EVERYMAN'S SCIENCE

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COVER PHOTOGRAPHS

Past General Presidents of ISCA

1. Sir U. N. Brahmachari (1936)
2. R.B.T.S. Venkatraman (1937)
3. Prof. Rt. Hon. Lord Rutherford of Nelson *(1938)
4. Sir James H. Jeans (1938)
5. Prof. J. C. Ghosh (1939)
6. Prof. B. Sahani (1940)
7. Sir Ardeshir Dalal (1941)

* Lord Rutherford unfortunately passed away before the Science Congress and Sir James H. Jeans presided over the Congress in his place.

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EDITORIAL

KNOWLEDGE SOCIETY AND THE STEEL INDUSTRY

In recent times there has been much talk about strengthening the science base to help India emerge as a knowledge society. As is well known, better financial rewards and other opportunities have been luring students away from scientific pursuits. Planners and thinkers have, therefore, correctly recommended establishment of newer scientific institutions, upgradation of facilities in the existing ones, as well as better incentives to brighter students to attract the student community towards careers in science.

The knowledge society envisaged will, however, also need a technology base to ensure a prosperous economy. The large fundings necessary for to-day's scientific education and research necessarily require a thriving economy based on technological achievements to make available the infrastructure. The iron and steel industry will have a vital role in this.

Some two or three decades ago the world produced around 700 million tonnes of steel per year and the largest share of production was with the developed nations such as the U.S, U.K and Russia. However, for a variety of reasons, the dominant players are now in the east e.g. China. Japan and South Korea. India is poised to enter this group. It should be noted that L. N. Mittal an Indian passport holder, whose world-wide chain of steel companies makes him the largest producer of steel, does not, as yet, have any steel plant in India.

The Indian steel industry is nearly a hundred years old. The earliest steel works were located in Burnpur, Jamshedpur and Bhadravati (Mysore). However, at the time of Independence the country produced anually only about 7 million tonnes of steel which was marginally more than that of China. But today steel production figure for China has risen dramatically to over 300 million tonnes which is about a third of the total world production. Although our planners after Independence had envisaged a production target of 75 million tonnes by the year 2000, our actual production is only about half of this even now. Thus we are producing about a tenth of what China is producing. The steel industry of China is driving its economic growth.

There are, however, encouraging signs now and, with the wind of liberalisation blowing in India, many investors have come forward with proposals to set up new steel plants in various locations, particularly Orissa, Jaharkhand and West Bengal. L. N. Mittal is no exception. These new plants will have to be necessarily more environment-friendly and in the basic sciences will play an important role too. Perhaps the annual steel product in India will exceed the 100 million mark in 15 years.

This journal attempts to propagate the message of science in all its varied branches to its readers and through them to every one interested in science, Engineering and Technology. Generally, however, Engineering and Technology oriented articles are uncommon. To remedy this, a beginning is made in this issue with an article on the iron and steel industry.

Technology Dissemination Centre (TDC) of R & D Centre for Iron & Steel, Steel Authority of India Ltd. (RDCIS), has been publishing a quarterly technology bulletin "*Technotrends*" since 1994. Each issue of *Technotrends* focuses on a specific technology related to steel plants and it is described

in a reader friendly format with the aim of augmenting technological awareness in the Company. TDC has recently compiled the technical articles, published during the last 10 years, in the form of a book "*Steel Plant Technologies-An Overview*."

The book aims to provide a good reference material to practising steel plant technologists, academicians & students in technical institutes and researchers.

From this issue of "Everyman's Science", we are reproducing a few selected articles from this book for general awareness about steel industry.

H. S. Ray

"Where is the knowledge we have lost in information?
Where is the wisdom we have lost in knowledge"

—T. S. Eliot

PRESIDENTIAL ADDRESS

ON RESEARCH IN CHEMISTRY IN INDIA

PROF. J. C. GHOSH*, D. SC., F.N.I.

The Indian Science Congress meets today at Lahore for the third time. Those of us who attended the meeting of the Congress held in 1927 know well that in warmth of welcome and hospitality, and in providing a congenial atmosphere for our deliberations, this city has few equals ; and I am sure that on this occasion also, she will live up to that reputation. As President that year, we had Sir Jagadish Chandra Bose, and I well remember the illuminating address in which he outlined some of his beautiful methods for probing the secrets of plant life. That voice is now stilled in death, but he will always be remembered with gratitude as the great Master and Pioneer whose work and example have revived the spirit of scientific enquiry in India after centuries of stagnation.

Last year, the Indian Science Congress celebrated its jubilee with great pomp in the city of Calcutta, which had witnessed the birth of this Association two years after her dethronement from the proud position of the Imperial Capital. A brilliant galaxy of scientists took part in the deliberations, and for President we had elected the greatest scientist of the British Empire. The sudden death of Lord Rutherford was a cruel blow, but it was some consolation that he finished the writing of his inspiring address which was read by his brilliant successor Sir James Jeans.

* General President. Twenty Sixth Indian Science Congress held during 3 to 7 January, 1939 at Lahore.

As I recall today these great names, I feel weighed down by a sense of responsibility. To follow them is perforce to follow very far behind. Eleven years ago, Professor Simonsen was called to this office, and in the course of his address, he suggested that the chemists of India should study more intensively the wealth of natural materials that lay at their doors, and devote less time to the study of problems of only theoretical interest. In the decade that has passed since Professor Simonsen made this eloquent appeal, the organic chemists of India have made many important contributions to our knowledge in this field. Only recently I attended the symposium on this subject held at Bombay under the auspices of the National Institute of Sciences. Distinguished visitors from Lahore, Bangalore and Calcutta joined in the discussion and it looked like a miniature Science Congress. While not long ago, Professor Simonsen was the solo-scientist in this field, we have now flourishing centres of research at Lahore under the guidance of Dr. J. N. Ray and at Bangalore under Dr. P. C. Guha. Valuable work is being done in Bengal, by Dr. P. C. Mitter, Dr. P. K. Bose, Dr. Khuda and Dr. Guha Sarkar, in Bombay, by Drs. Wheeler, Shaha, Venkataraman and their colleagues, in Madras, by Dr. B. B. Dey, at Allahabad by Dr. S. Dutta and at Aligarh, by Dr. Siddique. Although their interests are mainly pharmacolgical, Colonel Chopra and Professor S. Ghosh have carried out systematic chemical examinations of many indigenous medicinal plants at the School of Tropical Medicine. In very broad outlines, it may be stated that these

investigations have embraced the isolation, the determination of the constitution, and in some cases the synthesis, of a large variety of terpenes, bitter principles, glucosides, plant colouring matters, alkaloids, etc. Special mention may be made in this connection of P. C. Mitter's elegant synthesis of *Munjisthin*. J. N. Ray's work on berberine, palmitine and vasicine, and P. C. Guha's synthetic work on thujane, pinane and camphane series.

To a physical chemist, the development of a new technique for the separation of allied substances occurring together in nature has a special appeal. In the Bombay symposium, Prof. Ray demonstrated the existence of six allied colouring matters in rottlerin by their differential adsorption on specially prepared surfaces of alumina. Equipments for fractional distillation under very high vacuum, 10^{-5} or 10^{-6} cm. of mercury, are now not rare. In the laboratories of Drs. Krishnan, B. B. Ray, K. Banerjee and Mata Prasad, have been installed excellent X-ray equipments for determining the configurations of unit cells in organic crystals. It is hoped that these methods will find increasing application in the Indian laboratories where many difficult problems are now being tackled by chemists who estimate work by its quality and not by any other standard.

The subject of vitamins and hormones have now become favourite topics of conversation even in our drawing rooms ; and in recent years Nobel Prizes have become practically the monopoly of the great leaders in this field-Hopkins, Neuberg, Wieland, Szent-Gyorgi, Haworth and Peters. It is a matter of satisfaction that synthetic work in India is being directed more and more to the preparation of substances of biological importance. The elegant syntheses by Bardhan and co-workers in the phenanthrene, hydrophenanthrene and retene groups which are closely allied to the sex-hormones have justly received a wide recognition. A class of compounds which now fills the centre of the picture in the chemical world is known as the sterols. Irradiated ergosterol is the vitamin D which is responsible for the formation of bones in animal organisms. It is remarkable that in the economy of nature these sterols should be so closely related on one side to the cancer-producing substances and on the other to the sex-hormones. Vegetable oils and plant juice contain any number of sterols, and I commend to your attention the work on plant sterols that is being done by Drs. K. P. Basu and Nath in Dacca.

Dr. B. C. Guha and co-workers have isolated renoflavin from ox-kidney, and have thrown considerable light on the multiple nature of vitamin B_2 of which lacto-flavin is one component. It may interest you to know that pure and crystalline lacto-flavin is now available in the market at a cost of Rs. 1,000 per gram, and physico-chemical methods have been evolved for estimating it even to a billionth of a gram. Since Szent-Gyorgi's classical investigation on the isolation of vitamin C in a pure crystalline form, the determination of its constitution has formed the subject of brilliant work by Haworth and his school. Work of considerable value has been done in India on the occurrence, stability and physical properties of this vitamin. In the pure state, it is easily oxidized by the oxygen of the air, but it is remarkable that it is very stable in plant and animal organisms, though the tissues receive an ample supply of oxygen. This stability has been traced to the simultaneous presence in these tissues of sulphur compounds or of chlorophyll which act as powerful inhibitors of this auto-oxidation (Ghosh and Rakshit).

In the limited time at my disposal, it is not possible to refer to all the investigations in this field, but I have given you sufficient indication of the striking change that has come over in the outlook of our organic chemists. Professor Simonsen's appeal from this chair has fallen on a rich soil and is now bearing ample fruit.

A few years ago, Sir Gibert Morgan referred to the question that was often anxiously raised in the

British chemical circles as to "what had become of Inorganic Chemistry" and gave a decidedly assuring reply by his masterly survey of the progress of Modern Inorganic Chemistry. He showed how apart from such sensational discoveries as the hydrogen isotope or deuterium, Inorganic Chemistry has now gained freshness of outlook and fertile fields of research by new ideas on valence force. Three kinds of links are now well-recognized as binding atoms to form molecules, or binding molecules to form, what we used to call, additive compounds. They are

1. the electrovalent link where the forces are mostly of electrical attraction,

2. the covalent links where the atoms are bound together by sharing two electrons, and

3. the coordinate links where generally both the shared electrons come from the same atom.

The applications of these theories have been amazingly wide. To mention only a few, I may refer to ionic isomerism, isomorphism in crystalline compounds, stability of organometallic compounds, espeically when one associating compound occupies two places in the coordination complex and the elucidation of the structure of even such a complex molecule as $H_3P(W_3O_{10})_4.n.\ H_2O$, where the chemist's intuition has been verified by X-ray analysis.

A similar question "What has become of Inorganic Chemistry in India ?" has often been asked and by no less an eminent person than Sir P. C. Ray. The dawn of modern chemical researches in India was heralded by his discovery of mercurous nitrite which was followed by many interesting studies on the stability and the properties of the nitrites. The University College of Science at Calcutta has continued to be a very active centre of research in this field. Indeed Sir Gilbert Morgan's review contains appreciative references to the researches of Dr. P. B. Sarkar, which revealed the isomorphism of the thicyanates and acetylacetones of scandium with those of the iron family, and to his interesting study on the homology of beryllio fluorides, sulphates, and monofluophosphate ions. This work has been followed by the interesting discovery that a nitrite can form mixed crystals with such an apparently dissimilar ion as the formate. Of the many interesting contributions of Professor P. R. Ray, I may mention his preparation of the two isomeric modifications of thiosulphuric acid, whose salts are commonly known as hypo in commerce.

One of the most remarkable developments in the field of Inorganic Chemistry has been the discovery of specific reagents for detecting and estimating metallic radicals even when present in such small traces as one millionth of a gram. These newer methods of microchemical analysis bid fair to supersede, in ordinary laboratory practice, the painstaking and disagreeable methods of qualitative and quantitative separation which have hitherto formed the basis of a chemist's practical training.

To the Indian chemists we owe the introduction of many important microchemical reagents, e.g. rubeanic acid, urotropine, quinaldinic acid, dimercaptothiobiazole, and the triple nitrites of the alkali and rare earth metals. These names may appear as Greek to many votaries of other Sciences who are present here, but I may assure them, that if these regents were in common use in their early youth, the goddess of Chemistry would not have appeared to them in her frowning forbidding looks, and perhaps many of them would not have hesitated to transfer even their allegiance to her.

But when all is said and done, it cannot be denied that the enthusiasm for research in organic Chemistry has overshadowed the claims of Inorganic Chemistry in India. Isolated work in this field appears often from the laboratories of Lahore, Patna, Bombay and Bangalore, but they do not appear to emanate from flourishing centres of research, where the wisdom and experience of elders combine with the freshness, enthusiasm and

devotion of the younger men and create new channels of knowledge. This lop-sided development is indeed to be deplored. They say that all knowledge is one ; and with greater truth can it be said now, that there are no longer any barriers between organic and Inorganic Chemistry. With our newer ideas of valency, the systematization of the enormous accumulation of chemical facts is no longer the prerogative of Organic Chemistry. Nor can it be said now that the nature of carbon-carbon links is better understood, in spite of its regularity of behaviour, than the links between the other atoms. The elucidation of the structure of inorganic compounds has to be tackled more or less on the same principles which are familiar to the organic chemists. In the common region of the two Sciences a vast body of organometallic compounds has emerged, which apart from their interest in microchemical process of analysis, are now working miracles in the fields of industry and in the alleviation of human suffering. I need only mention a few names–lead tetraethyl, neosalvarsan, neostibosan. Our president of the Indore Session described last year how Kala Azar had been practically eliminated from the otherwise smiling fields of Assam and Eastern Bengal, with the aid of the drug ureastibamine. Antimony III pyrocatechine disulphonate of sodium has brought under control Bilharziasis in Egypt, and is now named Foaden after the King of Egypt, who took a great interest in this work. With Inorganic Chemistry revitalized by the electron concepts of valence, there is a rich harvest to be garnered in the near future by our brilliant young chemists, if only they could resist the lure of pure Organic Chemistry.

A sketch in bold lines of the progress of Physical Chemistry in India, may not be out of place here, if only to complete the picture that was drawn by Professor Bhatngar as the President of the Chemistry Section of our congress in 1928. It was only after the war that this branch of Chemistry came really to be cultivated in the Indian laboratories. Progress here depends no doubt, as in other branches of knowldege on inspiring leadership ; but the proper equipment of laboratories is also an equally vital factor for success. In many centres, this youthful Science has suffered from a chronic anæmia for lack of funds available for research ; and the cry has sometimes been raised in authoritative circles, that in consideration of this lack of resources, physical chemistry should better be merged into physics. It is also extremely unfortunate that the professorship of Physical Chemistry in the Indian Institute of Science at Bangalore should have been kept in abeyance, and the department practically wiped off the scene. Now that the Irvine Committee has strongly deprecated this measure of retrenchment, it is to be hoped that the department of Physical Chemistry should re-occupy, at an early date a worthy place in that Institute, which was intended to be the premier centre for chemical researches in India.

The credit of initiating researches in Physical Chemistry in India goes to Professor Dhar who was called to the chair of Chemistry at Allahabad in 1919. Then came in 1921, the three musketeers from the laboratory of Professor F. G. Donnan– Bhatnagar, Mukherjee and Ghosh ; and later on the torch has been kept burning by Qureshi at Osmania, Joshi at Benares, Mata Prasad at Bombay, Ganguli and Ray at Patna, Krishamurty and Kappanna at Nagpur, Ramkrishna Rao and Gopal Rao at Waltair, and Sanjib Rao and Jatkar at Bangalore.

During recent years Dhar and his pupils have applied the methods of Physical Chemistry to the elucidation of various chemical processes that occur in soils and have come to the conclusion that tropical sunlight is one of the governing factors in these transformations. Such powerful radiations easily decompose potassium nitrate, bring about reaction between sulphurous acid and oxygen, give rise to formaldehyde in solutions of alkaline bicarbonate, and in presence of catalytic surfaces like zinc oxide, and titanium oxide, even produce amino acids by reaction of glucose with potassium

nitrate. They have observed that amnio acids are readily oxidized to ammonia in air and light, and ammonium salts in their turn are oxidized to nitrites and nitrates. These observations coupled with the fact that the amount of nirate in the soils of Northern India is maximum in summer when bacterial activity is practically negligible, lead to the very important conclusion that tropical light plays an important rôle in the nitrification of soils. The parallel investigations of Fowler, Subramanyan and their collaborators on the fixation of nitrogen in energy-rich soil with the aid of microorganisms, of Dr. P. K. De on the fixation of nitrogen by pure algæ and of Dhar on the fixation of nitrogen by catalytic surfaces during the photo-oxidation of organic residues are throwing a flood of light on the economy of carbon and nitrogen in the soil system. This is, as it should be, for the fundamental problem of Indian agriculture is the conservation of nitrogen and moisture in the soil. It is a matter for sincere congratulation that these researches on soil processes will be continued with greater chances of success, because of the singleness of purpose and devotion, in the Indian Institute of Soil Science which has been recently established at Allahabad by Professor Dhar.

While Professor Dhar's interest has centred round the physico-chemical processes that occur in soils, Professor Mukherjee has of late concentrated his attention on the colloid chemical behaviour of the soil constituents. He has applied with success his well-known theory of the electrical adsorption of ions to the elucidation of the properties of clay-acids and soil-suspensions. The accurate experimental technique which he has evolved, in this connection, for the determination of cataphoretic speed, and for conductometric and electrometric titration of acid-sols is well-worthy of imitation in all soil Science and electrochemical laboratories. The colloid constituents of the soil are responsible for many of its most important physical properties, its power of holding water, of forming crumbs and tilth and for its general relation to plant growth. Professor Mukherjee has gone into the root of the problem. He has made comparative studies of the changes that happen when alkali is gradually added to

1. Simple sparingly soluble acids in :

   (a) presence, or

   (b) absence of solid phase.

2. Colloidal acids like palmitic and silicic acids and finally.

3. Far more complex clay acids.

His programme of work may well serve as a model when a complex piece of very difficult research is planned ; results of far-reaching value have thus been obtained which have received wide recognition in Europe. It is also worthy of note that researches on the colloidal behaviour of drilling mud has just been started by the Assam Oil Company under the supervision of Professor Mukherjee at Calcutta. The problem of reversible transformations of suspensions into jelly-like masses and *vice versa* is also of great technical interest. The studies of Professor Mata Prasad on the mechanism of the formation of many inorganic and organic gels thus deserve special mention. By the proper control of H^+ ion concentration, he has prepared many beautiful transparent gels whose properties are being exhaustively studied by him. An important application of the methods of colloid chemical separation to a problem of great therapeutic interest has been made by Dr. B. N. Ghosh who is investigating the physico-chemical properties of snake venom. The possibility of separating completely the neuro-toxin from the haemolysin factor in the snake venom appears to be at a promising stage of development.

Apart from his ever-increasing activities as a pioneer industrial chemist, to which reference will be made later, Professor Bhatnagar has carried on systematic investigations on Magneto-chemistry

and molecular structure. Perhaps the most sensitive instrument that has yet been designed for the study of magnetic susceptibility is the Bhatnagar–Mathur interferometer balance, which has now been put in the market by Adam Hilger, Ltd. I wish it were, possible to discuss in detail and in a non-technical manner, the more important contributions of Bhatnagar, D. M. Bose, P. R. Ray and Krishnan to the rapidly developing field of Magneto-chemistry. It is well-known that in a non-uniform field, paramagnetic substances experience a tractive force towards the strongest part of the field, while diamagnetic substances experience a similar force to the weakest part. Bhatnagar has shown that such magnetic behaviour is not an unchanging property of atoms or ions. The remarkable fact has been noted that paramagnetic substances like iron, nickel and cobalt, exhibit diamagnetism when adsorbed by charcoal, which indicates that chemical valence forces are in operation in the process of adsorption. The magnetic susceptibilities of organic isomeric molecules are not the same, but depend on the arrangement of the atoms in the molecule. Again the study of chemical reaction in a magnetic field has led to the important generalization, that the velocity of reaction is accelerated, retarded or unaffected by the field according as the sum of the molecular susceptibilities of the final products is greater, less or equal to the sum of the molecular susceptibilities of the initial substances.

Important researches are in progress at Benares on the mechanism of chemical reactions under electric discharge. It has been found that many chemical reactions will occur only if the voltage across the reaction space exceeds a limiting value which has been aptly termed the threshold potential. Traces of impurities which act as catalytic poisons also increase considerably this threshold potential. Velocities of reaction were also found to be markedly depressed in presence of molecules which have large affinities for electrons.

While the laboratories at Lahore and Benares are engaged in the study of properties of molecules in magnetic and electric fields, physico-chemical researches in Dacca have been concerned with an intensive study of the interplay of matter and radiation, mostly in liquid systems. The nature of such interaction when atoms and molecules are in the gaseous state, is now fairly well understood, but in liquids the phenomenon is much complicated. Our interest ceases when the light absorbed is simply converted into heat. But radiant energy, of a particular wavelength, may in some cases be absorbed by a molecule, which immedicately emits a band of secondary radiation. This is the so-called fluorescent band. For a true understanding of the mechanism of the process it is necessary to measure accurately the distribution of energy over the various wavelengths of such a band and also to compare the amount of radiant energy absorbed by a molecule with the amount that it emits as fluorescence. This ratio is called the fluorescent yield. Absolute photometric methods of extreme sensitiveness have been devised, and some of the results obtained may here be stated. As the concentration of fluorescent molecules in an inert solvent like water or alcohol diminishes, the fluorescent yield increases until a maximum steady value is reached at molecular concentrations of the order of 10^{-4} or 10^{-5}. Electrochemical studies indicate that at these low concentrations, the fluorescent molecules only exist as simple ions whereas at higher concentrations ionic aggregates or micelles are formed. The decrease in fluorescent efficiency is associated with an increase in the complexity of ions. Even, under the most favourable conditions, this efficiency never reaches unity. Molecules like rhodamine and fluorescien are good energy tranformers, the yield reaching up to 0.8, while low down in the list we have phosphine G with an yield of 0.1 of the absorbed energy. A molecule of rhodamine again may absorb a quantum of radiation corresponding to wave lengths 313, 365, 436, 546, 10^{-7} cm. But in each case, the nature of the fluorescent band and

the amount of fluorescent energy per quantum of absorbed radiation remain the same, though the absolute magnitude of the exciting quanta thus varies over a wide range. It is possible to go deeper into the problem. For example, in the delicate experiments of Mr. S. Mitra a beam of light with vibrations arranged in one plane only, was made to strike such a molecular target in a viscous medium, and the fluorescent light measured along a direction normal to the plane containing the direction of vibration and the direction of propagation of incident light. It was found that in the fluorescent light the vibration along the direction of propagation is generally less intense than the vibration in the perpendicular direction. This anisotropy, or polarization as it is called, diminishes as the viscosity of the medium diminishes. This is to be expected for if within the life period of the excited molecule, which is of the order of 10^{-10} second, the fluorescent molecule is capable of considerable free rotation in all possible directions, no particular direction of vibration will be favoured in the emitted light. Based on this elegant method, the life period of excited molecules has been measured.

The emission of fluorescent light is a relatively simple response called forth in a molecule under the stimulus of radiation. A more complex process occurs when the radiation is stored up as the internal energy of molecules. The green plants bottle up sunshine to the extent of 670,000 calories when they transform six gram molecules of carbon dioxide and water into one mol of sugar. These are the fundamental capitalists of the world on whom all the animals have to depend for their existence. A molecule with such an accumulated store of energy may occasionally remain fairly stable as in the case of sugars. But in other cases instability and far-reaching changes are noticed ; for example, with bromine the molecule splits up into two atoms ; in the case of iodine, either the molecule is split up or an excited molecule is formed. These free atoms and excited molecules are very active agents and they start all kinds of reactions when other receptive molecules are present. Where the induced chemical reaction is attended with evolution of heat, each such atom or molecule acts, as it were, as a centre of explosion, which proceeds in a chain involving sometimes the transformation of hundreds of molecules. The conditions which are favourable for the propagation of such chains, the dependence of the chain length on the magnitude of the quantum of radiation responsible for starting the chain, the disruption of the chain by substances which we call catalytic poisons, the life period of excited atoms and molecules, and of the unstable substances that are formed as intemediate products in such reactions–these are some of the problems which have been studied in Dacca.

It is possible with the aid of suitable devices to obtain a beam of light in which the vibrations are circular and either dextro-rotatory, i.e. moving in the direction of the hand of the clock, or lævo-rotatory, i.e. moving in a contrary sense. Such radiations may be called in short dextro-light or lævo-light. If dextro–light has a different velocity than lævo–light in a medium, the medium is said to be optically active. Again if the absorption coefficient of dextro–light is different from that of lævo–light, the medium is said to be circularly dichroic. Such optical activity and circular dichroism are often exhibited by naturally occurring molecules ; and the prevalence of such asymmetry in living organism has been considered as a proof in favour of vitalism. The brilliant researches of Kuhn in 1930 indicated how with the aid of one kind of circular light, an asymmetric molecule can be decomposed in preference to its optical isomer which is always present in equal amount in all synthetically produced sub-stances. The plant pigments which under the stimulus of solar radiation are responsible for the production of complex organic materials, exist in living cells as colloidal micelles, which are both optically active and circularly dichroic. Attempts to prepare relatively

simple colloidal micelles exhibiting circular diochroism have been quite successful in our laboratories. When colloidal solutions of tungstic acid, vanadic acid, or ceric borate are allowed to mature in dextro-light which they are capable of absorbing, the molecules during the process of aggregation to form micelles appear to be subjected to the directive influence of such radiations. Such colloidal solutions have greater absorption for dextro–light than for lævo–light, i.e. they become circularly dichroic. Experiments now in progress also lead to the conclusion, that these dichroic suspensions, which become active oxidizing agents under the influence of light, exhibit differences in the velocities of oxidation, when exposed to equal intensities of oppositely polarized circular vibrations. It looks now, as if it may be possible to prepare in the laboratory, simple anisotropic catalysts which will produce much faster one optically active substance in preference to its isomer.

I should not let this occasion pass without dwelling on a matter of vital importance relating to the training of a physcial chemist. Half a century ago, this Science was brought into being by the labours of Van't Hoff, Arrhenius, Ostwald, and Raoult. Even the mathematical equipment of Van't Hoff, the greatest of these leaders, was according to Sir James Walker, no better than that of an ordinary graduate in Mathematics. An easy familiarity with relatively simple mathematical tools coupled with a clear grasp of the fundamental laws of Physics, has since enabled many to collect a rich harvest from the virgin soil. But things are now changing fast. The appointment of Dr. Lenard Jones to the chair of Inorganic and Physical Chemistry in Cambridge is a symbolic event. Of a physical chemist is now demanded not only a sound basic training in Chemistry, supplemented by a high experimental skill in handling delicate instruments but also a clear understanding of the higher branches of Applied Mathematics and Statistics. How we wish that we were trained up on this basis ; but let not those who come after us, have occasion to complain that they did not receive proper guidance and counsel in the years of their apprenticeship. And I appeal to the Indian Universities to take up seriously the question of a thorough over-hauling of the methods of teaching this branch of knowledge.

I must confess that the section of Physics and Mathematics has to its credit more far-reaching discoveries than the section of Chemistry. I need only mention the Raman effect, the Shaha theory of thermal ionization in stellar systems and the Bose Statistics. I should like to stress here one great obstacle to progress, which the chemists of India have not yet been able to remove. Chemists are apt to describe themselves as the most painstaking of all animals–not even the ass excepted. It is more true of their Science than that of any other, that innumerable experiments must be performed, innumerable facts observed, catalogued, correlated and classified before an important generalization can be made or the structure of a new conception of the phenomenal world can be raised. But life is short and Science is long. Hence it is, that we find that outstanding discoveries in Chemistry have in recent years been made in laboratories, where inspiring leadership has been associated with large-scale team work. The paper on the synthesis and constitution of vitamin C appeared from the Birmingham laboratories under the joint authorship of a team of seven workers. Such teamwork is, however, yet comparatively unknown in India. It is to be deplored that the idea of close cooperation among the scientific workers, has not taken a firm root in the Indian soil. Is it due to the fact, that the traditional religious atmosphere of India teaches a child to be self-centred, to be complete within himself and to work out his own salvation, unaided and in isolation ? Then again, I am told, that a tradition has grown in some institutions, that the senior member of the staff is given credit for senior authorship in a joint publication, independent of any consideration of the share he may have in the

planning and execution of the work. This, if true, is unfortunate, for the highest spirit of cooperation, loyalty and devotion can only be evoked in an atmosphere of impartial justice and deepest sympathy and good will. Notwithstanding these handicaps, there are pointers to the road of success. In the palmy days when Sir C. V. Raman was Professor in Calcutta, one could easily feel that in his laboratory, the researcher has become forgetful of self and mindful only of the work ahead. One also notes with pleasure the observation of Sir John Russel that Professor Mukherjee is fortunate in having secured the help of a band of skilled and devoted workers in his researches on soil colloids. Any casual reader of Indian publication in Chemistry will not fail to see that work of considerable value has been done during the last decade. He will observe, however, that it is the individual enterprise in research, rather than a magnificent team work to solve a fundamental problem, which has been up till now, the keynote of our activities. But for greater efforts and higher achievements we should all endeavour to inaugurate an era of cooperative team work.

Within the precincts of this university, it is not necessary that I should have to make a special pleading for the thesis that scientific knowledge and industrial activities should be coordinated or that our academic laboratories should not be divorced from practical affairs. We have here a flourishing Honours School of Technical Chemistry ; and the genius of Professor Bhatnagar has provided a bridge of communication between scientists and industrialists. Nowhere is the beneficial effects of contact between universities and industry better exemplified than in the programme of researchs on oil technology now carried out under the supervision of Professor Bhatnagar, with the aid of funds provided by Messrs. Steel Brothers. In pre-war days, such close intimacy existed in Germany alone, with the result that she rapidly out-stripped her rivals in industrial enterprise. But a new epoch of industrial research in Eurpoe and America has begun with the end of the great war. Last year in the Presidential address of Lord Rutherford we had a very clear exposition of the extensive activities of the Department of Scientific and Industrial Research in Great Britain. He stated with evident satisfaction that this bold experiment in the cooperative organization of research, which is unique in the world, had undoubtedly proved a great success.

The Government of India have, in recent years, done a good deal in promoting researches relating to plant industries. The Royal Commission on Agriculture has ardently looked forward to a state of affairs in which the universities will not only initiate agricultural research but will also undertake schemes of research, the importance of which is brought to their notice by the departments of agriculture. This end has been steadily kept in view by the Imperial Council of Agricultural Research. We have already referred to the researches of Professor Dhar and Mukherjee. With the aid of funds provided by this council, long-range schemes of research are in progress in the statistical laboratory of Professor Mahalanobis at Calcutta, in the chemical laboratories at Dacca, and in the botanical laboratories of Agra, Madras and Benares. The cotton technological laboratory at Bombay, the Institute of cotton breeding at Indore, the Imperial Institute of sugar technology at Cawnpore, the cane breeding station at Coimbatore, the jute technological laboratory at Calcutta and the agricultural research laboratory for jute at Dacca are notable examples of the solicitude of the Central Government for meeting the research requirements of valuable money crops. Researches on forest products have been organized in the Forest Research Institute at Dehra Dun and the Lac Research Institute at Ranchi. The work that is being done in these institutions has gone far to refute the allegation that Indian chemists are doing little to help industry. Take for instance, the lac industry. Researches are in progress under Dr. H. K. Sen, relating :

1. To better methods of washing stick-lac to produce high grade seed-lac,

2. Separation of pure lac resin from ordinary shellac,

3. Bleaching of lac,

4. Recovery of refuse lac, and

5. Production of moulded articles for electrical industry and household use.

With synthetic resins, like bakelite, having entered the field, it is certain that severe competition is ahead. But now that Science has been linked to this industry, we may hope with greater confidence, that the lac industry of Chotanagpur will not meet with the same fate as the indigo cultivation of Behar.

At Dehra Dun the "Ascu" process of Mr. Kamesam which fixes arsenic and copper in wood through the agency of chromium salts has given rise to a wood preservation industry. The researches of Dr. S. Krishna on "Ephedra" have helped Baluchistan in organizing the trade in this drug. Of particular interest is the work that is now being done there on vegetable tallows. The physical and chemical properties of mowra tallow and sal butter have been studied, and they are recommended as admirably suited for yarn sizing. It is estimated that about 400,000 maunds of these tallows can be put in the market ; and owing to their cheaper cost of production, they are expected to displace animal tallows for various industrial purposes. Nor should we forget to mention that researches conducted on proper utilization of such forest products as bamboo and grass, have resulted in the establishment of several paper factories ; and the time is not far off when the country will be producing enough pulp from these raw materials to meet the overgrowing demand for paper. Dr. Chaudhury and co-workers at Dacca have made extensive studies on the properties of the jute fibre. They have found that colour can be improved considerably by the action of chlorine peroxide, the tensile strength and resistance against rot by the action of formaldehyde, that jute nitrocellulose can be made as stable as cotton nitrocellulose, and that owing to its lower viscosity and high solubility, it would be more useful for the lacquer industry. It has been found that the jute plant does not ret in tanks of galvanized iron ; and Dr. Barkar, in his recent review of jute industry in India, has drawn pointed attention to this observation, as indicating the possibility of controlled retting in central stations for the production of high grade fibres.

I have dwelt in some detail on these researches on money crops which have received generous assistance from public funds, in accordance with the recommendation of the Agricultural Commission, with a view to bringing out in bolder relief the cold indifference with which the recommendations of the Indian Industrial Commission have been received by the Central Government. Much was expected of the policy laid down by the Government of India in 1915, under the stress of the war, that India would consider herself entitled to demand the utmost help which her Government could afford to enable her to take her proper place in the world as a manufacturing country. But these lessons of war were soon forgotten, and all that has been achieved is the setting up of an Industrial Research Bureau, controlling with the aid of an Advisory Committee, a small research laboratory attached to the Test House at Alipur. The report of this Bureau for 1937–38 is a miserable document compared with the corresponding report of the Imperial council of Agricultural Research. I should not be misunderstood. I have no complain against the personnel, but only against the stepmotherly treatment meted out to industrial research in the country. Nor should we forget that many great leaders of public opinion have been so impressed by the evils of the modern capitalistic world that they have not hesitated to declare that the introduction into India of the scientific and technical

methods of the west should be resisted ; that it is no business of governments to subsidize higher scientific research ; those who employ scientific men or exploit their researches should pay for their training and provide them with facilities for work. The forces of public opinion and of Government rarely join hands in this country, but men of Science found to their dismay, that this miracle was going to happen in this instance. It was feared that human society in India would in the end crystallize into a community of artisans and peasants. It is therefore with great relief and thanks giving that we welcome the resolution passed at the conference of the provincial Ministers of Industries recently held at Delhi that the problems of poverty and unemployment, of national defence and economic regeneration in general, cannot be solved without industrialization ; and as a step to such industrialization, a national planning committee should be set up which will formulate comprehensive schemes for the development of industries in India.

As an indispensable adjunct to this planning commission there should be set up an All India Council of Scientific and Industrial Research with functions and powers similar to those entrusted to the Department of Scientific and Industrial Research in Great Britain. In India, however, men and things get, so easily and without questioning, under offical control that it would be apt to quote here the following observations of Lord Rutherford–"In Great Britain the responsibility for planning the programme of research even when the cost is directly borne by the Governement rests with research councils and committees who are not themselves state servants, but distinguished representatives of pure Science and industry. It is to be hoped that if any comparable organization were set up in India, there will be a proper representation of scientific men from the universities and also of the industries concerned."

Indeed for any one who has followed the recent happenings in this world, with any attention, this industrial planning for India would seem to be long overdue. Now, more than ever, a planning on all fronts, would seem an urgent and immediate necessity. The lesson of the crumbling empires, and the rapid rise of countries organized in deadly earnest are patent to all but the oblivious utopian. If an industrial and progressive India appeared a desirable necessity in 1915, how much more urgent and imperative would such a task of consolidation of her intellctual and material resources appear to all in 1938. But we orientals often forget realities, in our search for the ideal ; with the furious tempo of development and consolidation all round, the least delay, however, in this urgent task may prove fatal and irreparable in the end. Already we are regrettably late in putting forth our best efforts in this direction, but now that events have rudely awakened us to the dangers that our slackness exposes us too, we should try to make up for lost time by forced marches in the path of progress, and by a resolute determination to pool all our material and intellectual resources to solve our own problems. It is obvious that such a tremendous task cannot be achieved by isolated efforts of industrialists, and by private enterprise. The utmost cooperation of the individual with the state will be necessary if real success is to be achieved.

The stupendous task need not make us despair. The very creditable performances of her sons in the different spheres of scientific and intellectual activity have amply demonstrated that with proper guidance and plan, India is quite capable of solving her own problems, and of maintaining her position and ideal with dignity and prestige. What is only wanted is prudence and foresight, liberal statesmanship resolute cooperation and efficient leadership.

The universities of India have a great responsibility to discharge at this juncture. If the process of industrialization is going to be a forced march in this country it will not do for them to take

up an attitude of *laissez-faire*. The forces of nature are the enduring wealth of mankind, but for the solution of India's economic problems and the prosperity of her 380 millions, it is necessary that brilliant young men should be trained up in ever-increasing numbers, who are capable of tapping these sources of wealth. The modern young student of Science must realize that while fundamental theoretical work must continue to be basis of all scientific advance, his subject would lose much of its importance, if this training did not fit him for tackling large-scale problems which arise in industries. Simulataneously with the development of industries, there arises in every country a great demand for well-trained personnel to man these industries. Professor Philips recently estimated that 12,000 graduates in Chemistry are employed in industrial pursuits in England. Lord Rutherford even complained that the demand in England for well-trained researchers in Physics had outrun the supply. Dr. Hamor, assistant Director of the Mellon Institute for Industrial Research, has estimated that in 1937, America spent about 100 million dollars in scientific and industrial research ; and though the expenditure is high, the results have more than fulfilled expectations, even if for a time, some of them may be kept secret. Such a consummation may be long in coming to India, but every effort should be made to prepare the ground in advance. A very good example of what the Indian universities can do in this direction has been shown by Bombay, where under the inspiring leadership of Mr. Chandravarkar and the able guidance of Dr. Forster, an Institute of Textile Chemistry and Chemical Engineering has been established, which in equipment has few equals. Already successful students have so proved their worth, that, I am told, there is an advance booking from the mill owners for the products of this institution.

It is a welcome sign of the times that the Indian industrialists are not all blind to the value of research as a means of improving production, and in consequence, of increasing the demand. The Tata Iron and Steel Works have led the way by the foundation of a magnificent laboratory at Jamshedpur for the study of alloys of iron and steel. The Lala Sriram Trust contemplates establishing soon at Delhi and Institute on the model of the Mellon Institute of America. The Luxminarayan Bequest at Nagpur may soon begin to yield the beneficial results which the donor so ardently cherished. But when one recalls that most of the industries in India are now sheltered by a tariff wall–call it revenue tariff or protective tariff as you like–and that a substantial part of the income of the Indian business magnates accrues to them because of this tariff, one has a right to expect a much wider recognition on their part of the need for cooperation between Science and industry, and a greater readiness to endow industrial research with a view to cheapening production. Such research is considered, in all enlightened countries, as an insurance against the dark days ; and today when the world seems so much out of joint, the enlightened industrialists should do well to consider themselves only as servants of society–essentially moral beings whose main dividends are the benefits, which they confer by providing employment, and by manufacturing commodities essential for the national well-being.

But the world will not be set right if this change in outlook were confined to one class of men only. Every intelligent man and woman have now got to ponder deeply over the problem that the scientific search for truth has not assured the advance of civilization. Inventions intended to relieve toil, and to control the forces of nature which should have given to all a fuller and more satisfying life, have been perverted into forging instruments of destruction. The paradox of poverty amidst plenty mocks us in the face. In one part of the world wheat and cotton are being burnt and milk thrown into streams, while in another part half-naked people are starving. It is not difficult to get at the root of

this evil. In respect of scientific knowledge and its applications to the problems of life, each generation stands on the shoulders of the preceding one, but in respect of social, cultural and spiritual qualities, no comparable development is noticeable–perhaps there has been a retrogression since the days of Asoka and Christ. Modern Science has, indeed, become a menace to civilization, because we have refused to work for social justice, because the interests of individuals and communities have not been subordinated to those of the country, and because considerations of patriotism and the prejudices of race, creed, and colour, have been allowed to override the wider considerations of humanity. Therein lies the tragedy of the modern world–the tragedy that we witness in the flaming cities of Spain and China, in the mountain homes of Abyssinia, and in the concentrated hatred in the armed camps of Europe.

"It is not enough that mankind should be provided with tools of progress. It is a much bigger task to teach them how to use these tools. Men of Science cannot escape moral responsiblity even for the evil fruits of their labours." The chaos of modern world is calling out to every man of good will and understanding to join in a great educative effort, with a view to making the minds of men more flexible and adaptable, with a view to removing those narrow prejudices which are choking the paths of progress. These prejudices did not matter much in olden days, when communications were difficult–in fact, they were born because of such inacessibility. But today when increasing rapidity of communications is causing the world to shrink with a disconcerting rapidity, these prejudices spell disaster for mankind. We, on this occasion, therefore welcome the efforts of the British Association and the American Association for the Advancement of Science to mobilize the moral forces of the world for promoting better relations between men and nations, and we offer them our willing cooperation.

In this hall, many years ago, the first President of the Indian Science Congress, Sir Asutosh Mookerjee concluded an inspiring address with the hymn.

"Where knowledge is free

Where words come out from the depths of truth,

Where the clear stream of reason has not lost its way into

the dreary desert sand of dead habit.

Unto that Heaven of Freedom, my Father, let my country awake"

Search for such a Heaven of Truth and Freedom–self-surrender to such a great quest–it is to this, that the noblest spirits are called ; and it is such men and women who make the world a better place to live in. May we all join in this quest.

DIVINE PROPORTION : THE MATHEMATICS OF GOD

Ayon Ghosh*

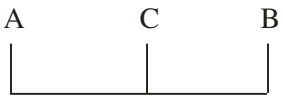
Phi, a number so unique in nature that the Renaissance intellectuals and artisans considered it to be the quintessence of God Himself. A number that exists in and all around us, in all living beings including ourselves, to which we can attribute the 365 days of the year, the 360 degrees system of measuring angles, and paganism.

INTRODUCTION

Is there really a number that represents God? Is there a number that is more intriguing than pi or Euler's number ? As a matter of fact, there is, the elusive phi, what mathematicians claim is one H of a lot cooler than pi. Truly, one of the most intriguing numbers in mathematics is the Golden Ratio, also known as the Divine Proportion, named *phi.*

By Euclid's definition in *The Elements* which almost definitely is not an original work, the Golden Section is a geometric proportion in which a line is divided so that the ratio of the length of the longer line segment, called the *major,* to the length of the entire line is equal to the ratio of the length of the shorter line segment, called the *minor*, to the length of the longer line segment.

Here is a diagram to illustrate the situation :



In the above diagram, a golden section is created by the point C on line segment AB if $\frac{AC}{AB} = \frac{CB}{AC}$, provided that AC < AB. What, exactly, is the mathematical value of this ratio ? There really is an easy way to derive that, provided we know about quadratic equations, and ratio and proportion Let AB = 1 unit, and the length of AC = x units.

Now, by condition of the golden section :

$$\frac{AC}{AB} = \frac{CB}{AC}$$

$$\text{or,} \quad \frac{x}{1} = \frac{(1-x)}{x}$$

$$\text{or,} \quad x^2 + x - 1 = 0$$

The above is a quadratic equation that gives two real and unequal roots. $\frac{(\sqrt{5}-1)}{2}$ and $\frac{(-\sqrt{5}-1)}{2}$. Now, the latter value is not possible, since the value of x cannot be negative. Thus, the value of the golden section, or divine proportion, as we have obtained, is $\frac{(\sqrt{5}-1)}{2}$, which expressed as a decimal, up to thirty-four significant figures, is aproximately 0.61803398874989484820458683436563 8..... It is said that a recetangle with sides in the ratio phi exbibits a special beauty. From Euclid's pentagon, it is obvious that in a pentacle (or, pentagram, that is, a symmetrical five-pointed star), the lines are divided according to the Golden Section. This is the reason why many cultures all over the world consider the pentacle to be a divine or magical symbol.

WHY PHI IS SPECIAL

What makes phi so special? Here are just a few reasons out of many. When you add the length of

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the major line segment, that is, AC, to the previous whole segment, that is AB, the new whole is again the same phi ratio to the initial whole, and the new one to the next, and so on. In fact, you may go on repeating this process till infinity but you will continue to get that same phi ratio!

The same is also true for the traingles, rectangles, cubes, parallelepipeds, triangular prisms, tetrahedral pyramids and logarithmic spirals formed from this golden ratio. It also applies to the construction of the regular pentagon and pentacle since this figure is entirely formed from golden triangles and produces phi over and over again with the ratios between its component lengths.

The magic phi lies in its mirroring property. The sequence of all digits after the decimal point in the number phi mirror exactly those in its reciprocal, that is, $\frac{1}{\text{phi}} = 1 + \text{phi}$. There is an easy way to prove this :

Now, $\text{Phi} = \frac{(\sqrt{5}-1)}{2}$

Therefore, $\frac{1}{\text{phi}} = \frac{2}{(\sqrt{5}-1)}$

$$= \frac{2(\sqrt{5}+1)}{(\sqrt{5}-1)(\sqrt{5}+1)}$$

[rationalising the denominator by multiplying both numerator and denominator with $(\sqrt{5}+1)$]

$$= \frac{2(\sqrt{5}+1)}{(5-1)}$$

[since, $(a + b)(a - b) = a^2 - b^2$]

$$= \frac{2(\sqrt{5}+1)}{4}$$

$$= \frac{(\sqrt{5}+1)}{2}$$

$$= 1 + \frac{(\sqrt{5}-1)}{2}$$

$$= 1 + \text{phi} = \text{phi}^0 + \text{phi}^1 = \text{phi}^2$$

Similarly, $\text{phi} + \text{phi}^2 = \text{phi}^3$, $\text{phi}^2 + \text{phi}^3 = \text{phi}^4$, $\text{phi}^3 + \text{phi}^4 = \text{phi}^5$, and so on....

Thus, one of the most important properties of phi is that : $\text{phi}^n + \text{phi}^{n+1} = \text{phi}^{n+2}$, where n is any real number, that is, integer or fraction, positive or negative, including zero. It is easy to prove this property in the same way as has been proved above. Thereby we get a golden progression as follows :

$$\ldots \frac{1}{\text{phi}}, 1, \text{phi}, \text{phi}^2, \text{phi}^3 \ldots$$

in which each term equals the sum of the preceding two terms, as in the Fibonacci sequence. In fact, phi has a remarkable connection with the Fibonacci sequence which will be discussed later on.

Another interesting property of phi is that it is the sum of its reciprocal powers up to infinity. In mathematical form :

$$\frac{1}{\text{phi}} + \frac{1}{\text{phi}^2} + \frac{1}{\text{phi}^3} + \frac{1}{\text{phi}^4} + \frac{1}{\text{phi}^5} + \frac{1}{\text{phi}^6} + \cdots = \text{phi}.$$

$$\sum_{n=1}^{\infty} \text{phi}^{-n} = \text{phi}$$

A series very similar to the Fibonacci sequence can be generated from this number. It is observed that $\text{phi}^{-d} - \text{phi}^d$ (where d is an odd natural number) gives a natural number, and $\text{phi}^{-n} + \text{phi}^n$ (where n is an even natural number) also gives a natural number. Working on this progression, we will get a series as $(\text{phi}^{-1} - \text{phi}^1)$, $(\text{phi}^{-2} + \text{phi}^2)$, $\text{phi}^{-3} - \text{phi}^3)$, $(\text{phi}^{-4} + \text{phi}^4)$, and so forth. The series, in number, is 1, 3, 4, 7, 11, 18.... This is quite similar to the Fibonacci series, since each term in the series is the sum of the preceding two terms. Moreover, the ratio between these terms approach closer and closer to phi.

HISTORY OF PHI AND ITS APPLICATIONS

All this while we had been talking regarding the mathematical aspect of the Golden Section, phi. Let us now look towards the historical side of it. which is even more interesting. The ancients regarded phi as God since phi is the most beautiful number in the world, or perhaps, even in the Universe.

In the 16th Century, Luca Pacioli (1445-1514), geometer and friend of the great Renaissance painters. rediscovered the 'golden secret". Luca pacioli, however, was a great admirer of the Golden Section, as evidenced by the name of his treatise, *Divina Proportione* (1509), which actually comprises three indepenent works.

Leonardo da Vinci (1451-1519) was one of the greatest versatile geniuses in the history of humankind. He was the first to study the human figure and find the Divine Proportion in relation to its various parts. Leonardo's unfinished canvas a Saint Jerome shows the great scholar with a lion lying at his feet. A golden rectangle fits so wonderfully around the central figure that it is often said the artist deliberately included the golden ratio in the proportions of the painting, which is likely, since Leonardo has a love of "geometrical recreations" as he described them.

Artists of the Renaissance like Michelangelo (1475-1564), Albrecht Durer and Raphael (1483-1530) revived the golden ratio in their artworks. The proportions of Michelangelo's David conform to the golden ratio from the location of the navel with respect to the height to the placement of the joints in the fingers. Mathematicians who studied the Golden Ratio, both knowingly and unknowingly, include Theodorus of Cyrene, Pythagoras, Proclus, Eudoxus, Plato, Heath, Hypsicles, Heron, Ptolemy, Al-Khwarizmi (of *algorithm* fame), Adu Kamil, Cardan, Bombelli, Kepler, Simson, Albert Girard, Ramus, and Clavius. The term *"golden section",* *"golden ratio",* or, *"golden number"* was first used in the book *Die reine Elementar-Matematik* by Martin Ohm.

Leonardo Fibonacci (circa 1170-1240), also called Leonardo of Pisa, an Italian mathematician, discovered the Fibonacci Series, a series of numbers in which each number is the sum of the two preceding numbers, that is, 0, 1, 2, 5, 8, 13, 21, and so forth. Fibonacci number have many interesting properties and are widely used in mathematics. Natural patterns, such as the spiral growth of leaves on some trees, often exhibit the Fibonacci series. The Fibonacci series is very closely related to the Divine Proportion, in a way that the ratio between subsequent pairs of Fibonacci numbers converge closer and closer to phi as the series progresses. The thirty-eighth term, 39088169, divided by the rhirty-ninth term of the sequence, 63245986, gives 0.6180339887498947364027181108378 96, which is accurate up to fifteen digits after the decimal in phi.

The Medieval churches and cathedrals are intricate constructions based on the golden section. According to the book *Proportonality in the Architecture* (1935) by the Russian architect Prof. Grimm, the classic examples of such architecture that conform to the Golden Ratio are the Parthenon, Jupiter's temple in Tunis, Doriphor's statutem monuments of the Byzantium art, the Jerusalem Temple, the Sun Pietro in Montorio in Rome, Calleoni monument, Sun Peter's cathedral in Rome, the Christmas Christly Church in Yaroslavl, the Pyramids of Egypt, and Smolny cathedral in St. Petersburg, to name a few. Even the United Nations Headquarters in New York conform to the Golden Ratio.

DIVINE PROPORTION'S SYMBOLIC ANALOGIES

Modern mathematicians and also those of the Renaissance have derived symbolic analogies from

the Divine Proportion's behaviour outside the numerical domain, and such properties are truly amazing. The cycle of the moon resembles that of the digit sequences in phi after the decimal point as phi is multiplied with itself. The digit sequences following the decimal point in phi^d (where *d* is an odd natural number), is exactly the same as in phi^{-d}. For even powers, however, the decimal expansion of phi^{-n} (where *n* is an even natural number) in phi^{-n} subtracted from one. Hence the expansion of the powers alternately produces reflection and hides it again, just as the moon once reflects the light of the sun and then does not.

Phi seems to be related to the moon in another aspect, in the radian system of expressing angles, in a way that the squares of the doubled sine and cosine for each successive twentieth of pi (Π) are all reflected by simple functions of phi that grow and decrease according to the progress of those pi fractions along the circle. Together, these form the well-ordered display of quasi-mirrored symmetries as in the following Table-1

Angle θ(Π radians = 180°)	$(2 \sin^2 \theta)$	$(2 \cos^2 \theta)$
$\frac{\Pi}{20} = 9°$	$2 - \sqrt{(phi + 2)}$	$2 + \sqrt{(phi + 2)}$
$\frac{\Pi}{10} = 18°$	$1 - \frac{1}{phi}$	$phi + 2$
$\frac{3\Pi}{20} = 27°$	$2 - \sqrt{\frac{2-1}{phi}}$	$2 + \sqrt{\frac{2-1}{phi}}$
$\frac{\Pi}{5} = 36°$	$2 - \frac{1}{phi}$	$phi + 1$
$\frac{\Pi}{4} = 45°$	$phi - \frac{1}{phi}$	$phi - \frac{1}{phi}$
$\frac{3\Pi}{10} = 54°$	$phi + 1$	$2 - \frac{1}{phi}$
$\frac{7\Pi}{20} = 63°$	$2 + \sqrt{\frac{2-1}{phi}}$	$2 - \sqrt{\frac{2-1}{phi}}$
$\frac{2\Pi}{5} = 72°$	$phi + 2$	$1 - \frac{1}{phi}$
$\frac{9\Pi}{20} = 81°$	$2 + \sqrt{(phi + 2)}$	$2 - \sqrt{(phi + 2)}$

The above may be considered a reflection of pi the sun advancing along its circuit by the waxing and waning and self-mirroring of the corresponding phi-functions, thereby resembling the behaviour of the moon.

RELATION BETWEEN PHI AND 360 DEGREES & PAGANS

Apart from the radian system of measuring two-dimensional angles, the Divine Proportion also bears a strange relation to the division of a circle into 360 degrees. It sounds stranger than it is since the 360 degree system of measuring angles has been invented by human beings, and is not any inherent who used the sexagesimal system. The Assyrians had divided their cultic year as well as the circumferene of the Universe into 360 parts which they called days. The Egyptian sky watchers had divided the sky into 36 section, the "*decans*", that succeeded each other in ten-day intervals thereby matching the 36 ten-day weeks in their 360 day civil year, as early as the second millennium BC. Like the Assyrians, 360 was a sacred number to them. In this regard, it must be said that the contangent of phi equals 35.4 approximately, and ten times this number, that is, 354 is the number of calendar days in lunar year, used till date in the Near East. It is to be noted here that the Egyptians measured angles in the form of contangents, too.

Mysterious, indeed! A number so unique that was considered by the ancients to be the epitome of God. The constant phi expressed with small error the ratios of the numbers : 8:5, 5:3, 3:2, four of the first few numbers from the Fibonacci series, corresponds to numerical values of consonance intervals of the octave, the diminished sixth, the sixth, and the quint in music. In fact, the Divine Proportion occurs in the organizational frameworks of Beethoven's Fifth Symphony, Mozart's sonatas, and the works of Bartok, Debussy, and Schubert. The placement of the f-holes in Stradivarius' violins obeys the Golden Section. There are countless examples of how phi occurs and exists in nature. In a honeybee community, the number of female bees is always more than that of male bees ; the ratio

between the number of male bees to that of female bees is phi! In a nautilus (it's a spiral-shelled cephaloped mollusc and not Captain Nemo's submarine!) the ratio between the diameters of subsequent spirals is phi. In a sunflower, the ratio between the diameters of consecutive seed spirals is phi again. In other words, these diameters expressed in simple ratio give the terms in the Fibonacci series, and the ratio between subsequent Fibonacci numbers is phi. Similarly, spiralled pinecone petals, leaf arrangement on plant stalks, insect segmentation, all conform to the Fibonacci series and consequently the Divine Proportion.

It is easy to test the Golden Ratio present in the human body. The distance from the navel to the feet divided by that from the tip of he head to the feet gives phi. The ratio between the distance from the elbow to the fingertips and that from the shoulder to the fingertips gives phi. The distance from the knee to the ground divided by that from the hip to the ground gives the Divine Proportion. In fact, the closer these ratios conform to phi, the more perfect is a person's physique.

Dorothea Rockburne. Canadian-American painter and sculptor, best known for folded paper and linen works based on mathematical relationships, produced works such as the Golden Section Paintings (1974-1976), in which she marked and folded stiffened linen according to the fold patterns of drapery in Byzantine and early Renaissance paintings, themselves based on a mathematical formula for harmonic proportions, an ancient mathematical equation known as the Golden section.

There are endless wonders the Golden Section exhibits. You might try to explore the unique properties of the number yourself, and the more you discover, the more stunned are you likely to be. In the end, you will surely find there are more things in Heaven and Earth, and one of them is this number – an epitome of the all pervading, the One that confers shape and size to all earthly objects, the One that is beyound understanding, the true essence of God.

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DO YOU KNOW ?

Q1. In India, which source generates maximum share of commercial energy-thermal power plants, hydroelectric projects, solar devices, nuclear plants?

Q2. All present day horses have come from a single wild stock. Which country is the home of that original breed?

THEORIES OF AGING IN ANIMALS

Amrit Kaur*

Several theories have been proposed to explain the unique phenomena of aging in animals. According to some researchers it is genetically determined, but others have shown that several hormones like growth hormone, dehydroapiandristerone, melatonin, and estrogen show antiaging effects. Besides these, caloric restriction, stress, oxygen free radical, Telomere Theory and Gene Silencing-SIR Genes Theory are discussed.

INTRODUCTION

Aging is a complex phenomenon seen in all animals, but it is more obvious in higher ones. Age-related changes have been studied in cells, tissues, macromolecules, organs and organisms so that general principles could be defined. The rate of aging is variable in different species and even organisms within a species. There is neither a single cause nor a single way of defining and no universal marker of aging, still some general principles are :

- Aging is mainly observed in protected areas which allows survival beyond the natural life span. In the wild, animals die of infection, predation or accidents.
- Aging is progressive failure of haemodynamics or the ability of an organism to respond to internal or external stress.
- Development is highly genetically programmed process but exact survival is not genetically determined.

THEORIES OF AGING

Different aspects of aging have been studied extensively and several theories have been proposed to explain this complex phenomenon.

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GENETIC THEORY

Individuals in different species survive for definite time period specific for the species which may range from hours, days, months to several years. The life span is probably genetically determined and some genes may have evolved to cause aging. Such genes responsible for life span are termed as longevity assurance genes or vitagens[1]. Further studies reveal that one or few biochemical systems have a major impact on the rate of aging, this lead to search of genes associated with retarded aging. Application of transgenic techniques reveals more facts that same genes from one species may function differently in another species[2]. Transgenic Drosophila having longer life span mainly due to extra copies of Cu-Zn Superoxide dismutase (50D) and catalase genes is mainly due to better defense against oxidative damage. There is negative relationship between longevity and rate of damage including mutations, epimutations and macromolecular oxidation etc[3]. Although specific genes that cause aging have not been identified yet, there is every possibility that genes influence survival and rate of aging. Further studies reveal that mutation in certain genes can either shorten or prolong life span in lower animals (nematodes, insects) or higher animals (rodents and humans)[1].

Endocrine Dysfunction Theory : Some hormones like growth hormones, dehydro-

epiandrosterone or DHEA, pineal gland and melatonin and estrogen are antiaging. By grafting younger pineal gland into the thymus of old mouse resulted in melatonin synthesis and its right normal release, whereas old pineal grafted into pinealectomised younger mouse only accelerated its death because of less melatonin synthesis. Older pineal probably sends death signals to the body resulting in accelerated aging[4]. This suggests that in the pineal gland growth and puberty onset as well as aging are programmed and melatonin administration only delays aging. Pineal gland is the primary cause of failing immunological system network which concerns all cells and regulatory hormones of the immune system[5].

The Telomere Theory : Aging changes at cellular levels are also explained by telomere theory. Telomeres are the functional ends of chromosomes. Replication of linear DNA by DNA polymerase would result in the loss of terminal sequences. The ends of linear chromosomes consist of a repeated sequence of bases whose length decreases with each cell division. The loss of sequence containing important information could cause cellular senescence[6]. However, germ line and tumor cells are able to protect their telomeric DNA from shortening by a special form of DNA polymerase that is identified as telomerase[7,8].

Calorie-restriction Theory : Diet too has significant effect on life span and caloric restricted animals show extended life span. Therefore caloric restriction is antiaging and longevity extending in rodents and humans. Lifetime energetic expenditure is highest in human. Caloric restriction minimizes glucose entering cells and decreases ATP generation and thus less production of free radicals which produce aging. Majority of free radicals are emitted during ATP synthesis[9]. This may also be via modulation of insulin like signaling pathways which also explains variations in life spans of animals due to variations in the timing of release of hormones that control vitality and mortality as well responsiveness to those hormones[10].

Free Oxygen Radical Theory : In recent years, attention is focused on damaging effects of highly reactive free oxygen radicals and its consequence on aging[11]. Dietary antioxidants have been shown to increase lifespan in nematodes and some strains of mouse. In monkeys, caloric restriction produces low body temperature and low pancreatic insulin and therefore more youthful levels of dehydroxyepiandrosterone sulphate (DHEAS) which tends to fall with age. Besides this stress like temperature, shock, irradiation or heavy metal peroxidants have been reported to delay aging and prolong longevity in forms like yeast, paramecium, drosophila, nematodes, rodents and humans[12].

Gene Silencing-SIR Genes Theory : In recent years, role of SIR (Silent Information Regulator) genes in chromatic silencing and aging is widely studied and well projected. In Saccharomycas deletion of SIR2 shortens and additional copy of this gene increases life span[13]. SIR2 gene homologs have been found from bacteria to humans[14] and is likely responsible for chromation silencing of NAD-dependent histone deacetylase[15]. It is also suggest that SIR2 is recruited from silenced chromation to sites of DNA damage to help in its repair. There is gradual erosion in the integrity of silenced chromatin over time leading to incorrect gene expression and acceleration of aging[16].

Although substantial information is available on different aspects, still it is not clear how genes influence longevity. Probably there is intricate interplay between genes, endocrine system, free oxygen radicals and environment, which sets in aging changes.

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DO YOU KNOW ?

Q3. At the time of Independence what was the forest coverage of India?

Q4. What is the forest coverage of present India and which state has the highest coverage?

FOOD ALLERGY (HYPERSENSITIVITY)

BP Mohanty[1]*, SK Gupta[2] & S Mohanty[2]

Food allergy (hypersensitivity) is an important health issue. Fish and fish products represent one of the most common causes of IgE-mediated food hypersensitivity. Wide varieties of fish are known to induce allergic reactions following ingestion or inhalation of vapors by sensitized individuals. The present paper discusses food allergy (hypersensitivity), with emphasis on fish and fish products, genetically modified (GM) foods and current trends in research in this line.

INTRODUCTION

Food allergy is a group of distinct clinico-pathological conditions that have an immunological basic in common and in which an abnormal or exaggerated immunological response to a specific food leads to a disease. Ingested food provides antigenic load that confronts the human immune system. In most individuals tolerance develops to food antigens that continually gain access to the body. When tolerance fails to develop, the immune system may react with hypersensitivity. Symptoms include the gastrointestinal, cutaneous and/or respiratory symptoms, as well as systemic anaphylaxis with shock.

Food allergies affect as many as 6% of the young children and about 2% of the general population[1]. Although any food may provoke a reaction, relatively a few foods are responsible for the vast majority of food allergic reactions. The greater incidence of food allergy in infants and children may be explained by the greater permeability of the intestinal mucosa to foreign protein and also by immaturity of digestive processes in them. In children, the most common foods eliciting an allergic reaction are cow's milk, eggs, fish, peanuts and soya and in adults celery, fish, nuts, peanuts and shrimp are the major source of food allergy[2]. A variety of the allergens conserved among plants (e.g. profilling and lipid transfer proteins) and animals (e.g. tropomyosin and caseins) have been characterized. (Table 1).

Table 1. Approximate Rate of Clinical Reactivity to One Other Related Food. (Adopted from Sicherer, 2001)

If allergic to :	Risk of reactin to at least one :	Risk :
A legume (Peanut)	Other legumes (Peas, lentils beans)	5%
A tree nut (walnut)	Other tree nuts (brazil, cashew, hazelnut)	37%
A fish (salmon)	Other fish (swordfish, sole)	50%
A shellfish (shrimp)	Other shellfish (carb, lobster)	75%
A grain (wheat)	Other grains (barley, rye)	20%
Cow's milk	Beef (hamburger)	10%
Cow's milk	Goat's milk	92%
Cow's milk	Mare's milk	4%
Pollen (birch, ragweed)	Fruits/Vegetables (apple, peach, honeydew)	55%
Peach	Other Rosaceae (apple, plum, cherry, pear)	55%
Melon (cantaloupe)	Other fruits (watermelon, banana, avocado)	92%
Latex (latex glove)	Fruits (avocado, banana, kiwi)	35%
Fruits (banana, kiwi avocado)	Latex (latex gloves)	11%

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The prevalence of allergy to individual foods is known to vary geographically, due largely to differences in dietary practices. Genetic perdisposition is also an important determinant. Sensitization of food proteins with subsequent allergic disease is also known to be influenced by a variety of environmental factors and the timing, duration and extent of exposure. Moreover, the nature of the allergen itself may have an important impact on the severity and persistence of the clinical disease.

In food-allergic individuals, IgE is produced against naturally occurring food components, primarily glycoproteins that usually retain their allergenicity even after heating and/or proteolysis. The majority of immediate allergic reactions to food are IgE-mediated[3]; however, there are a section of the individuals (about 10%) in whom non-IgE-mediated reaction have heen reported. Many of the food allergens have been characterized at a molecular level that has increased our understanding of the immunopathogenesis of many responses. Currently, management of food allergies consists of educating the patient to avoid ingesting the responsible allergen and to initiate therapy in case of an unintended ingestion. The food-allergic individuals must be provided with an emergency kit containing an oral antihistamine and a corticosteroid.

COMMON FOOD AND NON-FOOD ALLERGENS

Food allergens consist mostly of protein though simpler substances present in food may have allergenic action. They are generally theremolabile and can be transferred to the skin of the normal human. Common food allergens include cow milk, goat milk, egg, fish and shelfish, meat and pollen. In countries where fish consumption is high, allergenic reaction to fish are common among patients diagnosed with food hypersensitivity. Allergens from fish and egg belong to some of the most frequent causes of food allergic reactions reported in the literature[4]. Egg allergens have been described in both white and yolk, and egg white proteins ovomucoid, ovalbumin, ovotransferrin and lysozyme have been adopted in the allergen nomenclature as Gal d1-d4. The most reported allergen from egg yolk seems to be alpha-livitin.

Among the non-food allergens, pollen is a vital aeroallergen. Pollen from sweet scented flowers is disseminated by insect while that causing hay fever is usually spread by the wind. Since many plants produce large quantities of pollen, a sensitive person can easily become over exposed and experience an immediate reaction., It is estimated that 10% of all seasonal hay fever is caused by tree pollen. Trees with allergy producing pollen include the oak, birch alder, hickory, black walnut, beech, maple, hackberry, sycamore, mulberry and elm. Grasses appear to account for about, 35% of all cases of seasonal hay fever, the three most common grass involved are Timothy, Bermuda and June (blue grass). There are eighty varieties of grasses that have a common antigen. Therefore, a person sensitive to one type of grass is usually sensitive to all type of grasses. The table shows a partial list of common food and non-food allergens, as seen in literature (Table 2).

FISH ALLERGY

Fish allergy is a relatively common and potentially fatal condition. A wide variety of fish are known to induce allergic reactions following ingestion or inhalation of vapors by sensitized individuals, contact with and consumption of fish can lead to severe health problems, ranging from urticaria and dermatitis to angiedema, diarrhoea, asthma and at worst, systemic anaphylactic reactions and death[5]. Although the exact prevalence of fish sensitivity is not known, fish are among the most important food allergens ; and as consumption of fish increases, rates of sensitization are expected to increase. Clinical history, skin prick testing (SPT) and *in vitro* assays aid diagnosis of fish allergy.

Table 2. Major Fish Non-fish Allergens

Source	Major allergen	Designation in allergen nomenclature	Mol wt./pt
Fish			
Baltic cod (*Gadus callarias*)	Parvalbumin	Gad c 1	12.3-kDa
Altantic cod (*Gadus morhua*)	Parvalbumin	Gad m 1	11.5-kDa, 4.34; 41-kDa
Atlantic Salmon (*Salmo salar*)	Parvalbumin	Sal s1	14.1
Carp (*Cyprinus carpio*)	Pravalbumin	Cyp c1.01 Cyp c1.02	 –
Tuna	Collagen	–	–
Shrimp			
Brown shrimp (*Penaeus aztecus*) White shrimp (*Penaeus setifecus*) *Penaeus indicus*	Tropomyosin	Pen a 1	36-kDa
Penaeus monodon	Arginine kinase	Pen m 2	38-kDa, pI 4,5
Sources other than fish			
Egg allergens			
Egg white proteins	Ovomucoid, ovalbumin ovotransferrin, lysozyme	Gal d1 Gal d2 Gal d3 Gal d4	
Egg yolk	α-livitin		
Bermuda grass pollen	–	Cyn d1	
Anisakis simplex (Fish nematode)	– –	Ani s1	– –
Insects	–	Chi t1	–

However, the 'gold standard' for diagnosing allergic food reactions is the double blind placebo-conrolled food challenge (DBPCFC).

Fish and fish products represent one of the most comon causes of IgE-mediated food hypersensitivity. Paravalbumin and collagen are the major fish allergens and have been extensively studied[6-9]. Sera from patients allergic to fish displayed IgE reactivity to parvalbumin (a small calcium-binding protein of 12 kDa) present in fish extracts from six different fish species (cod, tuna, salmon, perch, carp, and eel). Analyses of carp parvalbumin, by Circular Dichroism (CD) spectroscopy, revealed its remarkable stability and refolding capacity in calcium-bound-state. Calcium depletion reduced the IgE binding capacity that according to CD analyses may be due to conformation-dependent IgE recognition[6]. This may explain why parvalbumin, despite cooking and exposure to the gastrointestinal tract, can sensitize patients. After fish parvalbumin, calcium-binding allergens were discovered in pollens of trees, grasses and weeds and as autoallergens in man[7]. Although only a small percentage of atopic individuals display IgE reactivity to calcium-binding allergens, these allergens may be important because of their ability to cross-sensitize allergic individuals.

Recombinant carp (*Cyprinus carpio*) parvalbumin (rCyp) have been designed as a tool for diagnosis and therapy of fish allergy. It may be used to identify patients suffering from IgE-mediated fish allergy. A new oligomeric paravalbumin allergen of Atlantic cod (*Gadus morhua*) has been reported. This new allergen named Gad m1 formed oligomers in native and in reducing conditions. The major allergen of Baltic cod (*Gadus callarias*)

is a 12.3-kDa parvalbumin with two calcium-binding sites. A 41-kDa IgE-reactive protein (p41) from raw cod (*Gadus morhua*) extract, which had a high level of homology in different species, has been characterized. This protein is homologous to an aldehyde phosphate dehydrogenase (APDH)[8].

Collegen is identified as a new fish allergen[10-11]. It is commonly allergic regardless of fish species and there is cross-reactivity among gelatins (type I collagen) from various fishes. Some fish-sensitive patients possess IgE antibody to fish gelatin. Most children with anaphylaxis to measles, mumps, and rubella (MMR) vaccines had shown sensitivity to bovine gelatin that was included in the vaccines. It has been found that bovine type I collaen, which is the main content in the gelatin, is a major allergen in bovine gelatin allergy. Fish meat and skin also contain type I collagen ; however, no antigenic cross-reactivity has been observed between collagen from fish and other animals.

Most fish allergic subjects are allergic to multiple fish species. It is reported that sometimes children and adults both show severe allergic reactons to catfish proteins and both pediatric and adult fish-allergic patients have similar *in vitro* IgE binding to a 12.5kDa protein from fish extracts. Species specificity and patterns of cross-reactivity are not very well defined ; however, monospecific allergy due to the presence of species-specific allergens is also possible, as shown in case of swordfish 25-kDa protein. Cross reactivity among some fish species may be the result of common structures within related proteins. Cross-reactivity has been indicated to be of clinical relevance for several species, since patients with a DBPCFC to cod also react with other species, such as herring, plaice and mackerel[12].

Seafoods are composed of diverse sea organisms and humans are allergic to many of them. Crustaceans and mollusks are a frequent causes of food allergic reactions. The major allergen identified in shrimp is the muscle protein tropomyosin (Pen a1)[13]. At least 80% of shrimp-allergic subjects react to tropomyosin ; furthermore, tropomyosin is an important allergen in other crustaaceans such as lobsters, crabs and mollusks, as well as other arthropods such as house dust mites and cockroaches, and has been implied as the cause of clinical cross-reactivity among invertebrates. In contrast, vertebrate tropomyosins are considered non-allergenic.

Ingestion of raw or undercooked fish sometimes lead to infection of human subjects by the fish parasite *Anisakis simplex,* a disease known as anisakiasis or anisakidosis. Patients sensitized to this fish parasite show high levels of total and specific IgE. The cross-reaction seem to explain the fact that specific IgE antibodies are also found in a high number of normal subjects, as reported in other parasitoses.

GM FOOD AND ALLERGENICITY

Genetic modification involves insertion of genes from other organisms (within or between species) into host cells to select for desirable qualities. Potential benefits of GM (genetically modified) foods include increased nutritional value, reduced allergenicity, pest and disease-resistance and enhanced processing value. Some of the specific fears include potential toxicity, possible antibiotic resistance from GM crops, potential allergenicity and carcinogenicity from consuming GM foods[14]. GM foods may be as safe as conventional foods but public distrust runs high. Therefore, benefits to individuals or populatons need to be weighed against adverse health and environmental risks.

Basically, three categories of GM crops can be considered (FAO/WHO 1996; EU 1997) : (a) GM crops which have the same composition as the parent crop, (b) GM crops which have the same composition as the parent crop with the exception of a well-defined trait, and (c) GM crops which are different from the parent crop[15]. There are two

issues from an allergic standpoint. First, the transfer of a known allergen may ocur from a crop into a non-allergenic target crop. The second is the creation of a neo-allergen where *de novo* sensitization occurs in the population[16]. The first secnario occurred in 1996 when 2S albumen protein from Bazil nut was transferred to soyabean. 2S albumen was found to be a major Brazil nut allergen and the newly expressed protein in transgenic soy retained its allergenicity. It is therefore, necessary to proceed cautiously in assessing individual GM foods on the basis of their individual merits and risks prior to introducing them in market.

A large proportion of soybean cultivars grown in the USA are now of genetically modified varieties and concern has been raised about the safety of these products for consumers. EPSPS (5-enolpuruvylshikimate-3-phosphate synthase) is a 57-kDa-enzyme protein that confers specific resistance to soyabean. A study of the impact on allergenic potency in soyabean, comparable except for the newly introduced gene (CP4 EPSPS), was performed using soyabean-sensitized patients. All the methods showed variations in the allergenic potency between the individual extracts but allergenic petential was not affected by presence of the transgene[17]. It has been experimentally proven in rat model that EPSPS proteins in the GM soyabean show no significant allergencitity. When incubated in simulated gastric fluid (SGF) containing pepsin at pH 1.5, the purfied EPSPS protein was completely digested within 1 min[18].

WHO/FAO GUIDELINES OF THE ASSESSMENT OF ALLERGENICITY

Clinical and immunological tests are available for the diagnosis of allergy to known food allergens, but this does not extend to the evaluation, or prediction of allergenicity in novel foods[19]. The introduction of novel proteins into foods carries a risk of eliciting allergic reactions in individuals sensitive to the introduced protein. Therefore, decision trees for evaluation of the risk have been developed, the latest being proposed by World Health Organization/Food & Agriculture Organization (WHO/FAO) early in 2001(20). Key to this strategy include amino acid sequence analysis for similarity to known allergens, methods for assessing degradability under standard condtitions, assays for detection of specific IgE against the protein and histamine release from human basophils. Proteins developed using modern biotechnology and derived from fish are being considered for use in food and other applications, and since allergy to fish is well established, a potential risk from such proteins to susceptible human beings exists[20].

PROSPECTS

One of the major challenges of molecular allergy is to the allergenic potential of a protein, particularly in novel foods. Two aspects have to be distinguished : immunogenicity and cross-reactivity. Immunogenicity reflects the potential of a protein to induce IgE antibodies, whereas cross-reactivity is the reactivity of (usually preexisting) IgE antibodies with the target protein. In addition to these two issues, the relation between IgE-binding potential and clinical symptoms is of interest. This is influenced by physical properties (e.g., stability and size) and immunological properties (affinity and epitope valence).

Factors that determine the clinical appearance of allergy in the face of sensitization are complex and relate to the host (immune response and target-organ hyperreactivity) and the allergen (lability and digestibility). Similar factors determining the clinical relevance of cross-reacting food proteins are immune responses (affinity of IgE antibody), protein characteristics (homology, solubility, stability-digestibility) and exposure (concentration, route-oral/respiratory) and cofactors like exercise and alcohol that increase absorption. The prevalence and magnitude of clinical allergy caused by cross-reacting proteins and panallergens appear to be increasing and reflect an increase in atopy and

allergen sensitization. The fact that allergy can be severe and that cooking-canning and other processing can alter allergenicity must be considered during evaluations.

Molecules concerned with the allergic reaction, such as cytokines, chemokines, their receptors, major histocompatibility complex molecules and transcription factors, could provide the candidate genes of the allergic diseases. Identifying susceptibility genes for allergic diseases is motivated by the conviction that the identification of disease genes may permit the design of new classes of anti-inflammatory compounds. A variety of genetic factors are related to allergic diseases ; environmental factors are also involved in disease expression. Elucidation of disease gene expression and protein function based on information about single nucleotides polymorphisms (SNIPs) at individual level may lead to the development of prophylactic and therapeutic regimens tailored to the individual patient.

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DO YOU KNOW ?

Q5. Choose the correct answer :—
The lunar shadow exactly covers the sun during total solar eclipse because
(a) of a fundamental law of physics (b) it is a happy coincidence (c) it is an optical illusion

Q6. Which famous Indian Emperor had stone edicts erected to proclaim the importance of environmental protection

WEST BENGAL FOREST SCENARIO : A GEOGRAPHICAL REVIEW

Sisir Chatterjee*

Generally a forest is defined as a plant community predominantly of trees and other woody vegetation. Food and Agriculture Organisation of United Nations defines forest as land with a tree conopy cover of more than 10 percent and area of more than 0.5 ha. There is increasing realisation of the fact that forest not only provide mulitiple benefits to mankind but also help in conserving the environment and therefore has created global concern for their protection and preservation. The National Forest Policy (1988) of India aims at having a minimum of the third of geographic area of the country under forest and tree cover and enjoys maintaining two third of the area in hills under forest cover in order to prevent erosion and land degradation and also to ensure maintenance of ecological balance and enviromental stability. The objective of this paper is to prepare a geographical appraisal of West Bengal's forest scenario with a scientific approach *towards the future.*

INTRODUCTION

Topographic expressions of West Bengal hardly speak of any well-defined stage of their evolutions. Except the northern highs and western undulations, the monotonous surface is very much dissected frequently by the channels of the tributaries or distributaries of the main river-Ganga.

The region experiences a hot and humid monsoonal climate. The proximity to the Bay of Bengal on the south, the alignment of the Himalaya in the north and that of the Meghalaya Plateau in the north-east determine largely the climatic character, i.e. the distribution of the weather elements with respect to time and space irrespective of the general vagaries and mechanism of the monsoon. The spatial and seasonal distributions of the elements such as temperature, rainfall and relative humidity are too uneven[1].

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RURAL URBAN POPULATION DISTRIBUTION IN W.B.

The State of West Bengal, situated in the eastern part of the country between the Himalayas in the north and Bay of Bengal in the south where mighty river Ganga meets the ocean forming well known mangrove forests in Sundarbans, mainly embraces the fertile aluvial gangetic plains. The geographic area of the State is 88,572 km^2, which is 2.7% of the country's geographic area. The human population of the State is 80.22 milion (2001) constituting 7.8% of the country's population of which 72% is rural and 28% is urban. According to 2001 census, the average population density is 904 person per km^2. The tribal population is 5.6% of the the State's population. The livestock population is 47.09 million, which is 7.5% of the country's livestock. The State ranks sixth amongst states in terms of percentage of area under tree cover in the dawn of new century[2]. West Bengal Forest Department, in collaboraton with the RRSSC, Kharagpur, Department of Space, Government of India took up a periodic comparative assessment of forest cover every 3 years in 1988, 1991, 1994 and 1997 spread over a decade (1988-97). Such assessment clearly shows that there has been

consistent accretion to the forest cover of the State. The Working Plan & GIS Cell of the Directorate has interpreted NRSA digital data for March, 2000. This shows that the forest cover stood at 15.30% in March 2000. But according to the State of Forest Report 2001, Forest Survey of India, it is about 12.05%[1].

FOREST AREAS IN WEST BENGAL

Physiographically, except the Darjeeling Himalaya and Purulia highland the state is termed as lower Ganga plain or the (West) Bengal plain covering about 80,968 km^2 area. Natural vegatation of the lower Ganga plain can be grouped into several classes according to distribution, growth and expanse. After two decades of independence it was nearly 900000 hectares. The mangrove and tidal forests in the Sundarbans and humid tropical forests in the extreme north of the region are the only preserves of natural vegetation while the western fringe is covered by tropical deciduous forests mostly in the induced form. But Darjeeling Himalaya is an exception. The forest types range from tropical evergreen in the foothills, through temperate evergreen in the middle ranges, to the coniferous in the higher elevations. Darjeeling is the world famous hill tourist spot (and also district headquarter and once it was summer capital of West Bengal) of Darjeeling Himalaya. Birch Hill is a natural park and beauty spots. Lloyd Botanical Gardens (1865) is also famous for natural vegetation conservations. There are also plantation of Cinchona trees and a quinine factory at Mungpo, 16 km southwest of Kalimpong. Cardamom is another important production which is grown at altitudes from 330 to 500 mts in 2001. Darjeeling district has 2196 sq km area with forest cover which is nearly 70% of the total district area (3.149 sq km). It is highest in West Bengal also. Interestingly there is no scrub forest cover in this hilly distict[3].

FOREST CONSERVATON ACT

It is important to note that diversion of forest land to non-forestry purposes has been common in the past. In 1980, Government of India enacted the Forest (Conservation) Act, 1980 [FCA] with the objective of arresting diversions of forest land to non-forestry purposes. FCA as amended in 1981 and 1988 stipulates that a State Government or any other authority is prevented from diverting forestland to non-forestry purposes and that prior approval of the Central Government is required for any such diversion.

Since enforcement of the FCA, 1980, a total of 9217.35 hectares of forest land has been diverted in the State to different purposes in accordance with the advice of the Government of India. Out of this, 7640.52 hectares of forest land was diverted to such activities for which no compensatory afforestation was stipulated. Such activities mainly include collection of surface boulder and riverbed materials from riverbeds located in the reserved forest areas in the districts of Darjeeling and Jalpaiguri.

Table 1
Recorded Forest Area : West Bengal[1]

Reserved Forest (RF)	7054 km^2
Protected Forest (PF)	3772 km^2
Unclassed Forest (UF)	1053 km^2
Total	11879 km^2
Of State's Geographic Area	13.4%
Of Country's Forest Area	1.5%

FOREST COVER IN WEST BENGAL

The tropical evergreen forests are concentrated in Duars region. It was nearly 1,67,000 hectares after the late sixties of previous century. But today, Jalpaiguri District covers 2,337 sq km. forest which is nearly 38% of total district area and Coochbehar covers 38 sq km. forest which is nearly 2% of total district area. These two districts cover nearly 1200 sq km. dense forest which represent 'Duars' jungle.

Deciduous and scrub vegetation covers greater part of the western regions of the lower Ganga

Plain in Medinipur, Bankura, Birbhum, Bardhaman which was nearly 300000 hectareas before 30 years. Today the (united) Medinipur district which was largest in state (14081 sq km) covers only 1468 sq km forest area which is 10% of the total district area. This district has second largest sharing of open forest (832 sq km) among the other districts of the state after Jalpaiguri. Birbhum has 1.3% forest cover, Bardhaman 2.9% forest cover, Bankura 13.6% forest cover in respect of their district geographic area. Scattered and isolated patches are also visible in **Howrah** and **Hooghly** districts of the Delta proper. The well known species of lower Gangetic plains are Supari, Aam, Coconut, Shisham, Neem, Babu1, Rain tree, Nilgiri, Semal, Siris, Jamun, Kadamb, Palm, etc. The Western districts also observe Palash, Mahua, Ber and True Laurel also. It is very uninteresting to write that Kolkata has no forest cover, even asociate district Howrah has only 2 sq. km and roughly has 13 sq km forest cover which are less then 1% of their respective distrcit geographical area.

In West Bengal the geographical observations are : in the tropical evergreen forests, the natural vegetation comprise of gurjan (mainly), the tropical moist deciduous forests-comprise of sal (mainly) and tropical dry deciduous forests comprise teak, bamboo (mainly).

Mangrove forest which is one of the rare resource of West Bengal. Mangroves in India account for about 5% of the world's mangrove vegetation and are spread over an area of about 4,5000 km^2 along the coastal State/Union Territories of the country. Sundarbans in West Bengal accounts for a little less than half of the total area under mangroves in India, it has maximum of mangrove cover in the country.

Mangrove forests are one of the most productive and bio-diverse wetlands on earth. Yet, these unique coastal tropical forests are among the most threatened habitats in the world. Growing in the inter-tidal areas and estuary mouth between land

Table 2 : Districtwise Forest Cover : West Bengal[1]

	Forest Cover					(Area in km^2)
District	**Geographic area**	**Dense forest**	**Open forest**	**Total**	**Percentage**	**Scrub**
Bankura6,882	453	482	935	13.59	26	
Barddhaman	7,024	104	98	202	2.88	15
Birbhum4,545	25	34	59	1.3	13	
Calcutta (Kolkata)	185	0	0	0	0	0
Kochbihar	3,387	22	16	38	1.12	1
Dakshin Dinajpur	2,219	10	6	16	0.72	0
Darjeeling	3,149	1,417	779	2,196	69.74	0
Haora	1,467	2	0	2	0.14	0
Hugli	3,149	13	0	13	0.41	0
Jalpaiguri	6,227	1,156	1,188	2,344	37.64	12
Maldah	3,733	102	6	108	2.89	0
Medinipur	14,081	639	932	1,468	10.43	47
Murshidabad	5,324	59	6	65	1.22	0
Nadia	3,927	44	0	44	1.12	0
24 Parganas (North)	9,960	1,818	422	2,240	22.49	0
Puruliya6,259	328	367	695	11.1	35	
24 Parganas (South)	3,140	23	107	130	4.14	0
Uttar Dinajpur	3,140	23	107	130	4.14	0
Total	**88,752**	**6,346**	**4,347**	**10,693**	**12.05**	**149**

and sea, mangrove provide critical habitat for a diverse marine and terrestrial flora and fauna. The mangrove ecosystem is highly fragile, subjected to long duration of intrusion as well as incessant physiological and morphological stresses, salinity effect, aeration and onslaught of wave action. Before a decade, Sundarbans was in the crisis of suvival. But today, the West Bengal Government protects the world's most important forest very consciously—it is not only India's national park and bio-diversity zone, but also now it is in care of UNESCO.

The West Bengal Government has taken initiatives now to expose the beauty and ecological diversity of Sundarbans to the scientists, tourists of various countries by some joint ventures. In fact, healthy mangrove forests are key to a healthy marine ecology. Recently, the Chief Minister, Government of West Bengal, clearly stated that "this mangrove forest is the most effective protection wall against all wave action, even Tsunami" (*Gansashakti Daily Newspaper, 27th March '05).* The Sundarban Development Authority now prefer and is ready to maintain the dense mangrove forest cover (canopy density over 40 percent) and then open mangrove forest cover (canopy density from 10 to 40 percent).

Table 3 : Mangrove Forest Cover Statistics

Sq. Km.			
	Dense	**Open**	**Total**
India	2859	1623	4482
West Bengal	1615	430	2081
Medinipur	2	6	8
24 Parganas (North)	25	2	27
24 Parganas (South)	1624	422	2046

India as well as West Bengal is committed to the concept of sustainable mangement of its forest resources and tree wealth. The National Forest Policy, which aims at covering at least one third or the country with forest and trees, is strictly followed by the West Bengal Government with the inspiring participation of the common people and the *Panchayats.* The concept of involving communities in protecting and restoring forests came in the early mineties from where Joint Forest Management (JEM) emerged. The philosophy of the JEM was to involve the communities in protecting forest and sharing the benefits there of.

JOINT FOREST MANAGEMENT

The traditional system of Forest Management followed for more than a hundred years was found ineffective in the seventies of previous century due to various factors. The major reasons are population explosion, increasing demand for forest produce, traditional emphasis on production of commercial wood and disregard for local needs. Therefore, a management system, which could not adequately take care of the people's needs and real demands, did not work. As a result, forests were gradually degraded and the people had no stake in the preservation of forests. They considered themselves deprived and neglected. This isolation of the people from the forest contributed to an accelerated degradation of forest after two decades of independece in some regions. **The Pilot Arabari Socio-economic Project was launched in 1971-72. The objective of the project was to protect forest resources by involving forest fringe dwellers through improvement of their socio-economic conditions.** The review of this prject during 1985-86 clearly brought out its success in restoring degraded sal-coppice forests and plantation and this led to the issue of the order in March, 1987 permitting revenue sharing to the extent of 25% of the net revenue with the identified beneficiaries[4].

The success of the Arabari experiment coupled with an extensive interaction of administrative poeple with the rural people in forest fringes and the functionaries in the three-tier *panchayat* during the years of exceution of West Bengal Social

Forestry Project, paved the way for setting up Forest Protection Committees in different agroecological regions of the State. The formation of Forest Committees and their protection, registration, duties and responsibilities, functioning, etc. have been formalised through the issue of a series of Government Resolutions in 1989, 1990 and 1991.

It is very important to mention that Forest Proection Committees in West Bengal were awarded the Paul Getty Award in 1994 in recognition of their outstanding and excellent performance in reviving vast tracts of degraded forests in the lateritic tracts of South-West Bengal. This award is looked upon as the Nobel Prize in the field of conservation of wildlife and bio-diversity.

West Bengal has pioneered the concept of participatory management of forests in the country. The concept of participatory forest management has been a major force of socio-economic development in the State. It is deeply entrenched in the five districts of South-West Bengal, viz Medinipur, Bankura, Purulia, Birbhum and Barddhaman and is also gaining momentum in the tracts of the Sunderbans as well as in the forests of the districts of Jalpaiguri and Darjeeling. Till now 3650 registered Forest Protection Committees (FPC) have been formed, which comprise 4.07 lakh members and provide protection to 5735 sq.km of forests, that is, more than 40% of the total forest area[4].

According to Ministry of Environment and Forest 2002 report, there are 63618 JFM commitees in India managing 14 million hectares of forest land. School Children are very enthusiastic on this programme. That is the reason why the participation of Panchayat in *Social Forestry* has always an unique character in State as well as in the country, for example, Purulia district of West Bengal. This district is one of the backward districts of West Bengal as per as the human development index is concerned. Agricultural lands are utilized once in a year due to the lack of irrigation water. Rest of the period the common people, mostly women practise illegal lumbering particularly in the Baghmundi and Balarampur block in and around Ayodhya Pahar area which is located in the south and the south-west part of the district. Whereas in the north and the north-eastern part (covering Puruliya II, Hura block) of the district, Panchayat has successfully implemented the social forestry programme to save the under ground water table and the productivity of the soil. It is however a true field experience where the possibility of agriculture and availability of under ground water are maximum in those green cover areas. Slowly but steadily, now common people realise that these type of green covers are effective for steady agricultural growth and that will be the permanent solution for opening of many economic oppertunities. It is realised that the urgent task is to monitor these periodically and to assess the involvement of common men with their surrounding green covers for future functional action. An ethnobotatnical research project funded by the Council of Science & Industrial Research (CSIR), Extramrual Research Division, New Delhi on "Inventorisation of Medicinal Plants in Panchet Hills, Puruliya District, West Bengal, Documentation & Analysis of Indigenous Knowledge (*IK*) System on their use by Ethnic communities Located in and around Panchet Hill" is being carried out by WWF-India, WBSO, Kolkata since May 2002. Of the 240 plant specimens collected, 200 have high medicinal value and the balance have other economic importance. A new distribution record for West Bengal of a plant specimen, locally called Kalaphul, has been identified.

The project aims to locate and assess the IK of ethnic communities in and around Panchet Hill range regarding their natural resources with special focus on medicinal plant usage. This project also aims to assess and evaluate the phyto-diversity of

this range with their conservaton in *in-situ* condition and also select some medicinal plants with high commercial value for *ex-situ* cultivation by local people. Through this project, local communities will be aware about threats to phyto-diversity of that area. With the help of traditional medicine practitioners (like Kavirajs, Vaidyas etc.) and knowledgeable individuals about 370 plant specimens were collected from the field. Of this, 310 plant specimens have medicinal value and the rests have other economic uses. Among the collected medicinal plants, some are regionally threatened as well as endangered like *Rauvqlfia Serpentina, Tribulus terrestris, Sterculia urens, Aginobia indica, Ochna Pumila* etc. After inventorisation of medicinal plant is completed, a few easy cultivable species will be given to willing members of the community for cultivation in their field. In near future, inventory of the phyto-diversity with their uses by the tribal and ethnic communities of entire lateritic zone of West Bengal will be prepared and mapping of sacred groves will be done[5].

WEST BENGAL FORESTRY PROJECT

The project successfully used the strategy of increasing participation of local people and introducing forest management practices to address the broad project goals of

(a) Preventing continuing degradation of the forest lands,

(b) Establishing a sustainable protection system,

(c) Enhancing productivity and

(d) Conserving bio-diversity.

The achivements of halting forestry degradation, establishing a sustainable protection system, and conserving bio-diversity are particularly noteworthy and are universally appreciated.

More specifically, the project was intended to support regeneration and afforestation of 1,69,000 hectares of degraded lands, 7000 hectares of mature government plantations, and 1,14,000 hectares of farm forestry demarcation, watershed conservation for special action programmes in research and plant propagation, training and development of joint management (with peoples' participation), bio-diversity reseach and protection, and regeneration of 25,000 hectares of mangroves. In addition, the project included service support (houses, office, vehicles, information systems, etc.) and fodder research and development[4].

The major institutional aspects of the project objectives comprised departmental system, the involvement of NGOs in JFM support and the creation of community-based organisations like Forest Protection Committees. The reorganisaton of the Forest Directorate was accomplished. The object of this reorganisation was to strengthen the interface between the forest functionaries at different levels and the beneficiaries of the Forest Protection Committees inclusive of *Panchayat* functionaries.

Table 4 : Achievements in Different Components of Plantation Activities[4].

Activity	Target (in hectares)	Achievement (in hectares)
Rehabilitation of Degraded Forest Lands	76030	72023
Production Forestry on Forest Land	5000	6432
Strip Plantation	4000	3824
Farm Forestry	91925	102769
Mangroves	27750	20663
Total	203903	205711

The project has also a strong social objective which was to improve the living conditions of the rural poor who live inside or at the fringes of forests, Pas and Mangroves. The farm forestry component was designed to improve the livelihood of the landless and the poorest farmers by focusing on asset creation on formerly unproductive wasteland. The project benefited more than 4,00,000 people, principally women and the poor, especially those from SCs and STs. The other benefit was increased production of forest goods, firewood and farm trees. Furthermore, the forestry investments generated about 34 million man days of employment, which again benefited the poorest and landless households living in villages near forests.

One of the greatest achievements of the project is the fundamental shift in the attitude of the foresters to the people living in the vicinity of the forests and the appreciable change in the attitude of the people living on the forest fringes towards the foresters.

It is no doubt that only a holistic programme with close partnerships with grovernmental agencies, scientitific and education institutes and common people's platform like Panchayat shall play most effective role in survival of the green resources of the State as well as the animal community.

RURAL-URBAN GREENING PROGRAMME

The three-tier Panchayat system in West Bengal has been entrusted with a major role in the decentralised planning process. The forestry sector has been identified as one of the key sectors for the alleviation of rural poverty. Forest department staff are members of the *Ban-O-Bhumi Sanskar Sthayee Samity* and have been given the ex-officio status of the corresponding panchayat functionaries who will draw up and implement the social forestry component of rural development work.

INDIA ECO-DEVELOPMENT PROJECT

India Eco-development Project has been launched in the Buxa Tigar Reserve in the district of Jalpaiguri with the assistance of the International Development Association and the Global Environment Trust. This project is one of the seven such projects in the country that have the objective of promoting bio-diversity conservation through implementation of an eco-development strategy in villages within and around the protected area. The Project has started producing beneficial results in the protection of forests and wildlife in some areas of the Buxa Tiger Reserve.

NATURE INTERPRETATION AND ECO-TOURISM

Eco-tourism is a concept where the programmes of nature Conservation and Tourism are made to match so as to have a combined effect. Eco-tourism is also seen as a tool of generating local employment and involving Forest Protection Committee and EDC members in economic activity to earn their support in bio-diversity conservation. Interpretation Centres have been established in Sukna (Mahananda Wildlife Sanctuary), Rajabhatkhawa (Buxa Tiger Reserve), Madarihat (Jaldapara Sanctuary), Darjeeling (Senchal Sanctuary), Lataguri (Gorumara National Park), Lava (Neora Valley National Park) and Sajnekhali (Sunderban Tiger Reserve).

Today, after all bitter history, all the local habitat of North Bengal are truly confident that the alignment of *East-West Corridor* will take the alternative route thereby saving the beautiful forests and wildlife of the region. They all experienced that dwindling forest cover, fodder shortage and poaching have created a barrier between the peaceful co-existence of man and the elephant, which is of course teaching to all. At last this is most valuable realisation that the living of plant and animal community will be the only strategy for safe and secured earth in future.

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MASLOW'S MOTIVATIONAL THEORY OF NEED HIERARCHY

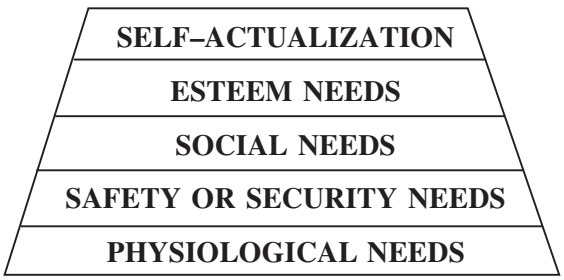
S. N. Sinha and Aparajita Sinha

The established traditional Maslow's motivational theory has been revisited in the context of empirical reality. The theory illustrates human being's transcendence from bio-social needs to self-actualization as an upward journey from one need satisfaction to another. This approach has been formulated based on the lives of well-known self-actualizers like, Isaac Newton, J. C. Bose, Tagore, and C. V. Raman who gave their epoch making contributions without prioritizing their biosocial needs.

THEORY OF SELF-ACTUALIZATION

Abraham Maslow, the world renowned Humanistic psychologist, gave the globally famous "Theory of Self-Actualization" or "Theory of Need Hierarchy". In his theory, Maslow presented a ladder or pyramid of needs.[1]

According to him, every human being has to go through the lower rungs of this ladder, satisfying each subsequent need, to reach the highest level of self-actualization. These bio-social needs may incorporate the physiological, safety/security, social, and esteem needs. Following is the diagrammatic expression of Maslow's Motivational Hierarchy of Needs :



Self–Actualization was defined in 1970 by Maslow as "the desire to become more and more what one characteristically is, to become everything that one is capable of becoming." That is, the level or state wherein an individual becomes capable of realizing his true potential. Speaking in a practical fashion, self-actualization is that stage where an individual in search of spiritual enlightenment attains it, a person with a penchant for perfection in whatever he does fulfils it, a person capable of reaching great heights of success reaches it.

As far as Maslow's theory of self-actualization is concerned, it is reached with common consensus. But, there is a Catch 22 regarding the journey that every individual has to partake in order to reach self-actualization. According to Maslow, one cannot reach the final stage unless one has satisfied all the lower stages or needs. This is the point of difference where we bid adieu to the theory of Maslow and a new theory takes flight.

ERG THEORY OF MOTIVATION

Clayton Alderfer, of Yale University of USA has reworked Maslow's theory to align it more closely with empirical research. He gave the ERG Theory[2] of motivation which, was an offshoot of Maslow's theory of motivation. According to Alderfer there are three groups or core needs : (i) Existence. (ii) Relatedness & (iii) Growth.

These needs were quite similar to that of Maslow's. But there was also a difference of

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opinion. According to Alderfer multiple needs can be operating as motivators at the same time and it is not necessary to satisfy a lower-level need, before one can move to higher–level needs. We hold on to this thought and extend our concepts about the variables vital to the attainment of self-actualization. The probable constructs of self-actualization may be : 1. Creativity, 2. Spirituality, 3. Resilience and Tenacity, 4. Highly cognitively integrated and 5. Innovativeness.

The concept which we are putting forward is, "People who are self-actualized in a true sense, are the ones who do not lay much emphasis on the fulfillment of bio-social needs. The bio-social needs in fact act as a barrier to their attainment of self-actualization."

The arguments in support of our theory are not neo-proclamations, rather, they are based on the realistic, matter-of-fact critical analysis of Maslow's existing theory of need-hierarchy. Before proceeding any further, first, as a matter of illustration let us take a look at some well-known individual cases which we can call as instances of self-actualized or people who have reached their true potentials such as Rabindra Nath Tagore, Sir Isaac Newton, J. C. Bose et al. These are some examples of the people who have successfully reached their full potential.

What would be their common effective trait in terms of Maslow's motivational theory. Firstly, they were people with humble beginning. Secondly, they had a burning desire to do what they finally became successful in doing. Agreed, that they became capable of fulfilling their physiological, security, social, and esteem needs in the process. On the other hand, considering globally there are some such persons who are among those who became the wealthiest people in the world like, say, Ambani or Chopra. Their wealth has provided them food, shelter, safety, social presence, and resultant augmentation in self-esteem. But the fact lies in the truth that, when they began their career, their aim in life was not to procure food and shelter. Rather, they wanted to attain cultural or aesthetic heights, achieve scientific breakthroughs, and make optimum use of their intellect.

Almost none of these people cared whether they were fed for the day or what comments others made about them. Imagine what would have happened if Rabindra Nath Tagore had become satisfied with his opulent heritage that fulfilled all his other needs, or, if Sir Isaac Newton would have cared mainly about food, and other physiological and social pleasures of life, none of them would have given every moment of his deprived life to accomplish what they have done.

These examples show that the most self-actualized people would have not been so if, they would have cared about needs for just food and social pleasures, or were more concerned with what "others" thought about them and their dreams.

CONCLUSION

In this article, following Maslow's theory our aim is to make people rethink about their existing beliefs regarding the attainment of self-actualization. Before we end we leave the readers with a question : "Does the fulfillment of the other lower needs lead to self-actualization or self-actualization leads to subsequent obvious resultant fulfillment of the lower needs ?

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IRON & STEEL MAKING : HOW WE REACHED HERE?

Iron and steel making processes have gone through a very long and tortuous path of development. While steel remains the key factor catalysing Industrial Production and Economic Growth, the integrated iron and steel works of today, despite being under threat from competitors, remain the focal point of economic activity. Integrated steel plants have been successfully thwarting the challenges posed to it, through adoption of newer and improved technologies in all facets of its operation. This book presents a glimpse of such technolgies.

INTRODUCTION

Iron and steel have played very important roles in the sustenance and development of human society over the ages. This is mainly due to the unique combination of strength, ductility and toughness exhibited by iron and its alloys—more specifically steel.

Steel has become an essential part of our present day society. The extent of consumption of steel is considered a key economic indication for assessing the state of development of a country.

Although type of usage have been changing, but iron and steel were essential to even primitive human societies. Almost no human society could be conceived without iron and/or steel from about 500 BC onwards. However, in isolated instances, human societies existing from even 2500 BC were known to use some form of iron and steel.

In the Indian sub-continent primitive method of iron extraction were developed and adopted in five different regions—possibly independent of each other—probably from 2000 BC, but more definitely between 1300 BC to 1000 BC. Mud furnaces were initially used in all such cases.

Just before industrial revolution, India was one of the world leaders in making and trading iron and steel. The Wootz iron ingot (commonly referred to a as Wootz steel) was exported from Indian ports to West Asia for making quality swords (Bulat, Damascus Sword), for meeting the requirement of entire world. All iron extraction in India was through the primitive mud furnaces (Fig.1) until 1857 when the first blast furnace was blown in, at Kulti (WB), in Eastern India. Presently the per capita steel consumption for India is one of the lowest in world. But the situation is ideal for India to play a dominant role in the growth of iron and steel industry of the world.

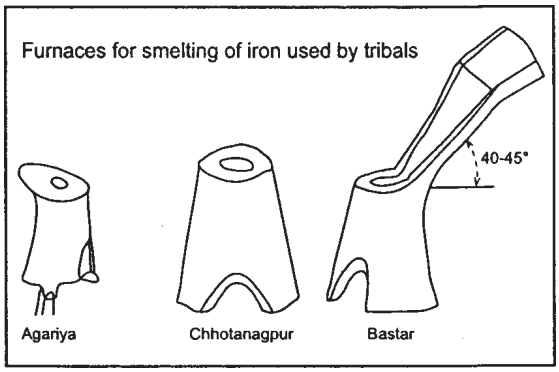

Fig. 1 : Remnants of primitive iron making furnaces

IMPORTANCE OF IRON AND STEEL IN PRIMITIVE SOCIETIES

Primitive human beings were dependent on hunting for their subsistence. They developed tools for more efficient hunting. In the beginning these were limited to stone tipped wood spears. The stone tip was made sharp and pointed by breaking a large piece of stone along strategic points and across visible cleavage planes. They were constantly looking for materials to upgrade their tools. Some were fortunate in locating remains of meteorites. In

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most such cases, it was their first exposure to a metallic material and that too a ferruginous material.

The first iron extraction was probably an accident. If a Chhatisgarh folklore is to be believed, one such 'accident' took place in Bastar region. A termite mound (anthill) is generally hollow from inside. In many cases, it is formed over a tree stub. A hunter saw a rat entering such an anthill from an opening on the top. He covered the top opening with a red rock (!) as he was busy and wanted to catch the rat later. In his free time, he made an additional opening at the base, in a direction where wind was favourable. He made a fire with dry leaves and blew in the fire. The suffocating rat tried to come out and the man caught it. But during the night the favourable wind intensified the fire and next day a thin strip was found, which was much better for their hunting weapons than anything they had used before.

Since there are evidences of development of iron extraction independent of each other most probably similar "accidents" took place in many locations and at different points in time.

Ancient Greeks probably started extracting iron earlier than Indians did. But, in the latter part of ancient era, Indian iron and steel dominated the civilized world.

Like other parts of the world, North African tribes also started extracting iron and making steel. Later on, they upgraded their techniques and made improved quality steel ; but for getting a premium in return, they started calling it "Indian steel". This act of theirs should be considered a real tribute to Indian steel makers.

EMERGENCE OF STEEL

While making wrought iron implements from the mud furnaces, primitive iron makers tried to perfect the techniques of blowing to get consistent properties in the product. Whenever they used over-burnt sponge iron lump, they noted that the properties of final product were not consistent. Very often, they were more brittle than the material from normally smelted sponge. But if they were reheated and beaten more number of times, the product become stronger and more durable than the normal wrought iron implement. Steel was thus discovered and it was realised that over-association with charcoal had something to do with it. Later on, they could achieve similar and more consistent result by exposing already perpared wrought iron implements to characoal over long periods. This process we now call as the "Cementaton Process" of making steel. This became more popular route of making steel than the more logical route of making and using over-burnt sponge iron, possibly because of higher toughness of case-hardend steel which is obtained by cementaton process – i.e. harder and stronger surface with a soft and tough interior.

In the late ancient and early medieval era, the focus of use of iron and steel shifted from hunting and agricultural implements of war time application–to swords, shields, armour–and later guns and connons. It was in making of swords that best quality steels were required. The best of swords were carburised by cementation process and thereafter suitably heat treated–quenched and tempered–to get a very hard surface and tough core. Then came the Indian Wootz iron ingot, using which, by some accident not yet fully known, the Surians could produce the best ever sword–the "Damascus Sword" (Russians called it "The Bulat"). Prof. Mrs. Thelma Lowe of Pennsylvania State University found references in Dutch documents, available in Hyderabad (Deccan) museum of export of huge quantities of Wootz Iron ingots from Masulipatnam port on the Andhra coast with Bay of Bengal, apparently headed for Damascus. It appears that making of Wootz Iron ingot, which is a high carbon (2 to 2.5%) iron made by melting wrought iron with carbonaceous material in a closed crucible by firing from outside, remained a secret with Indians. On the other hand, the Syrians kept closely guarded their technique of forging the Wootz Iron in a super plastic temperature zone to make

swords, not only of the highest quality, but also exhibiting "damask" or regular pattern on the entire length.

Wootz Iron and Damascus Swords (Bulat) are a rare example of iron composition in cast iron range being in great demand, but it was steel of various composition which gained in demand as material of construction, engineering and various other applications.

EVOLUTION OF BLAST FURNACE IRON MAKING

The primitive mud furnaces (or equivalent) were the forerunners of modern day blast furnaces. Intensification of the process led to higher temperatures, which caused melting of reduced iron, which then picked up carbon and ended up as high carbon hot metal. It was convenient to cast it in the pattern of sow-and-litter of pigs and 'pig iron' was born.

Some of the important stages of development can be listed as follows :

- Manual blowing was replaced by powered blowing,
- Size of furnaces was steadily increased,
- Mud and stone were replaced by suitable refractory and back-up structure.
- Top was sealed,
- Cup-cone and latter bell-hopper arrangement was introduced (now bell-less system) to facilitate charging without breaking seal.
- Gas was collected, cleaned and used as fuel,
- The air blast was preheated,
- There was a tendency to use prepared burden,
- Charcoal was gradually replaced with coke.

EVOLUTION OF MODERN STEEL MAKING

During reduction of iron ore in blast furnace, it is not possible to arrest carbon pick up so that steel could be made directly. Steel being a more useful product due to higher ductility and strength properties, it was in demand, much more than pig or cast iron obtained from blast furnaces.

In the middle of 19th century, Henry Bessemer made a successful attempt to decarburise liquid pig iron by blowing air from underneath. Very soon thereafter, Siemens and Martin developed the Open Hearth Process for decarbursing liquid pig iron to make steel. With these developments, steel could be made much faster, and on a much larger scale than the earlier method of first making sponge iron then wrought iron and carburising the same to make steel. The traditional method was a more direct route of making steel and this route was given the name Direct Reduction Route.

When tonnage oxygen became available, this caused another revolution in steel making. The basic oxygen furnace (BOF-LD was one of its variations) used blowing oxygen from the top to make the processs of making steel more thermally efficient. For steel making from iron ore, many variatons have been attempted but BF-BOF route remains the dominant steel making route of today.

Recycling of scrapped iron and steel implements was recognised as an alternative available for supplementing steel requirements economically. This was done by melting and refining in an elecric arc furnace (FAF). With larger steel consumption, and passage of time, larger quantities of obsolete iron and steel items became available and scrap-EAF route of making steel is the second most dominant route of steel making at present.

INTRODUCTION OF NEWER AND IMPROVED TECHNOLOGIES

Due to competition from other materials, iron and steel making process had to introduce a large number of improvements to meet the challenge. In blast furnace iron making the consumption of coke per tonne of hot metal has been decreased through increasing capacity, more efficient operation, partly

performing operations outside by using prepared burden etc. Coke making technology has also gone through many changes so that suitable coke can be obtained from inferior coals. Alternate energy sources are also being used in blast furnace such as through preheated air blast, injection of auxiliary fuels through tuyeres, etc. However, the attempt to make hard coke from non-coking coal (formed coke) has so far not met with adequate economic sources.

Similarly, in steel making area, new methods of intensification and refining have been introduced to obtain better and newer chemistry, which can go into making products with enhanced properties and even new products. Combined blowing, vacuum treatment for degassing, ladle treatment, incorporating features of BOF into EAF etc. are some of these newer measures. Thermo-mechanical treatment of rolled products, coating, micro-alloying, etc. have enchanced the range of application of steel. An overview of these can be found in the present compilation.

ALTERNATE IRON MAKING PROCESSES

The problems with blast furnace iron making have led to encroachment in its domain by newer iron and steel making processes. Some of these are resurrection of older processes (DR processes) while others have tried to split the operations of blast furnace in such a way, that need for coke is obviated (SR processes –Corex, Romelt, etc.)

Two units of Corex are successfully operating in Southern India, while two Romelt units are planned in Central East India. For Indian coals having high volatile matter and high ash, processes practising high degree of post combustion only (Romelt, Ausmelt) are suitable while Corex units are operating with 100% imported coal.

RESURRECTION OF DIRECT REDUCTION

While steel making by blast furnace based indirect route was gaining ground, sponge iron makers did not give up.

They tried rotary kiln, which could perform multiple functions of oxidation, mixing, reduction, heating etc., while being able to handle heavily dust-laden gases. Germany's Krupp-Renn process could make partially fused sponge iron called 'Luppen' which had significant contribution in supplementing Germany's iron and steel production during the World Wars. But the process was plagued with the problem of heavy deposit formation and was later abandoned.

But from the ashes of 'Krupp-Renn' emerged the 'Krupp-Codir' process, which dispensed with the idea of fusing sponge iron within the kiln. Almost parallely, Steel Company of Canada (STELCO), Lurgi Chemie und Huettenteknik GmbH, Republic Steel and National Lead joined hands to develop the SL/RN process with similar features. Thereafter, a number of other processes evolved using rotary kiln (DRC, TDR, etc.), which are all very similar.

There were parallel developments in the area of reforming of hydrocarbons, specifically natural gas, which yields a mixture of hydrogen and carbon monoxide, ideally suited for iron oxide reduction. Further, they could agglomerate iron ore fines into uniform iron ore pellets. Midland Ross Co. of U.S.A. and Hojalata ya Lamina of Mexico developed the Midrex and HyL Processes of sponge iron making from iron ore pellets in a shaft reactor. Hylprocess, developed earlier, used a static bed reactor for reduction, but later on, like the Midrex process, converted itself into a continuous reduction reactor. These processes could produce sponge iron of quality slightly superior to the coal based variety since carbon content was higher and contamination with char (surface adherence) was absent.

But this process required costly reformation process, costly inputs like pellets, and therefore could be viable only at place where natural gas was available cheaply (Venezuela, Mexico, Iran, Saudi Arabia). In India, three such plants are operating, but rising gas prices have discouraged further investments.

On the other hand coal based rotary kiln plants, mostly small, have flourished in India, mainly because of flexibity in size and location of plants.

India is poised to be the largest producer of sponge iron by overtaking both Venezuela and Mexico. But on coal based sponge iron making, the rest of the world put together do not match up to even half of Indis's production.

Presently, about 8% of the world's iron production comes from sponge iron route. Share of coal based sponge iron is only about one tenth, but is still more than the contribution made by smelting reduction.

IRON & STEEL MAKING AT PRESENT

The BF-BOF route dominates steelmaking at present. About 60% of total steel is made in India through this route at present, somewhat in line with the practice in rest of the world. About 30% is made in Electric Furnaces (Electric Arc Furnaces–EAF's and Induction Furnaces–IF's). Indian scene differs in the extent of usage of sponge iron or Direct Reduced Iron (DRI) in electric furnaces, which is higher than world average.

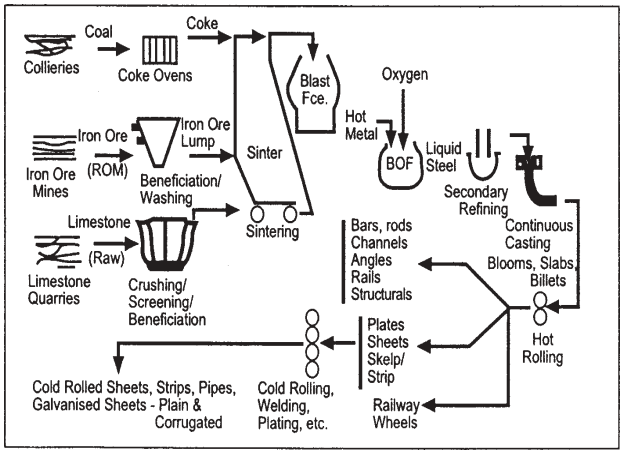

Fig. 2 : Present day integrated iron and steel works

Fig. 2 shows the typical process steps, which are being adopted, and the principal products being made in an integrated iron and steel works of today. Fig. 3 shows the variation in oxygen content (oxygen potential) when iron ore is converted to finished (rolled or forged) steel. Economic factors have forced this rather tortuous route. The primitive method via sponge iron was a more gradual approach in the reduction of oxygen potential of iron ore and therefore did not need an oxidation step in making steel, as in BOF. Economic factors are once again forcing us to adopt improved sponge iron making processes. A much smoother line than that in Fig. 3 would indicate variation in oxygen potential in steelmaking through this route.

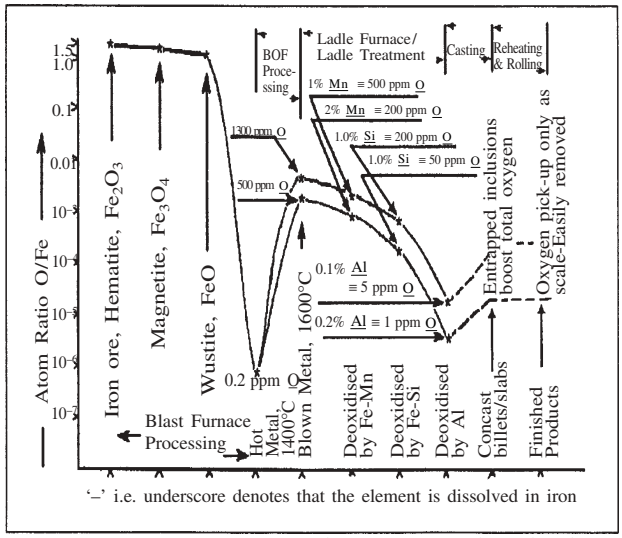

Fig. 3 : Oxygen to iron ratio during iron and steelmaking

Between BF and BOF, it is the former-the blast furnaces-which have been under serious pressure to improve or face the threat of extinction. But blast furnaces have proved themselves to be of unique resilience. It is doubtful whether any other metallurgical reactor can ever be as energy efficient as the blast furnace. But its heavy dependence on hard metallurgical coke for its operation has been proving to be its "Achilles' hell". Scarcity of metallurgical coal has forced it to reduce its dependence on hard coke-but cannot do without it and would need a certain minimum quantity. The modern blast furnace uses features, which, not only helps in using only the minimum quantity of coke, but also exhibits intensified processing and energy efficient operation. Fig. 4 exhibits some of these features.

Similar to blast furnaces, BOF–Basic Oxygen Furnace, has incorporated process improvement features. Refractory practices have undergone major improvements through introduction of new technologies. Tundish practices, continuous casting, rolling and other processing within integrated steelworks have had infusion of new and improved technologies. Further, to suit market demand, steelworks have been developing new and improved products. An attempt has been made in the ensuing sections to give an overview of such process and product improvements and developments.

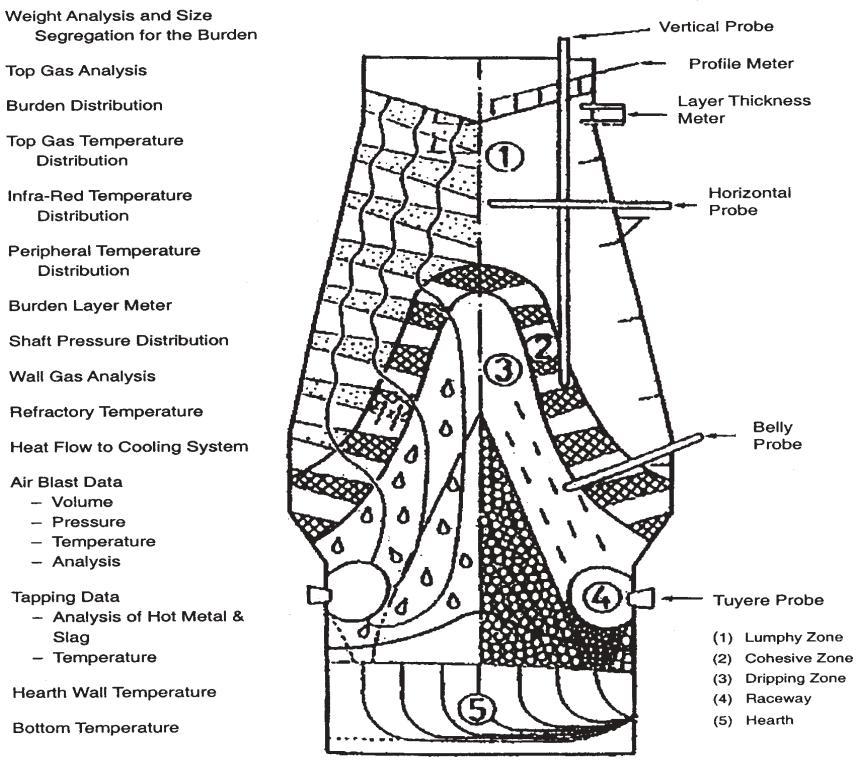

Fig. 4 : Features incorporated and sensors used in a modern blast furnace

Lately, increasing emphasis is being given to environmental considerations and use of mathematical modelling. The field of Condition Based Monitoring and Maintenance system is also developing. These aspects have also been introduced here.

CONCLUSIONS

Iron and steel making processes have gone through a very long and tortuous path of development. While steel remains the key factor catalysing Industrial Production and Economic Growth, the integrated iron and steel works of today, despite being under threat from competitors, remain the focal point of economic activity. Integrated steel plants have been successfully thwarting the challenges posed to it, through adoption of newer and improved technologies in all facets of its operation. This book presents a glimpse of such technologies.

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SOMETHING TO THINK ABOUT

GECKO (TIKTIKI IN BENGALI AND CHHIPKILI IN HINDI) AND NANO SCIENCE

H.S. Ray*

We humans walk on land and friction is all that we need to stand and walk. But, what makes it possible for the Gecko to stick to the ceiling and stay upside down? What adhesive on its toes does the trick? How do the toes get unstuck when it moves? Is there a vacuum pad, a conventional tape or a tacky polymer?

This question has been examined in a recent article published in Scientific American (January 2004, p 101). It seems that the trick is in the arrays of millions of microscopic hairs, ie setae, on the bottom of gecko's feet. Each seta ends in a smaller array of nanostructures called spatulae, which permits intimate contact with surfaces.

The setae adhere through weak intermolecular Van der Waals forces a function of the geometry of these nanostructures rather than their surface chemistry. Actually splitting of any surface into numerous portrusions can make it sticky. The large surface area under gecko's feet, about 6.5 million setae, in theory can lift 133 kilograms! Yet with this gripping power a gecko can detach the feet in just 1.5 milli seconds by simply increasing the angle of sets to 30 degrees.

Scientists of the University of California at Berkeley have used the basic principle to make the first synthetic version of the Gecko adhesive. It will now be possible to make shoes which will allow a person to walk upside down along the ceiling, of course, he or she does not fall out of the shoes or simply lose his head staying upside down.

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SHORT COMMUNICATION

SILKEN SNARE OF THE SPIDER

D. Balasubramanian*

Oh! what a tangled web we weave, when we first practise to deceive. —***Shakespeare***

As children, we were always exhorted to learn from the tiny little ant. It was held up as a paragon of the virtues of industry and purposefulness. In stark contrast to the ant was held the ass which usually stood around the broken wall of the dilapidated house at the village street corner. In retrospect I fell that the point was exaggerated and somewhat unfair toward the poor ass, which works harder than many other beasts of burden. It carries outrageous loads of laundry, bricks or whatever else, without a grunt of complaint and demands very little as reward or recognition. Indeed, I suspect it is this very docility and unremonstrative habit of the ass that has led to its fall from grace. The camel, which is just as efficient a beast of burden and as undemanding as the ass, ensures through its occasional flash of temper that it is nobody's pushover.

Come to think of it, much of the good press that the ant receives is due to its apparent "initiative". It appears to be self-driven and purposeful, getting on with its business from the word go. The constant activity around the anthill—the hustle and bustle, the frequent interchange among the ants and their touching and relaying around, doing all this without external direction or instructions—is altogether truly impressive.

The termite or the white ant is no different from the black ant—it runs around just as purposefully, it networks with its brothers just as well and its efficiency is just as legendary, if not even more—all you have to do is watch how quickly the termites finish off the leg of a wooden stool. But of course, this is what does the termite is—an efficient destroyer! The stool through, is man's and he will hardly appreciate the industry, purposefulness and the efficiency of the termite when it chooses his property to demonstrate these virtues!

With the spider, man's feelings are somewhat ambivalent. There is revulsion and even fear about its bite, sting and the venom that some species of spiders carry. All spiders are creepy crawlies—a feature that does not exactly help in winning friends and influencing people. Neither does their habit of weaving a web to snare and capture prey endear them to us. We see the spider as a crafty little monster whose lone purpose in life is to trap flying insects and make a meal of them.

On the other hand, we are duly impressed by the complex web that spiders weave. The web is an engineering marvel and an aesthete's delight. Made essentially of the same protein that silkworms and some moths make, it is a fascinating material that puts cotton or cellulose fibre, rubber, high tensile strength steel or the super-strong polymeric material kevlar to shame. Recent research on the properties of the spider silk has unearthed some more fascinating facets that make it the best material suited for its function. Dr. Fritz Vollrath, of the Zoology department at Oxford University, has been studying the spider's web for several years and his findings of the role of water in the formation, elasticity and efficiency of the capture web make

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fascinating reading (***Proceedings of the Royal Society of London***, Series B, 22 May, 1992)

The spider is a recent entrant to the panorama of life on earth-perhaps no older than 400 million years—emerging in the Devonian Era from a burrowing and ground-bound ancestor that produced just one basic silk fibre that it used as lining for its burrow and door, as material to cover the egg in the form of egg sac, and as trip lines to capture wandering prey. This devonian spider, studied by William shear, near Gilboa in New York State, was a sit and wait, tunnel or tube-dwelling predator that had just the beginnings of the segmented legs that typify the spider of today. It may have just made an aerial web—a small step out of its abdominal silk gland apparatus called the spinneret, which spun out the silk fibre, evolving into a giant step for spiderkind.

The common garden variety of spider (*Araneus diadematus*) spins at least seven different silks from its silk glands and spinnerets. The orb web that it weaves has many concentric circle of capture web, held in place by radial spokes of frame silk or structural fibre. The spider lowers itself into this web using a 'dragline' silk fibre. The frame silk and dragline silk and much the same and spun out by the major ampullate glands, while the capture web comes out of flagelliform glands. These sticky, spinal, silk fibres are coated with a special glue, generated by the aggregate glands. The glue drops can be seen dotted up regularly like pearls on the capture web—swollen in the early morning dew and shining. In ceontrast, the frame fibre and the dragline are not coated. Instead, they are reinforced with accessory fibres produced by the minor ampullate glands.

To round the matter of perfectly, the piriform glands produce the binding silk which attaches the frame and the dragline fibres to the substrate—tree branch or twigs or whatever—while the aciniform glands wave the silk thread to warp the captured prey and immobilize it to death; all that the spider needs to do is to lower itself down the dragline at leisure and feast on the prey, along with the silk wrapper and all. (Finally, of course, there are the clindrical glands which spin out the silk for the cocoon, common to spiders and other moths and insects). Four hundred million years of evolution have aided in fine tuning and honing the "kitchen in air" that today's spiders build from scratch by pure instint. It almost sounds like an insult to say so, considering the exquisite construction, the tailor-made materials and the success rate—but alas it is so, since whatever little brain the spider has is hard-wired for all its "house-keeping" chores. There is no cortex to speak of, using which the animal could "think", "decide" or "create".

Instead, there is plenty to marvel at what natural selection has endowed the spider with over these millions of years, in terms of materials to spin the web. What the spider would like is to have as large a web as possible in order to catch as much prey as it can. But this is costly in terms of the food budget since the spider has to make more protein. Approximately, a 75 mg spider makes about 0.18 mg protein to produce a web with a catching area about 50 to 100 cm^2, using protein fibres that are a micron thick.

The idea is to have a web that dead-stops and entangles the prey that flies into it. The net cannot be elastic, since in that case the recoil would bounce the insect out of the trap. The impact energy must be dissipiated away. It cannot be returned as recoil energy as in a trampoline and neither can it be used to fracture or break the netting fibre. It should disappear as heat. The stress-strain curve of the spider thread shows hysteresis, consistent with this idea, contributing both to the strength and the toughness of the material.

Even here, the capture thread and the frame thread differ in a major way. The capture thread is covered by glue drops, dotted regularly over its length. Mechanically too, the capture silk is very

different—it is extremely extensible and very low in stiffness. Just the two properties needed to trap the prey—no matter how hard the insect struggles, it has no solid structure to push against since the viscid silk simply stretches—sort of a quicksand. This fundamental difference has been studied at the molecular level in an ingeneous way by Vollrath, in collaboration with Dr Jeremy Sanders of Cambridge, using nuclear magnetic resonance (NMR) spectroscopy as the tool.

When the NMR spectra of intact capture threads were monitored, remarkably sharp spectral lines were observed. This is indicative of a very high degree of molecular mobility in the protein that makes up the thread. When the thread was dried so as to drive off the water, the signals disappeared showing that it is the bound water that offers the capture web its mobility and extendability. In contrast, the NMR spectra of the frame fibres do not give any sharp NMR signals, wet or dry.

Then they did a rather ingeneous experiment by feeding the spiders amino acids or glucose, artificially enriched with the isotope 13-C of carbon, for a few days so that this 13-C will be incorporated in its fibre molecules. The idea behind such a 13-C feeding is to help in geeting stronger signals in the NMR experiments that monitor carbon nuclei. What they found was while such labelling of capture thread increased its NMR intensity, no cush enhancement was seen with the frame thread. The intensification of the capture thread appeared to be due to the presence of glycoproteins—some of which are sticky, gluey materials. Thus, the capture thread is more mobile and richer in glycoprotein, while the frame thread is just plain silk protein.

Where does the glycoprotein come from? From the glue droplets that decorate the capture thread or intrinsic to the capture thread. That the droplets serve a vital function was shown by Vollrath, when he analyzed its components. It appears to be rich in choline, betaine, gabamide and similar compounds which are excellent to maintain the vapour pressure and water content, as also glycoproteins that act as mucilage. These droplets help in plasticizing the capture web, allow for mobility, hysteresis and expansion of the thread by as much as five times the original length, just as a rubber band does.

Something even more dramatic is that these droplets act as tiny winches or windlasses that are powered by surface tension. This helps winches or windlasses that are powered by surface tension. This helps in gathering up the surplus silk when the thread contracts, to prevent the web from lagging, remarkably similar to the winch or pulley that holds the thread in kite-flying competitions. The composition of the glue solution is as good as any that can be devised to prevent evaporation and yet not interact with the fibres, thus allowing the windlass action.

The molecular mobility of the capture web silk facilitates thread elasticity. X-ray analysis of the silk shows it to be arranged somewhat like a flat necklace with the flat stones acting as rigid bodies and the connecting thread acting as the rubbery network. When the fibre is dehydrated, it becomes rigid and stiff, while water hydrates and plasticizes to produce mobile, extended structures. The associated glue droplets ensure this. Finally, this may be the reason why orb spiders make their webs in the morning hours when the humidity is high and dew settles on the net. Building at high humidity ensures that the capture thread gets stickiest quickly. This further explains they mysterious behaviour of these spiders eating up the capture threads d®®aily in the morning hours. It is the time for the maximum water gain from the atmosphere. By eating the capture thread at this time, the spider is drinking water and makes good its daily water loss!

KNOW THY INSTITUTIONS

ANNAMALAI UNIVERSITY, CHIDAMBARAM

Divine Destiny, symbolised by the Blissfully Dancing Deity of the Hall of Wisdom at Thillai, inspired the unequalled prince among the men of commerce Dr. Rajah Sir Annamalai Chettiar of Chettinad to establish the Minakshi College in 1920. This bud blossomed into the mutipetalled and enchanting lotus flower, Annamalai University, in 1929. Dr. Rajah Sir Annamalai Chettiar had the true discrimination to distinguish between the impermanent material wealth and the permanent wealth of learning and knowledge and hence he denoted a fabulous sum of Rs. 20 lakhs and 300 acres of land besides the buildings, hostels, library and playgrounds of the Minakashi College, paving the way for the establishment of this unitary, autonomous and residential seat of higher learning and research. Today, it stands as an eloquent testimony to the high-souled humanism and service-mindedness of its Founder.

Since its inception in 1929, Annamalai University has, in the course of these seventy-five years of its development, manifested its vitality, adaptability to the new global trends and the capability to face challenges with Courage and Faith. The towering buildings, the towering personalities, the towering achievements of the University and its alumni point to the fact that the Founder's dream has come true. The remarkable growth and the distinctions gained by the University have made the alumni to hold their heads high with legitimate pride. Indeed, meticulous planning and unremitting perserverance of the Founder-Father and the members of his noble family have contributed to the raising of this lofty and vast Edifice of Knowledge.

HOLY LOCALE

Annamalai University is situated at the hamlet of Thiruvetkalam (at present called

Annamalainagar), which has the ancient abode of Lord Pasupateswara and Goddess Sadgunamabal. The Mahabharata episode of Arjuna performing penance to receive the *pasupata astra* from Lord Siva is associated with this place. In keeping with the spiritual tradition of this place, the masters and their aspirants of Annamalai University are sparing no pains to grapple with educational and social problems. Many a gem of a student of this University is shedding lustre at home and abroad. Many captains of industries and many political leaders and statesmen have had their higher education at this Citadel of Learning and Research.

CONTRIBUTIONS OF PRO-CHANCELLORS

Dr. Rajah Sir Annamalai Chettiar, during his tenure of Pro-Chancellorship for a period of two decades, paid devoted attention to its growth and development. Whoever was found an expert in a particular academic field was approached by the Founder and was brought to the University to head the department of study. The imposing Administrative Building flanking the magnificent Sastri Hall, the Guest House, the Music College, the Vice-Chancellor's Bungalow and the Quarters for the staff had all been planned and constructed under his able guidance and supervision.

The Founder's eldest son Dr. Rajah Sir Muthah Chettiar adorned the Pro-Chancellorship from 1948. A multi-faceted personality of rare calibre, he strove with sustained vigour and zeal to take the University into "fresh fields and pastures new." He gave new dimensinos and direction to the functioning of the University. He evinced keen interest in broadening the frontiers of the University's academic pursuits starting new departments of study, particularly in the domains of Agriculture, Engineering and Technology, Commerce, Business Administration and Medicine. The Directorate of Distance Education was established in 1979 and it renders yeoman service in the field of continuing education. During the 36 years of his Pro-Chancellorship, he strove hard to nurture and nourish those ideals that promoted the growth and development of this institution in quality and dimension.

Dr. M.A.M. Ramaswamy succeeded his father as Founder Pro-Chancellor of the University in 1984. True to the tradition of the Chettinad Family, the present Pro-Chancellor with the insight of an able entrepreneur, the organisational capability of an executive, the versatility of a venturesome industrialist, the qualities of leadership in organisation and with a sense of devottion and commitment, continues to show the same care and attention to the growth of this University. Under his able administration, the University has grown rapidly and widely. Now it has 48 departments of study with 2300 teaching staff and 50578 administrative staff. It has a student strength of above 20000 pursuing different regular programmes of study. The National Assessment and Accreditation Council has endowed the University with a Four Star Status.

Today the University occupies an extensive area of 955 acres. being a residential type of institution, the get-together of staff and students remains an essential dimension. Nearly every department at the University conducts its own seminars and there are also interdisciplinary seminars. At these seminars, the scholars and teachers interact and explore their academic interest together contributing to the academice excellence. Since its establishment, the University campus has been the venue of a number of important international and national conferences, symposia and seminars.

EMINENT MEN AS VICE-CHANCELLORS

A galaxy of distinguished Vice-Chancellors—eminent men of standing and achievement—have added charm and lustre to the office of the Vice-Chancellor, these seventy-five years. The impressive list has Sir Samuel Runganadhan, the

Right Hon'ble V.S. Srinivasa Sastri, Sir K.V. Reddy Nayudu, Prof. M. Ruthnaswamy, Dr. S.G. Manavala Ramanujam, Sir R.K. Shanmukham Chettiar, Dr. Sir C.P. Ramaswami Aiyar, Dewan Bahadur T.M. Narayanaswamy Pillai, Justice Mr. V. Subrahmanyam, Justice Mr. P. Chandra Reddy, Dr. S.P. Adinarayan, Dr. S. Chandrasekhar, Justice B.S. Somasundaram, Dr. S.V. Chittibabu, Prof. Rm. Sethunarayanan, Dr. T.C. Mohan, Dr. M.G. Muthukumarasamy and Dr. P.V. Vaidyanathan. The present Vice-Chancellor Dr. L.B. Venkatrangan is a distinguished educationist, demographer of erudition a discerning administrator, an innovaive organiser of faculty development programmes and an ardent promoter of extension activities. His contribution to the growth of the Directorate of Distance Education is immense.

LANDMARKS

In keeping with its growing service to society, the University is steadily registering physical expansion and pushing its frontiers further. The Srinivasa Sastri Hall, the epicentre of the University, is the mother of all grand and gorgeous buildings. It is at once an archetype and an architectural marvel symbolising the lofty and magnanimous aspirations of the Founder. The other landmarks include the high-roofed Minakshi Building, the historic Gokhale Hall, the solid and spacious Sir. C.P. Ramaswami Aiyer Library Building, the massive Engineering and Technology Buildings, the enchanting Agriculture Faculty Buildings, the grand and sprawling Rajah Sir Muthiah Chettiar Institute of Health Sciences Building, the vast 1050-bedded Hospital Complex, the imposing 5-storeyed D.D.E. Lecture Hall Building and the D.D.E Administrative Building. The ancient temple of Lord Pasupateswara at the heart of the Campus and the modern temple of Lord Iyappa in the north eastern corner or *isanyam* are the spiritual landmarks at Annamalainagar.

FOUR MILESTONES

The Silver Jubilee (1954), the Golden Jubilee (1979), the Diamond Jubilee (1989) and the Platinum Jubilee (2004) celebrations are four important milestones in the history of Annamalai University. These major events have brought some of the most distinguished men from different fields and academic luminaries to the campus and provided opportunities to everyone connected with the University to recall the achievements of this great seat of learning.

SILVER JUBILLEE CELEBRATIONS

The Silver Jubillee of the University celebrated on a grand scale lasted four days from 9th February 1955. The Vice-Chancellor Dr. Sir. C.P. Ramswamy Aiyar welcomed the Gathering in a eloquent speech. His Highness Sri Jaya Chamaraja Wadiyar Bahadur, Rajapramukh of Mysore, delivering the inaugural address, paid glowing tributes to the achievements of the University and the noble services rendered by the Founder and his son. His Excellency Sri Prakasa, Governor of Madras and Chancellor of the University, making a reference to the far-sighted vision of the Founder, dwelt upon the special features of the residential University. The Chief Minister of Madras, the Hon'ble K. Kamaraj, declared the newly built Rani Seethai Achi Hostel open. The Hon'ble Minister for Education of Ceylon Kanakaratnam felicitated the Pro-Chancellor on behalf of the alumni of the University hailing from Ceylon. Dr. Sir A. Lakshmanaswami Mudaliar, Vice-Chancellor, University of Madras, delivered the Silver Jubilee Address in which he praised the achievements of Annamalai University. An attractive *Silver Jubilee Souvenir* was presented by Sri A. Ramanathan Pillai, Deputy to the Vice-Chancellor, to the Rajapramukh of Mysore. Two other books—*Annamalai University and its Environs and Chidambaram : A Chronicle* by J.M. Somasundaram Pillai and K. Nagaraja Iyer respectively—were released on the occasion.

GLODEN JUBILLEE CELEBRATIONS

Befitting the momentous and memorable occasion of the University completing fifty years

of its service, the Golden Jubilee was grandly celebrated for three days—6th to 8th of December 1979. The Golden Jubilee was inaugurated by His Excellency Dr. Neelam Sanjeeva Reddi, the President of India. The Pro-Chancellor Dr. Rajah Sir Muthiah Chettiar, in his Welcome, recalled the founding of the University by his father and highlighted how the University has striven hard to accomplish the purposes which his father had held dear. The Hon'ble Chief Minister of Tamil Nadu M.G. Ramachandran delivered the Golden Jubilee Address. His Excellency Prabhudas Patwari, Governor of Tamil Nadu and Chancellor of the University, paid rich tributes to the Founder-Pro-Chancellors. Dr. M.A.M. Ramaswamy released the *Golden Jubille Souvenir.* The Hon'ble Minister for Education C. Aranganayakam declared the Central Instrumentation and Services Laboratory Building open. Mr. P. Sabanayagam I.A.S., Education Secretary opened the Damodaran Post—Graduate Education Building. The foundation stone for the New Women Student's Hostel was laid by Hon'ble K. Manoharan, The Minister for Finance, Govt. of Tamil Nadu. The Vice-Chancellor Justice B.S. Somasundaram laid the foundation stone for the Golden Jubillee Building. Justice V.R. Krishna Aiyar presided over the Alumni Day. Dr. Ma. Po. Sivagnanam delivered the Valedictory Address.

DIAMOND JUBILEE CELEBRATIONS

December Fourteenth 1989 was a red-letter day in the annals of Annamalai University as it celebrated the Diamond Jubilee with all the eclat the occasion demanded. The Pro-Chancellor Dr. M.A.M. Ramaswamy, in his Welcome, said that the function afforded an opportunity for the staff, alumni and the people connected with it to recollect and cherish the growth and development of this University in the past sixty years. His Excellency Shri. R. Vekataraman, President of India, and the most distinguished alumnus of the University, delivered the Inaugural Address. His Excellency Dr. P.C. Alexander, Governor of Tamil Nadu and Chancellor of the University, presided over the function. The Chancellor released the *Biography of Dr. Rajah Sir Muthiah Chettiar* written by K. Nagaraja Aiyar, an eminent Indo-Anglian writer. The Diamond Jubillee oration was delivered by the Hon'ble Chief Minister of Tamil Nadu Dr. Kalaignar M. Karunanidhi. The Hon'ble Minister of Education Dr. K. Anbazhagan released the English translation of *Kuraloviyam (Kural Portraits)* of Dr. Kalaignar M. Karunanidhi. The distinguished invitee Hon'ble Dr. Dotto S. Samyvellu, Minister for Energy, Telecommunications and Post, Government of Malaysia declared the Rani Seethai Achi Housing Complex open. Dr. Rm. Sethunarayanan, Vice-Chancellor, proposed the vote of thanks. Some of the publications brought out by the Publications Division were also released on the occasion.

PLATINUM JUBILEE CELEBRATIONS

The Platinum Jubilee of the University, the Birth Centenary of the Second Founder Pro-Chancellor Dr. Rajah Sir M.A. Muthiah Chettiar and the Silver Jubilee of the Directorate of Distance Education were celebrated at a triune function on 27th August 2004. The historic triune function was inaugurated by His Exceellency Dr. A.P.J. Abdul Kalam, the President of India. Dr. M.A.M. Ramaswamy, Pro-Chancellor of the University, welcoming the distinguished guests, recalled the services rendered by all those connected with the growth of University. Presenting a report Vice-Chancellor Dr. L.B. Venkatrangan highlighted the multifarious development of the University during the past 75 years. Hon'ble R. Venkataraman, the former President of India, unveiled the Rajah Sir Muthiah Chettiar Birth Centenary Memorial Arch. His Excellency Thiru. P.S. Ramamohan Rao released the Platinum Jubilee Souvenir and the Birth Centenary Souvenir of Dr. Rajah Sir Muthah Chettiar. On the eve of the Platinum Jubillee Celebrations, a grand float procession was

organised. The Alumni Meet, held on 26th August, offered the distinguished alumni an opportunity to cherish the memory of their fruitful days on the University Campus. To mark the great event, a spectacular Jubillee Exhibition conducted on the Engineering Faculty premises, lasted for 15 days and it attracted visitors from far and wide.

INTENSE RESEARCH IN NINE FACULTIES

FACULTY OF ARTS

The Faculty of Arts enjoys reputation across the country for its distinguished record of effective teaching at the higher level and continuing research. It comprises the Departments of English, History, Political Science, Economics, Commerce, Sociology, Philosophy, Population Studies, Business Administration and Library and Information Sciences.

FACULTY OF SCIENCE

The Faculty of Science with a strong commitment to research consists of the Departments of Mathematics, Statistics, Physics, Chemistry, Botany, Zoology, Marine Biology, Earth Sciences and Bio-Chemistry. The Faculty's post-graduate activities are strongly promoted by state-of-the-art instrumentation housed in well-equipped research laboratories.

FACULTY OF FINE ARTS

The Founder Dr. Rajah Sir Annamalai Chettiar's passion for Tamil Classical Music found its expression in the establishment of this faculty in 1929. The Faculty, popularly known as Music College on the campus, is housed in a splendid building that includes a spacious recital hall and practice rooms. The continuing tradition of the department is to have performing artistes and eminent musicians as teachers who cultivate in the students the gift for musical expression. Teaching is by a mix of lectures, seminars, symposia, workshops, group singing practice and individual consultative tutorials.

The Tamil Isai Movement was inaugurated at Annamalainagar by Dr. Rajah Sir Annamalai Chettiar to rehabilitate the ancient Tamil Music and restore it to its pristine glory in Tamil Nadu. In keeping with that ideal, compositions in Tamil have been accorded the pride of place in the curriculum.

FACULTY OF INDIAN LANGUAGES

This Faculty comprises the Departments of Tamil Studies and Research, Sanskrit, Hindi and Linguistics. The Linguistics Department has been raised to a Centre of Advanced Studies due to its great contribution to research. The Faculty's major constituent, the Tamil Department, which is as old as the University, has contributed immense scholarship to Tamil Studies and brought out trend-setting publications. A vigorous research climate is encouraged in all these departments.

FACULTY OF ENGINEERING TECHNOLOGY

The Faculty of Engineering, started in July 1945 on an expansive site, has grown into an institution of excellence to-day. The Faculty's nine departments—Civil Engineering, Structural Engineeirng, Mechanical Engineering, Manufacturing Engineering, Electrical Engineering, Instrumentation Engineering, Chemical Engineering, Computer Science and Engineering and Pharmacy—have well-equipped laboratories and workshops that are acclaimed the best in the country. All the departments are actively involved in research. The Faculty is housed in twelve spacious buildings of architectural splendour on the Western side of the campus adjacent to the Chidambaram Railway Station.

FACULTY OF EDUCATION

The Faculty of Education comprises the Departments of Education, Psychology and Physical Education and Sports Sciences. It affords immense opportunities to scholars to engage themselves in research activites. The academic staff take part in teaching and research in varied areas.

FACULTY OF AGRUCULTURE

The Faculty of Agriculture consists of the Departments of Agronomy, Soil Science and Agricultural Chemistry, Agricultural Botany, Genetics and Plant Breeding, Horticulture, Microbiology, Plant Pathology, Entomology, Agricultural Economics, Agricultural Extension and Division of Animal Husbandry. Ideally located in a rural set-up, the Faculty is a source of inspiration to the farmers of the Cauvery Delta.

FACULTY OF DENTISTRY

The second Founder Pro-Chancellor Dr. Rajah Sir Muthiah Chettiar announced at the Golden Jubilee Celebrations in December 1979 the decision to set up the Faculty of Medicine and start a Dental College under its purview as first step. Accordingly, the Rajah Muthaih Dental College came into being in December 1980. The Inspection Commission of the Dental Council of India after a thorough review accorded permanent recognition to the college. The college, since its inception, has been encouraging the enrolment of women students and about one third of its present students are women. The Rajah Muthiah Dental College and Hospital have earned a national reputation and the students are drawn from different countries.

FACULTY OF MEDICINE

The Faculty of Medicine came into being with the inauguration of the Rajah Muthiah Medical College on 5th August 1985 on the occasion of the 81st birthday of the second Founder Pro-Chancellor Dr. Rajah Sir Muthiah Chettiar. The present Founder Pro-Chancellor Dr. M.A.M. Ramaswamy took meticulous care and interest in establishing this prestigious medical college and hospital, thus translating the cherished dreams of his father into reality. The primary objective of the Medical College is to make its own worthy contribution to the community with well-trained doctors and paramedical personnel such as nurses, physiotherapists and occupation therapists. The special feature of Rajah Muthiah Medical College and Hospital is that it can boast of a national faculty with an international student-community and is run directly by this Unitary Residential University. The Faculty consists of two Departments—Department of Medical Education and Department of Nursing.

CAS IN LINGUISTICS

The Department of Linguistics, started in 1956 with the generous funds given by the Government of India during the Silver Jubilee Celebrations in recognition of the remarkable work done in the field of Linguistics, was conferred on the status of an advanced centre of research in 1963. With the special assistance given by the U.G.C. and other agencies, this Centre has published valuable books on Dravidian Linguistics and today it is considered the Mecca of Dravidian Linguistics.

CAS IN MARINE BIOLOGY

Located on the northern banks of the Vellar Estuary at Parangipettai (historically known as Porto Novo) 25 kilometres away from the main campus, the Centre of Advanced Study in Marine Biology attracts the attention of the Universities at home and abroad by its significant contributions in the sphere of tropical Marine Biology. Founded by the distinguished scientist Prof. R.V. Seshaiyya in 1951, the station is located in a place of strategic importance for investigations on various aspects of Marine Biology, Oceanography, Estuarine Ecology and Ecology of Mangroves and

Backwaters. The status of a separate department was accorded by the University in 1961.

TAMIL STUDIES AND RESEARCH

The Founder of the University Dr. Rajah Sir Annamalai Chettiar was keen to develop the University among other things as a seat of Tamil Language and Culture. To fulfil his ambition, he brought the best of scholars to the University to head the Department of Tamil Studies and Research.

DIRECTORATE OF DISTANCE EDUCATION

The Directorate of Distance Education was established in 1979, then known as the Directorate of Correspondence Courses and Continuing Education. The spectacular growth and achievemnets of the Directorate within a span of 27 years points to the meticulous planning and untiring work that have gone into its making.

The D.D.E. now offers 369 Programmes of study. The Dual Degree System recently introduced enables a student to earn two degrees in four years with a focus on I.T. A number of I.T. based programmes and also short-term computer certificate programmes have been introduced. Seasonsed teachers of various faculties at the Directorate along with talented Resource Persons invited from the University Departments tour the major cities of India and towns of Tamil Nadu to conduct Personal Contact Programmes for the students of the respective areas.

There are 359 teachers rendering invaluable service in the effective implementation of the innovative distance education programmes; on the administrative side, 887 non-academic staff help in the smooth functioning of the D.D.E. With a view to providing student-support services and improving the quality of distance education, the Directorate has started 57 Study Centres in the major cities of India and towns of Tamil Nadu. Significantly, the Directorate has been offering Overseas Programme since 2000-2001. The programmes are now offered in Singapore, Malaysia, Qatar, Abu Dhabi, Dubai, Mauritius and Nepal. The Directorate has recently introduced the Digital Voice Information System for the benefit of its students clientele.

THE LIBRARY

The University Library, named after the eminent scholar-statesman and former Vice-Chancellor Dr. Sir. C.P. Ramaswami Aiyar, is a key resource for students and staff. It has a collection of nearly 5 lakh volumes selected to support the various academic programmes of the University. The library, located at the centre of the campus in a beautiful environment, is noted for its architectural beauty. It subscribes to about 400 current periodicals and newspapers and maintains substantial backfiles of these periodicals in bound volumes.

PUBLICATIONS DIVISION

The Publications Division of the University is one of the earliest, the most popular and non-profitable publishers of scholarly books in India. Thanks to the benign wish of the Founder, it came into being to popularise the ancient Tamil classics and other modern research findings. The Founder's aim was to make available the classics in the language and other socially relevant research works at the lowest price. Accordingly, the books brought out by the Division, are sold at an unbelievable low price. The Division has published more than 600 titles on a wide range of subjects. Apart from books, it regularly publishes Humanities Journal, Science Journal, Engineering Journal, Indian Languages Journal and Agriculture Research Journal. Some of its prestigious publications have brought laurels to the University by winning awards and prizes.

CENTRE FOR YOGA AND MEDITATION RESEARCH

The Centre of Yoga and Meditation Research was inaugurated in December 1998. The Centre teaches practical meditation and yoga and helps the individuals to use the latent potentials of the mind to maximum extent.

CENTRE FOR GANDHIAN STUDIES

The Centre for Gandhian Studies functioning at the Department of Political Science, besides organising seminars on Gandhian themes, conducts training programmes for village panchayat presidents so as to enable them to function more effectively.

UNIVERISTY PR]INTING PRESS

Established in 1986 at a cost of Rs. 80 Lakhs, the Annamalai University Press (AUP) meets the print requirements of the University in general and the Directorate of Distance Education in particular. Equipped with four offset machines, computers, laser printers, automatic camera, scanner, paper-folding and paper-cutting machines, perfect binding machine and a host of high performer machines, the A.U. Printing Press with no loss of time, makes readily available, every printed material required.

MOU WITH UNIVERSITIES ABROAD

The University Departments have signed M.O.U. with many foreign Universities. (1) CAS in Matrine Biology with (i) Ehime University, Japan; (ii) CSIRO Queensland, Australia; (iii) Institute for Marine Environmental Research, Plymouth, U. K.; (iv) National University of Singapore; (2) Faculty of Engineering & Technology with (v) Fulki University, Japan; (vi) University of Technology of Australia, Sydney; (3) Department of Bio-Chemistry with (vii) John Hopkins University; (4) Department of Agronomy with (viii) University of Bristol, U.K.; (5) Exchange of faculty by Department of English with (ix) Ball State University, U.S.A. and (6) Zoology Department with (x) Swiss Federal Institute of Technology, Switzerland.

IMPROVED INFRASTRUCTURAL FACILITIES

On the eve of the triune celebrations, numerous infrastructural facilities have been created to cope with the voluminous increase in enrolment of students in various on-campus programmes. Many buildings that have come up recently point to diligent efforts to consolidate the gains and the meticulous planning for the future expansion. Mention must be made of the construction of Arts and Science Block Phase I & II for the students of Five-Year Integrated Programmes, Platinum Jubilee Building housing an aquarium of national significance, Guest House Annexe and a fully air-conditined computerised Medical College Library. Enormous renovation work has been undertaken to preserve the heritage buildings like the Minakshi Building and the Oriental Building. Renovation of the Sastri Hall with full air conditioning and installation of the latest auditorium facilities, the Senate Hall with additional facility of centralised air-conditioning and the Commerce Building with remodelling of the facade are the other noteworthy works that have been completed recently. Construction of an additional floor at the DDE Administrative Building and additional construction at the Engineering Faculty Library have added to the increased utility of these buildings. To keep pace with the increase in the numerical strength of the students in Physical Education Programmes, a new pavillion has been constructed. New laboratory facilities in terms of space and quality equipment have been provided to cater to the needs of learners and researchers. All the roads on the campus have been widened and made into two-way lanes with glittering sodium vapour lights. Sprawling green

lawn-cum-garden on the northern side of the Kumararajah Muthiah Avenue, the eye-catching Children's Park and the cemented pavements have added to the beauty of the campus. All these have been accomplished recently with a view to providing a clean, peaceful and comfortable environment for the pursuit of knowledge.

RECENT ACADEMIC ADVANCES

Among the recent academic achievements, the introduction of Five-Year Integrated Programmes in various disciplines is hailed as a worthy endeavour by educationists from across the country. Today, the University offers 197 On-Campus Programmes; and with the introduction of much-sought-after On-Campus Programmes, the student strength has gone up from 7500 to 18000. Programmes of Study in fast expanding areas of bio-technology and bio-informatics have been initiated. Four Departments of study are immensely benefitted under the U.G.C. Special Assistance Programme. The number of research articles published by the staff and researchers have increased substantially. An Internal Quality Assurance Cell has been set up to monitor the quality of academic output. The departments of study are encouraged specifically to conduct national and international seminars, symposia, workshops and conferences so as to expose teachers of the University to new trends in teaching and research at the global level. Students Progression Cell has been created to coach students from backward classes for taking the IAS exams. In keeping with the national policy of public health, the concept of 'No Smoking Zone' has been put into practice. A grievance Redressal Cell for On-Campus students has been set up in conformity with students welfare measures.

With the introduction of an array of innovative programmes by the Directorate of Distance Education in the academic year 2004, the number of programmes offered by the distance education mode has increased from 182 to 303; and over the years the enrolment of students has registered a quantum leap i.e. from a modest 59000 to 2.75 lakh. Currently it is offering student—support services through 75 study centres (of its own) spread over the country. The recently introduced Digital Voice Information System (Voice Net) and Video Conferencing are high-tech facilities offered to the distance learners. Plans are afoot to use EDUSAT for popularising the programmes conducted by the Directorate. The Directorate of Distance Education has signed an MOU with the National Institute of Fashion Design, Chandigarh and the Soorya Educational Trust to offer programmes in Fashion Technology and Catering Technology respectively.

TOWARDS NEW FRONTIERS OF KNOWLEDGE

Today, Annamalai University stands as a premier institution of higher learning and a vibrant centre of intellectual activities. The University proudly marches on, proclaiming its motto "With Courage and Faith" to its loftier destinies, in the eager expectation of continuing the adventure of imparting new dimensions of knowledge and enlightenment and conquering unknown frontiers of the intellect. The University as a Centre of Excellence will continue to serve the community with an added spirit of dedication in the years to come.

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LIFE SKETCHES OF GENERAL PRESIDENT AND SECTIONAL PRESIDENTS 94th INDIAN SCIENCE CONGRESS, ANNAMALAI NAGAR, 2006-2007

DR. HARSH GUPTA
General President

Dr Harsh Gupta had his education at the Indian School of Mines (B.Sc.(Hons), M.Sc. and A.I.S.M) and University of Roorkee (Ph.D.). He availed two years UNESCO fellowships for advanced studies at Tokyo. Dr. Gupta's specialization is in Earth Sciences and their application to address problems of continents and oceans, administration of educational and scientific institutions. He has published over 130 research papers in International Journals, written 4 pioneering books published by Elsevier Scientific Publishing Company, Amsterdam and edited over 15 volumes. He has held senior responsible positions for the past 22 years, including Vice-Chancellor of Cochin University of Science & Technology; Director, National Geophysical Research Institute, Hyderabad; and Secretary to the Government of India for the Department of Ocean Development. Presently, Dr. Gupta is a Raja Ramanna Fellow at the National Geophysical Research Institute, and General President, Indian Science Congress 2007. Dr. Gupta has a unique combination of rich scientific research and science administration experience. He is internationally well connected and has been a Research Scientist, Professor and Visiting Professor at a number of Universities and Institutions abroad.

Dr. Gupta is among the most well known earth scientists in the world. In the following, some facts on the Research carried out by Dr. Gupta are given.

- Provided the first geophysical evidence for an enormously thick crust (65-70 km) below the Tibet Plateau and Himalayan region in 1967, found to be accurate as confirmed by detailed field seismic surveys conducted in 1980s.
- Over the past 40 years, through detailed studies of earthquake focal mechanism, surface wave attenuation and other related work, threw much light on the geodynamic processes responsible for the high elevation of Tibet Plateau and tectonics of the Himalaya and nearby region.
- Pioneered investigations of artificial reservior induced earthqukes and developed criteria of discriminate reservior induced earthquakes from normal earthquakes. These criteria are now internationally applied. Also developed procedures to estimate potential of occurrence of reservoir induced earthquakes at a given site. He discovered that reservoir induced earthquakes of magnitude ≥ 5 are generally preceded by a couple of $M \geq 4$ earthquakes.
- Completed a detailed study in 1986 of earthquake swarms and quiescence that precede major earthquakes in the northeast India region and concluded that major earthquakes are preceded by well-defined swarms and quiescence. Also made a medium term forecast of a $8 \pm \frac{1}{2}$ magnitude earthquake to occur in area bound by 21°N and $25\frac{1}{2}$°N, and 93°E with a focal depth of 100 ± 40 km before the end of 1990. This has come true.

- Completed 'strees pattern' for the Himalayan and the Andaman-Nicobar Region as inferred from earthquake focal mechanism.
- Dr. Gupta has carried out detailed studies of Latur earthquake, one of the deadliest stable continental region earthquakes, and shown that fluids existing at shallow crustal depths played an important role in the genesis of Latur earthquake.
- Dr. Gupta has developed the concept of spectral magnitude and showed its application in learning about characteristics of seismic sources using broadband recordings. One latest application has been in characterizing the nuclear explosion.
- Recently, Dr. Gupta has successfully predicted (short-term) a $5 \pm$ magnitude earthquake at Koyna, which occurred on 22nd May 2006.

RESEARCH RELATED WITH OCEAN SCIENCE

Dr Harsh Gupta has been very deeply involved with inverstigations related to oceans. Early in his career during 1964-65 he participated in the India Ocean Expendition Programme where joint expeditions were undertaken in the Arabian Sea by the German research vessel Meteor and Indian research vessel Kistna.

He was the Leader of the 3rd Indian Scientific Expedition to Antarctica (983-84) which established a permanent base for India in a record time. This station fulfilled a very urgent scientific requirement of the country. One of the major requirements in Antarctica has been the setting up of a permanent seismic station as well as permanent GPS station. Under Dr Gupta's stewardship, these two major objectives were achieved during 1996-97 and 1997-98. India now boasts of one of the best state-of-the-art GPS station and a digital seismic data acquisition system in Antarctica.

At the Department of Ocean Development, he has implemented several new programmes, such as, scientific work necessary for submitting India's claims on Legal Continental Shelf where India may gain 1.5 million sq. km of additional ocean area over and above the 2 million sq. km Exclusive Economic Zone (EEZ); detailed bathymetry surveys in the entire EEZ of India; building of an Indo-Russian Gas Hydrate Centre at Chennai; acquisition of new research vessels; and latest being putting India on the global map by designing an Early Warning System for Oceanogenic Hazards (Tsunami and Storm Surges) for India, as well as successful commissioning of a 1 million litre per day Low Temperature Thermal Desalination Plant at Kavaratti, Lakshadweep Islands.

INSTITUTION BUILDING

Dr. Gupta has been involved from a very young age in senior administrative positions of institution building. He built Centre for Earth Science Studies at Trivandrum from a scratch. This included development of a whole campus in a short time of two ears (1984-86). He also had the responsibility of building Indian Scientific Station in Antarctica which he did with distinction and completed all the tasks in a record time of one Antarctic summer (1983-84). In his capacity as Vice-Chancellor of Cochin University of science and Technology (at the age of 45 years he was the youngest Vice-Chancellor in the country), he created DRDO-Cochin University of Science & Technology, Computer Centre equipped with the then latest available computers for joint research projects. He also hosted the Science Congress in January 1990, the first Science Congress in Kerala, which, people still remember as one of the best conducted Science Congress meetings.

During his tenure as the Direcor at the National Geophysical Research Institute (NGR), Hyderabad (1992-2001), NGRI rose to the position of one of the top CSIR laboratories. From a meager rupees

one crore external cash flow during 1993-94, it has grown to 11 crores during 1996-97 and the same level is maintained since then. NGRI won the prestigious Tecehnology Prize for Business Development and Technology Marketing during 1997. At NGRI, Dr Gupta revolutionized application of earth sciences to the basic needs of the country. This has included delineation of Mesozoic sediments (which could be petroliferous) under Deccan Trap cover, and a new chapter has been opened in looking for Gas Hydrates in offshore region of India.

INTERNATIONAL ASSOCIATIONS

Dr Gupta has been very active internationally. He is currently a Bureau Member of the International Union of Geodesy and Geophysics (IUGG). Earlier he has been Councillor of the International Union of Geological Sciences (IUGS); the Chairman of the Steering Committee of Global Seismic Hazard Assessment Programme (a UN initiative); Chairman of IASPEI/UNESCO/ICL Working Group on Seismology and Related Sciences in Africa, as well as Bureau Member and Chairman of several Committees of the International Lithosphere Pogramme. He was the Founder President of Asian Seismological Commission. Dr. Gupta is currently a Member of the CAPR/ICSU as well as Memeber, ISCU Planning Group on Natural and Human-induced Hazards and Disasters. He has convened several international symposia at IUGG, IASPEI and IGU Assemblies. During January 1998, he convened a Chapman Conference on "Stable Continental Region Earthquakes" at NGRI, Hyderabad, this being the first Chapman Conference ever held in Asia.

SCIENCE COMMUNICATION

Dr. Gupta has been extensively involved with science communication and popularization. He has given numerous talks on Earthquakes and what can be done about it, at different forums in India and abroad. He was the Chairman of the Steering Committee of the Global Seismic Hazards Assessment Programme, one of the programmes initiated by U.N. for International Decade of Natural Disaster Reduction (IDNDR), where over 500 scientists worked globally from 1992 to 2001 to prepare, for the first time, a global map of Earthquake Hazard. He has convened several interesting workshops and symposiums which produced excellent volumes.

HONOURS AND AWARDS

Dr. Gupta is Fellow of the Indian National Science Academy; National Academy of Sciences, India; and Third World Academy of Sciences, Italy. He has won several awards. To mention a few :

Indian School of Mines Golden Jubilee "Outstanding Alumni" Award (1977); Krishna Gold Medal of the Indian Geophysical Union (1977); Shanti Swarup Bhatnagar Prize for Science & Technology in Earth Sciences (1983); USSR Academy of Sciences "100 Years of International Geophysics" Memorial Medal (1985); The first "Dr Anil Kumar Ganguli" Memorial Oration Award, BARC, Bombay (1989); National Mineral Award, Government of India (1991); The Department of Atomic Energy, Government of India "C.V. Raman Lectureship" (1993); Indian Science Congress Association Jubilee Lecture (1995); CSIR Technology Prize for Business Development and Technology Marketing (1995); Ninth Professor K.P. Rode Memorial Lecture of the Indian Science Congress Association (1997-98); Second Outstanding performance Award by the 11th International Kharazmi Festival of Iranian Research Organization for Science and Technology, Teheran Iran (1998); Indian Geophysical Union Decennial Award (1998); Federation of Indian Chambers of Commerce and Industry, New Delhi, Award for Physical Sciences, 1998-99 (1999);

IGU Millennium Award (1999); Indian Society of Applied Geochemists Millennium Award (2000); Vikram Sarabhai Memorial Lecture, Department of Space (2001); First Dr. H.N. Siddiquie Memorial Lecture, Indian Geophysical Union (2001); 22nd G.P. Chatterjee Memorial Award, Indian Science Congress Association (2002); Jawaharlal Nehru Visiting Fellowship 2003, Indian National Science Academy (2003); The 4th Prof. C. Karunakaran Endowment Lecture (2003); Bruun Memorial Lecture, 22nd session of the Assembly of International Oceanographic Commission, Paris (2003); National Mineral Award for Excellence-2002 (2003); Prof. K. Naha Memorial Medal (2004) of INSA (2004); Sir Alladi Krishnaswamy Aiyer Endowment Lecture 2004 (2004); Prof. J.B. Auden Memorial Lecture 2005 (2005); Prof. M. Kurup Memorial Lecture 2005 (2005); Prof. Y. Nayudamma Memorial Lecture 2005 (2005); '*Padma Shri'*, Government of India (2006)

DR. M. S. SACHDEV
President
Section of Agriculture and Forestry Sciences

Dr. M. S. Sachdev born on June 6, 1949 in Chakrata (Himalayas), Dehradun, obtained his Master's degree in Chemistry from the Meerut University in 1970. He obtained the Ph. D. drgee from the Post Graduate School, Indian Agricultural Research Institute, New Delhi in Soil Science and Agricultural Chemistry in 1989. Dr. Sachdev has specialized in the use of isotopes in soil, fertilizer, plant and water research and has more than 35 years of experience in the use of isotopes in fertilizer use efficiency research with special reference to nitrogen use efficiency and balance in soil plant system including the pollution potential of fertilizer use. He was awarded the Professional Chair of National Fellow of ICAR in 1995 and continued in this position for two terms till 2005. Currently Dr. Sachdev is Principal Scientist. He was awarded the International Atomic Energy Agency Fellowship in 1974 to work at the Institute of Soil Biochemistry in Braunschweig, Germany in the area of Soil Organic Matter research.

Dr. Sachdev's work in soil fertility, fertilizer and water use research has been recognized nationally and internationally and has received many prestigious awards including, Dhiru Morarji Memorial Award (Fertiliser Association of India), FAI Silver Jubilee Award of Excellence ; *FAI Silver Jubilee Award* 1989; *Jawaharlal Nehru Award* (ICAR 1990); *Shri Ram Award Second Prize* 1990-91 given by FAI ; National Fellow Award of the ICAR (1995) ; Potash & Phosphate Institute of Canada_Fertiliser Association of India (PPIC–FAI) Award-2000. Dr. Sachdev is the Fellow of the Indian Society for Nuclear Techniques in Agriculture and Biology (FNAS) and Fellow (FNAAS) of the National Academy of Agricultural Sciences. He has worked and provided research guidance as Expert of the International Atomic Energy Agency in the area of N-15 and other isotope techniques in soil-plant-water relationship research in Zimbabwe (1993 and 1995), Srilanka (1994), Uganda (1996), Bangladesh (1997 and 2001) and Mongolia (2003). Also, he has trained several research workers in isotope techniques as IAEA Fellows from Indonesia, Mauritius, Philippines, Sudan and Bangladesh. He has participated in several Research Coordination Programmes of the FAO/IAEA held in Vienna (1994), Cimmyt, Mexico (1996), Vienna (1997,

1998), Izmir, Turkey (1999), Tunis, Tunisia (2000), Vienna (2001), Vienna (2002), China (2003) and Greece (2003). Dr. Sachdev was also invited to work as Soil Scientist at the Agriculture and Biotechnology Laboratories of the International Atomic Energy Agency at Seibersdorf, Vienna, Austria from March to September, 2002.

The focus of his research has been judicious and optimal use of fertilizer in cropping systems for increasing fertilizer nitrogen use efficiency and in assessing the pollution potential of agricultural nitrogen residues using ^{15}N stable isotope techniques. He has been teaching and guiding students at the Post Graduate level at IARI since 1991 and conducting training programmes in isotope and ratiation techniques since 1976. He has more than 140 publications in the form of research papers in international and national journals, books/ bulletins, seminar/symposia/conference proceedings, popular articles, technical reports and training manuals.

Dr. Sachdev has been associated with a number of Professional Societies in his area of research, *Treasurer* : Indian Society for Nuclear Techniques in Agriculture and Biology for four terms from 1980 to 1988 ; *Secretary* : Delhi Chapter of the Indian Society of Soil Science in 1990 ; *Secretary* **:** Indian Society for Nuclear Techniques in Agriculture and Biology since 1989 ; *Vice-President* : Delhi Chapter of the Indian Society of Soil Science, for the terms 1994 to 1996 and 2001 to 2005. Dr. Sachdev has also served as the Recorder of the Agricultural Sciences Section of the Indian Science Congress Association for the 86th (Chennai) and 87th (Pune) sessions (1999 & 2000), Member : Sectional Committee of Agricultural Sciences Section and Local Secretary of the Chemistry Section of ISCA 2001, 88th Session held at IARI, New Delhi.

PROF. U. C. GOSWAMI
President
Section of Animal, Veterinary and Fishery Sciences

Professor Umesh C. Goswami, Department of Zoology, Gauhati University, born in 1950 passed his M. Sc. in Zoology with a gold medal in 1972 and later obtained his Ph.D. from Gauhati University in 1979. He worked on Vitamin A and Carotenoids under the guidance of Professor A. B. Barua, Biochemistry and Biophysics, Department of Iowa State University USA. Professor Goswami started his teaching career in the Post Graduate Department of Zoology, Cotton College and later joined as lecturer in Gauhati University in 1977. After that he became Reader in 1985 in the same department and then permanent Professor in 1993. He also became the Head of the Department of Zoology for 1999-2002 and during that period the Department was elevated into a UGC's-SAP and DST-FIST sponsored department along with establishment of Three (3) Centres namely Aquaculture and Aquatic resources Management Centre, Biodiversity and Bioinformatics.

Professor Goswami has been working in the field of Vitamin–A and Carotenoids since 1974 along with fish biology and fishery science. He has conducted several research projects sponsored by UGC, DST, DAE, ICAR, World Bank, Schedule Castes and Schedule Tribes Dept. of the Govt. of Asom till date. He has produced 20 Ph.D. students and has published more than 70 research papers in

journals of national and international repute, and has attended several national and international seminars in India and abroad.

Some of his significant contributions are his studies on the biosynthesis of Vitamin A in freshwater fish and the distribution of retinoids molecules in freshwater piscian diversity and the biopotency of several naturally occurring Vitamin A_2 compounds from freshwater fish liver oil and modulating carcinogen DNA adduct function and breeding of *Clarias batrchus* under the agro-climatic conditions of North East India.

Dr. Goswami pursued his Post Doctoral research (on fish physiology) in the Charles University Prague (1979), Indian Institute of Science (1980-81), Michigan State University, USA, Michigan (1987-1988), Institute of Aquaculture Research, Norway (1993-1996). Besides these he has had several interactions during his visits to the laboratories of University of Leidem, The Netherlands, University of Tokyo, Japan, University of Sydney, Australia, AIT-Bangkok, University of Munich, Germany. Within India he had several collaborative research programme with Food Technology and Enzyme Engineering Division of BARC Carcinogenisis division of Tata Memorial Center, Mumbai and Central Institute of Fishery Education (Deemed University). He is a life member of several societies of India and abroad.

Professor Goswami has received several honours/ awards in recognition of his meritorious research works, some of which are : (i) Recipient of B. C. Guha Memorial Award, 2006, Awarded by Indian Science Congress. (ii) Admitted Fellow of Indian Academy of Environmental Sciences Gold Medal, 2003. (iii) Recipient of Indian Academy of Environmental Sciences Gold Medal, 2003 (iv) Admitted Fellow of Zoological Society of India, FZSI 2003 (v) Admitted fellow of Academy of Sciences for Animal Welfare. FASc. (AW) 2003. (vi) Elected President of Zoological Society of Assam since 2002, and continuing the same till date. (vii) Recipient of Paul Haris fellow from Rotary International, 2002. (viii) 20th century Gold Medal as Contemporary Indian Zoology for Outstanding Achievements in Zoology and Aquaculture Nutrition in particular. Zoological Society of India, 2001. (ix) Recipient of Senior Visiting Fellowship/Grant from the Norwegian Research Council, AKVAFORSK-Award, 1993. (x) Recipient of Dr. Biraj Mohan Das Memorial Award for Life Sciences, 1991. (xi) Admitted fellow of Nature Conservators, India, FNC, 2003. (xii) Admitted Fellow of Zoological Society of India (Calcutta), FZS. 1989. (xiii) Recipient of Academic Gold Medal, 1972 from Gauhati University.

Professor Goswami has been actively engaged in the Curriculum Development programme of Zoology of UGC (2001-2002) and at present he is the PAC member of DST, Govt. of India (animal science) for three years. He is also a national Member Co-ordinator of NAAC.

Prof. Goswami has taken the leadership in (i) establishing 100 eco-clubs in High & Higher Secondary School of Lower Assam under the sponsorship of Ministry of Environment and Forest (MOEF), Govt of India : and (ii) in adopting a fishing community village where more than 100 fish farmers' families are practising fish farming in the Hajo-Satdala of Kamrup District of Lower Assam with the sponsorship of SBI, the project *Grow More Fish-Fish For All*. Professor Goswami is also a distinguished social worker. He was the President of Rotary Club of Guwahati South (R. I. district 3240) and is a recipient of the Paul Haris Fellow of Rotary International.

PROF. K. K. BASA
President
Section of Anthropological and Behavioural Sciences (including Archaeology and Psychology & Educational Sciences)

Professor Kishor K. Basa (1958) did M. A. in History (Specializing in Ancient Indian History & Archaeology) from Delhi University, Delhi and M. A. in Anthropology from Utkal University, Bhubaneswar. Recipient of two gold medals–the Surajmal Saha Memorial Gold Medal for Securing the First position in the whole of Orissa in H. S. C. exam. (1973) and Professor Ghanshyam Das Memorial Gold Medal for standing First in B. A. History (Hons.) exam (1977) from Utkal University. He completed his Ph. D. from University of London in 1991 on a theme related to early trade between India and Southeast Asia. He was a Commonwealth Post-Doctoral Fellow in the University of Cambridge during 1999-2000 where he embarked a study on Social Theory and Indian Archaeology from a historigraphic point of view. He was nominated by the UGC for the Indo-French Cultural Exchange Programme in Paris in 1997 and was a Visiting Associate of the UGC at Deccan College, Pune. He has edited two books– Archaeology of Orissa (2 vols.) and Understanding Heritage : Role of Museum. He has published extensively in the fields of Anthropology, Archaeology, and Museology. He was a Member of the Editorial Board for Papers from the Institute of Archaeology (London). South-Asian Anthropologist, and Orissa Historical Research Journal. At the moment, he is the founder Editor of Humankind, a journal of the Indira Gandhi Rashtriya Manav Sangrahalaya, Bhopal. He is the General Editor of a new series on Intangible Cultural Heritage of India. He had delivered the Platinum Jubilee Lecture for the Anthropological and Behavioral Sciences Section of the Indian Science Congress in Chandigarh (2004) on the theme 'Globalization and Cultural Heritage in the Third World'. Besides, he had delivered Prof. Adhir Chakravarti Memorial Lecture (Kolkata), Padmashri Parmananda Acharya Memorial Lecture and Dr. K. C. Panigrahi Memorial Lecture (North Orissa University) and Dharanidhar Memorial Lecture (Keonjhar, Orissa). Recently, he has been invited by the Asiatic Society, Kolkata to deliver the Panchanan Mitra Memorial Lecture (2006). He is also the President (elect.) for the Archaeology Section of the Indian History Congress. A Professor and Former Head of the Department of Anthropology, Utkal University, Bhubaneswar, Dr. Basa at the moment is on Deputation as the Director, Indira Gandhi Rashtriya Manav Sangrahalaya (National Museum of Mankind), Bhopal under Ministry of Tourism & Culture, Govt. of India.

PROF. A. K. SINGH
President
Section of Chemical Sciences

Prof. Anil Kumar Singh (b. 1952) received M. Sc. (1974) degrees from the University of

Gorakhpur, and Ph. D. (1978) from the Indian Institute of Technology, Kanpur. Subsequently he went to the USA and did post-doctoral research at the Florida State University. Tallahassee (1978-79), University of Hawaii, Honolulu, (1979-81) and the Columbia University in the city of New York (1981-82). In 1982, he briefly served as Lecturer in Chemistry at the University of Roorkee, before joining IIT Bombay in 1983 as Lecturer. There, he rose to the rank of Assistant Professor in 1984, Associate Professor in 1988, and full Professor of Chemistry in 1990. He spent a year in 1989 at the University of Montreal, Canada as a Visiting Scientist. He was appointed Head of the Department of Chemistry at IIT Bombay in 1993, which he served till 1996. During 1998 to 2000, he served as convener of the Post-Granduate Academic Performance Evaluation Committee of IIT Bombay. He has also served IIT Bombay as Chairman of the Joint Entrance Examination. In the year 2002, he briefly served as the Director of the Regional Research Laboratory (CSIR), Jorhat, Asom. Since 2005, he is also serving as the Dean of Academic Programmes of IIT Bombay. He is also on the Board of Directors of KOP Research Centre, Bangalore.

Research supervisor of numerous Masters and Ph D students, Prof. Singh has over 100 research papers in reputed journals and periodicals in the field of organic chemistry, bioorganic/biomolecular chemistry, physical chemistry, photochemistry and photobiology. His contributions in the area of photoactive retinal proteins are widely acclaimed. Some of his current research includes : photocontrol of structure and reactions/functions of proteins/enzymes ; semi-synthetic photoreceptors based on bacteriorhodopsin ; synthesis of novel phototriggers for caging applications ; excited state nature of linear polyenes ; fluorescence probes ; radio-protective molecules based on vitamin A and E etc.

Besides being life member of many professional societies, he has been the Vice-President and President of the Indian Society of Radiation & Photochemical Sciences, and the Indian Chemical Society (Mumbai Branch). He has also been the Vice-President of the Indian Chemical Society (Kolkata), and the Indian Photobiology Society. He has been a Council Member of the Chemical Research Society of India. Prof. Singh is recipient of Prof. P. K. Bose Memorial Award of the Indian Chemical Society. In recognition of his scientific contributions, he has been elected Fellow of the Maharashtra Academy of Sciences, Fellow of the Indian Academy of Sciences, and Fellow of the National Academy of Sciences, India.

His expertise is widely recognized both nationally and internationally. Agencies like DST. CSIR, BRNS, UGC, Universities, national research laboratories etc. have been regularly making use of his expertise in various ways. He had been a Member of the Programme Advisory Committee, Basic Sciences Committee–1 of Board of Research in Nuclear Sciences. He is regular reviewer of research papers in many reputed journals in India and abroad. He is a Member of the Editorial Board of the Proceeding of the National Academy of Sciences (Physical Sciences).

Prof. Singh has given numerous lectures, at national and international forums. He has organized many conferences and symposia. He has served as Member of Advisory Committee of many national and international conferences. Recently, he has been invited to serve as Member of the International Scientific Advisory Board of the 14th International Congress on Photobiology, and also for the 3rd Asia and Oceania Conference on Photobiology, to be held in China.

Besides his research and teaching activities, Prof. Singh is also actively involved in initiating new teaching and research programmes in sciences and engineering at IIT Bombay, and also expanding the academic base and collaborations of IIT Bombay both in India as well as abroad.

PROF. M. P. SINGH
President
Section of Earth System Sciences

Professor M. P. Singh born on 10th June 1945 did M. Sc. (1963) and received Ph. D. Degree in Geology from the University of Lucknow (1967). He started his career as a Lecturer (1968) and then became Reader (1984) and Professor (1994). As a student he maintained a balance between academics and sports and represented the State in Volleyball at National Championship (1965). Professor Singh held several administrative positions of the University of Lucknow. He served University as a Chief Proctor (1992–1995) and as a Pro Vice Chancellor (2002–2005).

His research interests cover Micropaleontology and Biostratigraphy. He has published more than 50 research papers in reputed journals and guided number of research students for the award of Ph. D. Degree. Besides being the member of several learned societies, currently, he is the Secretary of the Paleontological Society of India.

Professor Singh proved his orgnizational potentials by successfully organizing numerous National and International Seminars and Workshops. He was the Organizing Secretary of the National Seminar on "Problems in Mesozoic and Lower Tertiary Paleontology, Sedimentation and Palaeoenvironment (1980), and the Convener of 13th Indian Colloquium in Micropaleontology and Stratigraphy (1989). He has successfully organized International Field Workshop on "Terminal Protozoic and Lower Cambrian of India (1990) and Cretaceous Environmental Change in East and South Asia (1997).

Professor Singh was invited to attend an International Field Meeting held under IGCP 350 at Bangkok, Thailand (1998). He was Local Secretary of 89th Indian Science Congress held at Lucknow (2002). He had delivered the Platinum Jubilee Lecture in the section of Earth System Sciences at 92nd session of Indian Science Congress held at Ahmedabad (2004). At present Prof. Singh is the Head of the DST-FIST Sponsored Department of Geology, Lucknow University and Coordinator of FIST (DST) and DSA Phase III (UGC) programmes.

MR. S. K. MITRA
President
Section of Engineering Sciences

Born in Delhi on 17th November 1938 Mr. S. K. Mitra had Schooling and eduation in Calcutta. Passed L. E. E. from Jadavpur Polytechnic, Calcutta in 1959 and thereafter studied engineering in Jadavpur University in Electrical engineering and leading to B. E. E. in 1965, worked as an apprentice in Lamp manufacturing company for 1 year and thereafter worked in C.P.W.D. (govt. of India) for six and half years in the post of Section Officer and promoted to the post of Assistant Engineer before resigning. For the last about 40 years he is associated in health industry in capacity of Chief Engineer for maintenance of Equipments, Design and construction of hospitals e.g. Multi speciality, Cardiac speciality and Eye hospital and

clinics etc. He is also member of several sports & cultural organizations.

DR. P. C. PANDEY
President
Section of Environmental Sciences

Dr. Prem Chand Pandey born on 10 August 1945 did his M. Sc and Ph. D in Physics from Allahabad University. He joined Central Water and Power Research Institution, Pune, as Research Officer in 1973 and was involved in hydraulic Instrumentation. In 1977, he joined Space Application Centre, Ahmedabad and initiated the application of satellite-borne data in ocean and atmospheric research. He also worked at NASA's Jet Propulsion Laboratory first during the period 1980–83 and later on during the period 1987–89 on two very important missions of NASA, SEASAT–dedicated to oceanographic research and upper atmospheric research satellites.

In 1997, Dr. Pandey joined the Department of Ocean Development as an Advisor and took over as the Director of the National Centre for Antarctic and Ocean Research at Goa and directed the Indian Antarctic programme till 2005. Dr. Pandey is internationally recognised scientist in the field of satellite oceanography, atmospheric and polar-Science. Currently, Dr. Pandey is working as visiting professor at Centre for Oceans, Rivers, Atmosphere and Land Sciences (CORAL), IIT Kharagur and leading a group of young scientists towards realising the goals of CORAL.

Dr. Pandey, has done pioneering and path breaking contributions in the applications of space borne technology for the study of earth's Oceans, Atmosphere and cryosphere. Satellite measurements of various geophysical parameters with sensors operating in various regions of electromagnetic spectrum are a rapidly evolving area of scientific research and are cheer in terms of providing inputs to numerical models of the earth system and improve our knowledge of the various processes for better prognosis and simulations.

The research contributions of Dr. P. C. Pandey have been well recongized both in India and abroad. In addition to the reference of his work in reputed journals, some of the advanced level texts and reference books, by leaders in their respective fields, have extensively referred the research contributions of Dr. Pandey. Dr. Pandey has more than three hundred research citations and written/ edited six books. Dr. Pandey has been invited by all the three leading academies in the country to write review articles, a testimony of his expertise and scholarly achievements. He has more than hundred publications in national and international journals.

Dr. Pandey has been honored with Shanti Swarup Bhatnagar Award in Oceanic and Atmospheric Sciences, in 1989, the first recipient of this award in the country, Hari Om Ashram Perit Dr. Vikram Sarabhai Award and Gold medal in the field of Atmospheric Sciences and Hydrology, in 1987 (first recipient in ISRO) and NASA's certificate of recognition and cash award in 1985. Recently Dr. Pandey has also been awarded "Vigyan Ratna Samman Award" from Council of Science & Technology, UP Government. Dr. Pandey has been honoured with Fellowship of the Indian Academy of Sciences, The National Academy of Sciences, Indian Geophysical Union, India Meteorological Society and Indian Society of Remote Sensing. He had been Vice President of India Meteorological Society and Chairman of the Indian Society of Remote Sensing, Ahmedabad Chapter. Dr. Pandey

has twice been offered the Senior Resident Research Associate-ship of National Aeronautics and Space Administration, USA based on global competition, to work at Jet Propulsion Laboratory/Caltech, on two very prestigious space missions of NASA–SEASAT and UARS, for oceanography and upper atmospheric research. In India, Dr. Pandey initiated the satellite borne passive microwave radiometry research right from the launch of BHASKARA and also initiated various algorithm development activities providing a sound basis for further satellite–related research using various regions of the electromagnetic spectrum.

PROF. M. S. P. BABU
President
Section of Information and Communication Sciences & Technology (including Computer Sciences)

Prof. Maddali Surendra Prasad Babu born on 1956 obtained his MPhil and PhD degrees in applied Mathematics from Andhra University. Prof Babu has put up 27 years of teaching and research experience and presently he is working as a professor in the Deparment of Computer Science and Systems Engineering of Andhra University College of Engineering. He has contributed about 30 papers in journals as well as National and International Conferences / seminars.

Prof. Babu received the ISCA young scientist award at the 73rd Indian Science Congress in 1986. Prof. Babu visited several universities and colleges all over the country as a member of inspection committees/selection committees of Universities. State Governments and AICTE. Prof. M. S. Prasad Babu is very active in motivating the students to achieve their goals. He and his students developed several Software Packages in Andhra University such as Hostel Information System, CDC Information System, Department Information System, AU Health Center Information and Administration System etc. as a part of Andhra University Campus Networking System. He has developed Andhra University Website : *www.andhrauniversity.info.*

Collaborating with Acharya N. G. Ranga Agricultural University, Hyderabad, Prof. Babu developed a website for famers *www.indiakisan.net* and launched in the internet very recently. He developed several Export Advisory Systems in the area of Agricultural science. He is guiding several students for their Ph. D./M. Tech/M. Sc./MCA/B. Tech project works/dissertations in the areas of Neural Networks. Al & Expert systems and Web Technologies. Prof Babu is also a social worker. He was the founder of Sri Vasavi Vijnana Mandali in 1984 and started the Vasvi colleges in 1988, in Visakhapatnam. He served as honarary Secretary and Vice chairman to Sri Vasavi Vijnana Mandali between 1984 and 1992.

PROF. R. C. AGRAWAL
President
Section of Materials Science

Prof. R. C. Agrawal born on 1951 obtained his M. Sc. (Physics) in 1974 and Ph. D. in the field of Solid State Ionic Materials in 1980 from Pt.

Ravishankar Shukla, University, Raipur. He joined School of Studies in Physics, Pt. Ravishankar Shukla University, Raipur as Lecturer in 1988 and appointed Professor in 2003. Before joining the present department, he worked as Post Doctoral Fellow (PDF) during 1979–81 in Physics Department, BHU, Varanasi and as faculty member during 1982–1987 in Physics Department, Al-Fateh University, Tripoli, Libya. He established Solid State Ionics Research Laboratory at the present department ~ 1991–92 and successfully completed several major/minor research projects sponsored by Government funding agencies. His major research interests include fast Ag^+ ion conducting solids in glass/amorphous phase and 2-phase composite electrolyte systems, using an alternate host, discovered by him and his co-workers, in place of the conventional host salt AgI. He has recently extended the activity in the field of nano-composite polymeric electrolyte materials. Prof. Agrawal is known to solid state community of India as well as abroad. Five students have completed their doctoral work and four are working under his supervision. He has published over 70 papers (including review articles) in various National/International journals and presented more than 40 papers at various National/International conferences.

PROF. J. C. MISRA
President
Section of Mathematical Sciences (including Statistics)

Dr. Jagadis Chandra Misra, Professor of the Department of Mathematics, Indian Institute of Technology Kharagpur, did his M. Sc. in Applied Mathematics from the University of Calcutta in the year 1966. He received his Ph. D. degree in Applied Mathematics from Jadavpur University in 1971 and the highly coveted D. Sc. degree in Applied Mathematics from the University of Calcutta in the year 1984. For the last 40 years he has been engaged in teaching and research at several distinguished institutions in India, Germany and North America. He has been the Chairman of the Department of Mathematics, IIT Kharagpur during the period 1998-2001. As a recipient of the prestigious *Humboldt Fellowship* he was at the University of Hannover during the period 1975-77 and 1982 where he carried out his research in the field of Biomechanics in collaboration with Prof. Oskar Mahrenhollz at the Institute of Mechanics, University of Hannover and Prof. Christoph Hartung from the Biomedical Engineering Division of the Medical University at Hannover. He has held the position of Visiting Professor at the University of Calgary, Canada, at the Indian Institute of Technology, Kanpur and the University of Bremen, Germany. In 1984 he received the prestigious Silver Jubilee Research Award from IIT Kharagpur, In 2004 Prof. Misra bagged the highly prestigious Raja Ram Mohan Roy Prize and Rashtriya Gaurav Award (National Glory).

Prof. Misra was elected Fellow of the National Academy of Sciences in 1987, the Institute of Mathematics and its Applications (UK) in 1988 and the Institute of Theoretical Physics in 1988. He was also elected a Fellow of the Royal Society of Medicine, London in 1989 in recognition of the significant impact of his research work in the field of Biomedical Engineering and a Fellow of the Indian National Academy of Engineering, New Delhi in appreciation of the impact of his researches on Engineering and Technology in 1999. He was elected a Member of the International Society of Biorheology New York, GAMM (Germany), Biomechanical Engineering Society (USA) and an

Active Member of the New York Academy of Sciences.

Professor Misra published 12 advanced level Books, a monograph and over 150 research papers in international journals in the areas of Biomathematics, Biomechanics, Mathematical Modelling and Theoretical Solid and Fluid Mechanics. His research results have appeared in highly prestigious journals. His publications have been well cited in scientific literatures and referred to in several textbooks. He has made pioneering research on mathematical modelling in each of the areas of Cardiovascular Mechanics, Mechanics of Brain Injury, Mechanics of Fracture and Remodelling of Bones and Peristaltic Flows in Physiological Systems. His theoretical findings on the compressibility of vascular tissues is a major breakthrough in the study of arterial biomechanics and were subsequently verified experimentally by Prof. Y. C. Fung at the Bioengineering Laboratory of the University of California, San Diego. The model developed by him for the study of arterial stenosis bears the potential to provide an estimate of the variation of blood viscosity as the height of the stenosis increases. Misra's theoretical study on the mechanics of cerebral concussion caused due to rotational acceleration of the head has opened up new vistas in neurological research and neurosurgery. On the basis of the study he could make some valuable predictions regarding the threshold of cerebral concussion for humans, in terms of angular acceleration. He was the first to account for the effect of material damping of osseous tissues on bone remodelling induced due to the surgical procedure of intra-medullary nailing. Misra's study on the effect of a magnetic field on the flow of a second-grade electrically conducting fluid serves as a very important step towards the perception of MHD flow of blood in atherosclerotic vessels. It throws sufficient light on the quantitative features of blood flow in constricted arteries.

Prof. Misra has been a Member of Expert Committees of the National Science Foundation of USA, Imperial Press of UK, World scientific of Singapore. CSIR New Delhi, Indira Gandhi National Open University, New Delhi as and Indian Statistical Institute, Calcutta. Professor Misra is an Associate Editor of the International Journal of Innovative Computing, Information and Control (Japan) and a Member of the Editorial Board of the International Journal of Scientific Computing.

He has delivered invited lectures in different Universities throughout the world. Professor Misra delivered the prestigious *Bhatnagar Memorial Lecture* in 2001 and the *Indian Science Congress Platinum Jubilee Lecture* in Mathematical Sciences in 2005. Prof. Misra built up an active school of research at IIT Kharagpur and guided 25 research scholars towards their Ph. D. degrees.

DR. A. ROY CHOWDHURY
President
Section of Medical Sciences (including Physiology)

Dr. A. Roy Chowdhury born in 1948 did his Master degree in Physiology in the year 1969 from the University of Calcutta. He joined as UGC Research Fellow in the Physiology Department, Presidency College in the year 1969. He started his work on Comparative Reproductive Endocrinology under Late Prof. Achintya Kumar Mukherjee. He was awarded Ph. D. degree in the year 1978 from the University of Calcutta. He started his career as a Lecturer in Physiology, Vidyasagar College under University of Calcutta. Then in the year 1972 he joined in Central Drugs Laboratory, Ministry of Health & Family Welfare. Government

of India, as Assistant Pharmacologist and developed a Toxicology Division there. In the year 1974 he joined as Junior Scientific Officer (JSO) in Defence Research Development Organization, Ministry of Defence, Government of India, Gwalior. He established a very sophisticated Toxicology laboratory in DRDO. Dr. Roy Chowdhury started the work on toxic effect of different chemicals on the male reproductive system. He is the pioneer worker in the field of reproductive toxicology in India. In the year 1981 he joined as Senior Research Officer at National Institute of Occupational Health (NIOH), Ahmedabad under Indian Council of Medical Research. At NIOH, Ahmedabad he started work on the effect of heavy metals on male reproductive system. In the year 1991 he shifted his research work as Assistant Director from NIOH, Ahmedabad to Regional Occupational Health Centre, Kolkata. Subsequently he was upgraded as Deputy Director in the year 1992. After his joining here he developed Industrial Toxicology division. In the year 1997 he took over the charge of Officer-in-Charge and became Deputy Director (Sr. Grade) in July, 1997.

Dr. Roy Chowdhury worked with many pioneer scientists both in India and abroad. He published more than 100 scientific papers in both national and international journals. He is visiting faculty of many universities in India like Gujarat University, Chennai University, Gwalior University and different universities of West Bengal. He is associated with different academic activities of University of Calcutta, Kalyani University and Vidyasagar University. He is a recognized Ph. D. guide of many universities. Till today about nine students have been awarded Ph. D. degree under his guidance. He published some chapters in books and review articles. He is a member of different committee in government and non-government agencies. He is the editor of many national and international journals. He is life member of many scientific societies both at national and international level. Dr. Roy Chowdhury is actively associated with the International Commission on occupational Health, Sweden and occupying the position as a Member in the Scientific Committee of Reproductive Hazards at Workplace Environment. He is the Fellow of Royal Microscopical Society (FRMS) in 1986. He is also a Fellow of many other acadmic societies like Fellow of Society of Toxicology India. He received many awards from the different scientific societies for his contribution in the field of reproductive toxicology.

Dr. Roy Chowdhury visited several International institutes of the world like National Institute of Hygienic Science, Japan, Chulabhorn Research Institute, Thailand, Strasbourg Medical Centre, Toxicology Division and many others. From his student life, he is actively associated with Science Awareness and popularization programme in Environmental Health. He is associated with All India Radio. Calcutta and Doordarshan, Calcutta, in different scientific programmes. He also organized many national and international scientific programmes.

DR. R. H. DAS
President
Section of New Biology (including Biochemistry, Biophysics & Molecular Biology and Biotechnology)

Dr. R.H. Das was born on 25th March, 1948 and graduated with honours in chemistry from St. Xavier's College, Kolkata in 1969. He passed M. Sc. in biochemistry from Calcutta University securing the topmost postition in 1971 and obtained the Ph. D. degree in 1975 from the same university

by working in the Institute of Chemical Biology, Kolkata. Dr. Das is presently Deputy Director in Institute of Genomics and Integrative Biology (Delhi), a constituent laboratory of the Council of Scientific and Industrial Research. He joined this laboratory in 1983 after working as a Research Associate in the laboratories of Profs. Malcolm L. Gefter and Phillip A Sharp in Massachusetts Institute of Technology, USA.

Dr. Das is a molecular biologist pursuing application oriented basic research on returning to India. His major significant contributions in biological sciences are briefly, elucidation of the mechanism of DNA unwinding in replication fork movement, development of hyperactive baculovirus expression vectors, involvment of lectin in host-Rhizobium recognition process for nodulation, demonstration of cytokinin antagonist function of a plant lectin and establishment of functional relationship of the genes by post-transcriptional gene silencing.

Dr. Das is an active researcher, and till date he has supervised over a dozen of Ph. D. students. He has been serving as an expert in various government funded projects, recruitment and assessment committees. He is the life member of a number of Scientific Societies and acting as a reviewer of the manuscripts for several prestigious international and national journals.

DR. R. N. SINGH
President
Section of Physical Sciences

Dr. R. N. Singh was born in 1938. He obtained his post-graduate degree in Physics in the year 1959 from B. H. U. He did his Ph. D. in 1963 from the same university working on the Infrared Spectroscopy, then a relatively new field. Dr. Singh served as a Lecturer in the department of Physics, B. H. U. from 1963 to 1966. He then joined Instruments Research & Development Establishment, Dehradun at a fairly senior position. Presently a U. G. C. Visiting Professor in Physics and formerly an Associate Director at Instruments Research & Development Establishment, Dehradun under the D. R. D. O. Ministry of Defence

At IRDE Dehradun, he has the distinction of pioneering R & D work in the field of infrared, lasers, thin films, holography and thermal imaging technology. In the field of Thermal Imaging, he has acquired a land mark achievement, by way of successfully developing a Thermal Imager for Target Acquisition System for the third generation, top attack, fire & forget Imaging IR guided antitank missile 'NAG'. The technologies evolved in this process have been extended to the design of more sophisticated systems for helicopter version 'NAG', Forward Looking Infrared (FLIR) Camera for Remotely Piloted Vehicle (RPV), Light Combat Air craft (LCA) and Main Battle Tank (MBT) "Arjun". During field trials of his thermal cameras, Dr. Singh has observed "MIRAGES" in infrared region for the first time which has been acknowledged by the scientific community all over. Dr. Singh has established a number of other advanced technologies like development of zinc sulphide infrared dome, development of diamond like hard carbon coatings, hundred elements compact miniaturized, discrete, low noise preamplifier, digital scan converters, infrared focal plane arrays (IR FPAs) with CCD processor etc in collaboration with DRDI, DMRL, NPL, HAL, SCL, ordnance factories and other DRDO laboratories.

Life time achievement awards have been showered on him by American Society for Photo-Grammetry & Remote sensing (1996), SPIE-the

International Society for Optical Engineering Services citation in recognition of a distinguished career in Opto-electronics and scientific contribution to FLIR and next generation detection technology (1996), integrated guided missile development programme cash award (1988), etc. Dr. Singh has taken keen interest in the promotion of science through Hindi and served as chief editor of in house journal "Sankalp" of IRDE and contributed is physics journal "Bhautiki". He was honoured by the Governor of U. P. by the Title "Hindi Shiromani" for his great contribution towards popularization of science in Hindi through Rastriya Hindi Parishad Meerut (1997) and "Sahitya Mahopadhyay" by the Hindi Sahitya Sammelan Prayag.

Dr. Singh has published more than 45 papers on experimental molecular spectroscopy, thin films, lasers, antilaser filters and thermal imaging technology in the national and international journals and has presented more than 40 papers in various conferences. Dr. Singh has been an approved Research Guide and member of Board of Studies & R. D. C. of various universities like HNB Garhwal Srinagar, Lucknow University, Agra University and Dharwad University and Indian Institute of Technology Chennai etc and has guided several students for their Ph. D., M. Sc., M. E. & M. Tech degrees and dissertations. He has been member & chairman of several selection boards of DRDO, CSIR, FRI & U. P. higher education commission etc. His first book on "Thermal Imaging Technology : Design & Application" sponsored by the Department of Science & Technology is in the press. Another book on "Fundamentals of Thermal imaging Technology" is being supported by D. R. D. O., Ministry of Defence.

Dr. Singh is very widely travelled person. He has visited Birmingham University Montreal Canada, France, U. K., Germany, Belgium. Dr. Singh is a life member of Indian Physics Association and life fellow of Optical Society of India, Fellow of the IETE Society of India, the Instrumentation Society of India (ISI), the National Institute of Advanced Studies Bangalore, member of OSI-SPIE the Society of Photo-Optical instrumentation and ICAPT of Canada. He has been executive member of the ISI for the year 2002-2004 and president of IPA Dehra Dun chapter for several terms. In addition to his academic activities, he has been and is still an active member of a number of NGO's in and around DehraDun working for the social upliftment of academically deprived strata of the society.

PROF. S. M. REDDY
President
Section of Plant Sciences

Prof. S. M. Reddy, Professor and Head, Department of Biotechnology, St. Martin Engineering College, Secunderabad, A. P. Prof. S. M. Reddy, Emeritus Professor, worked as Head, Department of Botany, Chairman, Board of Studies in Botany and Chairman Board of studies in Microbiology. After a brilliant academic career in Osmania University, Hyderabad obtained Ph. D. degree from University Jodhpur under Late Prof. K. S. Bilgrami. He did post-doctoral research in the Institute of Microbiology, Praha, Czechoslovakia during 1978-79. He joined as lecturer in Osmania University in 1970 and attained Professor of Botany, in Kakatiya University in 1988 and served the discipline of Botany in Kakatiya University. He worked in different capacities as Principal, University College,

Development Officer, Students Welfare Officer, Director Post-graduate Centres of Kakatiya University. He was on Board of Management, Kakatiya University. He was member of Core Committee for development common core syllabus for B. Sc. students in A. P. Universities. Administered A. P. Open University study centre, shouldered the responsibility for establishment of Microbiology department at Kakatiya University, He is actively involved in research and guided 36 Ph. Ds. and three M. Phils. He authored/ edited 19 University level books. His research interests are Fungal Taxonomy, Physiology, Soil Sickness, Post-harvest Pathology, Mycorrhizae, Mycotoxins, Anoxygenic Phototrophic bacteria and Thermophilic fungi and contributed richly to the understanding of biology of fungi. Published more than 450 research articles in different international and national journals. Attended 50 International Conferences besides large number of National Conferences he delivered lead lectures and chaired different sessions. He contributed chapters in different books and review articles and popular articles. He has completed more than 21 research projects funded by UGC, CSIR, ICMS, DST, DBT, DNES, AP-Netherland etc. He is the panel member of UGC, CSIR, DST and DBT. He is a member of academic bodies of different universities. He got Best teacher award of Govt. of A. P. in 1997-98. He visited Czechoslovakia, Austria, Hungary, USSR and USA under different programmes.

He has been an executive member, editorial member of different national and international subject societies. He is Treasurer, Indian Botanical society (1998–2004), Vice-President and President (2003–2004) of Indian Society of Mycology and Plant Pathology. Besides ordinary member of large number of societies, he is life member of Indian Phytopathological Society, Indian Botanical Society, Indian Science Congress Association, Microbiological Society of India. He has organized several national conferences and workshops. He is a fellow of Indian Phytopathology Society, Indian Society of Mycology and Plant Pathology, Microbiologists of India, India Botanical Society and A. P. Academy of Sciences.

DO YOU KNOW ?

Q7. Must the human heart be located only in the left chest cavity?

Q8. It is believed that elephants have phenomenal memory. Is this true?

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Programme of 94th Indian Science Congress

3-7 January, 2007, Annamalai University, Chidambaram

<table>
<tr><th>Date</th><th colspan="4">09:00-10:45</th><th>10:45-11:15</th><th colspan="4">11:15-13:00</th><th>13:00-14:00</th><th>14:00-15:30</th><th>15:30-16:00</th><th>16:00-17:30</th><th>17:30-19:00</th><th>19:00-20:30</th></tr>
<tr><td>03 JAN 2007</td><td colspan="8">Inauguration by the Honorable Prime Minister
Followed by Press Meet</td><td rowspan="5">Lunch</td><td>Public Lectures</td><td rowspan="5">Tea Break</td><td>Public Lectures</td><td>Cultural Program</td><td rowspan="5">Dinner</td></tr>
<tr><td>04 JAN 2007</td><td>R1 TS01</td><td>R2 TS02</td><td>R3 TS05</td><td>R4 TS09
R5 TS15</td><td>Tea Break</td><td>R1 TS01</td><td>R2 TS03</td><td>R3 TS13</td><td>R4 TS20
R5 TS15</td><td>Sectional Program 14 Parallel Sessions</td><td>Sectional Program 14 Parallel Sessions</td><td>Public Lectures</td></tr>
<tr><td>05 JAN 2007</td><td colspan="8">Address by the Honorable President
Inauguration of Children Science Congress</td><td>Sectional Program 14 Parallel Sessions</td><td>Sectional Program 14 Parallel Sessions</td><td>Public Lectures</td></tr>
<tr><td>06 JAN 2007</td><td>R1 TS10</td><td>R2 TS08</td><td>R3 TS04</td><td>R4 TS16</td><td>Tea Break</td><td>R1 TS10</td><td>R2 TS17</td><td>R3 TS07</td><td>R4 TS16</td><td>Sectional Program 14 Parallel Sessions</td><td>Sectional Program 14 Parallel Sessions</td><td>Cultural Program</td></tr>
<tr><td>07 JAN 2007</td><td>R1 TS06</td><td>R2 TS12</td><td>R3 TS18</td><td>R4 TS21</td><td>Tea Break</td><td>R1 TS14</td><td>R2 TS11</td><td>R3 TS19</td><td>R4 TS22</td><td>Sectional Program 14 Parallel Sessions</td><td colspan="3">General Body Meeting and Valedictory Function</td></tr>
</table>

TS : Theme Session ; **Rx : Auditorium Number**

Plenary/Theme Sessions

SN	Session	Slot		SN	Session	Slot
TS 01	Energy Security	R 1		TS 01	Energy Security	R 1
TS 02	Water Resources	R 2		TS 03	Earth-Ocean-Atmosphere Interaction, Climate Change, Monsoon Forecast	R 2
TS 05	Ocean Resources	R 3		TS 13	Agriculture	R 3
TS 09	Synergy of Science and Industry	R 4		TS 20	International Year of Planet Earth : Indian Initiatives	R 4
TS 15	Medical Sciences : Role of free radicals and antioxidants in diseases	R 5		TS 15	Medical Sciences : Role of free radicals and antioxidants in diseases	R 5
TS 10	Space Applications for Planet Earth	R 1		TS 10	Space Applications for Planet Earth	R 1
TS 08	Knowledge Commission (?)	R 2		TS 17	Mysteries of Planet Earth	R 2
TS 04	Mineral Resources	R 3		TS 07	Anthropogenic Hazard; Waste Management and Environmental Issues	R 3
TS 16	Nutrition and Health	R 4		TS 16	Nutrition and Health	R 4
TS 06	Natural Hazards	R 1		TS 14	Conflict management in Natural resources	R 1
TS 12	Bio-technology	R 2		TS 11	Nano-technology	R 2
TS 18	Geosciences in the 21st Century	R 3		TS 19	Earth Science Education in India : Opportunities and Challenges	R 3
TS 21	International Collaborations in Science and Technology	R 4				

Conferences / Meetings / Symposia / Seminars

Date	Topic	Contact
3-7 January, 2007	94th **Indian Science Congress,** Chidambaram	**General Secretary** Indian Science Congress Association 14 Biresh Guha Street, Kolkata-700 017 Email : iscacal@vsnl.net
18-20 January, 2007	National Conference on **Quality Improvement in Food Processing : Role of Science & Technology,** Kolkata	**Mr. S. Ghosh** Indian Association for Productivity, Quality & Reliability AD 276, Sector I, Salt Lake City Kolkata-700 064 Email : iapar@yahoo.co.com
22-24 January, 2007	**Sesquicentennial Celebrations** of the University of Mumbai, Mumbai	**Dr. D. V. Prabhu** Head, Dept. of Chemistry, Wilson College, Mumhai-400 007 Email : dyprahbu@rediffmail.com
9-11 February, 2007	National Seminar on **''Recent Diagnostic Trends and Control Strategies for Haemo-protozoan Infections of Livestock"** Sardarkrushinagar, Gujarat	**Dr. Veer Singh** Department of Parasitology, College of Veterinary Science & Animal Husbandry, S.D. Agricultural University, Sardarkrushinagar-385 506, Gujarat Email : veersinghgau@yahoo.com
10-11 February, 2007	**All India Peoples' Forum of Scientists, Technology Congress,** Kolkata	**Secretary** Engineers & Technologist State Centre 15N Nelli Sengupta Sarani New CMC Building, Kolkata-700 087 Email : foset@rediffmail.com
23-25 April, 2007	International Conference on **Geo-environment : Challenges Ahead,** Jammu	**Dr. G. M. Bhat** Department of Geology University of Jammu, Jammu-180 006 Email : bhattgm@jugaa.com

S & T ACROSS THE WORLD

KNOCKOUT GENES

Biologists at the Centre for Cellular and Molecular Biology, Hyderabad have succeeded in producing the first 'gene knockout mouse', which till now was the preserve of only a few advanced laboratories in the West.

The process involves removing or modifying a gene in the cells of the mouse and then reconstructing a new animal from the genetically modified cells. The team of biologists genetically engineered a mutant mouse strain that lacked one of the milk protein genes, known as kappa-casein. In the absence of this gene, females were healthy and could reproduce but they were unable to produce milk for their young. The technology has tremendous applications not only in the field of basic biology but also for creation of human disease models and in the drug discovery process.

Furthermore, the new mouse strain will be useful for animal models for the creation of novel dairy animals with modified milk properties and also in the efforts to produce genetically modified farm animals producing pharmaceutical proteins in their milk.

(The Tribune, May 5, 2006)

CARBON NANOTUBES

Carbon nanotubes or CNTs are hollow wires of pure carbon, nearly 50,000 times narrower than the finest human hair, but stronger than steel. They have great potential in a variety of biological applications including medical diagnostics and treatment. However, as they were cytotoxic-contact with them killed cells-their use was limited.

A team of US scientists have now succeeded in making these CNTs biocompatible. By coating them with a synthetic polymer that mimics mucin, the substance on cell surfaces that serves as lubricant, the researchers have been able to render them non-toxic and attach them safely to biological cells.

The polymer coating can also be customized to bind a particular type of cell.

(Science @Berkeley Lab, Aug 1, 2006)

VACCINE FOR ALZHIMER'S

Alzheimer's disease is believed to be caused by the overproduction of amyloid proteins which form clumps or plaques that litter the brain.

Scientists have now developed a protential DNA vaccine which has been tried out on mice with promising results. With the administration of this vaccine, the levels of key amyloid proteins were cut by upto 50 percent in some parts of the brains of mice without any side effects.

This approach has been tested in preliminary trials on humans but early results have shown that the immune response was too strong, leading to swelling of the brain. New studies are currently underway to ensure that the immune response is less aggressive, so that the swelling of the brain is avoided.

According to Dr Clive Holmes of the Alzheimer's Research Trust, this work represents a promising new line of vaccine development but more research would be needed to see if it could be replicated in humans.

(PTI Science Service, June 16-30, 2006)

INTELLIGENT CARPETS

Beware the next time you step onto a carpet! It might tell you not only your age but also your gender simply by the way you walk.

Researchers at the Japanese National Institute of Advanced Industrial Science and Technology have

developed carpeting material that can tell just than. Teh material contains a layer of silicon rubber filled with tiny sensors which are so snesitive that they can pick up differences in the way people walk.

The researchers at the Institute have found that these sensors can determine the age of a person by the size of that person's foot and walking speed, while the gender can be determined by the differences in centres of balance that men and women have in relation to their shoe size. During tests, the material was able to distinguish persons in their twenties from those in their sixties with near total accuracy, and between genders with an accurate degree of 70-80%.

Such carpeting material may be found useful for security purposes as a biometric as well as for advertising.

(Economic Times, Aug 3, 2006)

ANSWERS TO "DO YOU KNOW?"

A1. The Thermal Power Plants.

A2. Mongolia.

A3. 30 percent.

A4. Respectively 13 percent and state is Arunachal Pradesh, about 30 percent.

A5. It is a happy coincidence.

A6. Emperor Ashoka.

A7. No, In rare cases the heart can be located in the right side.

A8. Yes, the brain structure also suggests this.

भारतीय विज्ञान कांग्रेस संस्था

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6. Engineering Sciences
7. Environmental Sciences
8. Information and Communication Science & Technology (including Computer Sciences)
9. Materials Science.
10. Mathematical Sciences (including Statistics)
11. Medical Sciences (including Physiology)
12. New Biology (including Bio-Chemistry, Biophysics & Molecular Biology and Biotechnology)
13. Physical Sciences
14. Plant Sciences

(Please type or fillup in Block Letters)

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Date : Signature

- *As per resolution of Executive Committee in its meeting held on October 10, 2004 application for membership of ISCA in 'Care of' of some other person is generally discouraged. However, if in the application form "care of" address is given then there should be also signature of the person in whose name "care of" is given.*
- *Admission fee of Rs. 50/- is needed only for becoming a new annual member and not for sessional member / life member / Institutional member / student member / donor.*