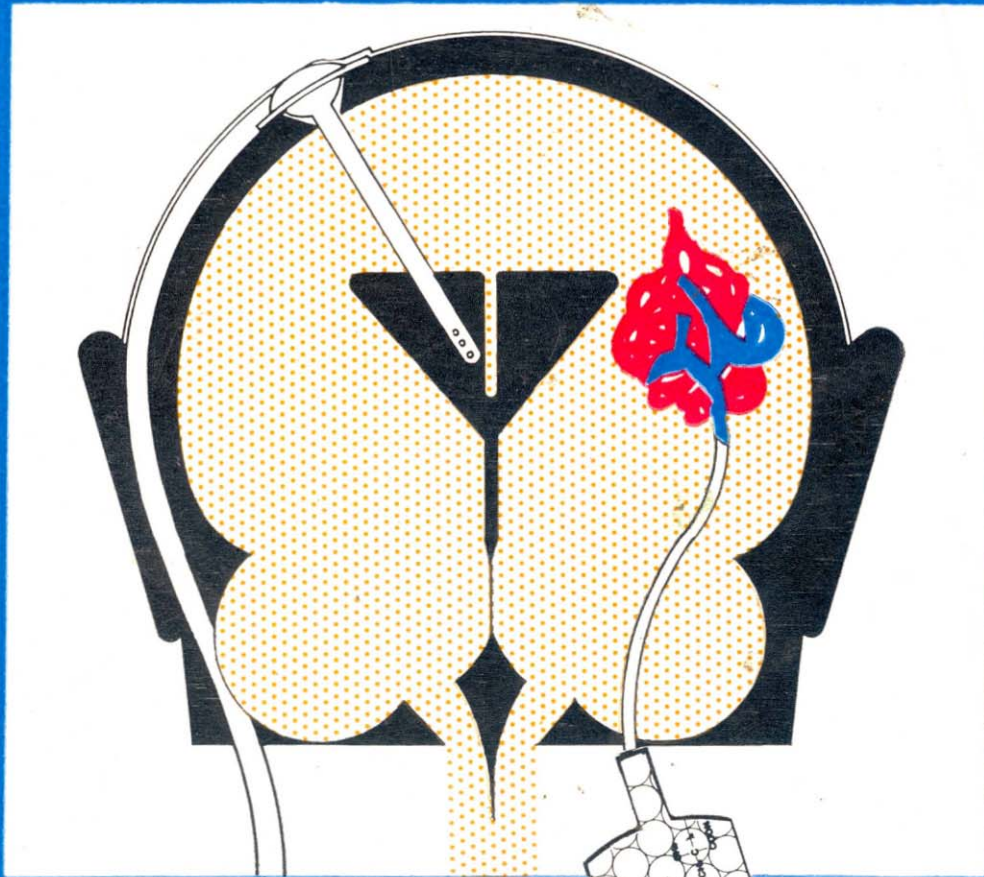
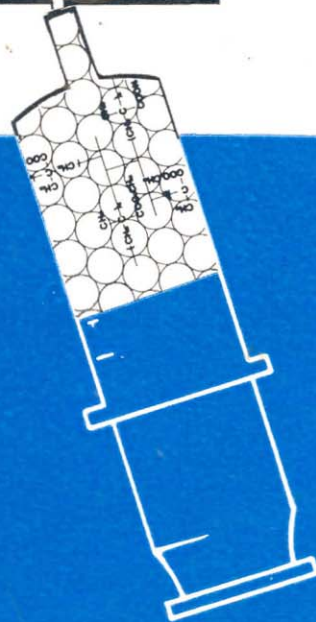


Sree Chitra Tirunal Institute for Medical Sciences & Technology  
Trivandrum 695 011



ANNUAL REPORT

1989-'90





# **Annual Report 1989-'90**

Sree Chitra Tirunal Institute for  
Medical Sciences and Technology, Trivandrum 695 011  
Kerala, India.

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Cover: A diagrammatic view of the hydrocephalus shunt and hydrogel beads developed by the Institute. Currently under clinical trial, they are used in the treatment of hydrocephalus and vascular lesions of the brain.

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## HISTORICAL

The origins of the Institute reach back to 1973 when the Royal Family of Travancore gifted a multi-storeyed building for the people and the Government of Kerala resolved to develop the gift as the Sree Chitra Tirunal Medical Centre for medical specialities. The Medical Centre was inaugurated by Shri. P. N. Haksar in 1976 and the growth of a Biomedical Technology wing followed quickly at the Satelmond Palace, Trivandrum. 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 in advanced medical specialities and the development of post-graduate training programmes of the highest quality in advanced medical specialities and biomedical engineering and technology.

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## OVERVIEW

In India where the demands of public health and basic hospital care are poorly met, the case for tertiary level institutions has always been controversial. Following the entry of the private sector in the field of tertiary care, the controversy has acquired a new edge. The criticism that Government institutions offer superspecialities at the expense of basic medical services has given way to a new species of impatience that tertiary institutions in the public sector are unable to match their private counterparts in the volume and efficiency of services. The arguments are familiar. The Government institutions are crowded; they lack comforts; they have waiting lists; they are deficient in 'latest' equipment and to boot, they fail to give personalised care. In the welter of criticism, it has become unfashionable to claim that these institutions are alone in serving people who are priced out by the private sector and that they are solely dependent on Government

grants for survival. These considerations are vital in studying the *raison de' etre* of the Sree Chitra Tirunal Institute. While its hospital statistics has shown an increase in the volume and variety of patient services over the years which compare favourably with that of the best centres in the country, the fact remains that demand has always exceeded supply. This is graphically brought out by the waiting period for open heart procedures which failed to shorten during a five year period when the number of open heart operations rose from four hundred to seven hundred. Notwithstanding the Institute's drive to do more, the fulfilment of the needs of the regional population for cardiac and neurologic services would be an unrealistic objective for it. Limits to the physical growth of hospital services need not however diminish the societal value of the Institute which is obliged to promote research and the training of a new generation of personnel who

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share the joint culture of medicine and technology. While healing the sick will always claim pre-eminence, prevention of illness and the creation of tools for the control of diseases cannot lag behind on the long haul. The non-clinical obligations could provide an opportunity for the Institute to offset the gap in patient services by promoting research targeted on societal good. A clue to the prevention of a cardiomyopathy or the emergence of a self-reliant industry for medical devices are challenges beyond patient care which the Institute can meet in

repayment of its debt to the society and the individual.

In the following pages the efforts made by the Institute in the service of patients and science during 89-'90 are outlined in the usual format. Their unmistakable message is one of confident and quiet growth and its growing international recognition as shown by the Second Indo-UK Symposium on the Frontiers of Medical Technology and the International meeting on intracranial vascular lesions. The time for the idea of the Institute would seem to have come.

# SURVEY OF MAJOR PROGRAMMES

## i. HOSPITAL SERVICES

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

*Administrative Medical Officer:* Dr. D. Hariprasad, MBBS, MD

As the ever-increasing demand for services could not be met by a corresponding expansion of the hospital, a number of measures were employed to control the mismatch between supply and demand. These included the introduction of an appointment system for new patient registration as well as follow up, institution of guidelines for the follow up of patients and the updating of waiting lists by postal enquiry among patients. As mentioned in earlier reports, techniques of management can be tailored to control the supply-demand problem, but they cannot solve it because of the extent of mismatch. The annual statistics on patient services are given in (Figs. 1-5).

The charging system for hospital services underwent a revision in January 1990 in view of the steady increase in wages and the cost of medications, chemicals, disposables

### HOSPITAL STATISTICS

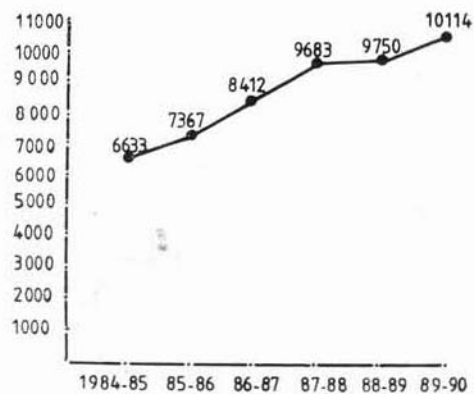


Fig. 1 New Registration

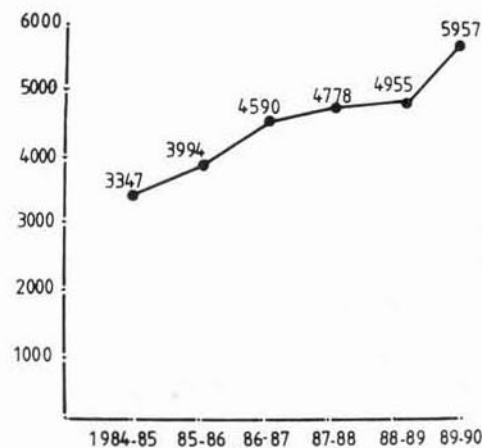


Fig. 2 Admissions



and utilities. The package system for billing which worked smoothly was generally accepted for reimbursement

purposes. It simplified the accounting operations for patients (Fig. 6 a & b).

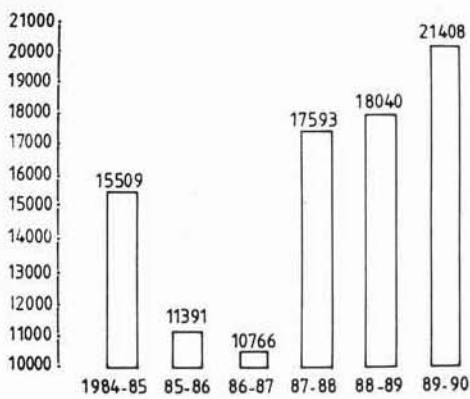


Fig. 3 Follow up cases

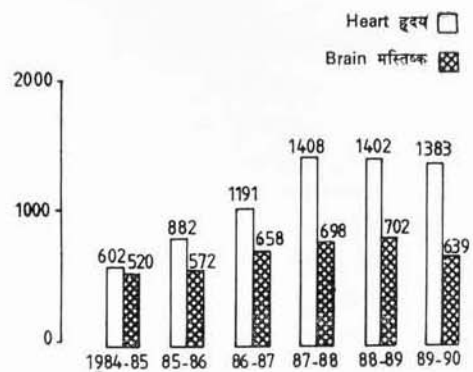


Fig. 5 Heart & Brain operations

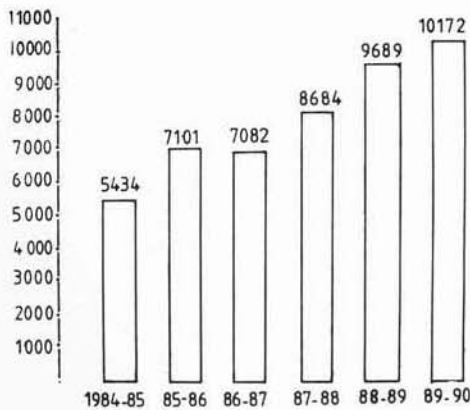


Fig. 4 Complex investigations

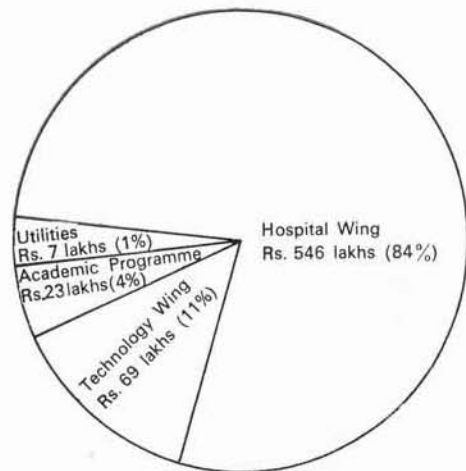


Fig. 6 (a) Distribution of expenditure

Thanks to the promise of support from the Royal Family of Travancore, the Physiotherapy section was

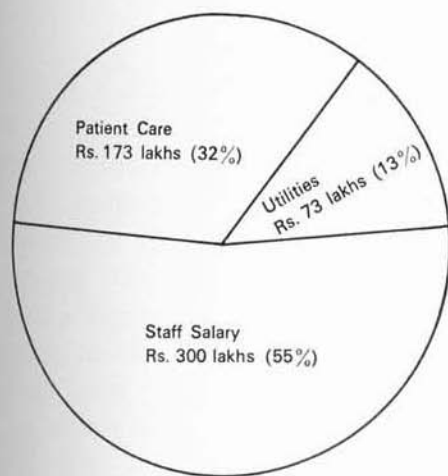


Fig. 6 (b) Distribution of expenditure

Gross Recurring Rs. 645 lakhs

.. Non-Recurring Rs. 137 lakhs

expanded into a new Rehabilitation unit with the addition of Speech therapy and Audiology. This was done in consultation with the specialists at the Ali-Yawar Jung Institute in Bombay and Dr. Vijayalakshmi Basavaraj of the All India Institute of Medical Sciences, New Delhi. The Rehabilitation unit is expected to function under the Department of Neurology and become fully operational during 1990.

The ambulance gifted by the Royal Family found regular use for the conveyance of patients to their residence, transport station etc. at the time of discharge, a service which was appreciated. A new vascular clinic was opened with treadmill and echo equipment for the increasing number of follow up patients in vascular surgery.

The Medical records section functioned smoothly in its new location. The Dietary section continued to provide training to candidates from hospitals and Colleges in hospital dietetics as in previous years. The Laundry was reorganised and partly updated with new equipment.

### Hospital Economic Study :

The hospital economics unit conducted studies of its own besides contributing to collaborative research projects. The following investigations were carried out by the unit during the year.

1. Evaluation of the CT scan with special reference to its impact on hospital services in Neurology;
2. Study of health care facilities in Kerala in relation to other socio

economic variables such as per-capita income, education, etc;

3. A course in research methods for the faculty and postgraduates in the Institute.

The unit also cooperated with other research institutions, especially the Centre for Development Studies, in the projects indicated below:

1. Socio-economic status and health status in rural Kerala (A Project of the Department of Science and Technology, Government of India).
2. Morbidity profile of urban children in Trivandrum (project funded by the State Committee on Science, Technology and Environment, Kerala).
3. Assessment of immunization coverage in Kerala, a comparison of ICDS and non-ICDS areas, (project of UNICEF).
4. Study on water borne diseases in children, (project of Socio-economic unit, Kerala Water Authority).

A research project submitted by the unit for the estimation of

the prevalence of coronary artery disease in Kerala was approved by the State Committee on Science & Technology for funding.

#### **Nursing Services:**

Fourteen new staff nurses joined against resignation vacancies, but the yearly departure of nurses for foreign employment continued. The nursing services however remained stable with emphasis on patient care, in-service education programme, monthly ward sisters' conference, orientation to new staff members and the introduction of 'Nursing Care Plan' in the Intensive Care Unit. The Seventh Annual Conference of Nurses was held in November, 1989 with thematic emphasis on endomyocardial fibrosis, encephalitis and spinal tumours. Undergraduate and general nursing students visited the Institute for 2-3 week periods for educational experience from several parts of the country including Bangalore, Ambilikai in Tamil Nadu and the Colleges of Nursing and hospitals in Kerala. Ward Sisters Ms. K. V. Rosamma and Ms. Lilly Bai attended the workshop on 'Nursing Clinical Managerial Skill Development' in the College of Nursing, Trivandrum and Mrs.

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Deenamma Koshy delivered a guest lecture at the 62nd Biennial Conference of the Trained Nurses Association of India at Cuttack in January 1990.

**Clinical Engineering:**

Apart from carrying out preventive and break-down maintenance of hospital equipment, the staff assisted students from the Engineering College, Trivandrum in project work which related to the recognition of arrhythmias and the development of hardware for warning epileptic discharge. Mr. R. Mohan Das visited the facilities of Siemens and Radiometer in Europe to observe

their advanced techniques in maintenance. Mr. Mohan Das and Mr. Koruthu P. Varughese took active part in organising a meeting of the IEEE on 'Lasers in Engineering and medicine' in Trivandrum which attracted an impressive audience. Mr. Madhusoodanan Pillai and Mr. Vijayakumar were elected members of the IEEE and Mr. Mohan Das became a member of the Committee on Electromedical equipment of the Bureau of Standards and the Advisory Committee of the Electronic Regional Testing Laboratory. He served as an examiner at the Kerala and Calicut Universities and the Institute of Human Resources Development.

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**ii. BIOMEDICAL  
TECHNOLOGY WING**

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

The experiment made by the Institute in starting a technology proving facility proved to be an unqualified success. More than 400 pieces of cardiotomy reservoirs were made in the facility and they were successfully used in major centres across the country during multicentric trial.

The rigid shell oxygenator received the clearance of the ethics committee and its controlled clinical trials in the Institute showed excellent performance. Bulk manufacture of the Oxygenator would form the major activity of the technology proving facility during the rest of the year.

The hydrocephalus shunt produced under a DST sponsored programme was also cleared by the ethics committee for clinical trial and the first batch of the device was readied for clinical trials at the Institute. Efforts are in progress in parallel to secure a sponsored project for the pilot production of the shunt in the technology proving facility.

After a long history of testing and set backs, the Chitra heart valve prosthesis seemed to enter the home

stretch. Preclinical animal trials with the UHMWHDPE—HAYNES valve reached an advanced stage. Fabrication problems were resolved with the assistance of Hindustan Aeronautics Limited. Bulk fabrication of precision cages and also discs were initiated in anticipation of the possible clinical trials of the valve in the last quarter of 1990.

An Indo-UK symposium on the Engineering Frontiers of Medicine was a highlight of the year and attracted medical and dental delegates from all parts of South India. Fine presentations and lively discussions between the speakers and the delegates made the symposium a catalyst to spark off interactive research in biomaterials science and technology.

The library at BMT Wing continued to support all academic activities. Nearly two hundred new books were added during the year bringing the total holding to 5570 volumes. Six new bibliographies were started besides updating the existing 17 bibliographies. What is probably the first computerisation activity of Libraries in Kerala was achieved in this library. A major effort is under way to consolidate the computerisation process of the Library in both wings of the Institute.

iii. EDUCATIONAL PROGRAMMES

**Table 1**  
Nation-wide response

<i>Registrar:</i> Shri V. Narasimhan M. Sc., MIMS.	<i>State/Union Territories</i>	<i>Number applied</i>
<i>Admissions:</i>  As in previous years, the pattern of applications reflected the nation-wide appeal of the academic programmes (Table 1). The response to the training in various disciplines also revealed no substantial change (Table 2). The list of admissions is given in Table (3).	Andhra Pradesh	23
	Delhi	17
	Gujarat	11
	Goa	2
	Haryana	1
	Karnataka	16
	Kerala	57
	Madhyapradesh	14
	Maharashtra	22
	Orissa	4
	Rajasthan	11
	Tamil Nadu	20
	Uttar Pradesh	13
West Bengal	9	

**Table 2**  
Course-wise Demand

<i>Course</i>	<i>No. of applicants</i>	<i>No. selected &amp; joined</i>
DM Cardiology	93	2
DM Neurology	30	2 + 1 (Govt. of Karnataka sponsored)
M. Ch. Cardiovascular Thoracic surgery	37	2
M. Ch. Neurosurgery	33	2
Post doctoral certificate in Anaesthesiology	19	4
Postdoctoral certificate in Radiology	8	2 + 1 (Govt. of India sponsored)

**Table 3**  
**Admission 1990 – State-wise**

Andhra Pradesh	3
Delhi	1
Karnataka	3
Kerala	2
Madhyapradesh	2
Maharashtra	2
Tamil Nadu	2
West Bengal	1

**Examinations:**

All the candidates who appeared for their DM and M.Ch degree examinations during 1989 were declared successful. Tables 4 & 5 list the names of successful candidates.

**Ph. D. Programme:**

Mrs. Lissy Kalliyana Krishnan who had registered for Ph.D. in Biochemistry under Dr. Jamaluddin submitted her thesis which was accepted after evaluation and defence during 1989.

**Training Course for Students and Technical Personnel:**

The demand for short term training in procedures, techniques and management was on the increase from several institutions and organisations. A notable example was the team of doctors, nurses, and technicians sponsored by the Jawaharlal Nehru Hospital and

**Table 4**  
**List of successful Candidates for DM/M.Ch**

<i>Name of candidates</i>	<i>Degree</i>	<i>Speciality</i>
Dr. Tiny Nair } Dr. Y. R. Yellury }	DM	Cardiology
Dr. Sekhar Rao } Dr. V. K. Kurien }	M.Ch	Cardiovascular and Thoracic surgery
Dr. Jacob Daniel	DM	Neurology
Dr. Subodh Darbari } Dr. Dilip Panikar } Dr. Satish Krishnan }	M.Ch	Neurosurgery

**Table 5**

**List of successful Candidates for Post Doctoral Certificate Course**

<i>Name of candidates</i>	<i>Speciality</i>
Dr. G. Mruthyunjaya } Dr. C. G. Raghuram } Dr. Damien Joseph } Dr. Nadraj Shyamala }	Cardiovascular and Neurosurgical Anaesthesiology
Dr. Varun Satija } Dr. Vijaya Gupta }	Cardiovascular and Neuroradiology

Research Centre, Bhilai for training in cardiac surgery. In all such instances, the Institute responded readily and positively with no fees being levied for offering its training facilities.

**Library:**

Library services grew steadily in terms of acquisition of volumes, manual selective discrimination of information, preparation of monthly accession list and provision of reprographic services to departments. The computerisation of library activities moved forward with an order being placed for a PC/AT for the libraries at the Hospital and Biomedical Technology Wings.

Smt. Prasannakumari participated in an advanced course sponsored by National Information System for Science and Technology (NISSAT) at Bangalore on computer based library and information work for six weeks. Smt. Jayaprabha attended a similar course sponsored by NISSAT at the University of Kerala, Trivandrum. The students and faculty from the Department of Library and Information Service, University of Kerala visited the library as part of their learning programme.

Four apprentice trainees joined the Library during the year.



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**Continuing Education Programme:**

Dr. P. K. Mohan, Head of the Dept. of Neurology, organised a programme for the medical practitioners in the region. It proved popular because of its emphasis on coronary artery disease and stroke which are disturbingly common.

**Nursing Education:**

The post-basic course which had attracted fewer applicants in 1989 picked up new momentum during 1990 with eight candidates, four of whom were sponsored by other institutions. On the basis of the comments of nurses who attended the continuing education programme and the experience of the nursing staff, an effort was begun to restructure the course with greater emphasis on practical training in nursing practices and techniques of the intensive care unit.

**National Science Day:**

The Institute held an open house for the postgraduate students of

the Medical College, Trivandrum on the National Science Day. The exposure to the service and research programmes and facilities of the Institute was greatly appreciated by the young visitors.

**New Course in Cardiac Laboratory Technology:**

The two year course which was offered for the first time attracted 25 applicants including a sponsored candidate for one seat. In view of the rapid growth in cardiac services across the nation, the products of the training programmes are expected to find ready employment.

Sri Narasimhan spoke to the course participants at the Institute of Management in Government, Kerala on Desk-top Management. He was also sought by other agencies and Universities for speaking and writing engagements.

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## SPECIAL SCHEMES OF RESEARCH

### i. Centre for Advanced Research in Cardiomyopathy (Sponsored by the Indian Council of Medical Research)

Prof. M. S. Valiathan    Head of the Centre

Dr. C. C. Kartha, MD	Additional Prof. of Pathology
Dr. R. Renuka Nair, Ph.D	Assistant Professor
Dr. K. Shivakumar, Ph.D	Senior Research Officer
Dr. John T. Eapen, Ph.D	Research Associate
Dr. Jose Jacob, MD	Research Associate

In pursuance of the hypothesis that Endomyocardial Fibrosis (EMF) may be the cardiac expression of Ce toxicity in combination with Mg deficiency, the research activities of the Centre included experiments on animals and cultured cardiac myocytes and fibroblasts to validate the claim. In long-term experiments on non-human primates (*Macaca radiata*), initiated in July 1988, twenty animals were put on a low Mg diet and administered cerium sulphate intraperitoneally. The effects of Mg deficiency and Ce were monitored by various hematologic and biochemical tests. The animals on the low Mg diet showed a significant decrease in the plasma Mg levels. Twelve months

after commencement of the experiment, 4 animals – 2 of the low Mg + Ce group and 2 of the normal Mg + Ce group – were sacrificed and tissues collected for metal analysis and histology. Ce estimation was done by neutron activation analysis at BARC, Bombay. Histology of the myocardium revealed focal lymphocytic infiltration in the interstitium in the two animals on low Mg + Ce and one animal on normal Mg + Ce. Similar experiments on rats were terminated at the end of six months and the cardiac tissue was examined histologically and for levels of Mg and Ce. A fall in tissue levels of Mg was observed in animals on the low Mg diet. Histologically, 3 of the 9 test animals had extensive endocarditis.

In the remaining 6, increase in interstitial cellularity and focal myofibre hypertrophy and perivascular scars were seen. In control animals, occasionally interstitial inflammatory infiltrates were seen. Since Ce absorption from the gut is reported to be more in the younger age group, an experiment was begun to induce Mg deficiency in weanling rats by diet control to be followed by the administration of low doses of Ce through drinking water.

Studies on the effects of Mg deficiency and Ce on cultured cardiac myocytes and fibroblasts revealed interesting inter-relationships between the two ions. In one set of experiments, it was found that Ce, at 10  $\mu$ M, had an inhibitory effect on protein biosynthesis in these cell

types, including the synthesis of myofibrillar proteins in the myocytes. Importantly, the effect of Ce was greater in Mg-deficient cells.

Another study revealed that Ce, at  $\geq 100 \mu$ M, caused vacuolation in fibroblasts and at least some of these vacuoles were lysosomal in origin. Ce was also found to bind to sarcolemmal vesicles and myocytes. Further, the cells took up Ce by adsorptive pinocytosis. (Fig. 7). Long term effects of different concentrations of Ce on cultured cells are currently under investigation.

Preliminary studies using X-ray diffraction on collagen from the EMF tissue were initiated in the laboratory of Prof. Viswamitra at the Indian Institute of Science, Bangalore, to determine whether

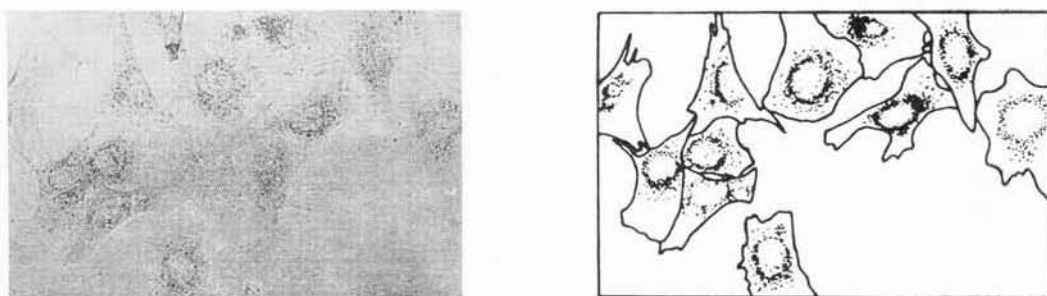


Fig. 7 Internalisation of cerium by heartcells. The bound metal is taken in by endocytosis as evidenced by peroxidase uptake. The dark spots in the picture represent the peroxidase staining organelles inside cells.

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there is any change in the molecular organisation of collagen in EMF. Should there be a striking and specific alteration, it could serve as a marker for the disease. For the same purpose, the amino acid composition of the collagen was also being looked into at the CLRI, Madras. Further, NMR studies on Ce - Mg interactions in the EMF tissue have also been initiated in the laboratory of

Prof. P. T. Manoharan at the IIT, Madras.

Prof. Viswamitra, Chairman, Department of Physics, Indian Institute of Science, Bangalore, visited the Centre and held discussions regarding the study of molecular structure of collagen in endomyocardial fibrosis.

Members of the Scientific Advisory Committee of the ICMR visited the Centre.

## ii. 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  
Dept. of Atomic Energy, Indore

Co-Investigators: Dr. K. Ravimandalam }  
Dr. Arthur Vijayan Lal } SCTI  
Dr. K. S. Neelakandhan }  
Dr. Meera Mohanty }  
Dr. V. R. K. Rao }  
Dr. V. K. Chatterji }  
Dr. TPS Nathan } BARC  
Dr. L. M. Kukhreja }

Project Scientist: Dr. T. Ramachandran

Duration: 3 years

Clinical laser angioplasty made modest but definite progress with two procedures at the iliac and four at the femoral level. Experimental work advanced at two levels. In order to test the indigenous delivery system, three types of experimental arterial occlusions in animals were produced and restudied after six months. Those with vascular occlusions from N. Butyl cyanacrylate showed an enduring occlusion with close resemblance to the clinical lesion. Secondly the heat delivery efficiency to the tissue was improved by a new design of the metallic hot tip arrangement. Fabrication

technique of this design was being optimised and its in vivo testing was expected to take place during the current year. A contact sapphire tip based on our design was fabricated and delivered by IRDE, Dehradun and its parametric studies were underway.

Dr. Ramachandran visited the Heracus Laser sonics factory in California and Dr. Ravimandalam presented a paper at the International Conference on Lasers in Medicine at Tashkent. Dr. Ramachandran also spent two weeks at CAT, Indore and BARC, Bombay for discussions on the collaborative work.

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## DEPARTMENTAL REPORTS

### HOSPITAL WING

#### Department of Anaesthesiology

Dr. K. Mohan Das, MD	Professor and Head of the Dept.
Dr. V. Padmanabhan, MD	Professor
Dr. R. C. Rathod, MD	Additional Professor
Dr. Mrs. A. Rout, MD	Additional Professor
Dr. H. D. Waikar, MD	Associate Professor
Dr. J. M. Shahani, MD	Associate Professor
Dr. Raman Chaddha, MD	Assistant Professor
Dr. Roopa Sreedhar, MD	Assistant Professor
Dr. Gopakumar, MD	Assistant Professor
Dr. N. Chandrasekhar, MD	Candidate for Postdoctoral Certificate *
Dr. T. Chandrasekhar, MD	-do-
Dr. P. V. Agnihotri, MD	-do-
Dr. Sunil Dhole, MD	-do-

Anaesthetic service was provided for the following procedures during the year:

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Cardiac surgery	..	768
Thoracic and vascular surgery	..	609
Neurosurgery	..	618
Cardiac catheterisation and intervention procedures	..	120

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Pulmonary function tests were carried out in 52 patients as part of their preoperative evaluation. While anaesthetic support to the surgical and other procedures kept the staff busy, the Department also provided assistance to the cardiac anaesthetic programme at the Calicut Medical College for one quarter of the year by deputing one of its post doctoral fellows. The staff of the Department collaborated with other departments in the development of blood conservation

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techniques and the implantation of Chitra Valve in sheep.

The following physicians and post-graduate students spent 1-4 months in the Department for special training in cardiac and neuro-anaesthesia.

Dr. Mercy John  
(Port Trust Hospital, Cochin)  
Dr. A. K. Ghosh }  
Dr. Sharma }  
(J N Hospital and Research  
Centre, Bhilai, MP.)

Dr. Arti Nadkarni }  
Dr. Hemal Keni } from  
Dr. Prashanth Kakodkar } Medical  
Dr. Shirley D'Souza } College,  
Dr. S. Bitá P Dasilva } Goa

Post graduate students from Medical Colleges at Trivandrum and Calicut also visited the Department.

In connection with the Interstate Zonal Conference, a continuing education programme was successfully organised in April 1989. Dr. Richard Douglas Jack FFARCS, Consultant Anaesthetist at the Hammersmith Hospital, London and Dr. Ruth Mansfield MBE, FFARCS one of the pioneers of anaesthesiology in India visited the Department and took part in seminars.

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**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 laboratory provided investigative services to the hospital and the total number of procedures in clinical chemistry and clinical pathology exceeded 1.85 lakhs, registering an increase of 12% over the previous year. Blood gas estimations alone increased by 50% thanks to the opening of a satellite laboratory next to the Intensive Care Unit. The laboratory introduced a new test for serum ceruloplasmin level using polyacrylamide gel electrophoresis.

The thrust of research was focussed on the extent of lipid peroxidation in atherosclerosis and the

relative involvement of various antioxidative defence mechanisms. Studies based on fasting blood samples showed that patients with coronary artery disease have raised serum level of lipid peroxide, decreased activity of superoxide dismutase, and enhanced levels of ceruloplasmin. These findings which suggested the existence of free radical pathology in atherosclerosis were presented by Dr. Jayakumari at an International Symposium in Bangalore. Further studies on patients with positive risk factors like hypertension but with no obvious coronary artery disease are in progress. The study of lipid peroxides along with other

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Project	.. Membrane lipid peroxidation in human atherosclerosis. A study of risk associated byproducts and apolipoproteins
Principal Investigator	.. N. Jayakumari
Funded by	.. DST
Status	.. Ongoing

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The Central laboratory provided investigative services to the hospital and the total number of procedures in clinical chemistry and clinical pathology exceeded 1.85 lakhs, registering an increase of 12% over the previous year. Blood gas estimations alone increased by 50% thanks to the opening of a satellite laboratory next to the Intensive Care Unit. The laboratory introduced a new test for serum ceruloplasmin level using polyacrylamide gel electrophoresis.

The thrust of research was focussed on the extent of lipid peroxidation in atherosclerosis and the

relative involvement of various antioxidative defence mechanisms. Studies based on fasting blood samples showed that patients with coronary artery disease have raised serum level of lipid peroxide, decreased activity of superoxide dismutase, and enhanced levels of ceruloplasmin. These findings which suggested the existence of free radical pathology in atherosclerosis were presented by Dr. Jayakumari at an International Symposium in Bangalore. Further studies on patients with positive risk factors like hypertension but with no obvious coronary artery disease are in progress. The study of lipid peroxides along with other

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Project	..	Membrane lipid peroxidation in human atherosclerosis. A study of risk associated byproducts and apolipoproteins
Principal Investigator	..	N. Jayakumari
Funded by	..	DST
Status	..	Ongoing

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known lipid risk factors demonstrated no apparent relationship between lipid peroxide levels on the one hand and that of cholesterol and triglycerides on the other. Using precipitation technique attempts were made to fractionate HDL and determine whether HDL2 could be of greater significance as a negative risk factor.

Laboratory support was provided to the postgraduate training

programme in cardiology. A student project consisted of estimating serum levels of Creatine Kinase (CK) and its isoenzyme MB (CKMB) in patients following the closure of atrial septal defect. The study showed the elevation of total CK and CKMB to average 1300 Iu/L and 80 Iu/L following an uncomplicated procedure for the surgical closure of atrial septal defect.

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### 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 increase in the volume and range of activities are reflected in Table 6.

**Table 6**

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Blood donation	..	5792
Whole blood transfusion	..	4302
Component transfusion	..	340
Compatibility tests	Saline	.. 8166
	Albumin	.. 8166
	AHG	.. 2422
Blood grouping – Patients	..	7379
donors	..	7192
HBs AG. Screening RPHA	..	4402
ELISA method	..	1510
Anti HIV Screening for donors	..	2700
RPR test for syphilis	..	6002
Therapeutic plasma pheresis	..	201
Washed cells for autologous transfusion	..	268
Components prepared: packed cells	..	295
	YYP	.. 245
	PRP	.. 51
	Buffycoat	.. 1
	Platelet concentrate	.. 1
	Fresh Plasma	.. 12

---

Apart from meeting the demand for blood and blood products in the Institute, the Division also provided specialised services to neighbouring institutions as shown in table 7.

**Table 7**

**Blood components issued to other Institutions**

Packed cells	—	3
Fresh plasma	—	12
YYP	—	232
Whole blood	—	21
PRP	—	42
Platelet concentrate	—	1

Research received considerable attention within the Division as well as in collaboration with other Departments. The internal projects included the comparison of third generation techniques (RPHA and Elisa) for Hb Ag screening, irregular antibody screening of donors using enzyme technique, determination of the IgA status of patients who develop non-haemolytic type of transfusion reactions, Rh genotyping and MNS grouping in suspected cases of transfusion reactions

and the study of factors contributing to the sustenance of repeat donations by individuals. The collaborative projects mainly consisted of the development of blood conservation techniques with Department of Cardiothoracic surgery and the investigation of the predictive value of immune complex assay in Guillain-Barre syndrome following small volume plasma exchange in partnership with the Department of Neurology. As in previous years, continuing efforts were made to enlarge the panel of voluntary donors by supporting the growth of donor forums, taking part in exhibitions, and creating community awareness towards blood donation and the uses of blood.

Dr. C. R. Usha joined the Division as Blood Transfusion Officer. A washing system and Elisa Reader were added to the laboratory for HIV screening.

Dr. S.B. Dutta, Director, Central Blood Bank, Calcutta and Dr. N. Banerji, Adviser in Health to the Government of West Bengal visited the Division and held discussions on the development and status of the blood bag developed by the Institute. Ms. Usha Kandaswamy participated in a 2 day workshop at

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Jamshedpur on the setting up of guidelines for voluntary blood donation programme and presented a paper on the 'effective management of repeat blood donors' at the international conference on blood donor motivation

at Calcutta. Dr. Jaisy Mathai presented a paper on the 'indigenous blood bag system for component separation' at the Annual Conference of the Association of Thoracic and Cardiovascular Surgeons at Pune.

## Department of Cardiology

Dr. K. G. Balakrishnan, MD, DM FACC, MNAMS	Professor & Head of the Dept.
Dr. C. G. Venkitachalam, MD, DM	Professor
Dr. R. Subramanyan, MD, DM	Additional Professor
Dr. Thomas Titus, MD, DM, MNAMS	Associate Professor
Dr. Jaganmohan Tharakan, MD, DM	Associate Professor
Dr. M. V. Joseph Joy, MD, DM	Assistant Professor
Dr. Rajiv Gupta, MD, DM	Assistant Professor
Dr. P. K. Goel, MD, DM	Assistant Professor
Dr. Shyam Sunder, MD, DM	Assistant Professor
Dr. V. K. Ajit Kumar, MD, DM	Assistant Professor
Dr. K. Raghu, MD	Candidate for DM
Dr. Sunitha Kumari, MD	-do-
Dr. Mahesh Kumar Shah, MD	-do-
Dr. Debanu Ghosh Ray, MD	-do-
Dr. Pramod Kumar Jaiswal, MD	-do-
Dr. Aravinda Saha, MD	-do-

In spite of the limits which had to be imposed on the number of registration of new patients as well as visits at follow-up clinics, the overall attendance increased, mainly due to the admission of urgent and semi-urgent cases. In parallel with the growth in outpatient services, the number of cardiac catheterisations increased by 60%, thanks to the functioning of two laboratories. While electrophysiologic studies doubled in number, intervention procedures including coronary

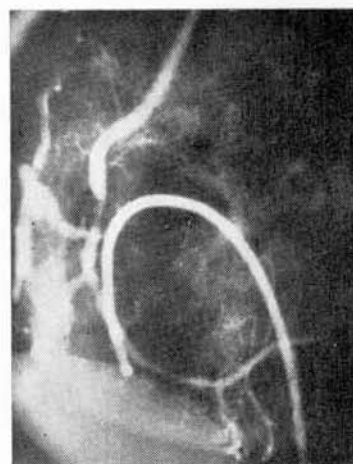
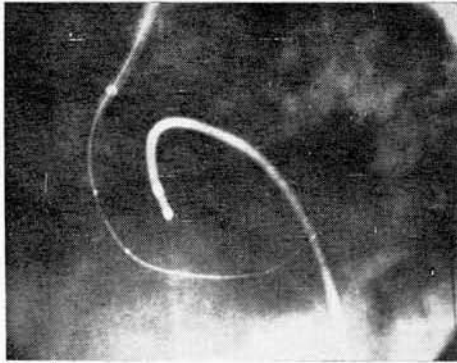


Fig. 8 (a) Right coronary artery angiogram showing stenosis in the proximal part



(b) The guide wire and the balloon catheter across the stenosis



(c) After successful dilatation the right coronary artery appears normal

angioplasties also increased considerably. These developments owed a good deal to the training received by Dr. Balakrishnan in coronary angioplasty at the New York University Hospital and Dr. Venkitachalam in intervention procedures in infants at the Boston Children's Hospital. The increase in the volume and variety of services were directly responsible for the approval for doubling the admissions for DM and for starting a 2 year training programme for technicians.

The Department collaborated with the Division of Biochemistry in their projects on the lipid profile

of patients and the estimation of oxygen free radicals and peroxidases in patients with coronary artery disease. Clinical trial of a new cardioselective beta blocker - Bisoprolol - was initiated in patients with chronic stable angina.

Dr. Rajiv Gupta joined the department as Assistant Professor. An ATL ultra mark 4 model echocardiograph was added to meet the growing need for diagnostic studies in the outpatient clinic.

The following physicians visited the Department for specialised training for periods ranging from 6 weeks to 12 weeks.



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Dr. Tennyson,  
(DM Candidate)  
Medical College, Trivandrum

Cardiac Catheterisation

Dr. Mathew Abraham,  
Idukki District

Clinical Cardiology

Dr. D. S. Mohan,  
PRS Hospital, Trivandrum

Exercise Laboratory

Dr. R. P. Parganiha  
Senior Medical Officer,  
Bhilai Hospital, Bhilai

Echocardiography

Dr. Premkumar. V,  
PNM Hospital,  
Kottakadav

Echocardiography

Dr. Sreepada Bhat  
Asst. Prof. of Medicine,  
JJ M Medical College,  
Davanegeri.

Echocardiography

Dr. Veerendra Kumar, M  
MD (Paed) Candidate,  
Medical College, Trivandrum

Echocardiography

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### 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 Dept.
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. Shyama Krishnan, MS, M.Ch.	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 Nair, MS, M.Ch.	Assistant Professor
Dr. R. N. Hyderabad, MS	Candidate for M.Ch.
Dr. Murtaza Ahmd. Chisti, MS	-do-
Dr. Mukhopadhyay, MS	-do-
Dr. Rajagopalan R. MS	-do-
Dr. Zachariah Philip, MS	-do-
Dr. B. Neelakantan, MS	-do-
Dr. R. Jaganathan, MS	-do-

The clinical and investigative programmes of the Department received a boost by the addition of two new faculty members. While the number of cardiac, thoracic and vascular procedures continued to rise, coronary artery bypass and major vascular operations showed a significant increase and

foreshadowed a new trend in the growth of clinical services. The growth of coronary artery surgery was dramatic (Fig. 9).

Nevertheless, surgical services fell short of demand. An analysis of the procedures at the present level vis a vis the list of patients awaiting

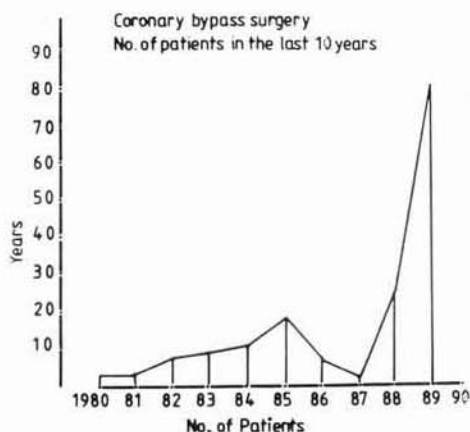


Fig. 9 Growth of coronary artery surgery

cardiac operations revealed that the waiting period for elective operations was as follows:

Repair of congenital cardiac anomalies	— upto 1 year
Valve replacement	— upto 3 years
Coronary artery bypass	— 12 – 15 weeks
Vascular and Thoracic procedures	— no waiting period

Given the fixed number of beds in the Intensive Care Unit and Surgical wards, efforts were made to reduce the duration of hospitalisation of patients from the present 12 days to 9 days in order to increase the total number of yearly operations to 1700 and reduce the waiting period for the ensuing year.

The clinical trial of the Spictra cardiomy reservoir was completed

successfully and Dr. Nazer visited the Christian Medical College, Vellore and Loka Manya Tilak Medical College & Hospital Sion, Bombay with the representatives of the manufacturer prior to the multicentric trial of the device. The clinical experience with SPICTRA cardiomy reservoir from the Institute, CMC Vellore, Lokamanya Tilak Medical College and Hospital, Bombay and Sanjay Gandhi Postgraduate Institute, Lucknow attracted serious interest at the Annual Meeting of the Association of Cardiovascular and Thoracic Surgeons at Pune. A special session at the Annual Meeting

was devoted to cardiac surgical technology with wide coverage of the activities of the Department.

The initiation of the clinical trial of the SPICTRA oxygenator was another major milestone during the year. Its continued use followed by multicentric trial on the lines of the cardiomy reservoir was expected to follow until the date of their anticipated commercial

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production in Madras in 1991 (Fig. 10). The long term implantation of the tilting disc valve model with Hayne's alloy cage and ultra high molecular weight polyethylene disc continued in sheep with a view to its clinical trial during 1990 as planned.

Dr. Valiathan was elected a Fellow by the National Academy of Sciences, Allahabad and appointed an Honorary Professor by the Jawaharlal Nehru Centre for Advanced Research, Bangalore. He was awarded the Padma Bhushan by the President of India.

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### **Division of Microbiology**

Dr. J. Shanmugham, Ph.D., FIMSA	Additional Professor
Dr. Aruna Shahani, MD	Assistant Professor
Miss. Moly Thomas, M.Sc., D.M.V.	Assistant Professor
Mr. M. Ravindranath B.Sc.	Scientific Assistant
Mrs. K. Naseema, M.Sc.	Scientific Assistant

Hospital service dominated the activities of the Division. Rapid agglutination test was introduced for the diagnosis of pyogenic meningitis using meningococcal, pneumococcal, hemophilus B and streptococcus group B antigens. Similarly antimicrobial sensitivity tests to newer cephalosporins and quinolones was introduced for the management of patients with serious illness like endocarditis and septicemia. Other new tests included ELISA for the detection of HBs - Ag and HAI for measles antibody in suspected SSPE.

The study on urinary tract infections was completed during the year and the results confirmed that meatal flora were not a major source for urinary tract infections. The leading pathogens were Klebsiella species followed by E. Coli. Among the five types of quinolone agents tested against urinary isolates, the maximum effect was found to be

for ciprofloxacin followed by Norfloxacin and Lomefloxacin. In a collaborative study with the Department of Cardiology, the presence of coxsackie B specific IgG and IgM was looked for in patients with carditis.

Dr. Aruna Shahani gave an invited lecture on 'Problems encountered during in-vitro susceptibility testing of aminoglycosides with special reference to Netilmycin at Bombay. As one of the participants from India, she initiated the Homefloxacin international surveillance trial. Dr. Shanmugham delivered key-note addresses at the Indo-UK Symposium on 'Updates in Viral hepatitis' at Madras and a symposium on AIDS in Tirunelveli. Mrs. Naseema participated in the WHO-IUI Advanced course in immunology in relation to tropical diseases in Delhi and proceeded to Uppsala, Sweden for three months to attend an International

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Workshop on biomedical separation methods.

Dr. J. T. Ramani Bai, post-graduate student in microbiology,

Medical College, Trivandrum and B. Sc. MLT students from the Priyadarsini Institute of Basic Medical Sciences visited the Division for short term training.

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### 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
Dr. M. Veerendra Kumar, MD DM	Assistant Professor
Dr. Asha Vijayaraghavan, MD	Candidate for DM
Dr. P. A. Suresh, MD	-do-
Dr. Mathew Alexander, MD	-do-
Dr. Anoop Ranjan Varma, MD	-do-
Dr. Gracykutty Mathew, MD	-do-
Dr. G. Sivanarayana, MD	-do-
Dr. V. K. Radhakrishnan, MD	-do-
Dr. Jagadish B. Agardi, MD	-do-

As in the previous years, most of the time and attention of the department was taken up by clinical work which included an increasing number of newly registered patients. While the number of in-patient admissions and specialised electrophysiological tests showed an upward trend, the newly introduced postal review for follow-up served to reduce the overcrowding in the special clinics. A patient counselling service was started, especially for epilepsy patients in the Epilepsy clinic with the active participation of Medico Social workers.

The teaching and training programme for DM residents continued

regularly in the form of weekly case discussions, seminars, journal club, EEG/EMG discussions etc.

The department was entrusted on in the responsibility of starting a speech therapy and Audiology Unit, as a part of the new Rehabilitation Unit (Fig. 11). Two rooms next to Physiotherapy Unit were converted for this purpose and the audiometer and other items of equipment installed. With the joining of a speech pathologist cum Audiologist soon, the services of this unit will be opened to patients by mid 1990.

The studies conducted by the Department on its own or in collaboration are listed below:

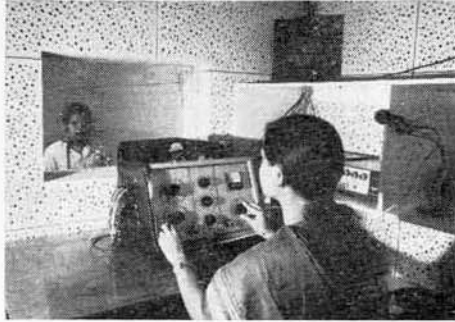


Fig. 11 Speech therapy facility

1. Development of a test battery for determination of cerebral dominance.
2. Lectin binding to skeletal muscle in various neuromuscular diseases (in collaboration with Division of Neurochemistry).
3. Immunological studies in post and para-infectious neurological disorders (in collaboration with Division of Pathology).
4. Study of brain asymmetry in dextrocardia and situs inversus (in collaboration with department of Cardiology).



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### Department of Neurosurgery

Dr. Damodar Rout, MS, M.Ch.	Professor & Head of the Dept.
Dr. B. K. Misra, MS, M.Ch, MNAMS	Associate Professor
Dr. Rajeev Sharma, MS, M.Ch.	Associate Professor
Dr. N. Suresh Nair, M.Ch.	Assistant Professor
Dr. G. K. Prusty, M.Ch	Assistant Professor
Dr. Vijay Iyer, MS, M.Ch	Assistant Professor
Dr. Sathish Krishnan, M.Ch	Post Doctoral Fellow
Dr. R. S. Diwanji, MS	Candidate for M.Ch.
Dr. Ashish Kumar Chand, MS	-do-
Dr. S. S. Praharaj, MS	-do-
Dr. Adil S. Chagla, MS	-do-
Dr. Sunil Pandit, MS	-do-
Dr. Moni K. Vinod, MBBS	-do-

The department could attain the status of a national referral centre for the management of vascular lesions of the brain with a continued and steep inflow of patients with intracranial aneurysms and arteriovenous malformations from different parts of the country. The department also registered an impressive rate of growth in microsurgical excision of spinal and intracranial tumours with special attention to various tumours of the base of the skull, posterior fossa, third ventricle and brain stem with gratifying results. Surgical management of a large number of cases with complex craniovertebral anomalies remained

another major thrust area. Application of ultrasonic surgical aspirator not only facilitated surgical removal of tumours but also the management of giant intracranial aneurysms with a large component of thrombus. With the increasing referrals of more difficult and challenging surgical problems, special follow-up clinics were introduced four days a week in order to streamline the postoperative evaluation of patients.

Four candidates successfully completed their M.Ch courses of study during the year.

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Project	:	Development of an indigenous viable hydrocephalic shunt system.
Principal Investigator	:	D. Rout.
Co-Principal Investigator	:	G. S. Bhuvaneshwar
Co-Investigator	:	S. N. Pal
Funded by	:	DST
Status	:	Completed

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In collaboration with the divisions of Artificial Internal Organs and Polymer Technology, the research project on "Development of an indigenous viable hydrocephalic shunt system" was completed. The device received the approval of the Ethics Committee of the Institute for multicentric clinical trial. The technology transfer of the device is also receiving the attention of the Technology Transfer Committee of the Institute.

Under the auspices of the Institute an international symposium on "Vascular Lesions of the Brain" was held on October 15-16, 1989 at Trivandrum as a satellite conference of the 9th International Congress of Neurological Surgery with Prof. Rout as the Organising Secretary

of the symposium. This two-day conference encompassed five symposia and two open scientific sessions. About 50 authorities of international repute in the field from various countries actively participated in it along with 150 Indian delegates. Mr. G. Parthasarathi, President of the Institute, inaugurated the Conference and Prof. B. Ramamurthi, President of the 9th Indian National Congress of Neurological Society delivered the presidential address. Prof. Keiji Sano, Director and emeritus Professor of Neurosurgery, University of Tokyo and Prof. Robert F. Spetzler, Chairman, Division of Neurosurgery, Barrow Neurological Institute, USA gave key-note address. A list of the other eminent speakers is given below:

1. Prof. Lindsay Symon, Institute of Neurology, Queen Square, London;
2. Prof. D.M. Long, Harvey W. Cushing Professor of Neurosurgery, The Johns Hopkins Hospital, Baltimore;
3. Prof. Bryce Weir, Chairman of Neurosurgery, University of Alberta, Canada;
4. Prof. Ernst H. Grote, University of Tübingen, West Germany;
5. Prof. Matti Vapalahti, University Central Hospital, Finland;
6. Prof. R. K. Jellberg, Massachusetts General Hospital, Boston;
7. Prof. V. A. Fasano, Director, Institute of Neurosurgery, University of Turin, Italy;
8. Prof. P. Schmiedek, University of Munich;
9. Prof. Ladislau Steiner, University of Virginia;
10. Prof. G. M. Malik, Henry Ford Hospital, Detroit, Michigan;
11. Prof. Taka Fukushima, UCLA Medical Centre, USA;
12. Prof. Luc Picard, Hospital St. Julien, Nancy, France;
13. Prof. S. Kobayashi, Shinshu University School of Medicine, Matsumoto, Japan;
14. Dr. D. S. Gordon, Royal Victoria Hospital, Belfast;
15. Dr. J. Moret, Fondation Ophthalmologique Rothschild, Paris, France;
16. Dr. R. P. Sengupta, New Castle General Hospital, U. K.;
17. Prof. K. Abbassiour, University of Tehran; and
18. Prof. N. W. C. Dorsch, Westmead Hospital, Sydney, Australia.

There were seven scientific papers from the department at the conference.

The valedictory lecture was delivered by Prof. Lindsay Symon, President of the World Federation of Neurological Surgeons. The proceedings were published in the form of a monograph.

Prof. Rout participated as an invited speaker in the first Indo-European symposium on Neurosciences organised at Eberhardkarls

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University at Tubingen, West Germany, under the auspices of Europa India Foundation in June 1989 and spoke on "Infectious intracranial aneurysms" and "vein of Galen malformations".

Prof. Rout attended the workshop on "Awareness and management of Subarachnoid haemorrhage" held in August 1989 at NIMHANS, Bangalore under the joint auspices of WHO and NIMHANS and spoke on the surgery of cerebral arteriovenous malformations. He was also invited to give a talk on "Neuroophthalmic manifestations of vascular lesions of the brain" at the workshop in neuro-ophthalmology organised at Madurai in December 1989.

Dr. SSR Murthy, Consultant Neurosurgeon, Hyderabad and Dr. Mohan Sampath Kumar, Reader in neurosurgery, Madurai Medical College spent a week in the Department as observers. Dr. Sunil

Kumar Gupta, Resident in neurosurgery, Banaras Hindu University, Varanasi spent two weeks in the department as an observer trainee. Dr. Thomas Eichmann, Resident in Neurosurgery, University of Kiel Federal Republic of Germany and Dr. K. Sridhar, senior resident in Neurosurgery, The Achanta, Lakshmi pathi Neurosurgical Centre VHS, Madras also worked in the department for a period of two months each as observer trainees.

Prof. Rout was invited by the Organising Committee of the 9th International Congress of Neurosurgery to participate in the symposium "trends in management of cerebral AVMS" and to speak on "problems of AVMS in developing countries - the Indian perspectives on AVMS". In addition he and his team contributed five scientific papers to the International Congress of Neurological Surgery.

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### Division of Neurochemistry

Dr. Debkumar Basu, Ph.D	Professor (On sabbatical leave)
Dr. P. S. Appukuttan, Ph.D	Associate Professor
Mrs. K. I. Annamma, B.Sc.	Scientific Assistant
Mr. Bobby Zacharia, M.Sc.	Candidate for Ph.D
Miss Yasmin Marikar, M.Sc.	-do-
Mr. P. L. Jaison, M.Sc.	-do-
Mr. V. M. Kannan, M.Sc.	-do-

Routine activity for patient services included assay of enzymes like hexosaminidases A and B and arylsulfatase A in urine and serum of patients with neurologic disorders. As in previous years, investigative work claimed major emphasis in the activities of the division. Cell surface glycoproteins of both neurons and glial cells of foetal brain were purified by affinity chromatography using the lectin Con-A. Three glycoproteins of size 65 - 72 kDa, 52 - 63 kDa and 43 - 48 kDa were obtained on SDS- electrophoresis. These bands were interconvertible on electroelution and reelectrophoresis, suggesting an anomalous SDS - binding behaviour. These glycoproteins contained nearly 10% carbohydrate on average. The N-terminals of all polypeptides were found blocked. Study of binding of peroxidase - conjugated plant lectins to these glycoproteins

revealed the presence of predominantly N-linked oligosaccharide side chains of high mannose, hybrid and complex types. Fucose linked  $\alpha$  (1 $\rightarrow$ 6) at the core N-acetyl glucosamine moiety, as well as sialic acid was detected. No significant difference between 2nd and 3rd trimester foetal brains in glycoprotein structure was observed.

A high molecular weight  $\alpha$ -galactoside-preferring lectin from bovine heart detected in the Division was found to bind more than 64 times stronger to endogenous glycoproteins than does the reported low molecular weight lectin. Immobilized endogenous glycoproteins mostly retained the high molecular weight lectin, but only traces of the smaller lectin. These results indicated that *in vivo*, the dominant role is claimed by the new lectin. Size difference as well as immunological

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Project	:	Cell surface glycoproteins of developing brain.
Principal Investigator	:	Debkumar Basu.
Funded by	:	C. S. I. R.
Duration	:	4 years
Status	:	Completed 28th February, 1990.

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similarity between the two lectins was revealed also by crossover immunoelectrophoresis. Endogenous glycoproteins immobilized on agarose gel were developed as a tool for the preparation of animal lectins. Examples were those from human placenta and human and bovine brains. Initial results indicated that glycolipids of bovine

brain may also function as receptors for galactose binding lectins.

Lectin - histochemical probe using jack fruit seed lectin conjugated to peroxidase revealed characteristic differences in cell surface oligosaccharide structure in muscle tissues between myogenic and neurogenic muscle disorders.

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Project:	:	Galactose-binding lectins and endogenous lectin-binding glyco-conjugates (receptors) of mammalian brain: their structure and interactions in normal and tumor-affected tissue.
Principal Investigator	:	P. S. Appukuttan
Funded by	:	D. S. T.
Duration	:	3 years
Status	:	Ongoing

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The anti  $\alpha$ -galactosyl antibody present only in human and old world monkey serum was shown to bind strongly to  $\alpha$ (1 $\rightarrow$ 6) and  $\beta$ (1 $\rightarrow$ 4)-linked galactose polymers. These findings may help elucidate its unknown biological role.

In the binding of the bovine brain enzyme creatine kinase to a substrate analogue, Cibacron blue F3GA, it was shown that the natural cofactor of the enzyme,  $Mg^{2+}$  could be replaced by  $Th^{4+}$  or  $Ce^{3+}$  even more effectively; suggesting a way these rare metals may produce cellular toxicity.

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### Division of Pathology

Dr. V. V. Radhakrishnan, MD	Additional Professor
Dr. C. C. Kartha, MD	Additional Professor
Dr. S. Sandhyamani, MD	Associate Professor
Dr. R. Renuka Nair Ph.D	Assistant Professor
Dr. C. R. L. Shastri, MD	Assistant professor
Mrs. Annamma Mathai M.Sc.	Scientific Assistant

During the year, the division analysed 850 surgical pathology specimens, 265 cytology specimens and carried out 1850 investigations in immunology. Frozen sections for rapid diagnosis was performed in 282 cases. 30 muscle biopsies were evaluated for enzyme-histochemical profiles in patients with muscular and neuro muscular disorders. There was an overall increase of 20 per cent in the number of diagnostic investigations over the previous years. The division also performed 79 autopsies in cardiac and neurological cases which formed an important source of teaching and

research material for projects like endomyocardial fibrosis and mucoid vasculopathy.

The project on the investigation of mucoid vasculopathy made progress and the entity received increasing recognition among pathologists as distinct from atherosclerosis and aortoarteritis (Fig. 12). Apart from experimental work on primates to reproduce the lesions of mucoid vasculopathy by dietary means, extensive histopathological studies were made on surgical biopsy and autopsy materials to characterise the disease. Characterisation of the

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

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mucoid material by biochemical and histochemical techniques was also initiated. In advancing this work, the collaboration of Prof. Kinare of the KEM Hospital, Bombay was found to be valuable.

Another research project which made progress related to the immuno diagnosis of tuberculous meningitis. Various techniques developed in recent years were critically evaluated and the immuno blot technique found to be the most promising from the point of specificity. The evaluation of this technique was expected to be over during the course of the year.

Professor CWM Adams visited the division and delivered a lecture on the pathology of vascular

diseases. Another important visitor to the Department was Dr. B. N. Dutta of the Postgraduate Institute of Medical Education and Research Chandigarh.

Dr. Radhakrishnan presented a paper on immunoelectrophoresis for microbacterial antigens at the annual conference of the medical microbiologists of India at Jaipur and Dr. Sandhyamani presented a paper on the histochemical profile of mucoid vasculopathy at the annual conference of the Indian Society for Atherosclerosis at Madras. Dr. Sandhyamani attended the national workshop on immunocytochemistry at Madras. Dr. Shastri left the division to take an academic appointment elsewhere.

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**Department of Radiology:**

Dr. V. R. K. Rao, MD	Professor
Dr. Ravimandalam, MD	Additional Professor
Dr. Arunkumar Gupta, MD	Associate Professor
Dr. Sunil Kumar, MD	Associate Professor
Dr. Madhavan Unni, MD	Assistant Professor
Dr. K. Santhosh Joseph, MD	Assistant Professor
Dr. A. S. Rao, MD	Assistant Professor
Dr. Mathew Cherian, MD	Candidate for postdoctoral certificate
Rajeev Bapuraj, MD	-do-
Dr. S. K. Bajaj, MD	-do-

The main activities of the Department consisted of diagnostic and intervention procedures which are listed below:

**Table 8**

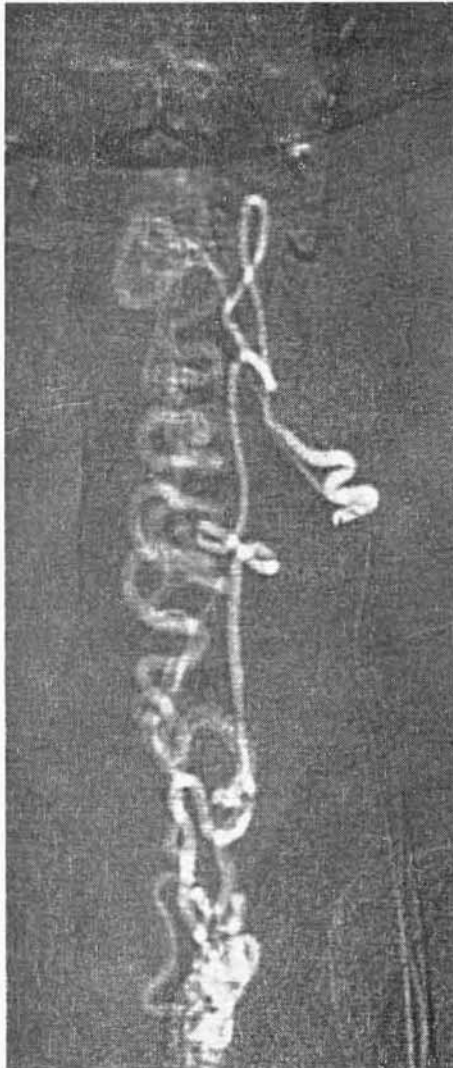
**Routine diagnostic procedures**

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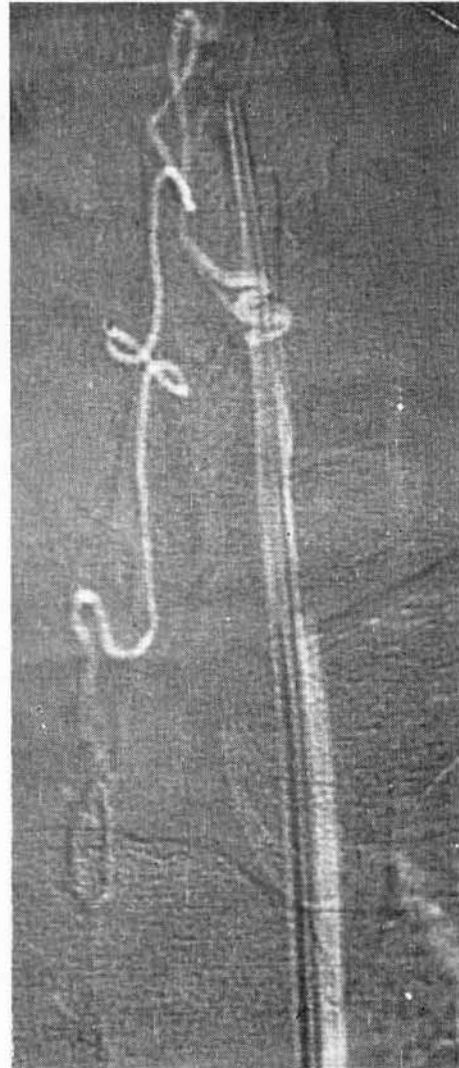
Routine OP X-rays	..	14,000
CT Scan	..	7,381
Cine Cardiac angiography	..	1,450
Cerebral Angiography	..	254
Aortography	..	349
Myelography	..	199
Tomography	..	62
Bronchography	..	30

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Apart from the general increase in radiological and intervention procedures, considerable effort went into the development and application of materials and devices for interventional applications. Hydrogel microspheres synthesised at the BMT Wing were approved by the Ethics Committee as embolic material for clinical use in the treatment of vascular lesions. Arteriovenous malformation of the upper spinal cord, hemangioblastoma of cerebellum and a falcine meningioma were completely devascularised by super-selective delivery of these microspheres in three patients (Fig. 13). Histological studies of the surgical specimens confirmed the inertness of the material.



(a)



(b)

Fig. 13 Hydrogel embolization of a spinal arteriovenous malformation.

- (a) Preembolization angiogram shows the malformation fed by a radicular branch of the left vertebral artery.
- (b) Post-embolization angiogram shows total obliteration of the malformation.

**Table 9**

**Interventional Procedures:**

	<i>No. of patients</i>	<i>No. of procedures</i>
<b>Angioplasty</b>		
Balloon angioplasty	52 )	58
Laser angioplasty	6 )	
<b>Embolisation</b>		
Intracranial AV malformations and tumours	16 )	44
Carotid cavernous fistulae	)	
Balloon occlusion	5 )	
Spinal A. V. malformations & tumours	3 )	
Cranio facial vascular lesions	5 )	
Broncho-pulmonary circulation	3 )	
Extremities and chest wall vascular lesions	5 )	
Aortic aneurysm	1 )	
Total	95	102

For internal re-inforcement of stenoses and occlusion of peripheral arterial system, zig-zag stents were designed and implanted in the canine vena cava, aorta and iliofemoral arteries. Long-term patency for 18

months was demonstrated by serial angiography as well as the specimen dissection. Scanning electron-microscopy revealed the neointimal covering of the stents. The stent has a potential application in the

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management of occlusive arterial lesions, particularly nonspecific aortoarteritis, restenoses following angioplasty, and superior venacaval obstruction due to extrinsic pressure. Approval of the Ethics Committee for the clinical application of these stents is awaited.

Drs. Luc Picard and Jack Moret from France visited the Department in October 1989 and discussed topics in interventional Neuroradiology. The following physicians visited the Department for short term training.

Dr. Ravikumar Varma

Davangere Medical College

Dr. Bajpai

Bhilai Steel Plant Hospital

Dr. Ravichandran

JIPMER, Pondichery.

Dr. Giridhar Gopal

” ” ”

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## BIOMEDICAL TECHNOLOGY WING

*Head:* Mr. A. V. Ramani, B.Sc. (Hons.) Chem. Tech.

### Department of Biomaterials Science

#### (i) Division of 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
Mr. N. Shanmughakumar, M.Sc	Candidate for Ph.D

Routine physicochemical characterization of polymeric materials was carried out as in previous years on the basis of intramural and external requests.

The research activities aimed at the evaluation of newer biomaterials intended for biomedical applications.

As a part of the ongoing DST sponsored project 'Studies on Material - tissue interface of experimental prostheses for reconstructive surgery', newer crosslinked polyurethane elastomer prepared by using hexamethylene diisocyanate was used for studies on the biomechanical factors which influence the material - tissue interaction. The soft flexible porous elastomer was implanted in the form of sheet ( $5 \times 1 \times 0.1$  cm). The material was implanted intramuscularly in

the para vertebral region (minimal motion site) and hind leg (maximal motion site) of pig along with negative control polyurethane Tecoflex 60D. The materials were harvested after implantation at 6, 10 and 12 months. The gross examination of the pig with implants at the end of harvesting period revealed no itching, rash, oedema or erythema at the implant site. The harvested materials and tissues were analysed. The gross investigations of the tissue and the test material revealed the dense adherence of implant to the surrounding tissues throughout its length and absence of infectious fluid collection. The test and negative control materials implanted in paravertebral muscle was found to have inflammatory cells with fibrous connective tissue ingrowth and small blood vessels

at the end of 10 months. The test materials implanted in the thigh muscle were found to have lesser degree of inflammatory reaction with fibrous connective tissue ingrowth. The presence of inflammatory cells in test and control materials was attributed to the porous and textured nature of the materials as can be observed in porous clinical prostheses.

The materials harvested at the end of 1 year were associated with fibrous tissue encapsulation which was absent in the samples of 10 months post implantation period. Calcification was found to be nil for the test materials in both implant sites. The degree of necrosis was rated as zero for the samples implanted in maximal motion site. However the test materials implanted in maximal motion site elicited an excess of foreign body debris and an excess of foreign body giant cells. The foreign body debris could be produced by surface corrosion of pore walls of the porous elastomer through-mechano chemical reaction. The degree of mechano-chemical reaction in negative control linear polyurethane, Tecoflex 60D, was found to be lesser than in the test crosslinked polyurethane. The studies suggested the following

conclusions. The material-tissue interface should be stabilized for materials implanted for reconstruction of tissues at the maximal motion site not only by matching the mechanical properties of the porous elastomeric material with tissues but also by selecting the materials with proper structural morphology of macromolecular chain of the polymer.

**Table 10**

<i>Test</i>	<i>No. of samples</i>
1. IR spectral analyses	185
2. Thermal analyses	84
3. Liquid chromatographic analyses	190
4. Mechanical tests using INSTRON	1300

In the ongoing Ph.D programme on the 'studies on stability of polyurethane and their interaction with tissue', new crosslinked polyurethanes prepared by using SMDI, HDI and IPDI were subjected to a series of in-vitro stability tests and tests for sterilizability. New interpenetrating polymer networks based on polyurethane and hydrophilic

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monomers were prepared and evaluated for invivo biodurability tests in rat as a part of another Ph.D programme. The studies indicated that these IPNS can be considered as suitable candidate materials for biomedical use. For the Ph.D programme on the 'studies on the diffusion of physiological fluid molecules in polyurethane' significant results were obtained with co-polymers of polyurethane which drastically alter the diffusion pattern of biological molecules. With the completion of DST project and other programmes nearing completion, the division started new research projects such as the evaluation of flex life of biomaterials through accelerated mechanical tests, diffusion of biocides and self-sterilization of polymers and evaluation

of lubricating characteristics of pericardial fluid.

In the collaborative research project on 'development of indigenous composite dental restorative materials' under the Division of Polymer Technology, the Division carried out a series of mechanical tests on the dental composites prepared with different formulations of BIS-GMA resin. Some of the formulations were also subjected infrared spectral and liquid chromatographic analysis.

Dr. Prabha D. Nair made a presentation on the 'development of IPNS for biomedical applications' at the annual meeting of the Materials Research Society, India in Pune.



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**(ii) Division of Thrombosis:**

Dr. M. Jamaluddin, Ph.D Scientist  
Dr. Lissy Kalliyankrishnan, Ph.D Scientific Assistant

Apparent positive cooperativity was discovered in the aggregatory reactions of calf platelets towards different agonists like arachidonic acid, A23187, thrombin,  $H_2O_2$  and platelet activating factor. And agonists acting in pairs were found to synergize or to abolish cooperativity. This discovery can be expected to lead to an understanding of the mechanism of synergism of platelet agonists and antagonists.

Hewlett Packard 8450A model diode array double-beam spectrophotometer was added to the laboratory.

Dr. Jamaluddin was an invited participant at a National workshop

on "Membrane Biology-Biotechnological aspects" conducted at the Department of Zoology, University of Poona.

Mrs. Lissy Kalliyankrishnan was awarded the Ph.D degree of the Institute for her thesis "Mechanisms and modulations of platelet activation: ligand-induced conformational change of a haemoprotein as a biochemical signal for activation".

Dr. Jamaluddin was awarded a cash award from the Institute for excellence in research contributions for 1988. He also received the P.B. Rama Rao Memorial Award of the Society of Biological Chemists, India for 1989 for the best work done in India in biological sciences.

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Project	: Mechanisms and Modulations of platelet activation and aggregation
Principal Investigator	: Dr. Jamaluddin
Funded by	: DST
Status	: Ongoing

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## 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.

The development of the Chitra Valve prosthesis progressed smoothly. The division was able to solve the fabrication and polishing problems associated with the Ultra High Molecular Weight Polyethylene (UHMWPE) discs and animal implantations of valves with these discs commenced during the second half of the year. The series of implantations were expected to be over during March - April '90.

With the identification of vendors for the fabrication and supply of both cages and discs, the Division readied itself to handle the larger number of cages to be polished and valves to be assembled for clinical trials, which are due in the second half of 1990.

Three units of the Mark II version Humidifier underwent clinical trials at the hospital wing for 4 to 5 months. Among the problems noticed, the major one related to the creep and consequent warping of the bakelite

top. These problems were solved by suitable modifications of the components and improved assembly of the units. Two units with these improvements underwent further clinical trials since November 1989 and showed no further problems. Another 10 units are under assembly. The division initiated action with the Technology Transfer Cell for the patenting and technology transfer of this device.

A pulsed doppler ultrasonic flow measurement system from Crystal Biotech, USA for the measurement of blood flow in experimental animals and fluid velocities in in-vitro test systems was installed. A Dantec Frequency tracker to track the frequency output of the doppler system was also added to the laboratory. A Metrabyte 12 bit A-D data acquisition card and ASYST data acquisition and analysis software to acquire and analyses the flow velocity data on a

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PC-AT computer greatly enhanced the quality of valve testing in-vitro.

In collaboration with the department of Neurosurgery and Division of Polymer Technology, the development of a hydrocephalus shunt was successfully completed and the Ethics Committee clearance for the commencement of clinical trials obtained. Fifty shunt systems were fabricated and the first clinical trial in the hospital was expected to begin shortly. The pilot production of 2000 shunt systems with industry support and participation has been proposed under the umbrella of the Technology proving facility. The

Institute is in the process of identifying an entrepreneur and finalising the project for the technology transfer of this product.

Under the Indo - UK exchange programme, the Division is actively working with Dr. Thien How of the Institute of Medical and Dental Bioengineering, University of Liverpool, UK for the setting up of a pulsed doppler ultrasonic velocimeter system for the measurement of velocity profiles of prosthetic heart valves in pulse duplicator studies. Dr. How is expected to visit the laboratory during October-November '90 for the final calibration and testing of the system.

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**(ii) Division of Biomaterials Technology**

Mr. A. V. Ramani, B.Sc. (Hons)	Chem. Tech. Scientist
Mr. B. Ajit Kumar, B. Tech.	Scientific Officer
Mr. D. S. Nagesh, B.E.	Scientific Officer
Mr. S. Vijayan, M.Sc.	Scientific Assistant

As its primary effort, the Division completed the development and evaluation of the disposable oxygenator which was approved by the Ethics Committee for clinical trial. In the clinical trial of the first batch of oxygenators, their performance was entirely satisfactory and trials in the Institute were expected to be followed by multicentric trials in India during 1990. In parallel, the Division continued to improve the cardiotomy reservoirs in the light of inputs from various cardiac surgical centres which had used it with a view to reducing the assembly procedures, improving quality control and esthetics and increasing its commercial viability.

Several other areas of biomaterials technology claimed investigative attention during the year. A zinc phosphate dental cement was developed conforming to international specifications and brought to the

stage of animal trials. In a DST sponsored multi-institutional project, it was shown that the Indian made carbon-fibre-reinforced carbon was suitable for implantable application. In another collaborative project, the Division accepted the responsibility for developing adaptor rings, flasking materials, moulding materials and kits for ear moulds which were being designed and developed by the All India Institute for Speech and Hearing, Mysore and the Raman Research Institute, Bangalore.

An ethylene oxide sterilisation unit was successfully set-up and its protocols including degassing cycles for large devices like oxygenators standardised. Two B. Tech. students from the Engineering College, Trivandrum were guided in a project on the diffusion of ethylene oxide through polyethylene films.

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**(iii) Division of Biosurface Technology:**

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

Biodegradable polymers are being widely used in a variety of biomedical applications, such as drug-releasing implants, bioabsorbable sutures and surgical prostheses. The mode of degradation of these polymers may be pure hydrolysis by body fluids and/or enzymatic degradation with loss of their strength between 4-5 weeks. The effect of surface treatments like plasma glow, glutaraldehyde and carbodiimide crosslinking on poly-lactic acid (PLA) and poly-benzyl-L-glutamate (PBGA) films were investigated to establish whether these surface treatments could modulate the degradation phenomena in invitro conditions. It was found that glutaraldehyde treatment retained the maximum strength of PLA in buffer followed by carbodiimide, compared to control films whereas plasma glow reversed the effect. Glutaraldehyde treatment also improved the enzymatic hydrolysis of PLA and PBGA films. It is therefore conceivable that surface

treatments of these polymers might have altered their physical and chemical configuration and the subsequent degradation properties. Such modifications may be helpful for controlling the biodegradation of polymers for biomedical applications.

In another study, the permeability properties and the protein and platelet interactions at the interface of the recently introduced cellulose dialysis membranes (Hemophan, Nephrophan and Modcell RA 21/IG) were investigated. The results showed that these membranes had higher permeability to urea, creatinine and uric acid than the standard cellulose acetate membrane. Protein adsorption was higher on to Modcell RA 21/IG and the platelet adhesion onto these membranes was higher. Changes in permeability due to the presence of the formed elements of blood was studied by observing the permeability of various molecules through

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the cellulose acetate membrane from plasma in the presence and absence of blood cells. Results showed that erythrocytes reduce the permeability of molecules through the membrane by aggregation and adhesion on to the membranes.

Thermodynamic model considerations suggested that the adhesion of biological cells to polymeric surfaces depends on the relative magnitude of the surface tension of the substrates, the surface tension of the cells and the surface tension of the suspending liquid medium. By optimising the hydrophilic, hydrophobic nature of the membranes and thereby reducing the red cell adhesion, membranes having better permeability properties could therefore be developed. Accordingly an attempt was made to

develop a dialysis membrane from poly-vinyl-alcohol with reduced cell adhesion, mechanical strength comparable with cellulose acetate membrane in wet condition and better permeability properties.

In view of the known role of lipids and lipoproteins in hemostasis and thrombosis, the Division examined the interfacial phenomena of low density lipoproteins (LDL) and high density lipoproteins (HDL), and their interaction with proteins and platelets on selected biomedical polymers. It was shown that the addition of LDL to the polymer-protein system increased the level of surface bound fibrinogen and reduced the albumin surface concentration whereas HDL reversed the effect. A slight reduction in mechanical properties was also

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Project:	: Studies on improving synthetic biomedical membranes for haemodialysis.
Principal Investigator	: C. P. Sharma
Co-Investigator	: Thomas Chandy
Funding	: DST
Duration	: 3 years
Status	: Completed during 1989.

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evident on prolonged storage of the polymer in LDL solution. It is therefore conceivable that preadsorption of HDL to prosthetic interfaces may enhance the blood compatibility of the substrate. It is also possible that an artificial implant in hyperlipoproteinemic patients may be degraded faster than in other cases.

As the adhesion of cells to substrates strongly influences many of their functions including growth, phagocytosis and hemostasis, the adhesion of red blood cells (RBC), platelets and lymphocytes on to a series of polymers with varying wettability was studied in protein-containing and protein-free media. The effect of glow discharge treatment (GDT) to these substrates and the stability of adhered cells under flow were also studied. It was shown that the adhesion of cells was promoted by preadsorption of globulin and fibrinogen variably onto the polymers and that GDT further increased the cell attachment. The GDT immobilized cells were highly stable under flow rates upto 20 ml/min to all proteinated or bare substrates. Albumination of the substrates did not significantly alter the cell-surface attachment whereas GDT enhanced the cell adhesion and their stability.

Modification of polymer surfaces with covalently linked indomethacin, an analgesic anti-inflammatory drug, using glow discharge technique was attempted. Results showed that the surface resembled a heparinised surface. It was also observed that, while immobilizing a bioactive molecule using a spacer onto a polymer substrate, the spacer being another biomolecule inhibiting platelet adhesion, there was no significant difference in platelet adhesion.

In another set of experiments, heparinoid water soluble polyelectrolyte synthesised from natural rubber was grafted onto polymer surfaces using  $^{60}\text{Co}$ - $\gamma$ -irradiation method and glow discharge technique. Results showed enhanced anti-thrombotic properties of the modified surfaces. Attempts were also made to graft polymeric monomers like HEMA, Acrylonitrile and Acrylamide onto Angioflex films (which is a silastic polyurethane) using  $^{60}\text{Co}$ - $\gamma$ -irradiation method by pre-swelling technique. The objective was to obtain surfaces with different chemical nature but similar surface energy characteristics. Cell adhesion on these surfaces was studied and found to be less than that of bare angioflex.

The Division investigated the feasibility of developing drug delivery systems based on chitosan matrix because chitosan, a natural polysaccharide, is biodegradable, non-toxic and structurally similar to glycosaminoglycans. The steroidal drugs namely testosterone, progesterone or b-oestradiol, were mixed with chitosan and the films were prepared by evaporation technique. The in vitro release profile of these steroids from the film matrix was monitored, as a function of time in phosphate buffered saline at pH 7.4, and 37°C using a U-V-Spectrophotometer. The degradation of these chitosans was also investigated by tensile strength studies. The steroid release from chitosan films was compared with the release of these drugs from their microbeads. It was shown that the films and the microbeads stayed intact during the dissolution study of 90 days and a constant steady state release of steroids appeared to be possible for this period. It would appear that chitosan based matrix may be suitable for controlled release of steroids in clinical applications.

A collaborative project was initiated for the study of fibroblast cell culture (adhesion and proliferation) on a variety of polymers

having varying hydrophilic-hydrophobic characteristics with the help of Dr. R. Renuka Nair of the Division of Pathology.

Dr. Chandra P. Sharma visited the Institute of Medical and Dental Bio-engineering, University of Liverpool, England during June-September 1989 under the Indo-UK exchange program. He investigated the effect of laser (KrF-Excimer laser) on titanium substrates by growth studies of fibroblast cultures and compared them with other substrates like  $Al_2O_3$ , polyethylene, polystyrene and silver.

Dr. Sharma continued to be the editor of Trends in Biomaterials and Artificial Organs. He also attended the second task force meeting on biomaterials for contraception held in April at IIT, Delhi. He was a member of the organising committee for the 4th national conference on Surfactants, Emulsions, and Biocolloids at IIT, Bombay.

Prof. Dieter Paul of Akademie der Wissenschaften der DDR, Institut für Polymerchemie, GDR visited the division on 18-20 April 1989 and had discussions on the development of hemodialysis membranes.



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Dr. C.P. Sharma delivered the presidential address in the 3rd national conference of the Society for Biomaterials and Artificial Organs (SBAOI) - India, during April, 1989. Dr. Thomas Chandy

presented a paper entitled "Chondroitin sulphate and phosphoryl choline immobilized albuminated chitosan membranes - Antithrombotic and permeability properties", at the 3rd National Conference of SBAOI, in Bombay.

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**(iv) Division of Research Toxicology:**

Dr. P.V. Vedanarayanan, B.V.Sc. Senior Materials Toxicologist  
Ph.D.

Dr. A. C. Fernandez, Ph.D. Scientist.

Analysis of the results obtained from the studies on serum protein changes in rabbits in response to the implantation of polymeric materials revealed an appreciable reduction in the gamma globulin region of the serum protein of implanted animals in comparison to that of normal and sham operated animals. This finding needs to be correlated with well recognised changes in immune response. It also poses questions such as (a) whether the polymer or its degraded components gives rise to constant antigenic stimulus and (b) if so, what is the

nature and intensity of the stimulus. It is, therefore, proposed to follow up the observation by immunological tests such as Gel diffusion, passive haemagglutination, passive cutaneous anaphylaxis and complement fixation tests. It is proposed to accomplish this work with the help of the Microbiology Division.

Dr. A. C. Fernandez visited the School of Environmental Science, Cochin University to deliver guest lectures in toxicology. He also attended the Board of Studies meeting of the School.

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

Mr. K. Rathinam, M.Sc. Scientist

Mohan P. V., B. Sc. Scientific Assistant

Toxicological screening and biocompatibility studies of candidate materials for a variety of Chitra devices on the basis of International protocols formed the pivotal activity of the division. Besides these tests, a number of mandatory tests like pyrogen, limulus amoebocyte lysate and sterility tests were also carried out. The Division was also responsible for the management of the small animal research facility involving breeding and care of guinea pigs, rabbits, rats and mice required for toxicological and other experiments. Support was provided in terms of animal care and technical inputs for investigating cardiomyopathies for the Advanced Centre for EMF. The pyrogen testing facilities (both rabbits test and LAL tests) were utilised for carrying out tests on thirteen samples of intravenous fluids received from the hospital wing. In-vitro haemolytic potential test carried out by the Division was instrumental in improving the cleaning process and the development of an excellent non-toxic

polypropylene filter pad for the SPICTRA cardiomy Reservoir.

In an important research activity, a new in vitro cytobiocompatibility test system using mesenteric mast cells of rats and chicken was standardised and established as the degranulation of mast cells is believed to be an index of toxicity of biomaterials. This was tested by injecting intravenously a saline extract of epoxy polymer material and barium methacrylate (monomer). The results showed that there is a positive correlation between in-vivo systemic toxicity and in-vitro mast cell degranulation potential of biomaterials. The study entitled "Degranulation of mesenteric mast cells as a spot test in toxicology" was accepted for presentation at the International Congress on "Ultra low doses" to be held at Bordeaux, France. In addition, standardization of terratogenicity and mutagenicity tests were also underway.

Sri. K. Rathinam delivered an invited lecture on "Biological

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characterization of any new material intended for biomedical applications” in the national symposium on New Materials, at the Madurai Kamaraj University 1990. He guided the experiments on ‘toxicological screening as part of the course work prescribed by the Doctoral advisory

committee for Mr. N. Shanmugakumar during July to August 1989.

Sri. K. Rathinam took additional charge of the experimental animal facility in the absence of Dr. Bhaskara Rao who had proceeded on sabbatical leave for a period of one year.

(vi) **Division of Pathophysiology**

Dr. Mira Mohanty, MD  
Scientist

Dr. T. V. Kumari, Ph.D.  
Scientific Officer

The main activity consisted of the study of tissue changes in response to materials. The wide range of materials studied can be seen from Table. 11.

**Table 11**  
**Histopathology**

<i>Material</i>	<i>Blocks made</i>
Polyurethane	150
Guinea pig - stent graft	8
PVC powder	24
PMMA beads	39
Barium Methacrylate	10
Titanium	7
Silicon	7
UHMWPE	6
Titanium wire	2
Dental cement	15

In addition to the evaluation of materials, the histopathological examination of devices following explantation was also carried out as shown below:

**Table 12**

<i>Device</i>	<i>Number</i>
Mitral valve replacement	7
Polyurethane vascular graft	6
Prosthetic BT shunt in pig	4
Stainless steel stent	8
Hydrogel spheres	3
Hydrocephalus shunt	14

The Division also took part in the development of medical lasers by studying the response of tissues to lasers and optimising the design of an indigenous tip (Fig. 14).

As in previous years, biochemical and hematological investigations were carried out for a variety of experimental projects undertaken by sister Divisions. These included detection of nonspecific esterases, aminopeptidase, succinic dehydrogenase and adenosine triphosphatase by histochemical methods (Fig. 15).

Dr. Mira Mohanty proceeded on sabbatical leave on a Colombo Plan fellowship to join the Institute of Medical and Dental Bio-engineering, Liverpool under Prof. Williams for advanced training in the biological evaluation of materials.

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**(vii) Division of Polymer Chemistry:**

Dr. A. Jayakrishnan, Ph.D.	Scientist
Dr. Chithambara Thanoo, Ph.D.	Scientific Officer
Mr. M. C. Sunny, B.Sc.	Scientific Assistant

The main research activity of the Division during the year centred on the preparation and characterization of new, improved particulate materials for embolotherapy. The earlier work on partially hydrolyzed polymethyl methacrylate microspheres found fruition this year with the Institute's Ethics Committee granting its approval for the limited clinical trial of this material for therapeutic embolization.

Though polyvinyl alcohol (PVA) has long been used as an embolization agent and has many characteristics that make this material an excellent embolization agent, the availability of this material in sheet form rather than spheres has been an impediment in its wider application in embolization. Furthermore, PVA has been reported to be difficult to be made radiopaque for display in vivo. Both these problems were solved by devising a method to make PVA microspheres and a procedure for encapsulating barium sulphate or other radiopaque

compounds in such microspheres. Ex-vivo experiments showed that the material could be displayed in vivo.

A method was devised in the laboratory for the preparation of polyurethane microspheres up to 1.5 m. m. in diameter. Though polyurethanes have found a large number of applications in medicine, the material in the form of microspheres has not received any attention so far. The method devised in the laboratory is novel as it makes use of the condensation reaction of polyurethane formation in suspension directly leading to the microspheres. A method was also devised to incorporate tantalum powder in such microspheres and making the surface highly hydrophilic by grafting hydrophilic monomers onto them. These microspheres are expected to be of potential interest in therapeutic embolization.

The Division entered the area of controlled release of therapeutic agents with the DST sanctioning

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Project	:	“Preparation and evaluation of casein microspheres as drug carriers”.
Funding agency	:	DST
Principal Investigator	:	Dr. A. Jayakrishnan
Co-Investigator	:	Dr. B. C. Thanoo
Duration	:	Three years

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the project, “Preparation and evaluation of casein microspheres as drug carriers”.

The laboratory has developed methods for the preparation of casein microspheres which may have potential clinical applications. Efforts were also made in the laboratory to make hollow floating type microspheres from polycarbonate containing model drugs such as para-nitroaniline and aspirin for sustained oral drug delivery.

Two patent applications were forwarded from the Division for obtaining Indian patents. They involve the preparation of hydrogel beads from poly (methyl methacrylate) and the preparation of poly

(2-hydroxyethyl-methacrylate microspheres using polymeric porogens.

Dr. Jayakrishnan spent twelve weeks in the laboratory of Prof. C.H. Bamford at the Institute of Medical and Dental Bioengineering at the University of Liverpool, England under the Indo-UK exchange programme and worked on the synthesis of blood compatible polymeric materials. He was invited by the Department of Biotechnology, Government of India as a special invitee of the task force on “Immunological Approaches to Contraception” and as a member of the Committee on “Drug delivery systems for fertility control vaccines” held in New Delhi in December 1989.

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**(viii) Division of Polymer Technology**

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

As routine activity, chest drainage tubing systems and inhaler tubings were supplied to the hospital wing in addition to the fabrication of connectors for the oxygenator project. Components for the hydrocephalus shunt were also fabricated.

Close collaboration with the Division of artificial internal organs and Neurosurgery continued in the development of the hydrocephalus shunt. The design of the components and moulds was frozen and components fabricated for about 200 shunts

which are being assembled by Division of artificial internal organs for clinical trial.

In another project relating to a blood filter, the effects of filtration on blood constituents like platelets, erythrocyte, leukocytes, total protein and plasma haemoglobin were evaluated on fresh/outdated whole blood and fresh/outdated cells at 10-12°, 20-22° and 35-37°C. The Divisions of Vivarium and Pathophysiology collaborated in this work which followed the guidelines of the American National standard.

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Project	Development of indigenous composite Dental Restorative materials.
Principal Investigator	— S. N. Pal
Principal co-investigator	— V. Kalliyankrishnan
Co-investigators:	1. A. V. Ramani 2. K. Rathinam 3. Arthur Vijayan Lal 4. M. Jayabalan 5. Mira Mohanty
Funding	— DST
Duration	— 3 years
Status	— Ongoing

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During the year, synthesis of BIS-GMA was standardised. The quantity synthesised was scaled up from about 100 grams per batch to 600 grams per batch. Modification of BIS-GMA by capping hydroxyl groups to reduce water absorption and the possibility of hydrolytic degradation was also attempted. Studies were carried out for purification of additives in composites. Two component chemical curing composite formulations were developed. Physicochemical characterisation of the formulations during and after setting was initiated. Working and setting time, temperature rise, diametrical tensile strength, compressive strength, microhardness, colour were some of the parameters studied.

The doctoral work of Sri. V. Kalliyanakrishnan on "radiation grafting of hydrophilic monomers onto to PVC" made good progress and neared completion. Platelet

aggregation, platelet adhesion, sterilization effects, hardness and optical transparency were studied during the year. Gas permeability and biocompatibility aspects of PVC blends were also studied.

The following items of equipment were procured during the year.

1. Cyclo-viscograph
2. Centrifugal ball mill
3. Laboratory sewing machine

Sri. V. Kalliyanakrishnan presented a paper at the international conference on Polymers in Medicine and Surgery organised by Plastics and Rubber Institute held at Leuwnhorst, Netherlands during April 1989.

Sri. G. Prasad and V. Vijayakumar of S. K. University, Anantapur were guided for their M.Sc. (Polymer) dissertation.

**(ix) Division of Technology Transfer:**

Mr. H. Vijayakumar, BE.	Biomedical engineer
Mr. D. Ranjit, BE.	Scientist
Mr. D. S. Nagesh, BE.	Scientist
Mr. K. Sunil, BE.	Project engineer

Technology proving facility (TPF) witnessed intense activity during the year. The second TPF project namely cardio pulmonary bypass (CPB) custom packs was completed without any cost and time over-runs and the technology proving exercise of the oxygenator and cardiotomy reservoir (CR) commenced. The major challenges were to:

1. absorb the knowhow from the Division of biomaterials technology;
2. streamline continuous but slow ramped batch production; and
3. simultaneously identify and implement cyclic improvements by working jointly with the development group.

The activities planned and implemented in this industry-sponsored projects were:

1. commissioning of plant equipment and setting up and standardising specific processes like anodising;
2. vendor development with emphasis on their capability in meeting specifications and bulk production demands;
3. procurement of input materials and evaluation as per applicable standards;
4. training project staff in good manufacturing practice;
5. development and standardisation of quality control (QC) protocols; and
6. maintaining a continuous outflow of devices for sustained market presence till commercial plant gets commissioned.

M/s. Ranjit on quality control and Nagesh and Sunil on production

played active roles in carrying out these multifaceted tasks. Mr. Vijayakumar participated in the multicentric trial of cardiotomy reservoirs.

Technology transfer received equal emphasis. Technical consultancy to South India Petrochemical Corporation (SPIC) for implementing their commercial phase of the oxygenator project like plant layout, machinery configuration etc, was given. Technology Transfer (TT) activities of CSF shunt commenced with the mailing of a techno-financial document. Many agencies responded with active interest and the Technology Transfer Committee (TTC) is in the process of finalising the selection. The exercise to conceive and plan a TPF project is ongoing in close consultation with the development team.

A techno - economic report for the production of injectable crystalloids was prepared for Kerala Health Research and Welfare Society (KHRWS).

**Table 13**

**Intellectual rights liaisoned by the Division**

Sealed Indian Patents	5
Registered design certificates	9
Sealed foreign Patents	1
Indian applications under examination	2
Foreign applications under examination	2

Mr. Pirovano, an expert from EEC, Brussels, on Good Manufacturing Practices on (medical devices) visited the TPF. The clean room for medical device fabrication and the centralised computer facility continued to be maintained by this division. Mr. H. Vijayakumar served as technical advisor to the medical electronics lab. of Electronic Regional Testing Laboratory. He also delivered a series of invited lectures at the Institute of Human Resources Development.

Mr. D. S. Nagesh organised a well attended one week scientific exhibition on the occasion of the Golden Jubilee of the Trivandrum Engineering College.

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**(x) Division of Tool Room and Engineering Services:**

Mr. O. S. Neelakantan Nair, B.Sc. Tool room engineer  
(Engg.)

The routine activities of the Division covered a wide range of services. They included the commissioning of the C-DOT electronic telephone exchange, supervision of the radiation sterilisation unit and incinerator and the maintenance of electrical and airconditioning systems.

Following the transfer of valve cage fabrication to the Government Tool Room, Bangalore, the Division supplied the satellite blanks to them.

This involved the standardisation of high cobalt content tool bits and carbide tool bits. The ultra high molecular weight-polyethylene discs (UH MWP) were machined by cryomachining technique which gave superior surface finish to the occluder (Fig. 16). Assistance was provided to the hydrocephalus shunt project by the production of a miniature connector. The components required for a batch of 25 humidifiers were also fabricated and supplied.

(xi) **Division of Vivarium**

Dr. Arthur Vijayan Lal B.V.Sc. Veterinary Scientist  
Dr. S. Bhaskara Rao, MVSc, LL.B. Veterinary Surgeon

Routine activity of the Division is listed below:

1. Procurement, quarantine and preconditioning of animals prior to surgery.
2. Maintenance of a modern animal house.
3. Maintenance of a well equipped operation theatre with x-ray, fluroscopy, angiography facilities for animals.
4. Collection and supply of blood, tissue organs to various research groups.
5. Animal autopsy/postmortem investigations as per experimental protocol.
6. Assistance to M.Ch students in experimental projects.
7. Care and management of laboratory animals.

**Table 14**

<i>Project</i>	<i>Investigating Dept./Division</i>
1. Animal model for chronic arterial occlusion – Laser angioplasty	Radiology Pathophysiology
2. Exvivo evaluation of SPICTRA Oxygenator	Biomaterials technology Cardiac surgery
3. Segmented crosslinked polyurethane-tissue interaction	Technical evaluation
4. Evaluation of blood filter	Polymer technology
5. Evaluation of hydrocephalus shunt	Neurosurgery Polymer technology Biological internal organs
6. In vivo evaluation for Chitra valve	Artificial internal organs Cardiac surgery
7. In vivo evaluation of small diameter, Biomer graft	Biosurface technology

A Hewlett Packard monitor was added to the laboratory.

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Collaborative support was provided to several departments in varied projects which are indicated in the above table (Table 14).

A group of 55 final year students from the Veterinary College, Anand visited the Division and watched a demonstration of heart lung bypass.

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## ADMINISTRATIVE BODIES (1986-91)

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Indore.
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7. Deputy Educational Adviser, (T)  
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Director-of Neurology,  
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Financial Adviser & Chief Accounts  
Officer of the Institute (Convener)

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Head, Biomedical Technology Wing  
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Mrs. Deenamma Koshy,  
Nursing Superintendent of the Institute.

Dr. Jaisy Mathai,  
Chief Blood Transfusion Officer,  
Sree Chitra Tirunal Institute.

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

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

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Emeritus Professor,  
NIMHANS, Bangalore.

A nominee of the Secretary,  
Department of Science & Technology of the  
Central Government.

Head, Biomedical Technology Wing of the  
Institute.

An expert from outside the Institute  
nominated by the President.

A Professor of the Institute.

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Department of Atomic Energy,  
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Manager,  
Technology Transfer Division,  
VSSC, Trivandrum.

A nominee of Kerala State Industrial  
Development Corporation, Trivandrum.

Head of the Division of Technology  
Transfer, SCTIMST.

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

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

FA & CAO of Sree Chitra Tirunal  
Institute.



## HOSPITALS REFERRING PATIENTS

Kerala State — District-wise

### Alleppey

District Hospital, Alleppey  
Government Hospital, Noornad  
Medical College Hospital, Alleppey  
SNMM Hospital, Shertallai  
St. Thomas Hospital Shertallai  
St. Thomas Hospital, Kattanam  
S. H. Hospital, Alleppey  
Taluk Hospital Mavelikara  
Taluk Hospital, Chengannur  
GEMS Hospital, Mavelikara  
St. Thomas Mission Hospital, Malakkara  
Govt. Hospital, Haripad  
Govt. Hospital, Kayamkulam  
General Hospital, Shertallai  
Velayudhan Memorial Hospital, Shertallai  
Priya's Hospital, Kandellore  
St. George Hospital, Kayamkulam  
Matha Medical Mission Hospital,  
Kayamkulam  
Philip Memorial Hospital, Mavelikara  
Vijaya Dispensary, Kayamkulam  
Poopally Hospital, Chengannur

### Calicut

Nirmala Hospital, Calicut  
Medical College Hospital, Calicut

### Cannanore

District Hospital, Cannanore  
Archana Hospital, Cannanore  
Govt. Hospital, Kanhangad

### Ernakulam

City Hospital, Cochin  
Janatha Clinic, North Parur  
Kunhali's Nursing Home, Cochin  
Lisie Hospital, Ernakulam  
Medical Trust Hospital, Ernakulam  
MOCM Hospital, Kolencherry  
Little Flower Hospital, Angamally  
Port Trust Hospital, Cochin  
General Hospital, Ernakulam  
Ananda Nursing Home,  
Kothamangalam  
Samaritan Hospital, Alwaye  
Santhinikatan Hospital Moovattupuzha  
St. Joseph's Hospital, Kothamangalam  
Sree Krishna Nursing Home, Cochin  
Sudheendra Medical Mission,  
Ernakulam  
George Tharakan Hospital, Alwaye  
P. H. C. Neriamaangalam,  
Sameksha Hospital, Cochin  
Mar Basilus Hospital, Kothamangalam  
AAJAM Hospital, Kottapuram  
ANVM Hospital, Banerji Road,  
Ernakulam  
Lourd Hospital, Ernakulam  
Indian Navy Hospital, Naval Base,  
Cochin  
FACT Hospital, Udyogamandal, Alwaye  
Govt. Hospital, Perumbavoor  
Vellukattil Hospital, Ernakulam  
Jubilee Hospital, Edappally, Ernakulam  
Philomina Hospital, Manjapra, Ernakulam  
Indira Gandhi Co-operative Hospital,  
Cochin

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**Idukki**

District Hospital, Idukki  
St. John's Hospital, Kattappana  
Karuna Hospital, Idukki  
Tata Tea Hospital, Munnar

**Kottayam**

Carithas Hospital, Kottayam  
Good Samaritan Hospital, Kottayam  
Holy Family Hospital, Kottayam  
KVMS Hindu Memorial Mission Hospital,  
Ponkunnam  
Medical College Hospital, Kottayam  
M.G.D. Hospital, Kottayam  
Govt. Hospital, Vaikom  
Mundakapadam Mandiram Hospital,  
Kottayam  
Kavakkattu Memorial Hospital, Anthinad  
N. S. S. Hospital, Karukachal,  
Chenganacherry

**Kasaragode**

Pande Maternity Centre, Kasaragode  
S. H. Medical Centre, Kottayam  
Bhavana Hospital, Kottayam  
E. S. I. Hospital, Vaikom

**Malappuram**

Govt. Hospital, Tirur  
Dist. Hospital, Manjeri  
Taluk Hospital, Tirur  
Wandoor Nursing Home, Wandoor  
C. S. I. Hospital, Codacal, Tirur

**Palghat**

Dist. Hospital Palghat  
Palat Memorial Hospital, Palghat  
7th Day Adventist Hospital, Ottapalam  
Taluk Hospital, Ottapalam

Taluk Hospital, Mannarghat  
P. H. C., Palghat  
Govt. Hospital, Alathoor, Palghat  
Nainan's Clinic, Palghat

**Pathanamthitta**

Dist. Hospital, Kozhencherry  
G. K. Hospital, Tiruvalla  
Govt. Hospital, Tiruvalla  
Marthoma Medical Mission, Ranni  
NSS Medical Mission, Pandalam  
People's Clinic, Pathanamthitta  
Pushpagiri Hospital, Tiruvalla  
Tiruvalla Medical Mission, Tiruvalla  
M. M. M. Hospital, Kozhencherry  
Christian Medical Centre, Pathanamthitta  
MGM Moothuttu Hospital,  
Kozhencherry  
Govt. Hospital, Pathanamthitta  
Medical Trust Hospital, Kulanada  
Govt. Hospital, Adoor  
Luke's Hospital Pathanamthitta  
K. T. C. M. Hospital, Thottambala,  
Pathanamthitta

**Quilon**

Benziger Hospital, Quilon  
Dist. Hospital, Quilon  
Deen Hospital Quilon  
ESI Hospital, Asramam  
Holycross Hospital, Quilon  
Janatha Clinic, Quilon  
Taluk Hospital, Karunagapally  
Upasana Hospital, Quilon  
St. Joseph's Hospital, Anchal  
Dr. Nair's Hospital, Quilon  
Jayabharatham Nursing Home, Punalur  
Taluk Head Quarters Hospital,  
Kottarakara  
Medical Trust Hospital, Kottarakara

H. M. M. Hospital, Ayur  
Udayagiri Hospital, Paravoor  
Govt. Hospital, Neendakara  
Medical Trust Hospital, Puthoor  
A. M. Hospital, Karunagapally  
Vijayakumar Hospital, Kottarakara  
Govt. Hospital Mayyanad  
Assisi Atonement Hospital, Perumpuzha  
ESI Dispensary, Perinad  
Govt. Hospital, Sasthamkotta  
PHC., Paripally.  
Victoria Hospital, Quilon  
Parakkadu Hospital, Anchal  
St. Vincent Hospital, Thoovayur  
Brother's Hospital Pathanapuram  
V. V. M. S. Group Hospital, Isfield Estate,  
Kaleuruthy  
Rai Sree Hospital, Ayoor  
Dr. George Memorial Hospital,  
Pathanapuram

#### **Trivandrum**

Simi Hospital, Kazhakuttam  
Saji Hospital, Kazhakuttam  
P. H. C. Kanyakulangara  
Khan's Hospital, Parassala  
Sivagiri Medical Mission Hospital,  
Trivandrum  
Gayathri Medical Centre, Poojapura  
Govt. Hospital, Vamanapuram  
G. G. Hospital, Trivandrum  
Valsala Nursing Home, Vazhuthacaud  
Ophthalmic Hospital, Trivandrum  
V. K. K. Mission Hospital,  
Venjaramoodu  
Sree Uthradam Tirunal Hospital,  
Trivandrum  
T. B. Hospital, Pulayanarkotta  
S. R. Hospital, Beemapally  
Edava Hospital, Edava  
Prakash Memorial Hospital, Kilimanoor

Prakash Clinic, Trivandrum  
Fort Hospital, Trivandrum  
P. R. S. Hospital, Trivandrum  
Stanley Hospital, Udiyankulangara,  
Trivandrum.  
Cosmopolitan Hospital, Trivandrum  
General Hospital, Trivandrum  
Govt. Hospital, Peroorkada  
Govt. Hospital, Parassala  
Medical College Hospital, Trivandrum.  
Nirmala Hospital, Trivandrum  
Sree Ramakrishna Mission Hospital,  
Sasthamangalam, Trivandrum  
Taluk Head Quarters Hospital,  
Chirayinkil  
Taluk Head Quarters Hospital,  
Neyyattinkara  
Taluk Head Quarters Hospital,  
Nedumangad  
VSSC Medical Division, Trivandrum  
W & C Hospital, Trivandrum  
Dr. Govindan's Hospital,  
Trivandrum  
Military Hospital Pangode  
Al-Arif Hospital, Ambalathara  
Regional Cancer Centre, Trivandrum  
Air Force Hospital, Trivandrum  
Kalyan Hospital, Aryasala  
ESI Hospital, Peroorkada  
SAT Hospital, Trivandrum.

#### **Trichur**

Agrasala, Kodungalloor  
Amala Cancer Centre, Trichur  
Balya Children's Hospital, Veliyannur  
E. S. I. Hospital, Olarikara  
Jubilee Mission Hospital, Trichur  
Dist. Co-operative Hospital, Trichur  
Royal Hospital, Kunnamkulam  
Lal Memorial Hospital, Irinjalakuda  
Dist. Hospital, Trichur

Govt. Hospital, Choondal  
Taluk Head Quarters Hospital,  
Chavakkad  
Elite Mission Hospital, Koorkancherry  
Govt. Hospital, Irinjalakuda  
Metropolitan Hospital, Kokkalal  
Guruvayur Clinic, Guruvayur

#### **Wynad**

Assumption Mission Hospital,  
Sulthan BATTERY  
Govt. Hospital, Mannantody  
Wynad Hospital, Sulthan BATTERY

#### **OTHERS — State-wise**

##### **Andhra Pradesh**

Apollo Hospital, Hyderabad  
N. S. General Hospital, Hyderabad  
Medical College Hospital, Guntur  
Vamsi Clinic, Visakhapatnam

##### **West Bengal**

Calcutta Clinical Lab. Calcutta  
Postgraduate Institute, Calcutta

##### **Jammu & Kashmir**

Sher-I-Kashmir Institute of Medical  
Sciences, Srinagar

##### **Karnataka**

Jayadeva Institute of Cardiology,  
Bangalore  
Kasturba Medical College, Manipal  
Vijaya Clinic, Mangalore  
St. Philomina Hospital, Mangalore  
Medical College Hospital, Bangalore

St. John's Medical Bangalore  
St. College Hospital, Bangalore  
General Hospital, Bangalore  
J. J. M. Medical College, Devengere  
Rangaraya Medical College, Karnataka

##### **Maharashtra**

Bharatiya Arogya Nidhi Hospital, Bombay  
P. D. Hinduja National Hospital, Bombay  
Diamond Polyclinic, Chembur  
Jaslok Hospital, Bombay

##### **Madhyapradesh**

Indian Ordnance Factory Hospital,  
Jabalpur  
MPEB Hospital, Chachal  
Govt. Medical College, Jabalpur  
Jabalpur Medical Centre, Jabalpur  
National Mineral Development  
Corporation, MP

##### **Meghalaya**

State Health Services, Meghalaya Shilong

##### **Orissa**

SB Medical College, Cuttack

##### **Pondicherry**

JIPMER, Pondicherry

##### **Rajasthan**

State Health Services, Rajasthan

##### **Tamil Nadu**

Medical College, Thanjavur  
Chandran Hospital, Marthandam  
P. N. P. Hospital, Marthandam  
Biswas Hospital, Marthandam

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Catherine Booth Hospital, Nagercoil  
Jayasekharan Hospital, Nagercoil  
Jawahar Hospital, Nagercoil  
Kunneth Hospital, Padanthalmoodu  
Vin's Hospital, Kaliakkavila  
Kanyakumari Medical Mission, Neyyore  
Mathai's Hospital, Nagercoil  
Merlin Hospital, Coimbatore  
Govt. Rajaji Hospital, Madurai  
Aravind eye Hospital, Madurai  
Kuppuswamy Naidu Memorial Hospital,  
Coimbatore  
General Hospital Madras  
Medical College Hospital, Tirunelveli  
Taluk Hospital, Tiruchandoor  
Dist. Head Quarters Hospital, Nagercoil

Gandhimathy Nursing Home, Tirunelveli  
Dominic Hospital, Kulasekharam  
Govt. Hospital, Tenkasi  
Abdul Kadar's Nursing Home, Nagercoil  
Annai Nursing Home, Tenkasi  
C. M. C. Vellore  
S. H. Hospital, Tuticorin

**West Bengal**

Appolo Clinical Lab, Calcutta

**ABROAD**

Marfaq Hospital, Abudhabi  
AL-DUSAMI Hospital, Sharjah

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46. Dr. J. T. Tolia (M.Ch. 1987), Cardiac Surgeon, Suhriday Surgical Clinic, Rajkot.
47. Dr. S.R. Krishna Manohar, (M.Ch. '88) Assistant Professor, Sree Chitra Tirunal Institute, Trivandrum.
48. Dr. Shekhar Rao, (M.Ch. '89), Cardiac Surgeon, Vijaya Hospital, Madras.
49. Dr. Baljit Sharma (M. Ch. '88) Cardiovascular Surgery Dept. Texas Heart Institute, Houston
50. Dr. V. M. Kurian, (M.Ch. '89) Cardiac Surgeon Institute of Medical Sciences, Calcutta.
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52. Dr. Damien Joseph, (PDCC '89) Quilon.
53. Dr. Mruthyunjaya, G. (PDCC '89) Hyderabad
54. Dr. C. G. Raghuram (PDCC '89) Madras
55. Dr. Tiny Nair (DM 1989) PRS Hospital, Killippalam, Trivandrum.
56. Dr. Y. R. Yellury (DM 1989), Consultant Cardiologist, Kovai Medical Centre and Hospital Ltd. Coimbatore.
57. Dr. Satish Krishnan (M. Ch. '89), SCTIMS & T, Trivandrum.
58. Dr. Subodh Darbari (M. Ch. '89), Jabalpur (MP)
59. Dr. Varun Satija (PDCC '89), Lecturer, Dept. of Radiology, CMC Hospital, Ludhiana.
60. Dr. Vijayakumar Gupta (PDCC '89), Jaipur, Rajasthan.
61. Dr. Dilip Panicker, (M. Ch. '89), Baroda, Gurat.
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**REPORT ON THE INDO-UK SYMPOSIUM ON "ENGINEERING FRONTIERS OF MEDICINE" HELD ON 11-13, JANUARY 1990**

Inaugurating the conference Dr. M. S. Valiathan, Director, Sree Chitra Tirunal Institute for Medical Sciences & Technology briefly recapitulated the first Indo-UK Symposium held in January 1988. The present exercise was aimed at creating an awareness of the engineering frontiers of medicine among clinicians and dental practitioners. He also hoped that the symposium would lead to the generation of specific project proposals by the participants in the area of biomedical technology. Dr. David Annis (Liverpool), in his presentation, delineated the role of a surgeon in the creation of medical devices. There was a great need for clinicians, scientists, and engineers to work as partners towards the common goal of healing. He stressed the need for clinicians to be rounded in the principles of physics, chemistry, and engineering so that functioning devices could be conceived and developed. The small diameter vascular graft developed by his group at the Liverpool University was cited as an example of fruitful multidisciplinary research. The lecture covered the reaction of tissues to foreign matter, the healing process, behaviour of tissues to varying forms of the same materials as well as the ethics of devices development. Prof. S. Ramaseshan's (Bangalore) lecture dealt with the underlying principles of physics in biomaterials science and

medical technology. In broad strokes he sketched the role of inertia, friction, fluid flow and strength of materials in the development of devices and the occurrence of physiological phenomena. Briefly covering mismatches in the moduli between the natural tissues and engineering materials, he indicated the potential for composites in medical applications. The burden of the talk was to highlight the crucial role of physics in medicine and physiology. The wide ranging talk took into account plung flow of blood in the lung's capillaries as well as the role of a surfactant in keeping different sized alveoli open.

Dr. William Bonfield's (London) first lecture dealt with biomechanics with special reference to the mechanical properties of human bones and the need for long term stability of skeletal implants. The problems of failure of the first generation devices caused by mismatch between the mechanical properties of natural tissue and implants were emphasised and the importance of a stable interface between the implant and the surrounding tissue stressed. Some mis-conceptions regarding the supposed alteration of mechanical properties, especially fracture toughness, of human bones with age were resolved in his laboratory thanks to detailed biomechanical studies. The potential for polymeric composites with the bone mineral,

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hydroxy apatite, was indicated with preliminary data on the favourable histopathology of animal implantations of this material. The formation of stable bonds and ability of composites to match the mechanical properties of bone were the highlights of the talk.

In the second session, Dr. M. Brown (Liverpool), described the use of ultrasound in medicine and surgery. The use of the ultrasound for imaging was described using analogies from every day clinical practice. The frequencies used and the limitation to resolution set by the tissue absorption properties were described. The relationship between frequencies and the broadening of images was indicated and the importance of pulse echotechniques for producing analytical images stressed. The various types of scanning procedures were exemplified as were the associated probes. Array type scanning, Doppler velocimetry were touched upon. He closed his talk on an optimistic note regarding the technical improvements in imaging and its decreasing cost. Professor D.W. Hill (London) pointed out that no more than 10% of the high health care costs could be attributed to technology related services. The tremendous advances in electronics and engineering had actually reduced the costs of modern methods of diagnosis such as CT Scan and MRI. Adequate MRI can be obtained with permanent magnets avoiding for most cases liquid helium. He cautioned against investing in frills like colour in scanning without serious attention to the cost benefit ratio. He also described the problems associated with the need for proper maintenance of equipment especially with regard to obsolescence and possible lack of spares.

Dr. S. K. Guha (Delhi) pleaded for preventive health care and emphasised the importance of delivering the health care to the door steps of the large rural population. The attempts made at IIT, Delhi to perfect portable health care kit comprising an accurate weighing machine, haemoglobinometer, blood pressure monitor and a data acquisition computer were elaborated. The importance of training the staff of primary health centres in the use of such kits for routine screening was also stressed.

In an entertaining and forceful lecture Dr. Arjun Rajagopalan (Madras) introduced the use of computers in medicine. The antipathy of clinicians to these machines was spelt out and the necessity for standardising data entry and storage discussed. The advantages of computers for performing repetitive tasks fast and for high speed retrieval of patient data were described. He also cautioned the delegates regarding the use of computers as expert systems for diagnosis and treatment. They should be used only as a guide to alert the physician regarding possible conflicts rather than for making diagnosis or prescribing.

Dr. A. Parameswaran (Madras) gave a comprehensive review of dental materials. From porcelains to polymeric restoratives in current use as well as historical materials were described. Trends in the use of direct bonding in orthodontics as well as that of materials like glass ionomer cements were also considered. Problems of shrinkage, marginal leak, and decalcification were indicated and the future of dental practice based on new materials under development discussed.

Mr. M. Mohanan (Hyderabad) made a detailed presentation on the use of metals and alloys in medicine. After touching upon the use of stainless steels and cobalt-chrome alloys, he concentrated upon the advantages of titanium and its alloys for the fabrication of implants. He stressed the properties of biocompatibility, light weight, low modulus, high toughness, corrosion resistance, and formability of titanium which made it a superb biomaterial. The use of alloying to improve properties by phase transformation was also indicated. Dr. K. P. Srivastava (Calcutta) spoke on the applications of ceramics in biomedical services. After a brief introduction on the nature of biomaterials in general, he went on to describe the various ceramics, inert, bioactive, and bio absorbable which were of use as biomaterials. He indicated that the use of bioceramics would triple by 1995.

In his second talk Dr. Brown dealt with evoked neural responses in medical diagnoses. The use of evoked potentials to monitor the condition of the spinal cord during corrective surgery was specially noted. New trends in magnetic stimulation, electroretinography, testing of motor nerve system and the evaluation of auditory function were detailed with illustrations.

Dr. D. W. Hill in his second lecture concerned himself with the training of biomedical engineering personnel. The content of a regular training programme and its role in ensuring satisfactory maintenance of hospital equipment were discussed in detail. It was pointed out that the training objectives should include medical physics and instrumentation.

Dr. B. Sankaran (New Delhi) emphasised the lack of standardisation and statutory regulation in the manufacture of orthopaedic devices. The problems of corrosion, failure, and reoperation due to faulty materials and poorly designed devices were considered in detail. He gave statistics of casualties including fatalities caused by the use of low quality devices. He concluded that reliability, safety and effectiveness were the three words guiding the setting up of medical device standards.

In his second lecture Dr. David Annis elaborated on the use of a polyether urea elastomer for small diameter graft applications. A novel method of electrostatic spinning deposited micron diameter fibrils over a metal mandrel to produce the grafts. Dr. Annis demonstrated the excellent mechanical handling properties of the device and how they could be changed by modifying spinning parameters. The highly flexible graft however showed sign of biodegradation and a compromise was effected to get adequate handling properties without compromising longterm healing or durability. Animal and controlled clinical trials indicated the suitability of the modified grafts for specialised applications such as A-V shunt for dialysis.

Prof. D. W. Williams highlighted the biological degradation of implant materials especially polymers and the mechanism of degradation. Chainscission, depolymerisation, crosslinking, side group changes, and leaching could lead to polymer degradation even though heat, UV, visible light, ionising radiation were absent in the body environment. Polymeric implants also

suffer long time degradation by enzymatic action and phagocytic activity. Fibrous materials can get attacked by cells leading to mechanical failure. Similarly inflammation at the site of implantation can lead to significant degradation.

Dr. C. P. Sharma (Trivandrum) spoke on the necessity for surface modifications to improve blood compatibility of foreign surfaces. Extensive data were presented on techniques like glow discharge, radiation grafting, and gluteraldehyde crosslinking which were used to attach various molecules such as enzymes, vitamins, antibiotics and albumin. Using contact angle measurements and platelet counts the suitability of these coatings for improving thromboresistance of surfaces was assessed.

Dr. Mira Mohanty's (SCTIMST) lecture on tissue responses to prosthetic materials was comprehensive. Drawing upon the large data bank of experiments in her Division, she brought out the spectrum of responses of tissues to materials in a variety of forms from powder to pellet. The progress of healing of an implant with time was described with the help of detailed histological sections.

Prof. D. F. Williams continued his exploration of tissue materials interactions in his second talk and referred to the non linearity of biodegradation in implants. The effect of water permeability on degradation was discussed. The difference in the responses of tissues to inert, nearly inert and biologically active surfaces was described with copious illustrations. The need for designing long term hydrolytic stability was stressed.

Prof. Bonfield discussed biomaterials designed for orthopaedic implants in his second lecture. While nearly inert materials like alumina were still in use, their long term performance was inadequate. The mismatch in mechanical properties like elastic modulus led to stress concentrations and implant failure. While materials like hydroxyapatite and other calcium phosphates promoted active bone ingrowth, their fracture toughness was quite poor. The solution to this problem might lie in the use of a composite of hydroxyapatite with polyethylene. It was important to recognise however that hydroxyapatite could vary considerably in properties depending on the source.

Prof. Ramaseshan's second lecture covered various fabrication techniques. Anodic coatings on aluminium for insulation, sputtered coatings of titanium nitride on implants and ion implantation for improved wear resistance were covered. Fabrication methods like investment casting were also outlined. Dr. A. Jayakrishnan (Trivandrum) gave a good review of drug delivery systems. He described various mechanisms of drug release and indicated the types of polymers that could serve each purpose. The chemistry of the polymers and mechanisms of degradation were discussed.

In the concluding session, Mr. A. V. Ramani (Trivandrum) used a case study of a rigid shell oxygenator evaluation to show the importance of proper design of experiments even within the ambit of applicable standards to avoid erroneous interpretation of performance of devices. The need to ensure the relevance of prescribed parameters to the measured quantity was indicated

using the heat exchanger performance evaluation.

Mr. S. N. Pal (Trivandrum) gave a detailed analysis of evaluation of the performance of dental restorative materials. Parameters like setting time, wear resistance were described. Cosmetics is an important aspect of dental restoratives. Methods for establishing of hue, chroma, and brightness were detailed. Mr. Bhuvaneshwar gave a good account of the evaluation of wear properties of materials used for fabricating artificial heart valves. The pitfalls in durability testing due to materials combinations were discussed. Pin on wheel method along with sand slurry test for screening materials combinations were presented with data from trials. This was followed by

Dr. G. A. Lal's (SCTIMST) on the use of large animals for the experimental evaluation of biomedical devices. The travails of the veterinarian in conditioning, anaesthetising, and postoperative nursing of animals were described with numerous illustrations.

Dr. M. S. Valiathan concluded the symposium by sketching the large area covered by various speakers. He stressed the scientific and economic importance of medical technology and hoped for fruitful collaboration between India and UK in the years to come in this promising field.

The formal sessions were followed by a visit of the delegates to the Technology wing and their discussions in groups with the expert speakers on specific areas of interest

**INDO – UK SYMPOSIUM ON THE ENGINEERING  
FRONTIERS OF MEDICINE, JANUARY 11–13, 1990**

**at Sree Chitra Tirunal Institute for Medical Sciences  
and Technology, Trivandrum.**

**SPEAKERS**

1. Dr. David Annis,  
The Institute of Medical and Bio-  
Engineering, University of Liverpool,  
Royal Liverpool Hospital, Post Box  
147, Liverpool, L 69 3BX.
2. Prof. William Bonfield,  
Head, Department of Materials,  
Chairman, School of Engineering,  
Queen Mary College, University of  
London, Mile End Road, London  
E1 4 NS
3. Dr. Malcolm Brown,  
Department of Ultra Medical,  
University of Liverpool, First Floor,  
Duncan Building, Royal Liverpool  
Hospital, P. O., Box. 147, Liverpool  
L 69 3 BX.
4. Prof. D. W. Hill,  
Regional Scientific Officer,  
Regional Health Authority,  
40 Eastbourne Terrace,  
London W2 3 DR
5. Prof. David Franklyn Williams,  
Institute of Medical and Dental  
Bioengineering  
University of Liverpool, U.K.
6. Prof. S. Ramaseshan,  
Professor - Emeritus,  
Raman Research Institute,  
Bangalore.
7. Dr. B. Sankaran,  
St. Stephen's Hospital,  
TiS Hazari, New Delhi – 110 054.
8. Prof. S. K. Guha,  
Professor & Head,  
Centre for Biomedical Engineering,  
IIT, New Delhi- 110 016.
9. Mr. Aijun Rajagopalan,  
Consultant in General Surgery,  
Dr. E. V. Kalyani Medical Centre,  
No. 4, Second Street,  
Madras – 600 003.
10. Dr. A. Parameswaran,  
Additional Prof. of Operative  
Dentistry,  
Madras Medical College,  
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11. Mr. M. Mohanan,  
General Manager, (O.S.D)  
Mishra Dhattu Nigham Ltd.,  
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12. Dr. K. P. Srivastava,  
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13. Dr. M. S. Valiathan,  
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Sree Chitra Tirunal Institute for  
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14. Mr. A. V. Ramani,  
Head, Biomedical Technology Wing of  
SCTIMST, Poojapura, Trivandrum  
695 012.

15. Dr. C. P. Sharma,  
Scientist, Division of Biosurface  
Technology, BMT Wing, SCTIMST,  
Poojapura, Trivandrum-12

16. Dr. Arthur Vijayan Lal,  
Veterinary Scientist, SCTIMST,  
Poojapura, Trivandrum-12.

17. Dr. A. Jayakrishnan,  
Scientist, Division of Polymer  
Chemistry, BMT Wing, SCTIMST,  
Poojapura, Trivandrum-12.

18. Dr. (Mrs.) Mira Mohanti,  
Pathophysiologist,  
Biomedical Technology Wing  
SCTIMST, Poojapura,  
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19. Mr. S. N. Pal,  
Chemical Engineer,  
Biomedical Technology Wing,  
SCTIMST, Poojapura,  
Trivandrum-12.

20. Mr. G. S. Bhuvaneshwar,  
Biomedical Engineer,  
Biomedical Technology Wing,  
SCTIMST, Poojapura,  
Trivandrum-12.

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Calcutta-700 032.

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Department of Prosthodontics  
Dental College,  
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23. Dr. D. Arunachalam,  
38/5, CPWD Quarters,  
Besantnagar,  
Madras- 600 090.

24. Dr. V. Arunachalam,  
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Madras Dental College,  
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25. Prof. Ashima Valiathan,  
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27. Dr. K. Chandrasekharan Nair,  
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- 
28. Dr. Fazil Marikkar,  
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Trivandrum-11.
29. Dr. George Skariah, P.,  
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Government Dental College,  
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56. Dr. S. Sujathan,  
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57. Dr. Louis K. Perumali,  
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58. Dr. Suja Mathew,  
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59. Dr. R. Sandhya,  
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60. Dr. C. V. Pradeep,  
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61. Dr. H. Govind,  
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62. Dr. K. V. Manoj,  
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