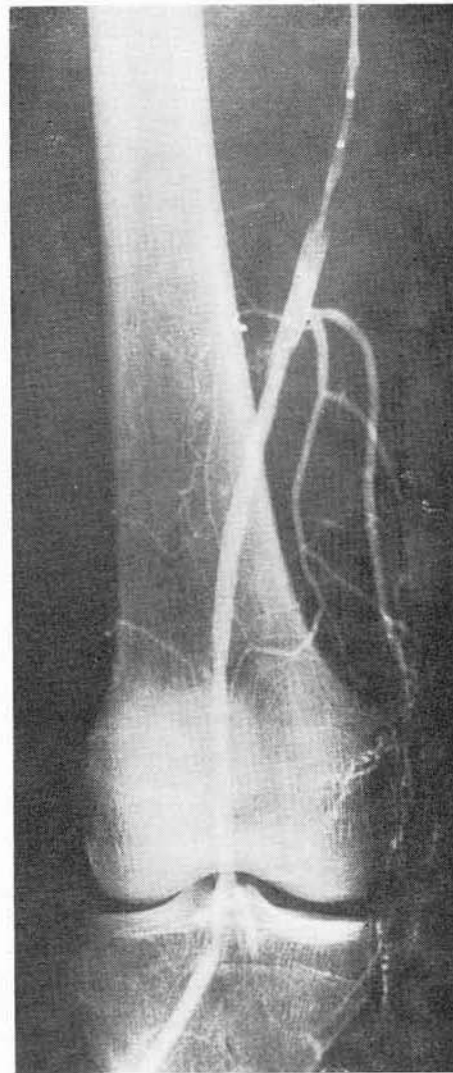


Fig. 10
Recanalisation following angioplasty

BIOMEDICAL TECHNOLOGY WING

Head:

Mr. A. V. Ramani, B.Sc. (Chem. Tech.)

Department of Biomaterials Science

(i) Division for Technical evaluation of Biomaterials:

Dr. M. Jayabalan, Ph.D.	Scientist
Mr. K. Sreenivasan, M.Sc.	Scientific Officer
Mrs. Prabha D. Nair, M.Sc.	Scientific Officer

As in the previous year, a major focus for investigations was centred on the effect of sterilisation techniques on polymers in clinical use. Radiation sterilisation of isotactic polypropylene was carried out as covered and uncovered samples and changes in percentage crystallinity upon aging monitored. The changes were rapid in the uncovered sample (maximum 70%, minimum 34%) whereas the changes in the covered sample were relatively slow (maximum 87%, minimum 43%). Aging of the sterilised isotactic polypropylene caused branching in the polymer which was found to affect the transition between the short range and long range orders. The degree of branching was found to be higher in the covered sample which resulted in long term stiffness. The reverse was observed in the case of the uncovered sample.

Multiple sterilisations by gamma radiation of polyethylene terephthalate (PET) was noted to produce no appreciable changes in the mechanical properties of PET yarn even though the crystallinity of yarn and fibres increased following single sterilisation. Molecular weight data suggested

the increase to be due to the degradation and recombination in the amorphous region.

Low molecular weight polycarbonate showed a general decrease of weight average molecular weight upon repeated sterilisation by gamma irradiation even though an increase in number average molecular weight was noted at 2.5 and 10.0 Mrads. This was attributed to the cage recombination preceded by the chain scission. The molecular weight data further indicated no recombination during sterilisation with 5.0 and 7.5 Mrad doses which were confirmed by thermogravimetric studies.

In the study on 'Material-Tissue interface of experimental prosthesis of reconstructive surgery' polyurethane was initially synthesised with different polyols and diols and the new polymer tailor-made to give the properties of an implantable elastomer. A candidate material was subsequently chosen on the basis of physico-chemically acceptable data for toxicological screening.

Project	— Studies on material tissue interface of experimental prosthesis of reconstructive surgery
Principal Investigator	— M. Jayabalan
Funding	— Department of Science & Technology
Duration	— 3 years
Status	— Ongoing

A Fourier transform Infrared spectrophotometer and a microtome cryostat were added to the division.

Dr. Jayabalan presented a paper at the fifth Southern Biomedical Engineering Conference in Shreveport, Louisiana, USA and visited the BioRad Laboratories at Boston. He also lectured at the Cochin University on the application of GPC for biomaterials

research. Dr. Jayabalan and Mr. Sreenivasan presented papers at the Annual convention of Chemists at Annamalai University. Mrs. K. N. Jalajamani, M.Sc. of the department of Polymer Chemistry, Gandhiji University took part for 3 months in the studies on the effect of multiple gamma irradiation procedures on plastics.

(ii) Division of Thrombosis Research:

Dr. M. Jamaluddin, Ph.D.
Mrs. Lissy Kalliyankrishnan, M.Sc.

Scientist
Scientific Assistant

The spectrophotometric assay for platelet aggregation which was developed in this laboratory was shown to detect the primary recruitment of platelets into aggregates unlike the conventional method which detects clumping of aggregates.

Dr. Chetan Trivedi, a candidate for DM from the department of Neurology employed the spectrophotometric method for investigating the role of platelet aggregation in cardiac patients with vascular headaches and detected abnormalities which were absent in control samples. This suggested the possible use of the method in the clinical context.

In further investigations, the prostaglandin endoperoxide receptor hemoprotein which had been reported earlier demonstrated a parallelism between its conformational response towards treatment with platelet agonist ligands and platelet activation by various stimuli. Preliminary data suggested the possible involvement of the protein in mediating platelet aggregation by dithiothreitol and other sulphur containing organic compounds.

A programmable temperature controlled water bath/circulator was added to the laboratory and a high speed refrigerated centrifuge was expected to be installed shortly.

Department of Biomedical Engineering

(i) Division of Artificial Internal Organs:

Mr. G.S. Bhuvaneshwar, B.Tech., MS Biomedical Engineer
Mr. C.V. Muralidharan, B.Tech. Scientific Officer
Mr. R. Sreekumar, B.Sc. Scientific Assistant

Chitra Heart Valve

The major project of the division continued to be the development of a tilting disc valve. Following the detection of unacceptable degree of wear in titanium, the cage material was changed to a highly wear resistant cobalt chromium alloy, Haynes-25, during the previous year. This being a very difficult alloy to machine, the problem of making valves cages had to be solved by using non-conventional machining techniques like EDM and the use of specially made tungsten carbide cutters. The durability was enhanced further by coating the cage with a wear resistant ceramic, Titanium Nitride.

Nine samples of this latest version of the Chitra valve were implanted in sheep during

October–December 86 and accelerated wear tests were performed in parallel. Data collected from explants and the accelerated tests indicated valve durability of over 20 years. With over 30 animals months accumulated with these implants, there was no incidence of thrombo-embolism or thrombus formation on valve. Simultaneously the Mark III accelerated wear tester for heart valves testing was assembled and commissioned.

This unit incorporates new design features for improved system reliability with digital instrumentation for data acquisition and logging. The unit is currently undergoing qualification tests to ensure that the data obtained from this unit will correspond to the older Mark II unit which has logged

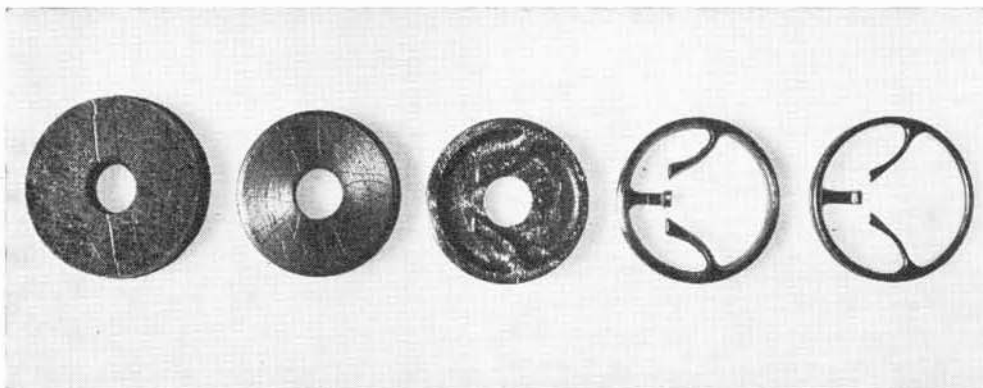


Fig. 11 Stages of Valve housing Development

30,000 hours of operation and which has, during the last year, functioned for over 90% of the time.

Humidifier

The mark I Chitra humidifier given for clinical trials last year showed satisfactory performance and six more units of this version were fabricated with the help of the Tool room for hospital use.

The encouraging results led to the further development and improvement of this product. A Mark II version with improved

(ii) Division of Biomaterials Technology:

Mr. A. V. Ramani, B.Sc.(Chem. Tech)
Mr. B. Ajit Kumar, B.Tech.

The development of stainless steel bands which had been taken up as a project supported by ICMR was completed successfully during the year and the material demonstrated to be as biocompatible and durable as the imported control samples. The transfer of the device for commercial production was expected to be arranged according to the procedures of the ICMR.

In the collaborative project on carbon-carbon composites with the Vikram Sarabhai Space Centre and National Physical Laboratory, the samples were shown to be nontoxic after one year of intramuscular implantation. In the next phase, the possible degradation of the mechanical pro-

features like better safety, smaller size, and easier cleaning of the patient circuit utilising a modular design concept was carried out. Comparative results from a study are shown in the accompanying figure.

Hydrocephalus shunt system

This DST funded project progressed on schedule. An invitro system was set-up during the year for testing the performance characteristics of these shunt components and assemblies. This system is currently being integrated with a microprocessor for more effective data acquisition.

Scientific Officer

erties of the material was proposed to be studied after tissue implantation. As in-situ nitriding of titanium was carried out during the previous year for the prosthetic valve project, the standardisation of the technique was addressed during the current year. An experiment was also setup for evaluating electro-metalliding technique in the production of biomedical devices in view of its potential for the diffusion of selected materials like silicon, boron etc. into metallic substrates. In all its technological activities, the Division worked in close collaboration with the Division of Artificial Internal Organs and the Tool Room.

Project	—	Development of Carbon-Carbon composite as biomaterials
Principal Investigator	—	A. V. Ramani
Collaborating institution	—	National Physical Laboratory, New Delhi
Funding	—	Department of Science & Technology
Duration	—	2½ years
Status	—	Ongoing

(iii) Division of Biosurface Technology:

Dr. Chandra P. Sharma	Scientist
M. Tech., MS, Sc.D., MEBE	
Mr. Thomas Chandy, M.Sc.	Scientific Assistant

In continuing studies on making polymer surfaces blood compatible, two new approaches were successfully employed in a urokinase-antithrombin III-methyldopa-prostaglandin E1 complex and phospholipid bilayers of phosphoryl choline, phosphatidyl choline and phosphoryl ethanolamine both of which showed thrombo-resistance due to different mechanisms. In a parallel study on the competitive absorption of proteins from a mixture of labelled albumin and fibrinogen by the oxide layer of implantable metals Ti, it was observed that an oxide layer thickness of 400 Å may be optimal from the blood compatibility point of view due to its relatively lower absorption of fibrinogen. Other interesting observations included the inhibition of the adsorption of albumin and fibrinogen on polymer surface by garlic oil and the apparent effect of magnetic field on protein adsorption.

In the project on improving synthetic bio-medical membrane for haemodialysis, an

attempt was made to optimise the hydrophobic/hydrophilic balance by grafting HEMA to the polymer substrate (Biomer) by glow discharge technique. It was observed that as the exposure time to HEMA and glow discharge time increased, percentage of grafting also increased and attained a saturation value over which there was no considerable increase. Percentage of hydration also followed the same rule. Contact angle measurements confirmed the hydrophilic nature of the grafted samples. Labelled isotope studies indicated that adsorption of albumin and fibrinogen increased with time for most modified surfaces and that the amount of adsorbed fibrinogen or albumin alone did not give a complete picture of the modified surfaces. Calculation of the fibrinogen/albumin ratio showed that relatively high level of albumin adsorption enhanced non-thrombogenicity. Further experiments are in progress to study the permeability of the membranes to molecules such as uric acid, urea, creatinine and albumin.

Project. 1.	—	Studies on improving synthetic Biomedical Membrane for Haemodialysis
Principal Investigator	—	C. P. Sharma
Co-Investigator	—	T. Chandy
Funding	—	Department of Science & Technology
Duration	—	Three years
Status	—	Ongoing (1 year completed)

A membrane was prepared from Chitosan, an abundant polysaccharide in nature, by blending proteins like collagen, albumin or gelatin to improve permeability and blood compatibility which was further sought to be enhanced by immobilising a bioactive complex via carbodimide. The novel membrane demonstrated good permeability for small molecules and reduction in platelet adhesion. Studies are currently in progress to improve the wet strength of the membrane.

photometer were added to the laboratory during the year.

Approval was obtained from the Indian Council of Medical Research for a research project entitled "Surface modification – tissue compatibility towards the development of artificial skin" to be carried out in collaboration with the division of the Toxicologic screening of materials.

Dr. Sharma was reelected President of the Society for Biomaterials and Artificial Organs of India and a Fellow of the Indian Chemical Society.

A table model tensile tester and a flame

Project 2	—	Surface modification – tissue compatibility towards the development of artificial skin
Principal Investigator	—	C. P. Sharma
Principal Co-Investigator	—	K. Rathinam
Funding	—	Indian Council of Medical Research
Duration	—	Three years
Status	—	Just approved

(iv) *Division of Extracorporeal Devices:*

Mr. V. S. Venkatesan, BE Biomedical Engineer
Mr. D. S. Nagesh, BE Scientific Officer
Mr. S. Vijayan Scientific Assistant

The variflo oxygenator which incorporated a cardiotomy reservoir, heat exchanger as well as a flow control module underwent clinical trial successfully in 20 patients. Based on the clinical inputs from the trial, the development of a simplified version of the oxygenator was taken up for ease of commercial production and reduction in the unit cost.

Institute and the Bhabha Atomic Research Centre for the development of lasers for vascular applications, the division of Extracorporeal Devices was given the responsibility for the design and fabrication of a fibre optic delivery system. This project had received the approval of the Department of Science and Technology for funding toward the end of the year under review.

In a collaborative project between the

Project	—	Medical and Surgical applications of Lasers
Principal – Investigators	—	M. S. Valiathan
	—	D. D. Bhawalkar (BARC)
Principal – Co-Investigator	—	V. S. Venkatesan
Co-Investigators	—	Arthur Vijayan Lal
	—	V K Chatterjee (BARC)
	—	T P S Nathan (BARC)
	—	L M Kukreja (BARC)
	—	Mira Mohanty
	—	V R K Rao
Funding	—	K S Neelakandhan
	—	Department of Science & Technology
Duration	—	3 years
Status	—	Ongoing

(v) *A. Division of Research Toxicology*

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

Studies on the serum protein changes in response to prosthetic implants and the development of a toxicologic test based on the response of the haemocytes of *periplaneta americana* were continued. Further studies on the contamination of intravenous fluids stored in commercially available plastic containers by combined

TLC – spectrophotometry yielded a method which could detect DEHP at levels as low as 10 mg.

The development of cell culture for screening the toxicity of materials received considerable emphasis and macrophage and lymphocyte cultures seemed to be particularly advantageous in preliminary studies.

(v) *B. Division of Toxicological Screening of Materials*

Mr. K. Rathinam, M.Sc. Scientist
Dr. S. Bhaskara Rao, MVSc. Veterinary Surgeon

In addition to discharging the responsibility for breeding, supply and routine management of small laboratory animals for various research groups, the laboratory of this division was principally concerned with the safety evaluation of materials and in the development of medical devices. The screening programme consisted of *in vitro* haemolytic potential test, direct intramuscular implantation and administration of various material extracts to laboratory animals. Apart from fifty tests in this category, fifty mandatory tests for pyrogen, sterility and safety were also carried out on finished Chitra devices during 86-87.

In terms of research projects, the division carried out a biocompatibility study of poly-ethurethane urea membrane and continued active collaboration with the division of Biosurface Technology for its further development as a substitute for skin. Progress was also made in standardising an

invitro Limulus Amebocyte Lysate (LAL) test as an alternative for pyrogen tests in rabbits in view of its simplicity and avoidance of the use of animals. Scientific and laboratory support was provided for the development of nontoxic HEMA (2 hydroxy-ethyl-methacrylate) and latex-mini-balloon which the department of Radiology had developed for the embolotherapy of intracranial aneurysms. Another project which received support was the ongoing studies on the experimental induction of endomyocardial fibrosis in rats by elemental manipulation of diet.

Sri Rathinam presented a paper on 'the biocompatibility characteristics of a skin substitute' at the National meeting of the American Chemical Society in Anaheim, California, USA in September 1986. He also became an Advisor to the Postgraduate cum Research Centre in Ayurveda, Poojapura in pharmacologic studies.

(vi) *Division of Pathophysiology:*

Dr. Mira Mohanty, MD. Scientist
Mrs. T. V. Kumari, M.Sc. Scientific Officer

Service activities

As in previous years, the routine activity covered histopathology, biochemistry and haematology. Evaluation of the tissue response to biomaterial implants and examination of autopsy specimens received from the veterinary division constituted the major part of histopathologic work

load. In addition, the division processed and evaluated tissues for the short term research projects conducted by postgraduates of the Neurosurgery department. Histopathology laboratory service was also lent for processing and slide making of tissues received from the ongoing animal experiments on endomyocardial fibrosis. (Table)

Table 9

	<i>Biochem.</i>	<i>Haematol.</i>	<i>Histopath.</i>
A. ROUTINE	1,125	1,755	194
B. EXPERIMENTAL			
1. Production of subarachnoid haemorrhage in dogs	}		182
2. Vasculopathy in experimentally induced subarachnoid haemorrhage in dogs			
3. Kaolin induced hydrocephalus in dogs—study of changes in cervical, thoracic and lumbar spinal cord and choroid plexus			
4. Production of endomyocardial fibrosis in rat			171

Regular haematological and biochemical tests were carried out at 24 hours, weekly for 1 month, fortnightly for next 1 month, followed by monthly and yearly samples obtained from all sheep having mitral valve replacement with the Chitra Tilting disc valve.

Hemoglobin solution

1986–87 was devoted mostly to a prolonged effort on perfecting a method for the preparation of Hb solution from outdated human blood. While the solution prepared in early '86 was found to be good in terms of oxygen affinity, oncotic activity, and Hb concentration (9–11 gms %) and ready for pyridoxilation, the time taken (4–5 days) to obtain the final solution resulted in methaemoglobin production and quick loss of sterility. The major research effort therefore related to perfecting the techniques which have been successful in yielding a completely sterile solution

in just 2 days. The solution has shown excellent in vitro results having a still higher concentration of Hb (10–15 gm%) and a very minute level of methaemoglobin. Given these results, a few experiments were carried out in the Toxicology division on small animals to ascertain the toxicity of the solution. No mortality occurred in mice receiving upto 54 ml/kg body wt. of solution. However, the same solution on being given intravenously to rabbits produced 100% mortality. Autopsies done on all the animals, revealed severe vasoconstriction in pulmonary vessels as reported in literature. An animal model for exchange transfusion experiments is being perfected. Efforts are also being made to increase the intravascular retention time of the hemoglobin preparation by polymerization.

In addition, an investigative study on the immunologic changes seen in blood during cardiopulmonary bypass operations was

initiated in partnership with department of Cardiothoracic Surgery. Blood samples collected at six intervals during CPB on 10 animals and 4 human patients undergoing cardiac surgery, were being analysed as a pilot project prior to the commencement of a more detailed study of the inflammatory challenge and response to cardiopulmonary bypass.

A Class laminar flow system – vertical flow-for preparing sterile haemoglobin solution was added to the laboratory. Dr. L.D. Serova and Dr. V.V. Golubeva from the USSR visited the division and held discussions on the test results of blood stored in Chitra blood bags and on the haemoglobin solution.

Project	—	Preparation and evaluation of haemoglobin solution as a blood substitute
Principal Investigator	—	Mira Mohanty
Funding	—	Department of Science & Technology
Duration	—	3 years
Status	—	Ongoing

(vii) Division of Polymer Chemistry:

Dr. A. Jayakrishnan, Ph.D. Scientist
Mr. Chithambara Thanoo, M.Sc. Scientific Officer

The main activity during the year consisted of the preparation and characterisation of a novel hydrogel material which was developed from polymethyl methacrylate by a simple reaction scheme. The hydrogel was found to possess a water uptake capacity of 50,000%. Another interesting outcome of the method was that the hydrogel could be prepared in the form of smooth spherical beads which could be swollen of the desired size. Possible applications of this interesting material include artificial emboli, cell labelling and separation and drug delivery.

Another project which was pursued related to the preparation of water plasticised

PMMA which, unlike the parent material, is flexible. Since PMMA is an ubiquitous implant material, its modified form is likely to widen its clinical applications in tissues such as cartilages.

A major project on the development and clinical evaluation of UV absorbing intra-ocular lenses was formulated in collaboration with the CBM ophthalmic Institute, Angamaly for external funding. The division has also made plans for developing carriers for drug delivery systems.

The laboratory became functional during the year with the acquisition and installation of equipment such as analytical balance and goniometer.

(viii) Division of Polymer Technology

Mr. S. N. Pal, M.Sc. (Tech.)	Chemical Engineer
Mr. V. Kalliyanakrishnan, M.Sc.	Scientific Officer
Mr. M. Muraleedharan, MS	Scientific Officer

As part of routine activity, the division continued to fabricate polymer components for the rigid shell oxygenator, custom pack tubings, containers for dental bands and urine bags.

Research and development projects related mainly to acrylics which have potential applications in dentistry, neurosurgery and orthopedics. Pearl polymers with the desired molecular weight, yield and size distribution were synthesised and detailed studies for characterisation initiated in comparison with imported materials which are in current use. Secondly, efforts were made to improve the desirable properties

of PVC by blending it with suitable polymers and by grafting and cross linking different monomers onto the PVC matrix. Thirdly, the design of a blood filter for use in transfusions was completed and fabrication trials undertaken.

In a collaborative project, the division worked closely with the department of Neurosurgery and division of Artificial internal organs for the development of an hydrocephalus shunt.

A two roll mill was added to the laboratory of the division. Mr. Pal guided Mrs. A.J. Aleyamma, a final year M. Sc. student Gandhiji University in her project work.

(ix) Division of Technology Transfer:

Mr. H. Vijayakumar, B.E.	Biomedical Engineer
Mr. D. Ranjit, B.E.	Scientist

As in previous years, the activities of the division covered virtually all aspects of the transfer of devices technology. Whereas the blood bag technology which had entered commercial production called for coordination and transfer of additional knowhow, new items such as dental bands and humidifier necessitated search for entrepreneurial initiative. In several of these activities the division functioned in collaboration with the National Research & Development Corporation.

Following the successful outcome of the tilting disc valve in engineering and animal

trials, it was felt necessary to ensure wider patent coverage for its unique features relating to design, materials of construction and production processes. Accordingly a patent of addition in India and applications for patent rights in eleven countries in Europe, USA and Asia were filed with the assistance of M/s. L. S. Davar & Co.

M/s. Rassme Crystalloids successfully completed its first year of production and supply of non-injectable crstalloids the knowhow for which had been transferred by this division earlier. To obviate the present practice of the gamma irradiation

of the product and to simplify the production process, investigations were undertaken to develop and standardise alternative methods of sterilisation. As part of the overall efforts to update patient care technology, the division provided 700 custom packs of extracorporeal tubing for open heart operations during the year and made arrangements for its regular supply on the basis of contract production. Preliminary studies were also initiated for the development of a cold cardioplegia delivery system.

As an independent quality control mechanism is a sine qua non for devices before production, the Technology Transfer Division accepted the responsibility for instituting inspection procedures for the component assemblies of the variflo oxygena-

tor. Mr. Ranjit took part in the initial stages of its clinical trial.

In response to the technical enquiries relating to various aspects of biomedical engineering and devices technology from institutions and industries, this division prepared and compiled detailed documentation which was made available to M/s. Southern Petrochemical Corporation, Madras, Caprihans Ltd., Bombay, Surgiwear Products Shahjahanpur and other agencies. As the enquiries were on the increase, a proposal was formulated by the division for setting up a computer based national hard data base and analytical centre in the multidisciplinary field of biomedical engineering and devices technology.

(x) Division of Tool Room and Engineering services:

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

Mr. Neelakantan Nair joined M/s. Peninsula Polymers for a period of eight months on deputation to setup their blood bag production facility. The assignment involved discussions with machine suppliers, inspection of machinery, erection and commissioning of machinery, testing and standardisation of the individual production rate and the initiation of production schedule under conditions of good manufacturing practice. His deputation to the factory not only facilitated the commercial production of blood bags, but also widened the institutional experience in the transfer of technology.

As in previous years, the Tool Room assisted other divisions in the development of medical devices. The assistance ranged from the fabrication of single cavity moulds to the development of new fixtures for the more precise finishing of Haynes alloy valve cages and optimisation of production rate. The Tool Room also contributed to the development of a modified version of the humidifier.

Supervision of the operation of Panbit, incinerator, airconditioning systems and electronic equipment continued to remain a major responsibility of the division.

(xi) *Division of Vivarium:*

Dr. Arthur Vijayan Lal, B.V.Sc. Veterinary Scientist

The central activity of the division continued to be the efficient management of the vivarium. This involved the procurement, care and conditioning of animals such as sheep, goat, pig, dogs etc. prior to surgery, maintenance of a well equipped operating

room for procedures including open heart operations, autopsy studies and experimental support for the research projects of various investigators. A list of the projects excluding the adhoc studies of postgraduate students are given in Table.

Table 10

<i>Project</i>	<i>Investigators</i>	<i>Animal model</i>
1. SS Bands for dental applications	A. V. Ramani	Dog
2. Invitro and exvivo evaluation of rigid shell oxygenator	V. S. Venketesan M. Unnikrishnan M. S. Valiathan	Sheep
3. Invivo evaluation of Chitra tilting disc valve	G. S. Bhuvaneshwar M. S. Valiathan R. Sankar Kumar	Sheep

The division provided experimental facilities for the postgraduates who were posted by rotation to the Biomedical Technology Wing. They included Drs. J. T. Tolia, Prakash, Suresh Rao, K. N. Krishna, Ajay Gehlot and Purohit during the year. The

vivarium also continued to supply blood samples from experimental animals for the ongoing research projects of other divisions such as Thrombosis Research, Microbiology and Biosurface Technology.

SCIENTIFIC PUBLICATIONS

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2. Appukuttan PS, Basu D. A Galactomann Hydrolysing – Galactosidase from jack fruit (*Artocarpus integrifolia*) seed: Affinity chromatographic purification and properties. *J Biosci* (in press)
3. Appukuttan PS, Basu D. Alpha-Galactoside Binding Isolectins from Wild Jack (*Artocarpus hirsuta*) seed. Affinity purification, properties and subunit stoichiometry. *Eur J Biosci* (in press)
4. Basu D, Nair JV, Appukuttan PS. Oligosaccharide structure determination of glycoconjugates using Lectins. *J Biosci* (in press)
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6. Chandy T, Sharma CP. Protein – polymer interaction with plasma components, vitamins and antiplatelet drugs at the interface. *J Polymer Plast Technol Engg* (in press)
7. Gobi Sankar S, Kartha CC, Balakrishnan KG, Valiathan MS. Calcified mitral valve: A clinicopathologic correlation. *Indian Heart J* (in press)
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10. Jamaluddin M, Krishnan LK. A spectrophotometric method for following initial rate kinetics of blood platelet aggregation. *J Biochem Biophys Methods* (in press)
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12. Joseph Joy MV, Venkitachalam CG, Balakrishnan K G. Post infarctional ventricular septal rupture: Negative contrast echocardiography. *Indian Heart J* 38:75, 1986.
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19. Nambiar MP, Basu D, Appukuttan PS. Physicochemical properties and binding-site amino acid residues of galactoside-binding protein of human placenta. *J Biosci* 11: 1, 1987.
20. Prabha D Nair, Sreenivasan K. A simple method for removal of oligomers in PET for biomedical applications. *Acta Polymerica* (in press)

21. Prabhu R, Rao GR, Jamaluddin M, Ramakrishnan T. N-(2-Naphthyl) – glycine hydrozide, a potent inhibitor of DNA-dependent RNA polymerase of *Mycobacterium Tuberculosis* H37 Rv: *J Biosci* 10: 163, 1986.
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28. Sharma R. Foramen magnum meningioma simulating intrinsic cervicomedullary mass. *Neurol. India*, 34: 346, 1986.
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ADMINISTRATIVE BODIES (1986-91)

INSTITUTE BODY

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1. Dr. V. R. Gowarikar,
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Nirman Bhavan,
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Welfare, (Representative of Union
Ministry of Health & Family
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 19. Prof. A. S. Paintal,
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 20. Dr. R. M. Varma,
Emeritus Professor, NIMHANS,
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 21. Dr. N. H. Wadia,
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Neurologist, J. J. Group of Hospitals,
Bombay.

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2. Director General of Health Services
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3. Chairman
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4. Director
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5. Head,
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Government of India

Member of the Institute representing
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Financial Adviser & Chief Accounts
Officer of the Institute (Convener)

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Medical Superintendent of the Institute

Head, Biomedical Technology Wing of the
Institute

Dr. P. A. Jayaprakash, Chief Blood
Transfusion Officer
Sree Chitra Tirunal Institute

Mr. O. S. Neelakantan Nair, Tool Room
Engineer,
Sree Chitra Tirunal Institute

Miss Saramma Abraham, Nursing
Superintendent of the Institute.

A representative of the Academic wing of
the Institute nominated by the Director.

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Emeritus Professor,
NIMHANS, Bangalore

Head, Biomedical Technology Wing
of the Institute

A nominee of the Secretary,
Department of Science and Technology
of the Central Government

An expert from outside the Institute
nominated by the President.

A Professor of the Institute.

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Government of Kerala, Trivandrum

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Prof. of Medicine & Head of the
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Medical Science, New Delhi

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Head, Laser Division,
Bhabha Atomic Research Centre, Bombay.

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Deputy Director & Head,
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BMT Wing, Sree Chitra Tirunal Institute

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Raman Research Institute, Bangalore.

HOSPITALS REFERRING PATIENTS

KERALA STATE – Districtwise

Alleppey

District Hospital, Alleppey
Government Hospital, Nooranad
Medical College Hospital, Alleppey
S.N.M.M. Hospital, Shertallai
St. Thomas Mission Hospital, Kattanam
S.H. Hospital, Alleppey
Taluk Hospital, Mavelikara
Taluk Hospital, Chengannur
GEMS Hospital, Mavelikkara
P.M. Hospital, Mavelikkara
St. Andrews Hospital, Chengannur
St. Thomas Mission Hospital, Malakkara
Govt. Hospital, Haripad
Govt. Hospital, Kayamkulam.
General Hospital, Shertallai
W. & C. Hospital, Alleppey
Velayudhan Memorial Hospital, Shertallai
Pooppally Hospital, Chengannur
Priya's Hospital, Kandellore
St. George Hospital, Kayamkulam

Calicut

Nirmala Hospital, Calicut
Medical College Hospital, Calicut
P.V.S. Hospital (P) Ltd., Calicut.

Cannanore

District Hospital, Cannanore
Dr. Kannan's Hospital, Cannanore
Koyili Hospital, Cannanore
Vimala Mission Hospital, Chemperi
Govt. Hospital, Kanhangad

Ernakulam

City Hospital, Cochin
Gautham Hospital, Cochin
Janatha Clinic, North Parur
Kunhali's Nursing Home, Cochin
Lisie Hospital, Ernakulam
Little Flower Hospital, Angamally
Mar Augustine Golden Jubilee Hospital,
Mookkannoor
Medical Trust Hospital, Ernakulam
MOCM Hospital, Kolencherry
Paul Mary Hospital, Cochin
Port Trust Hospital, Cochin

General Hospital, Ernakulam
Ananda Nursing Home, Kothamangalam
Pallikara Medical Centre, Ernakulam
AAJM Hospital, Kottapuram
Govt. Hospital, Koorkancherry
Samaritan Hospital, Alwaye
Santhinekethan Hospital, Moovattupuzha
St. Joseph's Hospital, Kothamangalam
St. George Mount Hospital, Kadaplamattom
Sree Krishna Nursing Home, Cochin
Sudheendra Medical Mission, Ernakulam
George Tharakan Hospital, Alwaye

Idukki

District Hospital, Idukki
Holy Family Hospital, Muthalakodam
Mount Sinai Hospital, Thodupuzha
St. John's Hospital, Kattappana

Kottayam

Carithas Hospital, Kottayam
Good Samaritan Hospital, Kottayam.

Holy Family Hospital, Kottayam
K.V.M.S. Hindu Medical Mission Hospital
Medical College Hospital, Kottayam
M.G.D.M. Hospital, Kottayam
St. George Mount Hospital, Kottayam
Govt. Hospital, Chenganacherry
Govt. Hospital, Vaikom
Mandiram Hospital, Kottayam
Cheriapally Hospital, Kottayam
Mundakapadam Mandiram Hospital,
Kavakattu Memorial Hospital, Anthinad
District Hospital, Pala

Malappuram

Government Hospital, Tirur,
District Hospital, Manjery
Taluk Hospital, Tirur

Palghat

District Hospital, Palghat
Palat Memorial Hospital, Palghat
Railway Hospital, Olavakkot
7th Day Adventist Hospital, Ottappalam
Taluk Hospital, Ottappalam
Taluk Hospital, Mannarghat

Pathanamthitta

District Hospital, Kozhencherry
G. K. Hospital, Tiruvalla
Govt. Hospital, Tiruvalla
Marthoma Medical Mission, Ranni
NSS Medical Mission, Pandalam
People's Clinic, Pathanamthitta
Pushpagiri Hospital, Tiruvalla
St. Paul's Hospital, Kadampanad
Thiruvalla Medical Mission, Tiruvalla
MMM Hospital, Kozhencherry

Sunny Memorial Hospital, Kozhencherry
Christian Medical Centre, Pathanamthitta

Quilon

Benzigar Hospital, Quilon
District Hospital, Quilon
Deen Hospital, Quilon
ESI Hospital, Asramam
Holy Cross Hospital, Quilon
Janatha Clinic, Quilon
St. Paul's Hospital, Quilon
Taluk Hospital, Karunagapally
Upasana Hospital, Quilon
St. Joseph's Hospital, Anchal
Dr. Nair's Hospital, Quilon
Jayabharatham Nursing Home, Punalur
Medical Centre, Quilon
Taluk Head Quarters Hospital, Kottarakara
General Hospital, Karunagapally
Medical Trust Hospital, Kottarakara

Trivandrum

Cosmopolitan Hospital
General Hospital
Govt. Hospital, Peroorkada
Govt. Hospital, Parassala
Medical College Hospital
Nirmala Hospital, Trivandrum
Sree Ramakrishna Mission Hospital
Taluk Hospital, Chirayinkil
Taluk Hospital, Neyyattinkara
Taluk Hospital, Nedumangad
VSSC, Medical Division
W & C Hospital, Trivandrum
Dr. Govindan's Hospital
Military Hospital, Pangode
Al-Arif Hospital, Ambalathara
Kalyan Hospital, Aryasal
Regional Cancer Centre

HQ SAC(u) AF, Trivandrum
ESI Hospital, Peroorkada

Trichur

Agrasala, Kodungallore
Amala Cancer Institute, Trichur
Balya Children's Hospital, Veliyannur
C.A.M. Hospital, Olarikara
Jubilee Mission Hospital, Trichur
District Co-operative Hospital, Trichur
Royal Hospital, Kunnamkulam
Sacred Mount Hospital, Irinjalakuda
Dhanya Hospital, Chalakudy
District Hospital, Trichur
District Co-operative Hospital, Trichur

Guruvayoor Polyclinic, Guruvayoor
I.V.G.A. Hospital, Chalakudi
J.M.M. Hospital, Trichur
Mar Augustine Golden Jubilee,
Mookkannur

Medical College Hospital
St. Joseph's Hospital, Choondal
Elite Mission Hospital, Trichur
Lal Memorial Hospital, Irinjalakuda
Bishop Alappatt Hospital, Trichur

Wynad

Assumption Mission Hospital,
Sulthan Batheri
Good Shepherd Hospital, Vythiri

OTHERS – Statewise

Andhra Pradesh

M.I.G. Hospital, Vijayawada

Goa

Mormugeo Port Trust

Karnataka

Jayadeva Institute of Cardiology, Bangalore
Kasturba Medical College, Manipal
Medical College Hospital, Mangalore
St. John Medical College Hospital,
Bangalore
Dr. Adappa Memorial Nursing Home,
Mangalore
St. Marthas Hospital, Bangalore

New Delhi

Patel Chest Institute, New Delhi

Pondicherry

JIPMER, Pondicherry

Tamil Nadu

Balasundaram Hospital, Nagercoil
Bensam Hospital, Nagercoil
Chandran Hospital, Marthandam
Catherine Booth Hospital, Nagercoil
Casper Hospital, Manalikkara
Jayskharana Hospital, Nagercoil
Jawahar Hospital, Nagercoil
Kunnath Hospital, Padanthalumoodu
Kanyakumari Medical Mission CSI
Hospital, Neyyoor
Letha Nursing Home, Nagercoil
Mathias Hospital, Nagercoil
Merlin Hospital, Nagercoil
William's Clinic, Nagercoil
Railway Headquarters Hospital, Madras
Vijaya Hospital, Madras
Medical College Hospital, Coimbatore
Kuppuswamy Naidu Memorial Hospital,
Coimbatore
General Hospital, Madras
Medical College Hospital, Tirunelveli
Vadamalayam Hospital, Madurai
Deepam Nursing Home, Virudhu Nagar

ABROAD

Rashid Hospital, Dubai, UAE
Marfaq Hospital, Abudhabi
Ministry of Health, Abudhabi
Hamad General Hospital, Doha
Ministry of Health, Oman
Ministry of Health, Libya

ALUMNI PAGE

1. Dr. H. D. Waiker (PDCC Anaesthesia, Mar. 1983) Assistant Professor in the Institute.
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13. Dr. Ravi Subramanya (DM Neurology, Dec. 1985) Asst. Prof. in Kasturba Medical College, Manipal.
14. Dr. H. L. Subba Rao (M.Ch, CVTS, Dec. 1985) Assistant Prof. at JJM Medical College, Davanagere.
15. Dr. KVSK Subba Rao (M. Ch., CVTS, Dec. 1985) Prof. in JIPMER, Pondicherry.
16. Dr. P. K. Neema (PDCC Anaesthesia, Dec. 1985) Consultant Anaesthetist at Shree Mahavir Hospital, Surat.
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23. Dr. Sunil Kumar (PDCC Radiology Mar. 1987) Asst. Professor in the Institute.