MAJ. GEN. S.L. BHATIA ORATION 1977:

DEVELOPMENT OF PHYSIOLOGY IN INDIA — A PERSONAL VIEW*

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I feel grateful and greatly honoured to have been chosen by the A.P.P.I. to deliver the Major-General S.L. Bhatia Oration for this year. My happiness is all the more, for I also claim the proud privilege of being one of the founding members of the Association. Earlier too the A.P.P.I. had honoured me by electing me as the President of the XXVI International Congress of Physiological Sciences. On this occasion, I wish to express my sincere gratitude and thanks to the members of this august organization for their generosity and affection towards me.

Major-General Bhatia, distinguished scientist, Professor of Physiology and Dean, Grant Medical College, Bombay, from 1921 to 1941, a magnanimous man with a towering personality, is the one scientist whom the physiologists of this country owe a debt of gratitude for having put the Indian physiology on a professional pedestal, for he was the first full-time Indian Professor of Physiology in the setting of a medical college, largely responsible for starting a section of physiology in the Indian Science Congress Association and the first President of this section in 1932, (Incidentally I was the President of this Section in 1967). I still remember with admiration the way he examined me in Physiology in the I Professional examination in 1937. I pray that we all continue to have his patronage and blessings for many years to come.

Major-General Bhatia comes in the same category of Doyens of medical scientists as Major-General Amir Chand, who was my mentor and teacher, and whose teachings and advice immensely influenced the course of my career. It is a happy coincidence that the first ever prize that I won in Physiology in 1952 (on the nervous control of ACTH secretion) was named after Major-General Amir Chand, and this last recognition that you have been generous to bestow on me is named after Major-General S.L. Bhatia.

Recognition such as this is never absolute, for it is the result of the joint endeavours of a large number of colleagues, some well-known and some not so well-known. I have been most fortunate to have been associated with a large band of bright, dedicated and dependable colleagues (some of whom I see in the audience today) and this recognition is as much theirs as mine. I have had the privilege of standing before this august body a number of times since its inception and speak on various scientific activities. I do not intend to do so today. Being provided the opportunity of being on the scene of physiology in India since 1943 as a teacher, I thought it may be more interesting, at least for our relatively younger friends, if I place before you today a glimpse of the development of physiology — from a personal angle.

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Let us look back at the evolution of physiology as an independent scientific discipline of modern medicine and surgery. In India, one notices that during the early years of 19th century instructions were given in Ayurvedic and Unani systems of medicine, for which the Sanskrit College and the Madarssa in Calcutta were well-recognized. It was only in 1822 that the first medical school was started in Calcutta by Lord Bantinck, which was later upgraded to a medical college in 1835. Grant medical college with Charles more as the principal, who also taught physiology, was started in 1838. Madras Medical College came into being in 1847. And later on followed the medical colleges in Lahore, Lucknow, Patna and Delhi (for ladies only). I may mention the names of some old teachers of repute in physiology — Col. Mckey in Calcutta, Col. Donovan in Madras, Col. Caleb in Lahore, and Col. Morehead, Col. Mayer and Col. Hutchison all in Bombay. However by and large the physiology teachers of the late nineteenth and early twentieth century belonged to IMS officers of the Armed Forces Medical Services, and primarily they were physicians awaiting to be posted as teachers or specialists in medicine. (Similarly Anatomy was taught by Surgeons). It was only later on that the wholetime professorships in physiology were instituted and as mentioned earlier Major-General S.L. Bhatia was one of the first ones in India. Physiology courses still consisted mainly of didactic lectures delivered from copious notes copied from text-books and repeated year after year. The laboratory exercises were mostly on frogs where contractions of skeleral and cardiac muscles were recorded on smoked drums rotating through a common pulley system employed for the whole class and at the end of the class we used to have our overalls as also hands and other exposed parts of the body smudged with smoke, as perhaps would be the case in many medical colleges even today. There were no demonstrations on higher animals, nor was there any glamour for research. Physiology as a discipline had not yet acquired an independent status in our country, as was being stressed at this point of time in some of the developed countries, as is evident from the sayings of Claude Bernard like "Physiology is the basis of all medicine" and of Sir William Osler like "The study of Physiology and Pathology within the past half century has done more to emancipate medicine from the routine and thraldom of authority, than all the work of all the physicians from the days of Hippocrates to Jenner, and we are as yet on the threshold."

In India perhaps the Calcutta University was the first to start a department of Physiology in the Presidency College under the headship of Professor S.C. Mahalanobis in 1912 after he returned from England. Calcutta continues to maintain this distinction of having a University Department of Physiology and many science colleges of Bengal have physiology as a regular subject. But this spirit of physiology was outside the fourwalls of medical colleges. In general, physiology was inalienably linked with medical sciences, and to a large extent continues to be so even today, which is understandable from the point of view of its evolution elsewhere in the world.

One can fathom the status of physiological sciences during those days by recalling that terms like biophysics, cell biology, etc. were non-existent. Biochemistry, more popularly termed as chemical physiology at that time, was a part of physiology and so was histology. Pharmacology was mainly pharmacy and pharmacopea. Teaching of chemical physiology and histology occupied almost 2/3rd of the total physiology teaching. The Cathode-Ray-Tube that goes to make oscilloscope had been discovered only a decade back. The electrocardiograph machine was a

rather heavy contraption housed in a huge teak-wood case, perhaps the only one available in the northern India. The E.E.G. machine as a clinical or investigative tool was yet non-existent. The ionic basis of nerve impulse was being hotly debated in the parlours of science. Kato in Japan was talking about decrementless conduction in the toad's sciatic nerve and the mysteries of saltatory conduction of nerve impulse had just started being unraveled.

In India the researches were mainly in the area of chemical physiology especially aimed towards finding the nutritional contents of various dietary items. This was the background, the atmosphere of my student days when the country was still a slave, and the only window through which one could look out to the West for knowledge, learning and training was available in the eastern part of our country. Two names had made news during those days and everybody looked upto them with respect and these were U.N. Brahamchari and P.B. Sen, specially for their studies on Kalazar and Malaria. Sachchidanand Banerjee, who is with us today and is one of the founders of your association, too had just come on the research scene as a young worker and student of Brahmachari and Sen, devoting attention to his first love — ascorbic acid on which he talked to us only last year. B.B. Dikshit, who later became the Director of All-India Institute of Medical Sciences and whom we lost only few days back, had published his beautiful work on acetylcholine, S.N. Mathur who occupied the chair in Lucknow, a student of R.J.S. MacDowell, had worked on the composition of saliva, and Inderjit Singh who had come back from U.K. was working on the smooth muscle and made some revolutionary contributions on the possibility of lack of ionic basis in muscle contraction. B. Narayan's was another name to be reckoned within the teaching of physiology. These were some of the pioneers who were laying the foundations of Indian physiology.

I had just graduated in 1940 as a fresh M.B.B.S. from one of the 19 medical colleges existing in the country at that time. The II World War had begun when I joined as a Provincial Service Officer and was posted for A.R.P. duties in Lahore. Very soon I was appointed Demonstrator in Physiology in Amritsar in 1943, when the Glancy Medical School was raised to a Medical College. Like others I did my post-graduation in Medicine but took courage to have physiology as my special subject for the M.D. examination. I am using the word courage as there were hardly any good facilities available in the country for the study of experimental physiology. The first mammalian experiment I ever did with my own hands was in my M.D. examination and I was lucky somehow to succeed in recording the blood pressure of a dog.

The war ended and the country became independent. Soon *i.e.* in 1949 I was asked to occupy the chair in Physiology at the Lady Hardinge Medical College in Delhi. Thanks to the personal influence of some of my teachers the spirit of enquiry that I had learnt from them remained kindled, and I did some clinical researches under their inspiration. But perhaps it was only after I started handling the department of physiology that the work on experimental physiology started fascinating me. In the year 1948 while demonstrating to the students the vagal inhibition in frog's heart, I met singular success when experiments were done in summer, but come winter, the failure was equally singular. It did upset me for these were the same smoked drums, same frogs of the species Rana Tigrina and the same Dr. Anand. When the story was repeated in the year 1949 too, it rang bells in my mind and I started a series of experiments on the effect of

temperature on the nervous regulation of cardiac activity, ultimately demonstrating that acetylcholine in smaller amounts activates the pace-maker and inhibits it only when its concentration increases. This research was then published in the American Journal of Physiology; my first publication in an International journal, but it also laid the foundation of my thinking regarding dual reciprocal mechanisms for most of the physiological regulatory functions.

It was not long after that I was offered a fellowship by the Rockefeller Foundation which enabled me not only to join a very active group of workers at Yale University in U.S.A., but also to visit many universities and seats of learning in the world.

Ladies and gentlemen I have already given you an approximation of what I had observed about the world of physiology in India and abroad when I had just graduated. About 10 years had passed after that. Both electrocardiography and electroencephalography had become now well-established investigative and clinical tools. Sturdy oscilloscope assemblies with preamplifiers etc. had started finding a place in the physiology laboratories. Electrophysiology was the fashion, and following its technology got one an air of immediate respectability. The Journals were full of research papers on action potentials and their behaviours. Horsley and Clarke were already famous for the fabrication of the stereotaxic apparatus which revolutionized the research endeavours aiming to explore the mysteries of brain as also the practice of neurosurgery. Magoun's concepts of the brainstem reticular activating system were being much talked about. Geoffery Harris, who later became an excellent friend of mine, and his colleagues were frantically researching to establish the portal system for hypothalamic control of anterior pituitary hormones. That was the ambience of physiology when I landed in U.S.A. to join John F. Fulton and John Brobeck in the fall of 1950 and also to get to know thinkers and workers like Paul Maclean, J.R. Delgado, Bob Livingston, Karl Pribram and others — all of them dedicated to the study of brain and behaviour.

The world of neurophysiology at that time essentially had 3 major groups of schools; (1) the British schools mainly pursuing fundamental problems like nerve conduction, synaptic transmission; etc. (2) the schools in U.S.A. of the type to which I got associated laid more stress on functional aspects and holistic approaches; and (3) the schools in U.S.S.R. where immense amount of work was being conducted on Pavlovian conditioning. My stay at the Yale was the most formative period of my life as a physiologist. New technology was available and chance helped me. It was during this period that I formulated the concepts of alternation of hunger and appetite as a reflection of events occurring in the hypothalamus.

My first assignment in the laboratory was to produce fat rats by making lesions in the ventromedial hypothalamus under the guidance of John Brobeck. But as it happened instead of producing fat rats I started making the rats thin and emaciated who would die of starvation in the end. Although it upset me in the beginning, ultimately it was found out that due to some fault in the lesion-maker gadget I was destroying lateral hypothalamus also, to result in the non-eating animals. This laid the foundation resulting in the discovery of what was designated as hypothalamic feeding centres, by sheer accident and luck — a case as they say of serendipity.

I returned to Lady Hardinge Medical College in 1952 and started a series of experiments to explore the nature and mode of functioning of these centres in various animal species using stereotaxic devices, possibly for the first time in India. I was lucky to be able to attract a dedicated band of workers like Dr. Dua who is now your General Secretary, Dr. Chhina who is now Professor of Physiology at the A.I.I.M.S. and colleagues like Dr. Baldev Singh and Dr C.L. Malhotra. These were the days when another star in Indian physiology had also started exhibiting his brightness. Dr. A.S. Paintal who after having done his M.B.B.S. in 1948 was working with David Whitteridge in Edinburgh and was breaking new grounds judged from any standards of the world of science by starting an era of recording from single fibres of the vagus nerve and later deciphered the electrophysiological nature of a series of visceral receptors. I.J. Singh in Agra was continuously productive with respect to his researches on stomach muscle. The Calcutta groups had expanded and were busily investigating aspects of pharmacology, hematology and nutrition and were going into the field of work physiology. It was now almost a decade after independence, and the plans of our national government brought a massive expansion on the educational front including medical education. Bhore Committee report was being given a serious consideration and the starting of a centre for excellence in teaching and research of medical sciences was being discussed and actually came into being in 1956 in the form of All-India Institute of Medical Sciences and I joined it to head and organize the department of physiology. Avtar Paintal also joined us in the Institute as Professor of Physiology at the end of 1958. And soon it became a nerve centre of training and research in physiology and together we started attracting students from various parts of the country and abroad. By 1964 Paintal had ransacked the cardiovascular, the gastrointestinal and the pulmonary systems, identified various types of receptors and elucidated their electrophysiological properties and functions. Perhaps in the field of sensory physiology, his contributions are ranked as one of best. He later on in 1964 joined Patel Chest Institute as its Director, and has a dedicated band of workers actively engaged in persuing research on sensory and respiratory physiology. You would hear more about it from him day after tomorrow. Dr. Dua-Sharma, Dr. G.S. Chhina, Dr. P.K. Gill, Dr. K.N. Sharma, Dr. S.K. Manchanda, and Dr. Usha Nayar (Subberwal at that time) also joined us at the Medical Institute alongwith others, and we also had a continuing fruitful collaboration with colleagues like G.P. Talwar and Baldev Singh. These were exciting times. Our studies on the Nervous Regulation of Food Intake had acquired a sizable proportion and I was asked to give an invited lecture in the International Congress of Physiological Sciences held in Argentina in 1959, which attracted a world-wide attention and was later published in the Physiological Reviews in 1960. By and large the hypothesis that was put forward at that time has stood the test of time and is accepted even today and is reverbrating with regard to its application in many fields of medicine, psychology and nutrition. The Indian Council of Medical Research had magnificiently come forward to give us financial support for these researches, by setting up a "*Neurophysiology Research Unit*" in the Department of Physiology. These were also the days when we ventured into investigations on the physiological effects of Yoga, and established that the practice of Raj Yoga can lead to an extraordinary control of visceral activities, and that meditation produces a predominence of alpha rhythm in the E.E.G. and raises the thresholds for sensory appreciation. Perhaps we were one of the first to propound the alpha dominance being a correlate of mental relaxation.

The researches in the Department of Physiology of the A.I.I.M.S. also got further expanded

to explore the functions of the Limbic system of brain and its role in the regulation of autonomic, visceral, and endocrinal activities and behaviour. The orientation was to document how these regulations maintain the normal 'homeostatic conditions' or the constancy of "*milieu interieur*". Hypothalamus as the effector system (described by some as the Head Ganglion of autonomic nervous system) was one of our main target of attack.

A unit of Environmental Physiology was also established in the department and groups of researchers went to Leh to investigate the physiological responses to stress of high altitude and cold, the interaction between the two, and how and to what extent acclimatization occurs — a field of study that was undertaken on the express desire of the Defence Organization in the aftermath of Chinese aggression.

I have no intention of elaborating on these studies. Scientific details on all these are available in accredited journals, text books and monographs. As mentioned earlier, I have also had the good fortune to place them before this august Association from time to time.

These researches were accompanied by intensive training programmes, leading to the award of postgraduate degrees to more than 60 students during the period 1956-73. As I look at the map of India a number of them are occupying senior faculty positions all over the country.

There are also now clear indications that physiology is outgrowing the precincts of medical colleges, and some excellent groups and schools have emerged on the scene. The culmination of these vigorous activities occurred in the form of New Delhi hosting the XXVI International Congress of Physiological Sciences on behalf of the Indian Physiologists in 1974. That was the first time that India held a prestigious scientific Congress of such a magnitude. The young and old physiologists of India gathered together, alongwith their counterparts from other countries and engaged in scientific intercourse. By the way, I have a feeling of special pride to mention that many foreign dignitaries personally conveyed to me their happiness on the intellectual capacity of our young physiologists, based on the papers presented by them, and also from their *active* participations in the discussions on papers presented in the seminars and by the well-known physiologists of the world. That was the most glorious moment of my life when I saw my dreams coming true.

Physiology which was being pursued by at the most 25-30 individuals when I was a student has since seen immense expansion. Each of the 106 medical colleges in the country now has a regular department with a professional chair and other facilities. Each of the 20 or so agricultural universities also have departments of physiology and pharmacology in their veterinary colleges. Besides these, many research establishments have sprung up and are doing noteworthy work in various fields of physiology; to mention a few, Vallabh Bhai Patel Chest Institute in the University of Delhi under the Directorship of Professor A.S. Paintal, Defence Institute of Physiology and Allied Sciences, under the Directorship previously of Rear Admiral M.S. Malhotra and now Surg. Capt. Nayar, research establishments of the I.C.M.R. like the Institute of Reproductive Research in Bombay and the Institute of Environmental and Occupational Sciences, Ahmedabad; School of Life Sciences in Jawahar Lal Nehru University; Institute of Aviation Medicine in

Bangalore. The work also continues in the older institutions of standing like the University College of Science in Calcutta, the All-India Institute of Medical Sciences, New Delhi, and many others which may be difficult to name here. Further, some outstanding departments have been established in some of the relatively new institutions, like St. John's. In Madras itself I have had the great privilege of long association with Professor Sarada Subrahmaniyam, who now heads the Physiology Department of P.G. Institute of Basic Medical Sciences and whose contributions to the science of Physiology are well-known. Professor K.P. Anandan's long friendship provides me a continuous inspiration. In this *milieu* one can find a fair sprinkling of excellent researches and teachers in Physiology throughout the country. In addition, the Physiologists now have a professional organisation of standing which provides forum for discussion and recognition of problem of research and teaching. An era of multidisciplinary researches in many fields of physiology has also begun. To quote an example in the field which I have been most concerned, are the endeavours of Prof. B. Ramamurthi, the moving spirit of neurological sciences in India. He and Prof. Baldev Singh, a neurosurgeon and a neurophysician, initiated this era of collaborative studies in the field of neurosciences, and I have no hesitation in labelling them as some of the best neurophysiologists of this country.

Meanwhile I see that Biochemistry has separated from Physiology and developed as an independent discipline on its own right. Histology has now found a new home in anatomy. At many places departments of biophysics have been initiated. (These are the signs of progress). In spite of these defections, Physiology continues to grow and physiologists are active and bubbling with energy.

I myself have reached a stage where my services have been requisitioned for jobs concerned with larger issues of education and research in the country and I am forced to leave the active pursuit of research and teaching in physiology for the time being, but I am happy to see these developments for I was involved in bringing some of these to reality through various committees at various levels, of which I was a member. I am also sure that the foundations of physiology are strong and each one of you is going to find a place that is worthy and will allow you the expression of the best of your creative instincts

The times have also changed. We have been now an independent nation for the last 30 years. It is a growing realization among the Indian scientists that they have to find an identity in the milieu of their own people and therefore their work has to have a relevance to the community they belong. This is equally applicable to the physiologists of the country. Like everybody else we too have to grapple with the issues of the day. As I discuss these matters with my younger colleagues I feel heartened that all of you are alive to these issues which involve both teaching and research. Only this year in June Dr. S.K. Lal organized and programmed a workshop for reforming the undergraduate teaching in view of the present day needs of the community. I am informed that another workshop on laboratory teaching is on the slate for the next year. There is a session on this aspect also in the present meeting. I feel very happy. My word of advice to you is that there are opportunities galore for physiology in the service of the nation. Take these up with confidence for you have a bright future. God bless you.

Thank you.