EVERYMAN'S SCIENCE

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COVER PHOTOGRAPHS ***(From the Top)***

Past General Presidents of ISCA

1. Colonel Sir R. N. Chopra (1948)
2. Dr. K. S. Krishnan (1949)
3. Prof. P. C. Mahalanobis (1950)
4. Dr. H. J. Bhabha (1951)
5. Dr. J. N. Mukherjee (1952)
6. Dr. D. M. Bose (1953)
7. Dr. S. L. Hora (1954)

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EDITORIAL

Technological innovation has pushed social science research to the threshold of a revolution in its global scientific structure. In a sense, traditional debates over "micro-VS-macro", theory of individual and group behaviour and so on have become obsolete. Beginning with the use of computers (PC-s) the process has rolled on gradually to place itself as if as a moving power of social research. The source of its strength is rooted in the innumerable number of users of various electronic devices of information and communication such as internet ; mobile phones, e-mail to mention a few among the most popular ones. In commercial parlance the users are "clients" who form a market. In societal scenario they are "actors" and as a matter of social reality, now-a-days, it is not at all fortuitous to say that they are elements constituting a field of world-wide interaction. Ego and altar need not be known to each other. Frequency of contact, intensity, distance and reachability do not play much effective role any more in this field. Connectedness is the key word. We perceive this "newness" not just as a morphological change—a change in size and shape—of social science research. We argue that our interface with the situation emerging under the impact of new technologies will demand reconsideration of many of our parameters, if not the paradigm as a whole.

Why is this so ? Because, the new technological devices provide the opportunity to collect massive data in an unprecedented number of dimensions about how do individuals, groups of institutions interact, how frequently, about what, and so on. Moreover, such massive data sets are now available longitudinally for millions of actors scattered all over the world. If we take only rural India, their number has almost trebled recently becoming a few hundred thousands! Continuous extension of connectedness like a snow-ball is the key feature of the new process we are experiencing across the world. How do we integrate such massive data and at least endeavour to arrive at an empirical generalization ? It may lead us to rethink about building blocks of the strategy for generalization, particularly if we like to construct a scheme to derive theories therefrom.

Let us consider the case of a basic element commonly used for the purpose of generalization-the case of a variable. Even if we agree to denote by this term a characteristic of subjects under study which varies from one to another, methodologically we are baffled by an unexpected problem at the level of analysis. This is that the underlying assumption of normal distribution of the values of such variables may become untenable. Rather the distribution may often follow Power law, i.e., of the form $y = a x^b$. We are usually prone to accept that as the "size", or, number of observations continues to increase, the distribution of an attribute tends to become Normal. But, here, we have a paradox. This is because of an implicit property of a variable in an infinitely large field : few units are endowed with extremely large values of the variable while most of them are characterized by extremely small values. Hence, power curve can most efficiently capture the characteristics of pattern of articulation of flow of interactions. In fact this has been conceptualized as Scale-Free Network by Barabasi, A.L. and Bonabeau, E. (One may see "Scale-Free Networks" by them in Scientific American, Vol. 288, No. 5. 60-69.) Given this new focus, social science researchers (like epidemiologists and natural scientists who are much ahead need to re-think about modalities of analysis and formulation of hypotheses.

To end our submission we must, however, draw attention to the political-economic side of such an academic venture. By this we refer to huge costs to compile such voluminous data ; availability, i.e., access to materials (to create database) ; control over data and findings from research ; safeguarding privacy of data ; and ensuring the rights of different nations (question of sovereignty). Obviously, it is a highly complex issue which can be solved by only a collaborative thrust of private sector, government and its different agencies and competent ambitious researchers from not only social sciences, but statistics, mathematics and computational sciences as well.

—Dr. Suraj Bandyopadhyay

"When a Scientist states that something is possible, he is almost right, when he states something is impossible, he is probably wrong." ***—Arthur C. Clarke.***

PRESIDENTIAL ADDRESS

GIVE SCIENTISTS A CHANCE

DR. SUNDER LAL HORA*

For forty years it has been the first courtesy of those who have stood before you, as I do now, to express their heartfelt appreciation of the honour conferred on them. I follow this proper tradition with a feeling of understatement, for my role on this occasion is so high a mark of your esteem that it can come but once in a lifetime. It fills me with pride and gratefulness, yet it also gives me an intense feeling of humility and a sincere desire at least to be worthy of your confidence. I shall not try to say more, though many thoughts and words are in my mind ; for I cannot hope to convey the depths of my gratitude and pleasure.

In thanking you I cannot help thinking of those whose sincere and wise encouragement, as one of many personal expressions of their devotion to Indian Science, have brought me to this platform. My memory goes back especially to a man who joined the Indian Museum exactly fifty years ago, who gave us so earnestly of everything he had that twenty years later, at the early age of forty-eight, he left us forever. It is peculiarly fitting that I should remind you of the Golden Jubilee of his coming to India, for he was my *guru*. He gave me the opportunities that made me a zoologist ; he inspired, guided and, when necessary, defended my early researches ; and he created the post which it is now my privilege to hold. I refer to Nelson Annandale, first Director of the Zoological Survey of India, father of comprehensive Zoology in our country, and one of the prime movers in the establishment of the Indian Science Congress. I hope that we shall acknowledge our debt to him in some fitting way.

In this year we shall also be celebrating, happily in a more festive mood, another important anniversary ; for Chandrasekhara Venkata Raman passed, his sixty-fifth birthday on November 7, 1953. I know we shall go on embarrassing him with tributes and affectionate good wishes through most of this year ; and it is equally certain that scientists all over the world will share our sentiments. He is a world figure, richly laden with honours. We take a just pride in his great reputation ; we recall with something like awe that while still in his middle thirties he became a Fellow of the Royal Society and a Nobel Laureate in Science ; and above all we remember his large and enduring contributions to the progress and organisation of Science and scientific education in our country.

I cannot resist the temptation, though past Presidents of this Congress have been stern enough to avoid anticipation, to remind you here of an Anniversary which we shall begin to celebrate when we meet next year. For in February, 1955, Shanti Swarup Bhatnagar will be sixty. He, too, has achieved world fame in the Physical Sciences ; he, too, has served India with exceptional devotion by his researches, his educational and industrial activities, and the gifts for organisation and planning which are now expressed in his capacity as Secretary to the Ministry of Natural Resources and Scientific Research. The completion of our National Laboratories programme, the setting up of Refineries and explorations for more oil in the Bengal and Assam Basins, are some of his

* General President, forty-first Indian Science Congress held at Hyderabad during January, 1954.

many other concerns with the progress of Indian Science as a integrated part of the general material and cultural advancement of our people. Moreover, it is not known to many that Dr. Bhatnagar has given away to the nation the large sums of money which he would have earned as royalties, for his many inventions.

You will see from this bare reference to Dr. Bhatnagar how strong my temptation has been. You will also think it excusable when I say that in one respect—and I fear it is only one—I am trying to follow in his footsteps. It is almost unnecessary to mention it, for you must have already detected that the title of my address is but a variant of his inspiring presidential appeal at our Nagpur session in 1945 to "Give Science a Chance".

I had thought at first, as is natural for any research worker, to lay before you a few ideas derived from some particular aspect of the enquiries it has been my good fortune to pursue. But my friends would not hear of it ; definitely nothing zoological, they insisted. Moreover, to encourage me they recited a long list of ichthyologists, led by David Starr Jordan who had moved outwards from their discipline to duties and generalisation of a larger nature.

I felt chastened and then ambitious. I planned a general survey of the progress and problems of Science in Hyderabad. It would have been most appropriate, for it is seventeen years since we last met here—and much has happened since then. Besides, it occured to me that there is much to be said for a brief regional survey, in which the emphasis could perhaps be usefully different, if the task were approached by a mind to whom the details are new. But I soon discovered, from the information I collected, that the wealth of scientific achievements in Hyderabad would defeat any attempt at synthesis within the limits of an address.

THE SIGNIFICANCE OF OUR PRESIDENTIAL ADDRESSES

I then turned for guidance to the presidential addresses of my predecessors. I hoped to find some significant links between the past and the present which I would be able, since the methods of forging "association chains" are not unfamiliar to me, to mould into a discourse. I had actually heard most of these addresses, but to approach them again in bulk, so to speak, was definitely instructive. They even form a statistical comment now on the state of Science in India, in which Indian scientists have held their own in spite of the weightage of British personnel during the twenty years following the first Science Congress in the rooms of the Asiatic Society. The President of that meeting was Sir Asutosh Mookerjee, and six of the nineteen Presidents who followed him were also Indians. During the next twenty years Dr. J. H. Hutton (1936) and Lord Rutherford (1938) were the two non-Indian Presidents.

The analysis of these addresses by subjects shows that a little more than half of them were by workers in Mathematics and the Physical Sciences, and six by Geologists. The second address (1915), by W. B. Bannerman (then Surgeon-General, I. M. S.), was on "The Importance of a Knowledge of Biology to medical Sanitary and Scientific Men working in the Tropics" ; but it was not until 1924 that a biologist Nelson Annandale, addressed our organisation as its President. Since then three zoologists, one botanist, one anthropologist, and three physicians have been our Presidents.

Frankly, I find this fact depressing. It indicates the rather casual attitude of the largest scientific organisation in India, and probably in Asia, towards the Biological Sciences. An emphasis on the Physical sciences and Geology is understandable and necessary in a country, now thinking in terms of the so-called "atomic age", that has been trying to transform itself industrially during the last fifty years. But this is also an age of vast human problems based on biological resources—and nowhere in the world are the problems more vast, and the biological resources in more urgent need of development, than in India. And that their development cannot be separated from industrial advance scarcely justifies the relatively minor role allotted to them.

Ours is an agricultural country, but only a few scientists concerned with agriculture have addressed

us as a body. We have enormous food problems which, in addition to agricultural growth, clamour for solution through improved animal husbandry and dairy farming, and through progressive fisheries policies that are vigorously implemented ; but no representatives of these practical disciplines have yet addrressed us.

Ours is a country of alarming forest and irrigation insufficiencies, including the alleged march of the Rajputana desert on the national capital, which can be converted into spectacular resources ; but we have yet to elect a forester or an irrigation expert as our President. Ours is a country, too, of malnutrition, epidemic diseases, feudal sanitation and bad housing, but the magnitude of the resulting problems has been barely recognised in our elections to the Presidential chair.

Again, ours is a country of basic educational problems ranging all the way from primary schooling and literacy to higher education and linguistic policies, but we have never been presidentially addressed by a widely informed educationist or a philologist. In fact, we do not even include linguistics among our sectional meetings.

And, finally ours is a country of complicated religious and cultural differences, of inter-group and inter-personal difficulties, of far-reaching demographic problems, of exceptional archaeological wealth ; but, apart from J. H. Hutton (1935), the Congress as a whole has never had the advantage of listening to a cultural anthropologist, an expert on inter-group relations, a social psychologist, a demographer, or an archaeologist, though we have men of eminence in all these fields.

THE MAIN THEME OF OUR PRESIDENTIAL ADDRESSES

These neglects are all the more surprising since a broad approach to the progress of Science in India, as a major contributing factor to the good of the people, has formed the dominating theme of our galaxy of past Presidents, regardless of their interests and specialisations. Some even went outside their chosen fields to continue this emphasis ; and I am happy that their names include that of a distinguished zoologist, M. Afzal Hussain, who addressed us on "The Food Problem in India" in 1940.

The keynote was struck by Asutosh Mookerjee, the renowed "Tiger of Bengal", in his inaugural address in 1914. Stressing the advantages of personal intercourse between scientific workers, he said :

> "The most beneficent results may be achieved by an instructive interchange of ideas between scientific men ; they may, however, not only mutually communicate their ideas, they may also state the advance made in their own respective spheres of action, and indicate to each other the special departments which may be most profitably cultivated or the outstanding problems which may be attacked with the greatest utility. But personal association amongst scientific men may be pregnant with important consequences, not merely by a fruitful exchange of ideas ; cultivators of Science, by periodical meetings and discussions, may bring their aims and views prominently into public notice, and may also, whenever necessary, press them upon the attention of the Government—a contingency by no means remote, for, as experience has shown, even the most enlightened Govenments occasionally require to be reminded of the full extent of the paramount claims of Science upon the Public Funds."

The latter part of this statement remained a possibility until the next Indian President, P. C. Ray, charged the Government with "apathy and niggardliness" in its educational policy, and with "studied care" in the exclusion of Indians from its scientific services. On the relations between general education and scientific progress he offered the opinion that :

> "It is almost a truism that the nations which have made the greatest advance in science are precisely those which have made ample provisions for the spread of education amongst the masses. Primary, secondary and higher

education all go together ... Speaking of education in India, Sir Michael Sadler has very aptly observed that we must broaden the base of the pyramid, but not whittle away the apex .... Without this foundation of primary and secondary education, it is not possible to make any substantial progress in the study of Science or its practical application in the field of industry in the country. This is the great handicap imposed on us and it makes itself felt in all directions of life."

In 1923, M. Visvesvaraya enlarged the dimension of Sir P. C. Ray's address. He warned his listeners that :

"It is now axiomatic that no nation can hope to maintain its progress and prosperity for long, if it is backward in the cultivation of Science and in its adaptation to the ends and purposes of everyday life ... (But) it cannot be said that adequate attention is given to scientific education and research in this country at the present time. With a population larger than that of any other civilised country in the world India is, today, in respect of intellectual equipment, the poorest of them all ... Knowledge of new discoveries and inventions filters tardily into this country, and technical and practical education is confined to an infinitesimal proportion of the population. The alumni of our universities lack the freshness of touch which contact with live problems gives..."

Sir M. Visvesvarya then proceeded to review the condition of scientific training and research in India, and to offer some salutary suggestions to the Indian Science Congress which we have partly neglected for thrity years. In particular, he pointed out that the Sciences concerned with "the giant problems" of population and food supply, low standards of living, undeveloped resources and untrained citizen, are engineering, agriculture, education and economics. "I wish to draw attention", he said, "to the fact that, with the exception of agriculture, none of these is taken up by this Congress although all of them are most essential ... We want vision, we want enterprise, and we must abandon 'the old and beaten paths' which have paralysed effort in the past."

For the addresses from which I have quoted above, we owe Sir P. C. Ray and Sir M. Visvesvaraya a special debt. They firmly established a tradition of concern for the larger questions of Science in India, and its bearings on public welfare, which continues in an almost unbroken line through the addressess of our Presidents. But it must be admitted, with all due respect, that the tradition was maintained within the prevailing political ideology and the belief that the expansion of education plus Science would soon solve all the ills of India and the world. Even Sir P. C. Ray, in spite of much evidence that should have been disconcerting, accepted as an article of faith Andrew Carnegie's dictum : "Educate the people and poverty will take care of itself."

THE HUMANISTIC ELEMENT IN OUR PRESIDENTIAL ADDRESSES

This complacency was roughly jolted, in a brilliant review of advances in Chemistry that is also a piece of literature, by J. C. Ghosh during our session of 1939. He introduced the element of doubt that was growing amongst scientists in the West ; he subtly stressed considerations, believed by many scientists to lie outside their field, which were clearly political and ethical. He insisted that :

"Every intelligent man and woman has now got to ponder deeply over the problem that the scientific search for truth has not assured the advance of civilisation. 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 spiritual qualities

no comparable development is noticeable ... Modern Science has, indeed, become a menace to civilisation, 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 ..."

These sentiments were naturally submerged by the outburst of Indian scientific activity during the war and its aftermath ; but they dominated Shri Jawaharlal Nehru's extempore presidential address to our Delhi Meeting of 1947, on "Science in the Service of the Nation". Scientists he said, "must think in terms of the four hundred million persons in India" ; and to think adequately in these terms they must also think in terms of large-scale coordinated planning. He hoped that the Science Congress would devote itself to these tasks without excessive reliance on the government : in fact, there are times when governments must be forced to act through public outcries which affect their future. He went on to say that :

"It is a tragedy, when enormous forces are available in the world for beneficial purposes, and for raising human standards to undreamt of heights, that people should still think of war and conflict, and should still maintain economic and social structures which promote monopoly and create differences in stadards of wealth between various groups and peoples. It is a tragedy, whatever other people might say about it, and no man of Science should accept it as a right ordering of events .... I myself am convinced that there is going to be no very great progress, either in Science or in other ways, unless certain fundamental changes take place in the social structure."

These are significant words for us, not merely because they come from our Prime Minister, but because they represent a growing feeling among scientists, as voiced by Dr. Ghosh that it will not be enough to give Science a chance unless scientists themselves prove worthy of it. Nor shall we prove our worthiness only by struggling to "catch up" with the West in the spread of education, of scientific training and achivements, of technological services to industry or agriculture. Indeed, there is the danger that in catching up, instead of developing in accordance with our history, traditions and environment, we may be catching up with techniques that a responsible and increasing body of Western scientific opinion has rejected.

I could perhaps illustrate this point by making a brief reference to the problems of fisheries development in India, in certain aspects of which, as many of you know, I have been interested since my student days at Lahore (1917–1919). While studying the fishes of India from a purely academic standpoint, I was very early drawn into the study of the customs of our fishermen, their methods of capturing fish and the utilisation of their produce. For this combination of scientific *cum* humanitarian outlook, I am again indebted to my *guru* Nelson Annandale who was a distinguished anthropologist also. Thus, trained in Annandalian philosophy, when I became Director of Fisheries of undivided Bengal in 1942, I soon found out that the problems of fisheries development were not so much scientific as they were humanitarian. Even the so-called crude and primitive methods of our fishermen, deep-rooted in past traditions, has a core of scientific knowledge which can be learnt only with tact and sympathy. There can be no doubt that marked further progress can be achieved by a proper appraisal of these traditional practices and their extension through modern scientific understanding.

The main national considerations laid down by the Planning Commission for developing national resources are :

"1. that the citizens, men and women equally have the right to an adequate means of livelihood ;

2. that the ownership and control of the material resources of the community are so distributed as best to subserve the common good" ; and

3. that the operation of the economic system does not result in the concentration of wealth, and means of production to the common detriment."

Judging by these considerations, as well as from the geography of our fisheries, two main points emerge : firstly, the inland fisheries have a much greater role to play in the nutrition of our people than the marine fisheries ; and secondly any new methods of development should be an evolution of the existing methods and not innovations which may prove abortive or upset the economic balance of the industry. Both these points require further elucidation.

From the distribution of inland fisheries (rivers, lakes, bheels, artificial impounded waters, estuaries, backwaters, canals, etc.), it is evident that efficient utilization and exploitation can increase production at a fairly rapid rate and offer opportunities for employment to a large number of persons. One of the greatest advantages of developing inland fisheries is that the problems of transport, refrigeration and expensive ground realizations are not required, as small ponds throughout the country can be used in the same way as kitchen gardens. With the completion of multi-purpose river projects, the geography of India will be changed and vast inland aquatic resources will become available for exploitation. It must also be remembered that the improvement of ponds for fish culture will reduce malaria and provide recreational facilities in the form of angling, boating, and so on.

Dr. S. B. Setna's work in Bombay has shown with marked success how a marine fishing industry can be developed in India through the provision of goods to the fishermen and the mechanisation of the country boats. Recently, I was told by the F. A. O. experts at Rome that the same amount of fish is being landed at Bombay by Dr. Setna's mechanised country boats at one-tenth the cost of Japanese trawlers. Besides the consideration of cost, small mechanised vessels are rooted in the economy of the fishermen themselves while large trawlers, even if successful, are likely to upset the economic system by the concentration of wealth and means of production in the hands of a few. Though, western authorities have by now realised what is good for us, we are still following certain opinions expressed earlier in ignorance of our history, tradition and environment.

THE REVIVAL OF THE NATURALISTIC OUTLOOK

Every year we find more and more factually supported criticism of the "chemical outlook" in agriculture ; of the cross-breeding of animals and plants for immediately inereased yields without thought of the long-term values ; of the conversion of small natural farms with a high yield per acre into vast mechanised businesses with a large quantitative yield obscuring the reduced yield per acre, of qualitatively poorer products of mono-cultivation for profit instead of mixed cultivation for more stable gains ; of forestry in terms of timber, at the expense of forestry in terms of public amenity and the biological benefits which trees bring to the land and its people.

Such practices, it is rightly claimed, have reduced essential food values, created the great dust bowls of America and wasted once productive lands in Britain and elsewhere, brought about floods and other disasters, reduced rainfall, and generally contributed to conflicts and misery. Some of these it is true, come from scientifically ignorant people who exaggerate their particular aspect of truth to the point of fantasy ; but we should not forget that they also come from scientists of high distinction—men like Albert Howard and Robert McCarrison, whose outstanding services to India we have good reason to remember.

In other words, the biological outlook of the old natural historians who worked respectfully with nature and not against it, who thought organisms and their environments as historical phenomena, is being strongly revived in the West at a time when we, who already possess this outlook by virtue of a tradition going back to the days of Susruth and before, are beginning to admire and imitate practices that may ultimately do India untold harm.

Moreover, this revival of supposedly old-fashioned Biology has been influenced by, and has

influenced, the corresponding revival of a philosophy in which learning (whether scientific or otherwise) and ethics are indivisible. In India this outlook, too, is at least as old as the *aptas*, of Epic times ; and it is a matter of some pride to me that we acknowledge its spirit in the National Institute of Sciences by a clause in its official *Objects*, which demands that we "promote and maintain a liaison between Science and Letters". The phrasing would perhaps be more forceful if "Humanities" replaced "Letters".

THE FOUNDATION OF THIS ADDRESS

It is against this background, which at least suggests a tradition of social concern in our Congress and the recurrence of certain patterns of thought in the addresses of our Presidents, that I turn to some of the problems involved in giving scientists a chance. It is not necessary to set them against a further elaboration of the affecting background, for the forty presidential speeches alone indicate your awareness of the circumstances influencing our demands and anxieties in connexion with giving science—and scientists—a chance.

Ultimately they are political. They involve, as our Prime Minister has said, the whole social structure ; they are rooted in the condition of the masses and the economic state of our country. Consequently, our conditions will improve only as general conditions improve—and in support of this statement we need look no further than the new vitality, in spite of all the new difficulties, that distinguishes Science in India since the supreme, event of August, 1947.

This does not mean that we must sit still and wait for conditions to improve. We must actively participate in their improvement by our work, ideas and discussions. We must, I am convinced, periodically venture out of "the groves of academe" into the marketplace. It will not be easy for some, as I know from the occasions when I have had to desert my fishes but it must be done. Therefore, I have taken advantage of the honour you have done me to try to make one kind of contribution to the need, knowing that it will soon be lost among the contributions, both actively practical and otherwise, that you yourselves will make.

I have been exceptionally fortunate in this task, for I have gained much assurance and information from the quality of the help I have received. Last year, for example, I sent out a questionnaire to all the Fellow of the National Institute of Sciences of India in which I tried to embody the questions arising from my preliminary thoughts on the ways in which Indian scientists should be given a chance. I confess that the quantitative response was disappointing, but the qualitative response far surpassed my expectations. Especially important replies, which obviously took much thought and time to shape, came from S. L. Ajrekar (botanist); D. P. Antia (metallurgist) ; J. L. Bhaduri (zoologist); D. Bhattacharya (zoologist) ; N. K. Bose (river research) ; P. K. Bose (lac research) ; J. F. Dastur (botanist) ; R. D. Desai (chemist) ; Hansraj Gupta (mathematician) ; K. Jacob (palaeontologist) ; A. C. Joshi (botanist) ; G. P. Majumdar (botanist); D. R. Malhotra (metallurgist) ; H. K. Mitra (refracroties engineer) ; M. A. Moghe (zoologist) ; P. Parija (botanist) ; N. V. Mohana Rao (agricultural chemist); H. N. Ray (zoologist) ; J. N. Ray (industrial chemist) ; R. Ray (chemist) ; S. K. Roy (mining engineer and geologist) ; B. N. Srivastava (physicist) ; and L. C. Verman (physicist).

I have also had the advantage of close discussion with Cedric Dover, who started his career in my own department, but eventually turned from zoological research to the studies of "race and colour problems" for which he is internationally known today. A clue to his social thinking on the subject which he first learned in the Zoological Survey of India will be found in his essay on "Zoology and Culture" in *Science and Culture* for December, 1952.

THE FINANCIAL POSITION OF SCIENTISTS

As I pointed out in my Annual Address to the National Institute of Sciences of India in October, 1952, the disparity between the emoluments of scientists in the unviersities and those in administrative positions, mostly in government or

semi-government departments "has upset the whole structure of scientific development in this country". For this reason, as I said on that occasion, our first demand must be for a uniform Scientific Service, with defined grades of status and pay, which have enough flexibility to permit unusual promotions by merit, and in which the salary differences between grades recognise service and ability without causing resentment and difficulty in the junior grades.

Unfortunately, I did not say at that time what I should like to stress now—that a uniform Scientific Service should be planned and integrated within a larger social philosophy. For example, the salaries of all grades of scientific workers should bear a proper relation (being neither too much nor too little) to national resources and standards of living. Moreover, such a Scientific Services should be a part of all the other public services, for the importance of Science does not mean that scientists should become a privileged class. It is to me quite unthinkable that a professor of Zoology should receive a higher salary than a professor of Sanskrit, or that the head of a scientific institution should be paid more than the head of an institution concerned with music or art. All branches of knowledge must be equally honoured if we are to develop a vigorous and well-balanced culture.

I am pointing here to a very real problem, for there is a feeling in some quarters in India, as in several other countries, that scientists form something of a "class apart", a class rendering such unique service that *ipso facto* its members should be rewarded by the highest salaries in the land, special allowances, privileged terms of employment, and other peculiar marks of public and governmental esteem. In return it is expected that they should be so content with their sheltered positions that they would regard service in public affairs or administration as a disloyalty to their high vocation. It is forgotten that a well-administered Scientific Service must have administrators ; and that, with a few outstanding exceptions, such administrators will be best supplied from the ranks of those who are working scientists. Should we not realise that familiarity with research means an experience in observation, disciplined analysis, and application of knowledge which improves the value of an administrator to the extent that he has it ? Let us grant too, without taking up attitudes about it, that transfers from one field of activity to another are very much matters of opportunity and inclination. In a well-organised Scientific Service, such transfers will occur both ways—from Laboratories to Administration and vice versa. The disparity in emoluments is the only important inhibiting factor at present which precludes migration from Administration to Laboratories and has been responsible for setting up a "Caste System" among the scientists of India.

It is also said that "Pure Science" loses by the movement of scientists into industry ; and there is a corresponding implication that they would not do so if they were better paid. There are admittedly arguments in favour of this statement, but they ignore certain important considerations. They centre round the fact that if Science is to serve industry, then scientists must be increasingly employed by industry at higher wages than the most highly paid Scientific Service can offer. This inevitable process must deplete the ranks of those engaged in Pure Science and scientific education ; but, when the process is fully comprehended, not least by industrialists themselves, the depletions will be compensated by the increased output of adequately trained scientists—men and women with particular interests in research, but without out-of-date notions about the purity and especial value of certain forms of scientific activity.

I offer these opinions because I have come to believe that there is danger in exaggerating our just claims for fair treatment, or clouding them with irrelevancies. Our insistence should be upon the simple fact that scientist, like all other workers, must be adequately paid and reasonably secured against worry and want, within an atmosphere that ensures the elimination of impositions (such as excessive teaching loads) and regulates fair prospects, full credit, and the prompt recognition of merit.

We have other claims as well, but they are founded on the nature and advancement of our

work rather than on our essential human rights as citizens and workers. I turn to consider them now.

THE ENCOURAGEMENT OF SCIENTISTS

It seems to me that a comprehensive and integrated Scientific Service would, by virtue of the social understanding which produced it, recognise the directions in which scientists should be encouraged to improve their quality and extend their usefulness ; but recognition will not be transformed into consistent action unless scientists themselves participate fully, and in an organised manner, in the transformation. Nevertheless, it may be useful at this stage to consider the main directions in which scientists deserve encouragements that will benefit Science and public welfare generally.

One obvious group of these directions would come under the heading of "Facilities". We need well-built, well-equipped, gracious places of work, which is no more than all workers need, except that some of our places of work should be very specifically planned for the work that is to be done in them. We need more libraries and the expansion of existing libraries, together with convenient access to general libraries that will help us to keep abreast with the advance of knowledge outside our fields. We also need, I believe, to build up personal libraries and to subscribe, in larger numbers than we do now, to periodicals important to our work and thought—which, in turn, means joining more societies than we do now.

This last point is extremely important, and you will have noted that its importance was stressed by Sir Asutosh Mookerjee at our first meeting. Indeed intellectual stimuli through reading and personal contacts are so important that there is no doubt that, when our economic position improves, we shall relax more in the good company of books and fellow-workers at home and abroad, within our own fields and far outside them.

But for juniors, difficulties will remain even under improved economic conditions. I accordingly suggest that funds should be established for making "book grants", that all our learned societies should allow "student members" or "associate members" at greatly reduced rates, and that these societies, helped by far-seeing philanthropists, and together with the Central and State Governments, should sponsor tours by juniors and students to various parts of India and abroad, sometimes to conferences but often for study and experience alone.

I am aware that the insistence here is on activities : more reading, more talk, more travel, more mental food and digestion. Yet we also need time and opportunity to go beyond the defined limits of our work when interest, or the urge for relaxation through a different activity, impels us. But, above all. we need time to think—an opportunity which has always been provided to officers in my own department by the tours which frequently withdraw them from the pressures of life and work at headquarters. The advantages are so immeasurable that I feel we should recognise the principle by building an even freer Institute of Advanced Study (such as they have in Princeton), where scientists of unusual capacity, and not necessarily seniors, may go for a year simply to think, to read, and to talk when they feel like it. No duties, "results" or reports should, be required.

So much for facilities. There remains the associated question of "Rewards". The career of a junior in Science (and, of course, in any branch of learning) must be secured as soon as he shows aptitude and positive intentions. He must be able to see in the Scientific Service, or in other opportunities for scientific employment, the fulfillment of his efforts and dreams.

But this is not enough. Before he begins his regular work he must be able to pursue and conclude some research of his own design at some centre of his own choosing, for a period which may vary from one to three years, according to his own purpose and performance. We know the usual way of providing such encouragements : it is to grant scholarships and fellowships through various agencies, and there is scarcely any need for me to say that they should be greatly increased in scope and quantity.

In this connection, Professor Ajrekar has suggested, in so far as the awards or the National

Institute of Sciences are concerned, that preference should be given to projects "which may reasonably be expected to help directly or indirectly in the solution of any of the numerous practical, industrial, agricultural or national health problems which await investigation". He proposes that a list of such problems should be drawn up and kept up-to-date by a special committee in consultation with the many departments involved ; and that "applicants should be asked to submit schemes of research preferably bearing on one or more of the problems in the list".

I feel that this is a most important suggestion, for the labour of producing such a list would influence a revaluation of our basic scientific problems, while its publication would have a helpful influence on the directions of research, which would not be confined to the winners of the awards. But I have stressed the word "preferably" in Professor Ajrekar's opinion because this qualification should not be smothered by the attitude of mind which is likely to develop in a committee that has painstakingly produced a list of approved, or even recommended, subjects for candidates applying for aid. Flexibility is essential. There is always the likelihood that exceptionally good research projects, not covered by the standard list, may be produced by applicants ; and nothing in the presentation of the list should discourage them from doing so.

I think Professor Ajrekar would also like me to say that his proposal should not be interpreted as meaning that the factor or service to the nation should affect all assistance given to young scholars. It is proper that we should insist on the national obligations of scientists, but it is equally true that we should not make a fetish of it ; and if one institution is to specialise in awards calculated to improve the material good of the nation, then at least one other should specialise in awards without this bias.

One quite simple reason for counterbalance is that, while we can produce a list of research requirements which would definitely benefit the nation, it is by no means easy, and in many cases impossible, to predict that some researches will or will not benefit the nation. Besides the benefits of good research are not only material. They can be also cultural, and are always cultural in a wide sense, if we include their intellectual effects. For instance, these were among the reasons for the stimulation we felt last year as we listened to the Presidential survey of "The Living and The Non-Living" by D. M. Bose.

These, as I have said, are expansions of the usual ways of giving financial encouragement to young scientists, but there are others too. Some lie within the potentialities of the universities, some within the enlightment of a developed publishing industry (which would then be able to give prizes and scholarships as many foreign publishers do), and some within the powers of employers who know that money spent on enriching the mental equipment of able recruits would pay dividends in the long run.

I come now to workers at the other end of their careers. All my correspondents are agreed that an incalculable wastage of scientific experience is going on in India through the neglect of retired scientists ; and that this wastage not only applies to the work they themeselves could be producing, but also to wastage in the efforts and directions of the young men and women who were working under their guidance. I pass over the ethics of leaving men, who have served their country as best they know, to the worries of trying to exist on pensions that are no longer adequate, in view of the sudden and dramatic changes that have taken place in the real value of money ; and to the soul-destroying frustrations of being deprived of their work-interests at the height of their maturity.

Some, no doubt, can still afford to continue their enquiries without payment ; but they are not necessarily allowed to do so. There are gravely disturbing cases of gifted scientists, with records that would have brought them the highest honours elsewhere, being refused "sitting accommodation" in the institutions they served for more than three decades. Their number is, however, far exceeded

by the men who wish to continue their work ; but cannot do so for financial reason. They have to find other employment ; sometimes in executive positions, sometimes in subordinate ones. In this connection, it is necessary to remember, as Dr. J. N. Ray has pointed out to me that "the expectation of life in India has now been increased by at least ten years."

The problem of keeping pensioners productive is an important one and I venture to make a few suggestions. Firstly, those who are still producing research or coordinating past work should be invited to remain in their institutions. They should have no duties, but they should retain their old titles with the prefix "Honorary" attached to them. And, if we believe that research and the gifts of maturity are worthwhile, their pensions would be supplemented by honoraria.

Secondly, if a pensioner wants a change from research to academic duties or vice versa, let him be adequately considered on the same basis of an honorary appointment carrying a suitable honorarium. Provided their are no contra-indications of a personal or medical nature, there is no reason why an ex-professor should not become an Honorary Associate Director of a research department, or why a retired head of such a department, should not join a university, where he would give special lectures and conduct seminars, as an Honorary Associate Professor. In fact, there is much to be said for such appointments.

Thirdly, if a pensioner wants complete change let him be considered for the type of engagement he wants. It is not altogether unusual for a man to wish to transfer from one branch of his Science to another, or from biology to education, or pure science to applied science, industry, administration and so on. More judgement is probably required in evaluating such requests, but their critically sympathetic consideration should not be impossible. It should always be remembered that a long apprenticeship in what ultimately resolves itself into the art of critical thinking is a qualification for any type of work where mature thinking is a special asset.

Fourthly, we must appreciate that these encouragements to productivity will sometimes need supplementing, especially when retired scientists have decided to continue their work at home. It is rather evident I think that such supplements would be chiefly in the nature of consultation fees, research grants, grants for equipment (including special books), and publication grants.

There remains the question of rewards for those who are neither at the beginning nor near the end of their carers. Their rewards would lie largely in the satisfactions of work and social duty, and in the recognition which comes to them. Apart from departmental and official recognition, and tokens of appreciation from international sources, there are the recognitions expressed by one's colleagues through election to the honours of learned societies. These are most important to scientists (for, like other men, we have our vanities), and it is a pity that in this aspect of the management of our own affairs there is much bad feeling in India, and not only in India today. Some of this resentment is justified ; some of it, I cannot help feeling, arises from an insufficient capacity of self-criticism. Various measures have been suggested, but the whole topic is so full of detail that I cannot discuss it now.

I do want to say, however, that, to the best of my knowledge, no society anywhere has solved the question of "fairness" to the satisfaction of all its members, since "fairness" is apt to be individually defined. At the same time, the position continuously improves in every reputable Society everywhere, in response to progress in the sense of responsibility of its Fellows, in whom a high regard for a flexible and democratic election procedure, with provision for complaints and appeals, thereby becomes increasingly evident.

There is much more that I had hoped to say, but I now conclude, as I started, by thanking you very gratefully ; for I am conscious of the patience any sympathy with which you have listened to this excursion from the confines of my laboratory. I shall return to it refreshed by your generosity.

IMMERSION OF IMAGES : A TRAGEDY OF POLLUTION

Shreerup Goswami and Saumyasree Pradhan*

Lakhs of Hindu idols coloured in synthetic paints and embellished with metal ornaments are immersed into the water bodies such as lakes, ponds, reservoirs, rivers and canals in a ceremonial farewell at the end of some Hindu festivals. Consequently, different types of chemicals, paints and organic matters are added to these water bodies and cause acute water pollution. The role of the Government and each individual is discussed in the present article to control and abate such water pollution.

INTRODUCTION

"Just as the world we inherited today is what our past generation left on us, The future generations would inherit the legacy we leave for them".

Water is essential for life on earth. However, water is facing a severe threat due to man made pollution. Water is a great solvent and thus it is vulnerable to get polluted easily. Water pollution refers to any type of aquatic contamination by toxic chemicals, which affect all forms of life. Water Pollution now has reached a point of crisis due to various deadly anthropogenic activities. One of these is idol immersion, which can cause acute water pollution by adding pollution load in the shallow aquifers (large ponds, lakes, reservoirs and rivers).

Yamuna, Ganga, Brahmaputra, Mahanadi, Godavari, Kauveri, Krishna, Tapti, Narmada and their tributaries and important lakes are the oldest shallow aquifers of India of great historic importance. These have been used by local inhabitants regularly for washing clothes, animals and vehicles. In addition, industrial effluents and Municipal sewage are generally added to them. Along with these activities, immersion of lakhs of idols (Saraswati, Ganesh, Biswakarma, Laxmi, Kali, Durga) also take place throughout the year. As a result different types of chemicals, paints and organic matters are added to these shallow aquifers.

Studies conducted by the Central Pollution Control Board have confirmed that idol immersion during festive occasions is putting "significant stress" (pollution) on rivers, lakes and local ponds. The idols are generally made up of clay, plaster of paris, hay, cloth, paper, wood, bamboo, thermocole, adhesive material, paints, colored pigments, etc.

IDOL IMMERSION AND WATER POLLUTION

Clay or Plaster of Paris does not get dissolved or disintegrated fast and thus they increase dissolved solids as well as suspended solids in waters and contribute metals and sludge. Plaster of Paris is not a naturally occurring material and contains gypsum, sulphur, phosphorus and magnesium. The idols

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take several months to dissolve in water and in the process water bodies are poisoned slowly.

Chemical dyes and colours used to paint idols contain poisonous elements. Tonnes of synthetic colours (like pigments, acids, paints such as varnish and water colours) which are used in painting these idols, alter the water quality of the respective water bodies. Different colours such as inorganic and organic pigments (for instance azo and phthalocyanine types) and carbon black and oil paints are all harmful. Synthetic inks, colours, paints, dyes etc. are non-degradable substances and most of them are toxic chemicals that have adverse effects on people and the environment. Impact of colour and dyes on human health can be alarming. Dyes contain metals such as copper, nickel, chromium, mercury and cadmium. Particularly, Red, Blue, Orange and Green colour paints contain Mercury, Zinc oxide, Chromium and Lead. These are potential causes of cancer. The colour compounds contain these heavy metals which pollute the surface and ground water. Heavy metals like lead and chrome are not easily assimilated in an aquatic environment and can cause adverse impact on flora and fauna of the river, pond, lake and coastal areas. As the same river, pond or lake water is used for bathing and drinking purpose, high leavels of lead can damage the heart, kidneys, liver, circulatory system and central nervours system. Researches have shown that different heavy metals in these water bodies substantially increase after the religious activities like idol immersion throughout the year.

It is evident that harmful elements, viz., magnesium, molybdenum, silicon, carbon, cadmium, arsenic, led and mercury, increase several fold in the water due to the idol immersion compared to allowable BIS and ICMR standards. This contaminated water inhibits photosynthetic activity of aquatic biota due to reduction in the penetrtion of sunlight. Besides, toxic chemicals and heavy metals directly affect the aquatic organism. The toxic chemicals enter into the water bodies and then to living aquatic organisms (especially fishes and weeds) and finally into the human body, which cause serious health effects. The heavy metals are known to be persistent in the aquatic environment and gradually accumulate and magnify through the process known as bioaccumulation and biomagnification, while they move up in the food chain. Thus, lead and marcury may magnify in their concentrations at different trophic leavels, including in fishes and birds inhabiting these water bodies, which finally reach the humans through food chains. Organic compounds of mercury, for example methyl mercury, when it enters the human body, concentrates in the brain and destroys the brain cells, damaging the central mervous system, and also causing corrosion and ulceration of the digestive tract.

In addition, several accessories used for decoration like thermocol, plastic flowers, other plastic and polythene items, cosmetic items, oily substances, ornaments, synthetic cloths supported by small iron rods, incense, camphor and numerous other materials are dumped carelessly adding more strain to the already polluted water bodies and these contribute suspended matter, trace metals (zinc, lead, iron, chromium, arsenic, mercury etc.) metalloids and various organic and inorganic matter, oil and grease etc. Thus floating suspended matter and organic contamination also increase. Careless dumping of idols with bamboo sticks, polythene and plastic items in water bodies blocks the natrual flow of water. This results in stagnation and breeding of mosquitoes and other harmful pests and insects. The polluted water causes several water borne and skin diseases. Thus, the pollution from idols damages the aquatic ecosystem, kills fishes and water plants. In many areas, the same polluted water gets pumped into homes.

ROLE OF ADMINISTRATION

The environemtal problems relating to surface water system relevant in water quality, pollution control and environmental concerns have attracted much attention in recent years. Conservation of freshwater environment has got paramount importance and monitoring of pollution is highly essential. Contamination by toxic substances has created a serious and complex scenario which needs urgent attention.

Therefore, immersion of gorgeous colourful idols must be stopped. Legislation must be formulated to prohibit this activity. Periodical monitoring of the water quality is required to assess the condition of surface water and immediate steps should be taken to check such anthropogenic activity at and around the water bodies. Moreover river bed sludge analysis to depict elevated level of trace metals should be conducted at regular intervals. Central Pollution Control Board and State Pollution Control Boards should test water quality before the immersion, during the immersion and after the immersion to assess the effect of pollution and then devise a guideline for upcoming occasions. Resepective State Governments at least should ensure that idol structures are collected from water bodies within 24 horus of immersion. Rag pickers activities through which recyclable material is removed should be encouraged further, especially after these festive occasions to avoid the contamination of water bodies with floating materials like plastics, flowers, wooden structure, etc. In the worst case Government should allow immersion of idols in a single pond (in a small captive water body) in each town and after each festive season the water must be treated by appropriate method.

ROLE OF EACH INDIVIDUAL

The Public should be made aware of all adverse affects of idol immersion in water bodies and some imperative steps should be adopted at individual level. Simple clay idols should be made. of unbaked clay and they should be painted with natural materials such as red earth and turmeric. Thus, use of eco-friendly clay idols painted with biodegradable/herbal dyes and paints should be encouraged at all levels. Otherwise, permanent idols should be used made of stone or brass and perfom a symbolic immersion and reuse the idol each year. One must not throw the beautification material and synthetic flowers into water bodies. Instead all these materials should be taken and kept aside. So that civic bodies can clean it easily. Flowers, banana leaves, garlands, coconut and nirmalyas should be collected and compost made of them. The use of thermocoles, plastics and polythene in decoration must be avoided. Lastly, public water bodies should be avoided to immerse the idols. Rather after the completion of all rituals, the idols can be immersed without ornaments in a bucket or tub or tank of water and the solution can be safely drained in the premises.

CONCLUDING REMARKS

Lakhs of Hindu idols reaching heights up to 15m with lavishly coloured in synthetic non-biodegradable paints and embellished with metal ornaments are routinely immersed into the water bodies such as lakes, ponds, reservoirs, rivers and canals in a ceremonial farewell at the end of all the major Hindu festivals.

In the name Ganesh 'Ga' symbolizes Buddhi (intellect) and 'Na' symbolizes Vijnana (wisdom). Ganesha is thus considered the master of intellect and wisdom. But by dumping idols of Lord Ganesh into water bodies, are we using our wisdom ? Saraswati represents learning, intelligence, consciousness, cosmic knowledge, creativity, education, enlightenment. music, the arts, and power. Her name literally means "the one who flows", which apparently was applied to the flow of a water body (in Sanskrit : "dhaara-pravaah"). But by immersion idols of deity Saraswati into our

lakes and rivers, we are just blocking the natural flow of water. Is it our intelligence and consciousness ?

Maa Durga, "the inaccessible" or "the invincible" the supreme goddess is the embodiment of feminine and creative energy (Shakti). She had taken the incarnation of Durga to destroy demons and save people and other life on the earth. But by immersing idols of Durga into our lakes and rivers, we are just damaging the aquatic ecosystem comprising many lives and acquiring water borne and skin diseases.

Lakshmi is the goddess of wealth, fortune, love and beauty. On such festive occasions we are not accumulating wealth ; rather crores of rupees are spent for the ceremonial immersion of idols in a country like India, where millions of people are below the poverty line.

Kali is the goddess of time and of the transformation that is death (*Kala*). Maa Kali is worshipped for "Tamosho Maa Jyotirgamaya" and to lessen the fear for death. But by dumping idol of Maa Kali into the water bodies, are we not inviting definite death of more lives.

Viswakarama, "Principal Universal Architect", the architect who designed the divine architecture of the Universe. The Rig Veda describes Viswakarma as the god with multi-dimensional vision and supreme strength. He is able to predict well in advance in which direction his creation will move. But by immersing idols of Lord Biswakarma into our lakes and rivers, do we justify multi-dimensional vision and can we predict well in advance in what extent we are polluting the God's creation ?

Therefore, prohibiting immersion of idols into water bodies is a common responsibility of citizens, administrators, media and NGOs for harnessing and sustaining the comfortable life as it will abate and control acute water pollution and will provide pure drinking water, safe domestic water, water for livestock, and water for small irrigation. As individuals, groups, and community, let us wake up before it is too late and not only understand the adverse impact of immersion of idols in the water bodies and the way and means of green and safe celebration of festival season is all about but also implement measures to restrain these activities.

DO YOU KNOW ?

Q1. What is chorophobia ?

Q2. Which is the only city in the world to be both in Europe and Asia ?

ORGANIC SOIL FERTILITY MANAGEMENT FOR ENHANCED PADDY PRODUCTION : MODEL PADDY FIELDS IN ORISSA

A.K. Panigrahi*, T.R. Sahoo, H.S. Behera and N.K. Swain

Green revolution was introduced in the country in the early sixties to meet the demand of food and add cereal cultivation in the Rabi. The aftermath of this revolution is alarmingly disastrous. The humus devoid soil has lost its water holding ability, pests have acquired resistance against pesticides. Indian paddy fields are adding roughly about 37.8 metric tonnes of methane, a green house gas, into the atmosphere. Food and underground water get contaminated with pesticides.

The Environmental deteriorations, food and water contaminations demand a paradigm shift from chemical to organic agriculture. With the growing demand of food, diminishing arable land holdings and exodus of the agrarian communities from village to towns abandoning agriculture, only organic farming will not suffice. The new technique conceived is known as sustainable agriculture, where soil fertility, crop yield and pest management are taken care of together with the environmental protection. This method of agriculture is in harmony with the nature. The article examines three *ex situ* experiments where the above mentioned issues are examined along with the cost benefit ratio and throws light in making agriculture sustainable.

INTRODUCTION

More than six decades ago, Sir Alerb Howard explained the nature of soil fertility in his famous book, "An Agricultural Testament" as under. The nature of soil fertility can be understood only when it is considered in relation to Nature's round. To study soil fertility we have to know the natural working system and to adopt methods of investigation in strict relation to such a subject. We must look at soil fertility as we would study a business where the profit and loss account must be taken along with the balance sheet, the standing of the concern, and the method of management. We have to consider the wood, not the individual tree. So it is with soil fertility. According to him, a fertile soil is one which has humus in abundance. If the soil is deficient in humus, the volume of pore space is reduced, the aeration of the soil is impeded, there is insufficient organic matter for the soil population, the soil machinary runs down, the supply of oxygen, water and dissolved salts needed by the root hairs is reduced, the synthesis of carbohydrates and proteins in the green leaf proceeds at a lower tempo ; growth is affected.

CHEMICAL AGRICULTURE :

Then came the war and ended sooner than expected, resulting in stock piling of war surplus explosive related materials, mostly compounds of nitrogen and phosphorus. Global approach to agriculture modified in the event of population

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growth and developments in material and biological sciences. New seeds were developed and introduced to enchance food production which soon became popular in populous countries like India, China, South East Asian Countries and Japan, War surplus chemicals were converted into compounds called artificial chemical fertilizers. The seeds, popularly called "Green revolution seeds" or "Miracle seeds", were developed to consume these synthetic artificial chemical fertilzers with water and produce more food. Thus, monoculture came into being at the expense of agro biodiversity and resources like water diminished.

Four decades into the green revolution in India, the situation is pathetic ; soil in general has become humus deficient, excessively hard and bear no pores for holding air and moisture. This soil no longer harbours the beneficial microbes but the pathogens and pest eggs, requiring excessive use of synthetic pesticides. The impacts of these agro chemicals, the artificial chemical fertilizers and synthetic pesticides are well observable. No data have been published by any the Indian agencies like the US Environment Protection Agency (USEPA). The USEPA revealed in 1991 that the project estimate of methane emission from the Indian paddy fields amounted to 37.8 metric tonnes per year, thus accusing the Indian paddy cultivators in adding to the global green house gas accumulation as methane is also considered as a green house gas. Consequently in India more emphasis is now attached to shift to non conventional agriculture and keep paddy culitvation limited to 47 percent of the total arable land. Use of artificial chemical fertilizer especially N-fertilizers always invite the agricultural pests and applications of pesticides, especially chemical pesticides. The disastrous consequences of the use of these tolerant pesticides over several decades are now clearly observable. There is a rise of pesticides resistance in the pest species and diseases causing microbes at the expenes of the several beneficial organisms like the beneficial insects (honey bee), Earth warm and scavenging birds (vultures) etc. Report of crop failfure are also linked to the changes in natural status of the soil. Reports of methane emission are obviously owing to excessive use of nitrogenous fertilizers like Urea. Reports of occurance of agricultural pesticides in underground water (bottled water and soft drinks) is certainly due to their excessive applications and non degradations.

PARADIGM SHIFT

It has thus become essential to find a solution both, enhance crop yield through enhanced soil fertility organically without further degrading its status and keep the pathogens and pests at bay through the use of natural pest repellants, botanical pesticides and employing biological pest control methods. But the most importance one is, following Sir Howard, to bring out a balance sheet of profit-loss, making cultivation a profitable enterprise so that uncalled for future situations like resource retirement, contract farming and above all exodus of the agrarian communities from villages to cities are successfully thwarted. In countries like India where agriculture is a million year old enterprise, which changed Sir Howard from being an western expert to an oriental expert, where the population is growing alarmingly but arable land is diminishing and where these days farmers are commiting suicides owing to crop failures, there ought to be a shift in approach to the whole practice of agriculture. The modern agriculture should be made sustainable, i.e. in harmony with the nature. With the foregone objective set in mind the authors experimented with the principal crop of Orissa, i.e. paddy cultivation, both in Kharif and Rabi. Report of approach, application, observation and cost benefit ratio of three such ex situ experiments, one of Rabi and the two others of Kharif are furnished below.

Material Method and Observations :

Experiment–1 : Rabi 2003-04

Farmer's name and address—Sri Surendra Nath Patra, Vill–Dharmapur, Fulwar Kasba, Balasore, Orissa.

Soil type—Deltaic alluvial

Crop type-Paddy (HYV)–Lalat (ORS-26-2014-4) known qualities–Duration : 125-130 days.

Grain type : Medium * Slender, Grain yield / hectare : 40 quintals (as on record)

Experimental Unit Area : 1 Acre

Source of Seed : Farmers own saved (OS)

Sl. No.	Activities associated	Control	Rs.	Chemical	Rs.	Organic	Rs.
1.	Seed cost	OS	0.00	OS	0.00	OS	0.00
2.	Seed be preparation	2HL 1BL	100.00 80.00	2HL IBL	100.00 80.00	2HL IBL	100.00 80.00
3.	1st cultivation	Tractor (2 hours)	600.00	Tractor (2 hours)	600.00	Tractor (2 hours)	600.00
4.	Farm yard manure	Not applied		Not applied		2 tonnes (II)	0.00
5.	Puddling	6HL 2BL	300.00 160.00	6HL 2BL	300.00 160.00	6HL 2BL	300.00 160.00
6.	Basal application	Nil		Gromor 70 kg MOP 20 kg	 70.000 100.00	Pongam Oil cake 1 qt Azolla (LI)	 400.00 0.00
7.	Transplantation	35HL	1750.00	40HL	2000.00	35HL	1750.00
8.	Interculture	5HL	250.00	7HL	350.00	5HL	250.00
9.	(a) 1st top dressing	Nil		Urea 12 kg MOP 6 kg	 60.00 30.00	Pongam Ouilcake 50 kg Cow urine 250 lts. (I.I)	 200.00 0.00
	(b) 2nd top dressing	Nil		Urea 10 kg MOP 5 kg	 50.00 25.00	 Cow urine 250 lts. (I.I)	 0.00
10.	Pesticide application	Nil			400.00		200.00 (lure appln)
11.	Irrigation (total)			250.00	250.00		250.00
12.	Cutting of crop	15HL	750.00	18HL	900.00	15HL	750.00
13.	Threshing	10HL	500.00	13HL	650.00	10HL	500.00
14.	Miscellaneous expenses (pest management)	Nil			100.00		150.00
15.	Total cost involved (in terms of Rs)		4740.00		6855.00		5690.00

Sl. No.	Activities associated	Control	Rs.	Chemical	Rs.	Organic	Rs.
16.	(a) Yield of grains		12.7 qntls @520/-per qntl. 6604.00		20.2 qntls @520-qntl 10504.00		23.5 qntls @520-qntl 12220.00
	(b) Yield of straw		15.85 qntls @80/-1268.00		25.07-qntls @70/-1755.00		29.47-qntls @80/-2358.00
17.	Total yield (in terms of Rs.)	7,872.00		12,259.00			14578.00
18.	Net benefit		3,132.00		5,404.00		8,888.00
19.	Cost benefit Ratio (17/15)	1.66		1,788			2,562

Experiment–2 : Kharif 2004-05 :

Name and address of the farmer : Raghunath Barik, Bhimpur

Soil type : Coastal alluvial

Crop type : Paddy HYV (Pooja) (recently introduced)

Experimental unit area : 1 Acre

Source of seed : Farmer's own saved seed (0S)

Sl. No.	Activities associated	Control	Rs.	Chemical	Rs.	Organic	Rs.
1.	Seed cost	OS	0.00	OS	0.00	OS	0.00
2.	Seed be preparation	2HL 1BL	100.00 80.00	2HL IBL	100.00 80.00	2HL IBL	100.00 80.00
3.	1st cultivation	Tractor 2hrs	600.00	Tractor 2hrs.	600.00	Tractor 2hrs.	600.00
4.	Farm yard manure	Not applied		Not applied		2 tonnes (II)	0.00
5.	Puddling	6HL 2BL	300.00 160.00	6HL 2BL	300.00 160.00	6HL 2BL	300.00 160.00
6.	Basal application	Nil		Gromor 70 kg MOP 20 kg	700.00 100.00	Pongam oil cake 1.5 q Sesbania 10 Kg. B.F. 500 gm V.C. 5 qntls. (1.1)	600.00 110.00 100.00 0.00
7.	Transplantation	35HL	1750.00	40HL	20000.00	35HL	1750.00
8.	Interculture	8HL	400.00	10HL	500.00	8HL	400.00
9.	1st top dressing	Nil		Urea 12 kg MOP 6 kg	60.00 30.00	Bacterial fertiliser 250 kg Compost 2.5qntls (1.1)	50.00 0.00
10.	2nd top dressing	Nil		Urea 10 kg MOP 5 kg	50.00 25.00	Bacterial fertilizers 250 gm Compost 2.5qntls (1.1)	50.00 0.00

Sl. No.	Activities associated	Control	Rs.	Chemical	Rs.	Organic	Rs.
11.	Pesticide application	Nil		Total	400.00	(1.1)	0.00
12.	Crop cutting	15HL	750.00	18HL	900.00	15HL	750.00
13.	Threshing	10HL	500.00	13HL	650.00	10HL	500.00
14.	Miscellaneous	Nil			100.00		150.00
15.	Total cost involved (in Rs)		4,640.00		6,755.00		5,700.00
16.	(a) Yield of grains	16.50 qntl.	8,580.00	21.9 qntl.	11,388.00	22.10 qntl.	11,492/-
	(b) Yield of straw	22.10 qntl.	1,768.00	27.5 qntl.	1,925.00	29.4 qntl.	2,325/-
	(c) Total yield (in Rs.)		10,348.00		13,213.00		13,844/-
17.	Net benefit		5,708.00		6,588.00		8,144/-
18.	Cost benefit Ratio (16c/15)		2.23		1.971		2,429

Soil fertility condition of the above crop at different stages.

Plot	N (Kg/ha) Subiah and Asija, 1956 (alkaline potassium permanaganate)			P (Kg/ha) Olsen's method		K (Kg/ha) Ammonium Acetate method			
	Initial	45DAT	After harvest	Initial	45DAT	After harvest	Initial	45DAT	After harvest
Control	511.9	499.4	426.49	50.00	44.6	15.2	312.0	300.8	200.25
Chemical	511.9	561.2	520.57	50.00	52.2	26.16	312.0	346.6	241.9
Organic	511.9	560.7	564.4	50.00	43.7	18.24	312.0	336.8	251.32

Experiment. 3 Kharif 2004-05

Name and address of the farmer : Sri Pitamber Jena

At-Mangalpur, P. O. Chengua-Mangalpur Via-Bhimda, Dist : Mayurbhanj (Orissa)

Soil type : Sandy loam

Crop type : Paddy (HYV) Kasturi

Source of seed : Purchased from other farmer (Pl)
(7.5 kg @ 5/-per kg = Rs. 37.50 p.)

Known yield potential of the variety (Kasturi) ± 20 quintals per acre (chemical)

Plot size : 30 decimals (100 decimals = 1 Acre)

Ingredients applied :

1. Sesbania (Dhanicha) seed @ 12 kg/acre = 3 kg 600 gm
   @ Rs. 11/- 1 kg = Rs. 39.60 p)
2. Pongam oil cake @ 150 kg/acre = 45 kg
   @ Rs. 4/-kg = Rs. 180.00
3. Cow urine soaked cows hed soil @ 4 quintals/acre
   = 1.2 quintls (Internal input)
4. Fresh cow urine @ 7-8 liters twice in a week for 6 week (internal input)
5. Home made heap compost 2 cartloads (II)

MATERIAL METHOD

Sesbania seeds were sown in the soil after the first ploughing and allowed to grow up to preflowering stage where after the field was ploughed and the plants were incorporated into the soil together with pongam oil cake, cow urine soaked cowshed oil and home made compost. The farm land top soil was thus converted into a paste of soil, sesbania plants, pongam oil cake, urine soaked cow shed oil, home made compost and stagnated water (just enough to create a muddy condition). It was allowed to stand overnight. The field was then transplanted with the paddy seedlings the next day. Thereafter the field was periodically weeded and fresh cow urine applied.

OBSERVATION :

1. Soil sample were collected at different stages for study of soil fertility conditions and the NPK values were ascertained.

Study of sample	N(Kg/ha)	P(Ka/ha)	K(K/ha)
Initial	283.7	42.6	168.3
45 DAT	458.2	45.8	273.6
75 DAT	462.1	39.9	260.1
After harvest	393.6	35.2	254.7

2. Yeild of grains at harvest : 8.5 quintals (@ 28.33 quintals/acre)

3. Yeild of straw of harvest : 9.9 quintals (@ 32.9 quintals/acre)

Cost Benefit Index :

1. Total expenditure incurred :

A. Ingredients : (purchased input)

(i) Cost of paddy seeds : Rs. 37.50

(ii) Cost of sesbania seeds : Rs. 39.60

(iii) Cost of pongam oil cake : Rs. 180.00

B. Labour :

(i) Seed bed prepartion 1HL : Rs. 50.00

(ii) 1st cultivation 1BL : Rs. 80.00

(iii) Puddling 1BL : Rs. 80.00

(iv) Transplantation 10 HL : Rs. 500.00

(v) Interculture 1HL : Rs. 50.00

(vi) Crop cutting 4HL : Rs. 200.00

(vii) Threshing 2HL : Rs. 100.00

Total Rs. 1,317.10

2. Total sale proceeds of yield :

(i) Value of grain,
8.5 quintals @ 600/-
per quintal = : Rs. 5,100.00

(ii) Value of straw,
9.9 quintals@ 80/-
per quintals = : Rs. 792.00

Total Rs. 5,892.00

3. Cost benefit ratio (2/1) = 4.47

Abbreviations used :

HL = Human labour, BL = Bullock Labour, MOP = Muriate of potash, N = Nitrogen (total), P = Phosphorus (available), K = Potash (available), II = Internal input, PI = Purchased input, B.F. = Bacterial Feriliser, V.C. = Vermi Compost.

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STEM CELL RESEARCH : A NEW FACE OF DEVELOPED INDIA IN MEDICAL BIOLOGY

Manas Kr. Mukhopadhyay* and Debjani Nath**

Stem cell, the master cell of a living body, has potency to regenerate or differentiate into new cells. Stem cell research is a highly interdisciplinary field of research in life sciences. The recent status of stem cell research in India has been focused here. The problems and prospects of this research in biological and clincial field, have also been discussed.

INTRODUCTION

The Myth in Adi Parva, one of the chapters of Mahabharata, it is said that Kauravas were created from pinda [a ball of flesh], which Gandhari delivered after two years of pregnancy. It was then handed over to the sage Dwaipayan, who divided the pinda into one hundred parts and treated with herbs and ghee. The pieces were covered with cloth and kept in a chamber to cool for two years out of which the Kauravas were born.

The Greek Titan, Prometheus, is a fitting symbol for regenerative medicine. As punishment for giving fire to Humankind, Zeus ordered Prometheus chained to a rock and sent an eagle to eat his liver each day. However, Prometheus' liver was able to regenerate itself daily. enabling him to survive.....

STEM CELL TECHNOLOGY : THERAPEUTIC APPLICATIONS :

The scientific researchers and medical doctors of today hope to make these myths and concept of regeneration into reality by developing therapies to restore lost, damaged, or aging cells and tissues in the human body. The search for stem cells began in the aftermath of the bombings in Hiroshima and Nagasaki in 1945. Those who died over a prolonged period from lower doses of radiation had compromised hematopoietic systems that could not regenerate either sufficient white blood cells to protect against otherwise nonpathogenic infections or enough platelets to clot their blood. The potential of higher doses of radiation also killed the stem cells of the intestinal tract, resulting in more rapid death. Later, it was demonstrated that mice that were given doses of whole body X-irradiation developed the same radiation syndromes. At the minimal lethal dose the mice died from hematopoietic failure approximately two weeks after radiation exposure. Significantly, however, shielding a single bone or the spleen from radiation prevented this irradiation syndrome. Soon thereafter, using inbred strains of mice, scientists showed that whole-body-irradiated mice could be rescued from otherwise fatal hematopoietic failure by injection of suspensions of cells from blood-forming organs such as the bone marrow cells or the stem cells.

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The stem cell technology is used to develop therapy for many untreatable diseases through cellular replacement or tissue engineering. Any disease where there is tissue degeneration, is the potential candidate for stem cell therapy such as burns, spinal cord injury and neurotrauma, cardiac problems, Parkinson's and Alzheimer's diseases, retinal and hair cell degeneration, amyotrophic lateral sclerosis (ALS), osteoporosis, rheumatoid arthritis, multiple sclerosis, acute myocardial infarct, diabetes, liver diseases, inflammatory bowel diseases etc. There are technical challenges at nearly every step of stem cell therapeutics like stem cell acquisition, manipulation, prevention of tumorigenesis, purification, transplantation and prevention of rejection. Therefore, extensive research is essential to understand the fundamental processes of cell development, relationship between stem cells and tumour formation, interaction between stem cells and microenvironment, creation of good animal models to understand disease patterns, evaluation of new drugs, etc. Progress is slowed by the further hurdles of financial, ethical cultural and political concerns. Nevertheless, the rate of advancement has become asymptotic from the early days of detecting teratocarcinomas in mice. The mechanism of stem cells are slowly being unravelled, from gross concepts such as niches and cell fusion, on down to individual cell signalling factors.

EMBRYONIC STEM CELL RESEARCH

Scientists believe adult stem cells should not be the sole target of research because of important scientific and technical limitations. Adult stem cells may not be as long lived or capable of as many cell divisions as embryonic stem cells. Also adult stem cells may not be as versatile in developing into various types of tissue as embryonic stem cells, and the location and rarity of the cells in the body might rule out safe and easy access. Embryonic stem cells are capable of unlimited self renewal while maintaining the potential to differentiate into derivatives of all three germ layers. Even after months and years of growth in the laboratory, they retain the ability to form any cell type in the body. These properties reflect their origin form cells of the early embryo at a stage during which the cellular machinery is geared toward the rapid expansion and diversification of cell types. Murine (mouse) embryonic stem cells were isolated over 20 years ago, and paved the way for the isolation of nonhuman primate, and finally human embryonic stem cells. Much of the anticipated potential surrounding human embryonic stem cells is an extrapolation from pioneering experiments in the mouse system. Experiments performed with human embryonic stem cells in the last couple of years indicate that these cells have the potential to make an important impact on medical science, at least in certain fields. In particular, this impact includes : (a) differentiation of human embryonic stem cells into various cell types, such as neurons, cardiac, vascular, hematopoietic, pancreatic, hepatic, and placental cells, (b) the derivation of new cell lines under alternative conditions, (c) and the establishment of protocols that allow the genetic modification of these cells.

This is a highly interactive field of life sciences and it requires close interaction of basic researchers, clinicians and the industry for the overall growth and development. Keeping in view its potential therapeutic applications, the need was felt to initiate programmes on stem cell science in the country. After a wide consultation with the national and international experts, priority areas in this area have been categorized into basic research, translational research, institutional development, creation of facilities/infrastructure and human resource development.

STEM CELL RESEARCH IN INDIA

In India both basic and clinical research are being promoted by several science agencies of the Government in various institutions and hospitals. The programmes have been identified and implemented on various aspects of both embryonic and adult stem cells such as limbal, haematopoietic, embryonic, panceatic, neural, cardiac stem cells, generation of human embryonic stem cell lines, use of banana lectins for stem cell preservation, haematopoietic stem cells (HSC) for haplo-identical HS transplantation, use of limbal stem cells for ocular surface disorders, isolation and characterization of mesenchymal & liver stem cells, *in vitro* differentiation of human embryonic stem cells to neural and non-neural lineages, etc. City cluster programmes have been implemented at Pune and Vellore by involving basic researchers and clinicians. This includes sharing of information, explore collaboration with clinicians and discuss emerging policy issues in this area, etc. In 2003, a separate Task Force of "Stem Cell Biology and Regenerative Medicine" was constituted to consider new projects, monitor the progress of ongoing projects, discuss the priority areas and others issues related to stem cell research.

The stem cell research is still in its infancy. Yet individuals, both professional and the general public, have given serious thoughts concerning embryonic stem cells as far as its research, medical, societal, ethical, moral and religious implications are concerned. Embryonic stem cell research is a controversial subject worldwide because of the differing views on when a human life begins. Harvesting of the stem cell from embryo is a very hot political matter all over the world.

However, unlike research on embryonic stem cells, there are diminished or minor concerns expressed by most individuals over adult stem cells. The vast majority of dilemma rests on the side of "embryonic stem cells". There is nothing wrong in using the discarded embryos from the fertility clinic for the embryonic stem cells research, but the opponents, mainly the "pro-life" advocates, want a complete ban on research and funding of any kind involving human embryonic stem cells as well as a ban on the intentional creation of human life by means of human cloning. They argue that funding could be diverted to other research approaches such as development of pharmaceutical or recombinant protein based alternative therapies. The "pro-life" lobby is of the view that adult stem cells, which have no ethical problems, can do the job of embryonic stem cells. Keeping in view the controversies associated with the stem cell research, it is, therefore, imperative to educate the massess regarding the differences between the embryonic and the adult stem cell research with regard to the science. However, the studies both on adult stem cells as well as embryonic stem cells should go ahead in parallel because what is learnt about one cell type can help progress research into the other. There is still too much to learn from stem cells and there are many hurdles to overcome before we know how useful stem cells therapies will be.

FACILITIES AVAILABLE TO HANDLE STEM CELLS

Though some of the institutions in the country initated stem cell research a few years ago, facilities were limited and were not adequate for taking up challenges coming continuously in this area as this is a comparatively new field of life sciences. Realizing the need to establish clean room facilities to handle stem cells and also carry out research in this field, a number of facilities have been created. These facilities have been established mainly in hospital set up because hospitals are the main source for providing these cells and no facilities were available to handle stem cells in their set up. Therefore the facilities have been created at Post Graduate Institute of Medical Education & Research (PGIMER), Chandigarh ; Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGIMS), Lucknow, LVPEI, Hyderabad and KEM Hospital Mumbai, etc.

Programme	Available at :
Network programmes	CMC, Vellore ; SGPIMS, Lucknow ; PGIMER, Chandigarh ; All India Institute of Medical Science (AIIMS), New Delhi ; R & R New Delhi ; National Centre for Cell Science (NCCS), Pune and National Brain Research Centre (NBRC), Manesar
Stem cell research facilities	PGIMER, Chandigarh ; SGPGIMS, Lucknow ; KEM Hospital Mumbai and LVPEI, Hyderabad ; CMC, Vellore (Opening shortly) ; CCMB, Hyderabad.
Embryonic stem cell research	National Institute for Reseach in Reproductive Health (NIRRH), Mumbai ; National Centre for Biolgical Sciences (NCBS), Bangalore ; NCCS, Pune ; NBRC, Manesar and Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Banglore.
Limbal stem cells	LVPEI, Hyderabad ; R. P. Centre, AIIMS, New Delhi and Regional Institute of Ophthalmology, Kolkata.
Neural stem cells	NBRC, Manesar ; National Institute of Mental Health and Neurosciences (NIMHANS), Bangalore and NCCS, Pune and University of Hyderabad, Hyderabad.
Mesenchymal stem cells	CMC, Vellore ; SGPGIMS, Lucknow and Manipal Hospital, Bangalore.
Pancreatic progenitor cells	National Institute for Nutrition (NIN), Hyderabad and NCCS, Pune.
Cardiac stem cells	Sree Chitra Tirunal Institute for Medical Science & Technology (SCTIMST), Thiruvananthapuram and AIIMS, New Delhi.
Cancer stem cells	Indian Institute of Science (IISc), Bangalore.

INTERESTED PRIVATE COMPANIES FOR STEM CELL PROGRAMME

India's first stem cell transplant opened in Chennai, capital of Tamil Nadu. Life Cell, a stem cell banking and research company in India, launched the centre with the US-based Cryo-Cell Inc. The company has invested $4 million to set up the transplant centre at the Sri Ramachandra Medical Centre of Excellence. Life Cell has 18 stem cell collection centres across the country, which has collected 3,600 samples so far and it plans to increase the number to 31 by March 2009. Life Cell also has facilities for umbilical cord blood stem cell banking and the company plans to expand its network of marketing and collection centres all over India. Life Cell has a technology tie-up with CRYO-CELL International (CCI), USA (www.cryocell.com), which is the pioneer in the field of cord blood banking and the world's biggest cord blood bank. Chennai-based Life Cell, the pioneer stem cell repository in India, has announced plans to foray into the Middle East region. Dubai will be the 22nd centre for Life Cell. The company will initially extend their services to reach one million Indians in UAE for umbilical cord stem cell banking. The company is all set to launch Plureon Placental stem cells from placental tissues as a new source for stem cells in India for the first time.

WHAT DO ALL THESE DEVELOPMENT MEAN FOR INDIA ?

Where is stem cell research heading in our country ? The Indian National Science Academy (INSA), the leading body of scientists, said strict guidelines need to be put in place to put stem cell research on a strong footing. Given the huge disease burden, the need for organs, affordable diagnostics and medicines, the promise that stem cells offer needs to be exploited to the fullest. However, there are pitfalls, in the form of false claims, unethical methods to get quick results or unregulated practices to harvest these 'miracle' cells. This trend needs to be brought under check. As there is also the keen interest from big biotech companies in the US, Canada and the UK, in joint venture projects with Indian researchers.

Recognizing this need, the Indian Council of Medical Research (ICMR) and Department of Biotechnology (DBT), Government of India, have brought out a draft of guidelines to regulate Stem Cell Research and Therapy (SCRT) in India. These have been posted on the website of ICMR for scientific and community comments. After public dialogue, the Guidelines may be put into a statutory framework. In any such exercise there are two competing considerations ; firstly, concerns of the public about ethical, legal and social aspects of scientific research and secondly value of freedom for scientific enquiry for advancement of knowledge. The proposed Guidelines have taken into consideration both potential risks of basic and clinical research in this field, as well as potential benefits of stem cell research and therapy that is not too restrictive for research.

The most salient aspect of these guidelines is the categorization of stem cell studies into 3 groups, viz., permissive, restrictive and prohibitive research ; and to suggest a provision for two tiers of evaluation, one at the institutional level for permissive research and the other at the national level for restrictive research.

Restrictive Research for example, reproductive cloning being repugnant to the society has been put in the prohibitive category, while *in vitro* studies on already established embryonic stem cells (hES) or adult somatic stem cells (hSS) to understand processess of development and differentiation are kept in the permissive category. Another clear area of prohibited research is any *in vitro* culture or manipulation of human embryo beyond 14 days after fertilization, or formation of neural tube, whichever occurs earlier. Likewise, implantation on any embryo after *in vitro* manipulation into human uterus (e.g., germ line gene therapy) is prohibited at present. A distinction has also been made between establishing embryonic stem cell lines from spare embryos and embryos specifically made for the purpose, including both *in vitro* fertilization and somatic cell nuclear transfer techniques. The former is kept in the permissive category provided spare embryos are obtained in an ethically acceptable manner while the later is kept in the restrictive category to require specific scientific justification and proof of technical competence of the investigator. It has been done to dissuade frivolous creation of embryos for establishment of hES cell lines, In this context detailed guidelines have also been developed regarding procurement of gametes, blastocysts or somatic cells for generation of hES cell lines. The Guidelines provide for continuous updating of the three categories enumerated above depending on scientific progress in this field. As far as *in vivo* research is concerned, studies in adult animals do not raise any ethical dilemmas, hence permissible. This may include introduction of human stem cells in small animals as well for preclinical studies, to evaluate their efficacy in experimental models and for toxicity studies.

One of the complex areas of basic research on stem cells is the creation of chimeras, particularly where human stem cells are used in experimental animals, small or large, including primates. These

studies are sensitive particularly where stem cells may contribute to development of brain. If stem cells are likely to contribute to germ cells (if transferred at the blastocyst stage), the resultant animals are prohibited to breed. Such studies have been kept in the restrictive category requiring approval of the National Apex Committee.

CLINICAL TRIALS :

In the field of clinical trials, a specific provision is made for the establishment of facilities for Good Manufacturing Practices (GMP)/Good Tissue Practices (GTP) for preparation of 'clinical grade' stem cells. It would be desirable that such facilities are inspected and accredited to ensure bio-safety. Appropriate standards would need to be laid down for 'clinical grade' stem cells. It can be done either by the National Apex Committee for Stem Cell Research and Therapy or the Drug Controller General of India (DCGI). Some parameters to be tested regarding safety of human embryonic stem cells have been given as an Annexure to the Guidelines. Approval for clinical trial can be given at the institutional level but it shall be reported to the National Committee. Requirement for clearance from the DCGI is envisaged since stem cells are akin to biological drugs. At present the stem cell preparation proposed to be used in the clinical trial may be considered to be an investigational new drug (IND). But later the DCGI will have to evolve a process for licensing manufacture and distribution of stem cells for therapy.

A distinction is made between nationally and multinationally sponsored clincial trials since the latter may raise special ethical and IPR issues which may need to be treated differently. A provision is made for multinationally sponsored trials to require clearance by the respective Government agency for collaborative studies by the National Health Screening Committee in other instances, particularly where transfer of bilogical material to countries abroad is envisaged. This provision may be subject to debate. With appropriate standards laid down for the purpose, the authority may be delegated to an appropriate level in the interest of speedy decisions. A reference has also been made regarding commercialization and patent issues but this is one area where public consensus is needed. Special guidelines have been made regarding precautions to be taken while using umbilical cord blood stem cells (and foetal stem cells) for research and therapy since foetus or the newborn cannot be the consenting partner. The basic principles include safety of the mother and the newborn, quality assurance of the product, and provision of appropriate and correct information to parents while taking their consent for collection of the cells/tissues. This is particularly important since umbilical cord stem cell banks are mushrooming both in the public and private sectors.

For implementation and monitoring of the Guidelines for Stem Cell Research and Therapy two separate Institutional, and National Stem Cell Research and Therapy Committees are proposed. This independent mechanism has been proposed considering highly specialized nature of stem cell research and to assure compliance with the laid down responsibilities of the investigator and the institution involved with stem cell research. One of the important functions of the Institutional SCRT Committee will be to decide whether the research falls in the permissive, restrictive or prohibited categories. This would require special expertise, hence the need for a separate committee.

NATIONAL APEX COMMITTEE ON SCRT

The Institutional SCRT will also be responsible to ensure that the National Guidelines for Stem Cell Research and Therapy are complied which can be reviewed after a few years of operationalization. It has to be noted that the Institutional SCRT Committee does not replace the Institutional Ethics Committee or Animal Ethics Committee, depending on the nature of the proposed studies. National Apex Committee on SCRT, besides evaluating the proposals on research in restricted

areas, shall also serve as a policy laying down body, which would periodically review the National Guidelines in light of new developments in the field. The National Apex Committee shall also serve to register all the stem cell research centres in the country, available stem cell lines in the country, including the newly developed ones, and ongoing clinical stem cell trials in the country. The function of the National Committee will also be to receive periodic reports from the Institutional SCRTs and to provide status of SCRT in the country from time to time. Unlike the public opinion in the west, which is against researches in this field, the public opinion in many eastern countries including India is far more supportive. When ethical jingoism dominate the scenario in the west, eastern country like India is taking rapid strides to reap the benefits of this science to the maximum possible extent. The epics and innumerable religious texts that are in many parts of the world acclaimed as having scientific value, may partly be the reason for the scientific temper inculcated in this part of the world. This openness is reflected in the Indian Department of Biotechnology [DBT]'s statement that India is open to stem cell research, and it promptly made regulatory provisions to control unethical practices, and in fact pioneered in bringing up a widely acceptable legal framework for research. As the globalization of stem cell science is increasingly being shaped by the emerging economies of the Asia/Pacific region, India is constructing models of innovation, policies and patterns of investment that challenge orthodoxies. Within the globalization of stem cell science, India is adjusting to the developing knowledge market in this field and its particular contribution to the likely future of this promising bioeconomy. So India has emerged as one of the major countries involved in Stem Cell research. A country which succeeded in becoming an IT superpower, successful in biotechnology is adding more horsepower to this booming economy of the country. India, having an enviable combination of manpower and infrastructure is also involved in cooperations with other countries thus promoting the free flow of information gained through research and their utilisation in the betterment of Human lives.

DO YOU KNOW ?

Q3. What is the hardest tissue in the human body ?

Q4. What is Tocopherol ?

Q5. The digits on opposite sides of a dice always add up to a particular number. What is the number?

ARE ELECTROMAGNETIC FIELDS OF COMPUTER MONITOR SAFE FOR IMMUNE SYSTEM ?

Upma Bagai and Ved Parkash Sharma*

The main objective of the present study is to analyse the effect of electromagnetic fields (EMFs) of video display unit (VDU) of computer monitor on white blood cells. Laca male mice (6-8 weeks old, weighing 21-25g each) were exposed to electromagnetic field by placing 40 cm away from the computer monitor (VDU) for 23 days. After two weeks of exposure, 6% decrease in total leucocyte count (TLC) of exposed mice was recorded as compared to controls. A comparative differential leucocyte count (DLC) of exposed and control group revealed 5% reduction in monocytes and 16% decline in polymorophonuclear (PMN) cells of exposed group. Contrary to it, number of lymphocytes has been observed to increase by 18% in exposed group. The percentage of live white blood cells in exposed group was reduced by 50% as compared to control mice after two weeks of exposure. Present investigation points to deleterious effects of EMF radiations emitted by VDU of computer monitor on white blood cells.

INTRODUCTION

No habitable area on earth is free of electrosmog to-day due to massive use of electrical and electronics systems. All these systems emit electromagnetic radiations of different frequencies in the environment which can be ionizing in nature. Cell phone and computer are some such devices polluting the environment with electrosmog. Despite benefits, EMF can affect living organisms.[1]

VDU of computer is a device used to convert a digital electrical signal into an image displayed on screen. VDUs are based on CRT technology processes necessary to generate and steer the electronic beam in the conversion of electronic energy to light, which results in the emission of electromagnetic fields and radiation across the spectrum. Various experimental and clinical studies have reported the harmful effects of Electromagnetic field emitted from computer monitor on hematological parameters and immune system.[2] Some epidemiological studies have suggested that prolonged exposure to low energy EMR may be associated with a higher risk of developing cancers, leukemia and brain tumours. A significant association has been reported between a type of brain cancer (glioma) and self reported occupational exposure to ionizing and non-ionizing radiation. EMFs have been observed to cause direct effects on the DNA and affect cell growth and reproduction. Some studies have reported the risk of adverse effects on human reproduction associated of EMF.[3] Histopathological studies have shown a noxious effect of electromagnetic radiations on human spermatogenesis, causing a disorganization of the seminiferous tubules, decrease in spermatid number, an increase in apoptoic and pycnotic cells,

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synaptonemal complex fragmentation and abnormal sex vesicle.[4] Electromagnetic fields emitted from VDU may increase embryo mortality, alter humoral immunity and its hormonal control and reduce body weight. Some studies focus on relation between neurodegenerative diseases and on suicide and depression.[5] Genotoxic effects of EMF emissions have been revealed by the higher frequency of chromatid breaks in individuals exposed to VDU radiations. Bonhomme-Faivre et al.[6] suggested that chronic exposure to a 0.2-6.6 micro T magnetic field can lead to decreased immunological parameters in both humans and mice. Luceri et al.[7] suggested that extremely low-frequency (50 Hz) EMFs do not induce DNA damage or affect gene expression in peripheral human blood lymphocytes. EMR of certain frequencies make alteration of T-lymphocytes and other immune system leading to immuno-suppression. WHO has taken up this issue by international EMF project to highlight and address to public concern about environmental exposure to EMF.[8] Most of the experimental studies have been performed using frequencies much lower than those used in cell phones which are so popular among humans. Moreover cell-towers keep emitting EMF radiation irrespective of usages and exposing majority of vegetation/population. A Few studies explore the ill effects of such wide uses of EMF radiations in the environment. In fact, it is the largest human/bilogical experiment where such a huge population of biotic population is under continuous exposure. An attempt has been made in persent study to observe the effect of EMFs from VDU of computer on leucocytes of Laca mice.

MATERIALS AND METHODS

Six to eight weeks old male Laca mice (n=8, weighing 21-25g each) placed in plastic cage were exposed to electromagnetic radiations by placing 40 cm away from the VDU. Exposure system was Samsung-Syncmaster 753s (17″ digital color monitor). Power density (0.136 μw/cm^2) was measured with 'RF Field Strength Meter' at 40 cm in front of monitor. Computer monitor was switched on for continuous 14 h/day for 23 days. The control group (n=8) was placed in another room. Light, temperature (23 ± 2°C), relative humidity (75%) and noise conditions were identical to both groups. Mice of both groups were given known weight pellet food and measured amount of water at fixed time every day. Control groups were not exposed to any type of radiation emitting device.

Body weight of each mouse (g), feed consumed (g) and water intake (ml) by each mouse/day were recorded. Gain/loss in body weight, food consumed and intake of water per 100g of body weight were calculated regularly at an interval of four days.

Haematological parameters [total leucocyte count (TLC) and differential leucocyte count (DLC)] were measured at days 0, 14 and 23, TLC was done by using Neuber's haemocytometer kit using Turk's fluid [10% (w/v) Gentian violet and 1.5% (v/v) Glacial acetic acid in distilled water]. Differential leucocyte counts of both groups were determined by microscopic examination of Giemsa-stained blood smears.

Pooled blood of exposed/control mice was subjected separately to double denity gradient centrifugation by layering Histopaque 1077 (Sigma) over histopaque 1119 (Sigma) to separate the mononuclear (MN) cells from the polymorphonuclear (PMN) cells using Sigma procedure.[9]

A cell suspension of 2×10^6 white blood cells in 25 μl of PBS was incubated with 2 μl each of acridine orange/ethidium bromide (AO/EB) solution (1 part of 100 μg/ml AO in PBS ; 1 part of 100 μg/ml EB in PBS). Suspension was mixed gently and observed under fluorescent microscope (Leica, Germany) for morphological assesment of live/dead cells.

RESULTS AND CONCLUSIONS

Initially upto 13th day, exposed mice recorded more weight gain as compared to those of control mice except on day 5 and day 14. In 3rd week, the body weight of exposed mice (g%) has been observed to be 50% less than those of control mice (Fig. 1).

In accordance with weight gain, exposed mice consumed more feed & water initially in first two weeks of exposure, following reduction in their feed & water consumption in exposed group than those of the control mice.

A correlation has been found with the amount of food consumption in the control and exposed groups of mice, which indicated that the initial exposure induced to increase its food intake followed by its reduction on increase of the period of exposure.

Another significnt observation recorded in the exposed mice was hyperactivity in behaviour than those of the control mice indicating the induction of irritable behavior in them.

TLC of exposed mice decreased by 6% compared to the mice on 14th and 23rd days respectively. Differential leucocyte count of mice showed approximately 5% reduction in monocytes and 80% increase in lymphocytes in exposed mice than those of the controls 37%±7% neutrophils were recorded in blood smears of the control mice. However, their number decreased to 21±5% in exposed mice (Fig. 2).

White blood cells constitute the defence system of body and their decrease has been associated with different types of infections. Present study points to stimulation of immune system of mice after exposure of EMF radiations as observed in infection with pathogens.

However, differential leukocyte count (DLC) in exposed mice revealed a different story. There was a decrease in number of monocytes (phagocytes) and increase in number of lymphocytes. (Antibody producing cells).

Moreover, despite numbers, the percentage of live mononuclear cells reduced by 50% on day 14 in exposed group. However, on day 23 there was only 25% reduction of live MN cells in exposed group as compared to controls (Fig. 3). Similar trend was observed in number of PMN cells.

However, in present study, lymphocyte number increased in the mice exposed to VDU. These cells are associated with antibody production and cell mediated immunity (B and T-cells) in the body. Continuous rise in the lymphocytes, when there is

no visible infection in the body can lead to many diseases. Our study supports the observations of Bonhomme-Faivre[10] et al. involving decrease in number of neutrophil counts in mice exposed to a color television screen. Thus, this study clearly indicates that the exposure to VDU radiations even for a shorter period of time affects the immune system adversely and makes the body more prone to infection.

Present study shows that majority of white blood cells seen in DLC are actually apoptotic/ dead cells. It further emphasizes the point that immune system is affected because dead cell can't participate in host's defense. Present study points towards the deleterious effect of VDU radiation on our defence system especially WBCs which seem to die under exposure. Although, there are gaps in knowledge on biological and physical effects, and health risks related to EMF, which require additional independent research and appropriate measure to counter these effects.

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MICROBES : THEIR ROLE IN SUSTAINABLE AGRICULTURE

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In developing countries, it is highly essential to produce enough food for the burgeoning population from the vast land. Cost-effective agricultural production process is of utmost importance to make food available at affordable prices. Products of microbial origin can be integrated to curtail a part of the energy-intensive supplies like chemical fertilizers and pesticides. In this context, crop-microbes (s)-soil ecosystem provides a key role in sustainable agriculture which maintains ecological stability and improves environmental quality.

INTRODUCTION

It is estimated that annually 25.1 mt of nutrients (N, P, K) are removed from the soil by the crops. Whereas, only 15.0 mt are supplied from soil sources including organics. The fertiliser production in our country is less than the required amounts. Moreover, the fertiliser industry depends on petroleum reserves which will be almost exhausted. To fill this gap alternative sources of nutrients have to be looked for. Organic wastes and biofertilisers are the alternative sources to meet the nutrient requirement of crops and to bridge the future gaps. Further, knowing the deleterious effects of using only the chemical fertilisers, there will be an environmentally benign approach to Untrient management and ecosystem function. Such integrated approach will help to maintain soil health and productivity[1]. Tiny microorgnisms in the soil play a significant role for sustaining and improving our agricultural production.

Soil micro-organisms like bacteria and cyanobacteria (blue-green algae) have the ability to use atmospheric nitrogen and supply this nutrient to the crop plants. Some of these 'nitrogen fixers' like rhizobia are obligate symbionts in leguminous plants, while other colonize the root zones and fix nitrogen either freely or in loose association with plants. A very important bacterium of the latter category is *Azospirillum*, which was discovered by Johanna Dobereiner, a Brazilian scientist in mid 1970s. The crops which respond to *Azospirillum* inoculation are maize, barley, oats, sorghum, pearlmillet, coarse grains, oilseeds, forage and other crops. *Azospirillum* applications increase grain productivity of cereals by 5-20%, of sorghum, millets like pearl millet and small millets by 30% and of fodder and forage by over 50%. The third group includes free-living nitrogen fixing microorganisms like blue-green algae and *Azotobacter*[2]. Mycorrhizal fungi have also been shown to have agronomical implications[3]. Several microorganisms have been enlisted recently as endophytic organisms which are capable of entering into the host tissues and influence the plant growth directly or indirectly[4].

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ANABAENA-AZOLLA SYMBIOSIS

Azolla, a water fern is commonly seen in low land rice fields and in shallow freshwater bodies. This fern harbours a blue-green alga, *Anabaena azollae*. The *Azolla Anabaena* association is a live floating nitrogen factory using energy from photosynthesis to fix atmospheric nitrogen amounting to 100-150 kg per hectare per year from about 40-60 tonnes of biomass. Reports about its use as a bioinoculant for rice are available[12-13]. An integrated system of rice-*Azolla*-fish has also been advocated[12]. We need to give greater thrust on this system.

The benefits accrued through the use of various bacterial fertilizers are given in Table 1.

Table 1 : Response of Bacterial Fertilisers on Selected Crops.

Biofertilisers Crops	Grain yield (kg/ha)		Increase (kg/ha)	Increase in yield (%)
	Control	Inoculated		
Rhizobium Chickpea	1956	2228	272	13.9
Rhizobium Pigeonpea	1985	2182	197	9.9
Blue-green algae Rice	4175	4650	475	11.4
Azolla Rice	2800	3480	680	24.3
Azospirillum Sorghum	3130	3700	570	18.2
Azospirillum Pearlmillet	1430	1789	359	25.1
Azotobacter Cotton	1254	1339	85	6.8

Source : Venkataraman and Tilka, 1990

CEREAL NODULATION

The *Rhizobium* host plant specificity has been overcome by cellulase treatment of seedling roots in the presence of polyethylene glycol (PEG) prior to inoculation with the bacterium. By this method, clover seedlings which could not normally nodulate with *Rhizobium loti* were made to do so in petri dishes and the nodules so developed were pink and showed nitrogenase activity. Extraneous source of sucrose appears to enhance nodulation in such enzyme treated seedlings. This report by Cocking and co-workers at the university of Manchester, UK prompted them as well as other workers to induce nodulation in other plant species[14].

MYCORRHIZAE

Arbuscular-mycorrhizal (AM) fungi are obligate endosymbionts and are capable of mobilizing unavailable soil phosphorus. It has not been cultured sofar under laboratory conditions. The quality and quantity of AM fungal inocula produced by the pot culture method with the host is subject to variation by external contamination and the inocula are not always free from other microrganisms vitiating experimental results. To overcome these defects, AM fungi have been grown in root organ cultures and in solution cultures. Recently aeroponic and membrane system cultures of a plant and a selected AM fungus have been grown to produce better spore counts on roots. Significant response of crops to inoculation with AM fungi have been reported by several workers. The response are more apparent when AM fungi are used in association with other beneficial microbes like N_2-fixers, P-solubilizers and other plant growth promoting organisms. Savings of fertilizer phosphorus to a tune of 25-30 kg P_2O_5/ ha has been reported by the use of these inoculants[15]. Besides supplying P to plants, these fungi also serve as biocontrol agents against certain soil-borne plant pathogens and can survive under inhospitable soil environments[16]. Lack of suitable inoculum production technology is the major limitation for the commercial exploitation of this system.

PHOSPHATE SOLUBILIZERS

In recent years several strains of P-solubilizing bacteria and fungi have been isolated. The

mechanism of action of these microorganisms involves secretion of organic acids which lower the pH and increase the availability of sparingly soluble P sources. Studies revealed that integrated use of P-solubilizing cultures with low grade rock phosphate can add 30-35 kg P_2O_5/ ha in neutral to mildly alkaline soils[17,18].

MICROBES AS BIOPESTICIDES

The few biopesticide products currently in the global market are strains of *Bacillus thuringiensis,* baculoviruses and entamopathogenic fungi. These biopesticides are now being regulated at national level under existing Insecticides Act.

The microorganisms that are exploited for insect control pruposes are relatively few in our country. The *B. thuringiensis* research and use have gained importance only after the ban was lifted due to their pathogenicity to silkworms. It is now being marketed in our country. However, pests like *Plutella xylostella* and *Heliothis armigera,* that have developed resistance to many pesticides could be controlled by *B. thuringiensis* products[19].

Different strains of *B. thuringiensis* belonging to the orders Coleoptera, Diptera and Lepidoptera against several pests have been reported. There is a possibility of isolation and development of novel indigenous strains of *B. thuringiensis* against the crop pests. Since it is a facultative pathogen, the technique of production through fermentation technology is standardised. Now this bacterium is commercially available in dust, wettable powder and flowable formulations under different trade names. The *B. thuringiensis* products are registered for use in all parts of the world and it amounts to more than 80 per cent of microbial insecticides sold.

The baculoviruses are currently developed for controlling specific insects pests of agriculture and forestry. These are obligate pathogens and are produced using laboratory reared host insects. There are nearly 40-45 insects pests on which viral pathogens are recorded in our country. Out of these, the baculovirus of two destructive pests *Heliothis armigera* and *Spodoptera litura* are being tried on large scale in many parts of our country[20]. The production techniques of these viruses are standardised and few biotechnology firms and private enterpreneurs are manufacturing and selling the product. The field trials on various crops have resulted in adequate control comparable to synthetic chemical insecticides.

Bacillus thuringiensis and baculoviruses molecular biology have led to either development of transgenic crops or recombinant strains with increased efficacy.

The other group of microorganisms of importance are fungi. Besides, they cause natural epizootics, some of these could be exploited for pest control purposes. These fungal biopesticides are *Bequveria bassiana, Metarrhizium anisopliae, Nomuraea rileyi* and *Verticillium lecani*[21]. The tendency of *Trichoderma, Gliocladium, Penicillium* and others which are biocontrol agents to produce potent broad-spectrum antibiotics is well known.

Fluorescent pseudomonads and bacilli are good examples as plant growth promoting rhizobacteria against certain soil-borne root pathogenic fungi like *Rhizoctonia solani, Fusarium moniliforme, Macrophomina phaseolina* and *Collectotrichum falcatum* etc[22].

MICROBIAL NEMATICIDES

So far, only three species bacteria of *Pasteuria* (*P. penetrans, P. thornei* and *P. nishizawae*) have been identified to parastize important group of nematodes.[23] They are obligate and host specific parasites. Of the three species, *P. penetrans* has been observed parasitizing juveniles of root-knot and cyst forming nematodes. The isolates of *P. penetrans* have been found to be very effective in inhibiting the egg production, reducing nematode penetration and improving the plant growth. Reports indicate maximum reduction in multiplication

penetration of *Meloidigyne incognila* on tomato with the use of this bacterial nematicide. Similarly, nematode infestation in pigeonpea by *Heterodera cajani* was greatly reduced with the use of *P. penetrans.*

CONCLUSION

Farmers are increasingly aware of the use of ecofriendly biologicals in plant protection that not only fetches better price but also contributes towards sustainable agriculture. The indiscriminate use of chemical fertilizers / pesticides leads to disastrous consequences of environmental quality as well as the development of crop resistance to chemicals. Therefore, the adoption of ecofriendly practices like Integrated Nutrient Management (INM) and Integrated Pest management (IPM) will lead to achieve proper nutrient availability and control of pests and diseases in crops.

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DO YOU KNOW ?

Q6. In cooking which oil is known as liquid gold ?

Q7. Who actually has blue blood ?

Q8. What is graphene ?

MAJOR NUTRITIONAL PROBLEMS IN CHILDREN

Shyama Choudhary*, Lalita Jha *
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Major problems are caused to pregnant mothers and children, when there are deficiencies in important nutrients like iodine, protein, iron, vitamins A and D. It is essential to provide education not only to medical and healthy personnel, but also to the primary healthcare workers and the community at large. When proper education can be given and dietary habits in the family be modified, pregnant and lactating mothers and infants and young children will get adequate amount of major nutrients to prevent nutritional problems. The magnitude of this problem is high in developing countries where 50% or more of the population lives below poverty line. Hence all concerned with healthcare of the community should be made aware of the major nutrition problem through mass media and education in the school. How to prevent these deficiencies by simple cheap food, preferably home based or community based, should be made part of National Programmes for the preventation of deficiencies of Iodine, Vitamins A and D, protein energy malnutrition and anaemia, in high risk subjects.

INTRODUCTION

The tragedy of nutrition problem is that though it can be prevented., yet it persists in large magnitude. This affects the socio-economic development of the country and leads to social inequality and poverty. Moreover with proper primary healthcare services, particularly for the more vulnerable population in the rural areas and urban slums, timely diagnosis and management of the deficiencies in nutrition can be life saving and prevent disease, caused by nutrition deficiencies.

In India nearly 300 million children constitute pediatric population under the age of 15, of which nearly 130 million are children below 5 years of age. The country has the second largest population of the world with enormous problems of poverty, malnutrition, illiteracy and disease.

Malnutrition does not start after the birth, but it is a continuation of intrauterine malmutrition, which leads to chronic growth retardation. 24 to 40 per cent of babies born in India have low birth-weight because their mothers are undernourished. After the birth of babies, mothers have severe anaemia and other chronic diseases. With such a bad start before life and poor beginning at birth, a child continues to suffer from malnutrition, which is most damaging particularly in the first 5 years of life.

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IODINE DEFICIENCY

Deficiency of Iodine leads to retardation of growth as well as growth of bone and various organs with maximum effect on the brain. There is often damage to the brain with marked or moderately severe mental disorders in babies who suffer from prolonged Jaundice at birth. This is all the more tragic because iodised salt given to them from birth eliminates or reduces markedly the iodine deficiency and its most tragic consequences.

ANAEMIA :

The Government has deployed various strategies to counteract anaemia by some of the following measures :

Iron and folic acid tablets to all children of adolescent age group particularly girls and pregnant mothers in the last 3 months of pregnancy and for about 4 months to lactating mothers.

Fortified Salt with iodine and without iron is also being tried as some of the measures to reduce the incidence of iron deficiency, anaemia particularly in high-risk communities. At the same time treatment of vulnerable mothers and children particularly in the rural areas against parasitic infestations like ankylostomiasis and other worms (need to be a part of routine programme of primary health care system.

PROTEIN ENERGY MALNUTRITION :

Sixty to Seventy percent of the total child population under 5 years suffer from deficiency of total calories including proteins. More than 4 million children have an extreme form of malnutrition.

Some of the adverse effects of PEM on the children are :

ON IMMUNITY

The most important adverse effect of the protein energy malnutrition is on resistance of the body against various infections. Protein energy malnutrition affects the T lymphocytes which are extremely important in cellular immunity and quick recovery from disease like tuberculosis.

ON GASTROINTESTINAL TRACT

PEM affects the border of the mucosa of the intestine, which is important not only for digestion and absorption of the nutrients but also for preventation of infection in the gastrointestinal tract. In a healthy child, the gut have strong immunity against pathogens and allergens, which are prevented from entering to gastrointestinal tract and also provide strong system immunity.

VITAMIN–'A' DEFICIENCY

Vitamin–'A' deficiency is a major health problem as it leads to blindness, which is one of the most crippling and miserable condition for the children under 5 years, but more commonly under 3 years. In India, every year 40000 children become blind due to severe deficiency of vitamin–'A' with additional factors like severe protein energy malnutrition, measles and other diseases, while 40000 are in the process of becoming blind. The Govt. of India has delployed strategy of supplementing vitamin–'A' 100000 units during the last 3 month of pregnancy of high-risk women and 50000 units to the newborns, if the mother have not received Vitamin-'A' during pregnancy, every 6 months from infancy to the age of 5 years.

VITAMIN–'D' DEFICIENCY

It is interesting to know that in spite of plenty of sunlight in India, rickets is a common condition in infancy and in early childhood due to a variety of reasons. Some of the children are dark skinned and hence the ultra violet rays from early morning and late evening sunlight cannot activate provitamin in the skin to active vitamin–'D'.

PRESENT MODE OF FEEDING AND RICKETS

There has been a lot of confusion about breast feeding and rickets. Vitamin–'D' deficiency rickets though more common among babies who are artificially fed without supplements of vitamin–'D', the condition is very common among breast-fed babies who have very rapid growth and hence get frank sign of rickets. Even through vitamin–'D' can pass through human milk, the amount is not adequate enough to prevent overt or manifest rickets.

VITAMIN–'D' AND IMMUNITY

Vitamin–'D' prophylaxis is important and it has been found recently that vitamin–'D' improves immune competence by increasing the number of lymphocytes and increases the number of receptors on the surface of IgG and IgA immunoglobalins.

VITAMIN–'C' DEFICIENCY

Scurvy due to vitamin–'C' deficiency has

become rare in recent years. It is still seen in non-breast fed children who are given cow's or buffalo's milk and are not given supplements of vitamin–'C'. Even now the latent scurvy is not uncommon. It leads to failure to thrive, anaemia, frequent infections, and is an essential supplement food for babies, particularly those who are not breast fed. It may be emphasised that breast milk contains adequate amount of vitamin-'C' to prevent scurvy.

MICRONUTRIENTS

The micronutrients, which appear to be most important, are copper and Zinc.

COPPER

Copper is usually available with the diet along with iron; copper deficiency per se can produce picture deficiency anaemia. High intake of copper from the copper vessels in which water may be stored may be harmful to liver cirrhosis.

ZINC

Zinc has been recognised as an important micronutrient not only for the physical growth and development of baby but also for immunity as zinc deficiency leads to various infections particularly acrodermatites enteropathica.

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ANSWERS TO "DO YOU KNOW ?"

A1. Fear of dancing.

A2. Istanbul.

A3. Enamel.

A4. Vitamin E.

A5. Seven.

A6. Olive oil.

A7. The blood of horse shoe crab is clear blue. This blood is used to make valuable medicine.

A8. It is one atom thick sheet of carbon that stacks with one another to such sheets to form graphite pencil i.e. lead.

SOMETHING TO THINK ABOUT

WHY THE WOODPECKER DOES NOT SUFFER FROM PECKING ?

Hem Shanker Ray

This question has been asked by many in the past and several explanations have been given from time to time. Obviously, the bird does not suffer the vigorous pecking on hard tree trunks, sometimes at a frequency of ten or more per second going like a machine, rather it seems to enjoy what it does. Animals generally avoid doing things that are painful or that inflicts pain on others except when it comes to fighting for food, territory or mating rights. They do not have sports like boxing, kick boxing and free style wrestling. The woodpecker pecks to look for worms under the bark or to build nest and because the tree trunks are generally hard they need to hit hard in each pecking. The anatomy of this painless pecking has been rather comprehensively explained in *National Geographic* (October 2007, p.31).

To understand the problem of pecking, imagine you have beaks and you start pecking a tree trunk or, for that matter, a wooden door. What will happen to you will, of course, depend on how hard you hit and with what frequency and how long. If you persist, then the following things should happen in sequence. First you will develop a terrible headache, then your retinas will get detached and finally you will collapse due to concussion. Yet nothing ever happens to the woodpecker, not even, presumably, a headache.

The journal lists the following explanation regarding how the bird has developed a technique for painless pecking. Its neck muscles are thick and strong, they absorb the energy from collisions with wood. The bird's brain is only a fraction of an ounce and, therefore, it does not hit the inside of the skull as hard as a much larger human brain would. The bird also has an unusual trick, it has a long tongue that wraps around the skull to batten it down when it pecks. There is a membrane that covers the eyes during pecking to keep out wood chips that can be damaging to the eyes. Finally, wood peckers eyes are held in place tightly by bone and surrounding tissue, unlike human eyes which have room to move around within sockets.

Perhaps we should not forget another factor. The woodpecker has practiced pecking over the millenia and it is practice that makes its art perfect.

* Emeritus Scientist, Central Glass and Ceramic Research Institute, Jadavpur, Kolkata–700032. Email : hs_ray@yahoo.com

KNOW THY INSTITUTIONS

NATIONAL CENTER FOR CELL SCIENCE, PUNE

The National Centre for Cell Science (NCCS) has emerged as a leading centre for fundamental research in Cell and Molecular Biology in the past ten years. Initially started as a National Tissue Culture Facility (NTCF) by the DBT in 1986, the mandate and objectives of the centre were subsequently widened leading to the establishment of a full fledged research institute as the National Facility for Animals Tissue of Cell Culture (NFATCC) in 1992. The name and the centre was changed to National Centre for Cell Science (NCCS) in 1996.

The mission of NCCS is to focus on important issues relevant to human health, specifically in the area of regenerative medicine, infectious diseases and lifestyle induced health adversities. The NCCS mandate, in specific, has been ;

- Research and development in modern biology.
- To receive, identify, maintain, store, grow and supply animal and human cell/cell cultures, cell lines of both existing (typed) and newly developed hybrid cells.
- To develop, prepare and supply culture media, other reagents and cell products independently and in collaboration with industry and other organizations.
- To serve as National Reference Centre for tissue culture, tissue banking and cell products, data bank etc. and to provide consultancy services to medical, veterinary and pharmaceutical institutions, public health services and industries in the country.

- To provide and promote effective linkages on continuous basis between various scientific and research agencies industries within the country.
- To participate in programmes conducted for the betterment of society and advancement of science and technology in the country.
- To collaborate with national and international research institutions/ laboratories in the areas relevant to the objectives of the centre.

NCCS functions in a tripartite manner as (i) a National Cell Repository, (ii) a centre for Human Resources Development and (iii) as an R & D centre focusing on the frontier areas of biology.

The National Cell Repository at NCCS is a major service centre for the Indian scientific community from both the public and private sector. Being the only centre in the country that houses human and animal cells, it serves to receive, identify, maintain, store, cultivate and supply animal and human cell lines and hybridoma. The repository has procured cultures from 35 different animals species from various sources within the country and abroad. The majority of the cell lines stocked in the repository have been procured from the American Type Culture Collection (ATCC) and the European Collection of Animal Cell Cultures (ECACC). During the last five years the repository has procured more than 35 new cell lines raising the total culture collection to 1161, of which about 334 are available for distribution to registered users (at present, approximately 510 researchers from 275 institutes are registered with NCCS).

NCCS is committed to making a significant contribution in the area of technical manpower development by way of reaching out to individuals at all levels including students, teachers and researchers in India. Basic training as well as custom-made programs are, and will continue to be, conducted at the institute as well as the user's end. One of the main objectives of the centre is to enhance human resources by conducting symposia, workshops, and individual-specific training programs.

NCCS also attracts students from all over the country to pursue Ph.Ds in frontier areas. The number of research fellows has increased from 46 to 140 in a span of just 5 years. As a part of providing training, the centre invites post graduate students from all over the country every year for training in and exposure to research activities during summer months. NCCS scientists also actively participate in teaching activities at University of Pune and local colleges.

Through its current faculty strength of 26, NCCS conducts cutting edge research activities in areas of stem cell biology, cancer biology, signal transduction, diabetes, insect molecular biology, infection and immunity, chromatin, chromatin architecture and gene regulation.

NCCS primarily focuses on application of stem cells in regenerative medicine through development of major therapeutic strategies for diseases in which there is damage or loss of particular types of cells. The research area involves isolation, cryopreservation and expansion of stem cells, and optimizing the conditions for differentiation into specific cell types. Efforts are also in progress to understand the cellular and molecular mechanisms defining stem cell differentiation and miantenance of the stem cell niche in normal organs.

Cancer is complex disease caused by misregulation of several signalling networks. In order to understand the biology of tumourigenesis and metastasis, NCCS is exploring pathways involving critical players such as Osteopontin, endothelial eNOS, p53, Cyclin D1, transcription factors such as Snail and Slug, and non-coding RNAs. Results from these studies are expected to

provide tools for better therapeutic interventions for cancer treatment.

Recent increase in the incidence of diabetes among Indian population has prompted further intensive research in this area. Efforts at NCCS focus on the machanisms involved in endocrine pancreas development and regulation of insuline biosynthesis. We have generated insulin producing islet-like clusters from pancreatic and non-pancreatic cells, with a potential to be used in cell replacement therapy.

Understanding the molecular mechanisms underlying the host parasite interactions is of paramount importance in developing strategies to combat infections. Scientists at NCCS study the viral evasion of human complement system, regulation of CD40 signaling in host cells by Leishmania, proteintrafficking in Leishmania, Plasmodium replication in red blood cells, HIV biology, and Host-pathogen interactions during Candida albicans infections

Epigenetic regulation of gene expression plays an important role in various cellular processes. Work of NCCS has shown that nuclear matrix associated proteins like SATB1 and SMAR1 regulated global gene expression by chromatin remodeling. Understanding the molecular mechanisms governing their functions in relation to development and tumourigenesis are being explored further.

Recent reports show that the microbial flora within an organism influences the metabolic processes of the host. Using modern methods such as whole genome sequencing and metagenomic analysis, work is in progress to unravel the complex microbial ecosystem in the midguts of humans and insects of clinical importance.

Novel biomolecule mining from hitherto untapped sources such as marine organisms and plants have been performed that would aid in treatments of AIDS, diabetes, malaria and osteoporosis.

NCCS has excelled in pursuing basic research in different aspects of biology, which is reflected in its publications over last several years. The centre has more than 300 publications to its credit in peer reviewed scientific journals in a wide range of areas (of biology) during the period 2000-2008. NCCS has been successful in acquiring many national and international patents as well. In the next phase of NCCS growth, the research area will be broadened to include regenerative, neuro and developmental biology by recruiting additional scientific personnel in these areas.

The centre has been focusing on understanding the molecular details of biological processes that are critical to human growth, development and homeostasis, which are often dysregulated in many diseases. This approach will not only unravel the fundamental mechanisms of important cellular processes but also provide basis for developing strategies for better management of disease caused due to impairment of these functions. NCCS hopes to contribute much more significantly in this direction in the future by coordinating the efforts using diverse research approaches.

Conferences / Meetings / Symposia / Seminars

International Symposium on Environmental Pollution, Ecology and Human Health, (ISEPEHH-2009) July 25–27, Tirupati, India

The symposium organized by Department of Zoology, Tirupati in collaboration with United States Environmental Protection Agency (USEPA), Savaannah State University, USA and DRDE, Gwalior, India.

Contact : Prof. G. Rajarami Reddy, Chairman, ISEPEHH-2009, Department of Zoology, S.V.University, Tirupati-517502, E-mail : gottipolu2002@yahoo.com, isepehh@gmail.com.

International Conference on Emerging Technologiesin Environmental Science and Engineering, October 19-21, Aligarh, India.

The International Conference is organized by Department of Civil Engineering, Z.H. College of engineering and Technology, A.M.U., Aligarh in conjunction with College of Engineering, The University of Toledo, Ohio, U.S.A

Environmental Pollution has emerged as a serious problem in the past few decades The indiscriminate use of chemicals as pesticides has introduced persistant toxicants in the environment. Over the last four decades there have been various advances in the field of engineering. This conference is an effort to bring together the scientists, researchers and engineers ti share ideas and experiences in the field.

The conference themes are :

Water Pollution Control, Wastewater Treatment, Solid and Hazardous Waste Management, Bioremediation, Wetlands, Advance Oxidation Process, Nutrient Removal, Emerging Pollutants, Air Pollution and Control, Noise Pollution and control, Environment Impact Assessment, Sustainable Environment, Biofuels, Modeling Approaches in Environmental Engineering, Life Cycle Analysis, Energy Efficiency, Green Engineering, Alternative Energy Technologies, Carbon di-oxide Capture and Sequestration.

Contact : **Dr. Izharul Haq Farooqui**, Organising Secretary, Dept. of Civil Engineering, Aligarh Muslim University, Aligarh, E-mail icetese 20094@yahoo.com.

S & T ACROSS THE WORLD

CHANDRAYAAN–1

India's first unmanned spacecraft Chandrayaan–1 entered the lunar orbit on November 8, 2008 after ISRO scientists successfully carried out highly complex and tricky manoeuvre, crossing another historic milestone in the country's space programme. For the first time in the history of India, an Indian-made satellite is circulating the Moon after a home-grown satellite broke away from the Earth's gravitational field for the first time and reached the moon. India becomes the sixth country to put a satellite in the moon orbit. The spacecraft has been orbiting the moon in elliptical orbit that passes over the polar regions of the moon. Chandrayaan–1 is further lowered gradually and placed in a circular orbit at a distance of 100 km from the lunar surface. As reported by ISRO, the performance of all the systems on board Chandrayaan is normal.

(PTI Science Service, Nov 16-30, 2008)

FASTER GENETIC DIAGNOSIS

Researchers at the University of Antwerp have developed a new method that enables them to track down the cause of hereditary diseases more quickly and efficiently. By means of this technique, genetic tests that take a long time today, such as screening for hereditary forms of breast cancer, can be carried out much more rapidly. This finding creates new perspectives for tests that are currently expensive and difficult to perform. Now, Dirk Goossens and his colleagues in Jurgen Del-Favero's research group have developed a new method, with which several pieces of DNA can be examined simultaneously, instead of one after the other. They have scucceeded in joining together two powerful existing techniques-multiplex PCR and massive parallel sequencing - making it possible to screen all of person's relevant hereditary matter at one time. With this new technology, the molecular diagnosis of genetic diseases, such as breast cancer, cystic fibrosis, and hereditary deafness, will be carried out much faster and more cost-effectively. It takes 3 to 6 months to receive a result with the techniques that are currently in use. By comparison, the new method produces a result within only a few weeks. Moreover, these tests run much more quickly, and are also very sensitive and provide a more detailed result.

(http://www.bionity.com, Dec 11, 2008)

NEW ANTIBIOTICS TO FIGHT MIRSA BUG

Two experimental antibiotics from the US and Switzerland show promissing results in fighting the methicillin-resistant staphylococcus aureus (MRSA) super bug, researchers said. US pharmaceutical Paratek said a new class of antibiotic it has developed called PTK 0896 was 98 percent effieicent in countering MRSA, 5.0 percent more effieicent than rival Pfizer's Zyvox drug, according to its phase II clinical trial on 234 patients. Switzerland's biopharmaceutical company Arpida said its Iclaprim drug administered intravenously was able to cure MRSA infection in 92.3 percent of patients.

Arpida rcently submitted Iclaprim for approval by the US Food and Drug Administration. Some scientists were, however, not optimistic and said the medical community was still basically powerless against the deadly bug.

(PTI Science Services, Nov 16-30, 2008)

WATERPROOF NANOTECH FABRIC

Lead research Stefan Seeger at the University of Zurich says the fabric, made from polyester fibers coated with millions of tiny silicon filaments, is the most water-repellent clothing-appropriate material ever created. Drops of water stay as spherical balls on top of the fabric and a sheet of the material needs only be tilted by 2 degrees from horizontal for them to roll off like marbles. A jet of water bounces off the fabric without leaving a trace.

The secret to this incredible water resistance is the layer of silicone nanofilaments, which are highly chemically hydrophobic. The spiky structure of the 40-nanometre-wide filaments strengthens that effect, to create a coating that prevents water droplets from soaking through the coating to the polyester fibers underneath.

The new coating is produced in a one-step process, in which silicone in gas form condenses onto the fibres to form nanofilaments. The coating can also be added to other textiles, including wool, viscose and cotton, although polyester currently gives the best results.

(http ://www.newscientist.com, Nov 28, 2008)

THERMIONIC EMISSION MICROSCOPE

Under a CSIR Network Project, the Central Electronics Engineering Research Institute (CEERI), Pilani, has developed a Thermionic Emission Microscope (THEM) for characterization of various types of cathodes, as a part of the developmental activity to meet indigenous needs of microwave tubes. THEM is used to study the spatial emission distribution of electron emitters.

A prototype of THEM has been developed at CEERI and a cathode has been tested. The spatial resolution is 20 micron. Further work is underway to improve the resolution to 2 micron. The instrument is integrated in a chamber, which supports Auger Electron Spectroscopy (AES) and Low Energy Electron Diffraction Microscopy (LEED). The cathode can be tested in-situ using all these analytical tools for a complete characterization.

As for its oepration and interpretation of results, the THEM is reportedly installed in a vacuum analytical chamber and tested using a harmonic cathode of 3.1 mm diameter. The pressure inside the chamber has been maintained at better than 2×10^{-9} Torr. The sample cathode is heated and is brought in fron of the THEM. Initially, a large area picture is obtained at low magnification from which the seelcted area is chosen for data acquisition. The bright areas represent good emission while the dark regions represent poor emission. Emission data acquired is plotted in the form of an Emission Map. The peaks represent high emission while the valleys represent relatively poor emission.

(CSIR News, Aug 15, 2008)

भारतीय विज्ञान कांग्रेस संस्था

14, डा० विरेश गुह स्ट्रीट, कोलकाता 700 017, भारत

THE INDIAN SCIENCE CONGRESS ASSOCIATION

14, Dr. Biresh Guha Street, Kolkata-700 017, INDIA

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Membership of the Association is open to persons with *Graduate or equivalent academic qualification* and interested in the advancement of science in India.

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A) **Presentation of Papers :** A copy of complete paper accompanied by an abstract in triplicate not exceeding one hundred words and not containing any diagram or formula, must reach the Sectional President General Secretary (Hqrs) Latest by *September 15*, each year.

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Note : All Money Orders, Bank Drafts etc. should be drawn in favour of "*Treasurer, The Indian Science Congress Association*". Members are requested to mention their Card No. while making any correspondence to ISCA office.

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* (A Foreign Member means one who is normally resident outside India.)

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Designation :

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(including State, City/Town and Pin code)

Phone No. & e-mail

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Yours faithfully

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- *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.*
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2. Manuscripts should be typewritten on one side of the paper with double spacing. Articles should be written generally in non-technical language and should not ordinarily *exceed 2000 words.* Articles must be understandable by the average enthusiastic readers with some modest scientific background but outside the field. It should not be a review article in a specialised area. Without being too technical, it must also reflect state of the art situation in the field. *A summary* in 50 words should be submitted along with the paper highlighting the importance of the work. *Two copies* of the manuscript complete in all respects should be submitted. The title should be written in capital letters and name(s) of the author(s) should be given along with the Department, Institution, City and Country of each author.

3. Illustration & Tables : The size of illustrations should be such as to permit reduction to about one-third. Legends and captions should be typed on a separate sheet of paper. Photographs should be on glossy paper with strong contrast in black and white. Typed tables should be in separate pages and provided with titles and their serial numbers. The exact position for the placement of the tables should be marked in the script. Authors are specially requested to reduce the number of tables, illustrations and diagrams to a minimum (maximum of 3)

4. References : References to be given on a selective basis, (maximum of 10) and the order of placement should be numerically with (a) name(s) of the author(s) (surname last), (b) name of the journal in abbreviated form according to the 'World list of Scientific Periodicals' and in italics, (c) volume number (in bold) (d) page number and (e) year of publication.

For citations of books the author's name should be followed by the (a) title of the book, (b) year of publication or edition or both, (c) page number, (d) name of publishers, and (e) place of publication.

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14, DR. BIRESH GUHA STREET
KOLKATA–700 017

YOUNG SCIENTISTS AWARD PROGRAMME : 2009-2010

To encourage Young Scientists, The Indian Science Congress Association has introduced a number of awards in different disciplines in January 1981. These awards carry a sum of Rs. 25,000/- besides a Certificate of merit.

1. Applications are invited from members (Life & Ordinary) of the Association who had paid their subscription **on or before May 31, 2009**. The upper age limit of the candidates for the award is 32 years as reckoned on December 31, 2008 (only those born on or after January 1, 1977 are eligible).
2. Four copies of full paper along with four copies of the abstract (not exceeding 100 words) shall have to reach the office of the General Secretary (Hqrs.) not later than May 31, 2009. At the top of each copy of the paper and its abstract, the name of the Section where the paper is to be presented should be indicated. The Sections are : (1) Agriculture and Forestry Sciences (2) Animal, Veterinary and Fishery Sciences (3) Anthropological and Behavioural Sciences (including Archaeology and Psychology, Educational Sciences and Military Science) (4) Chemical Sciences (5) Earth System Sciences (6) Engineering Sciences (7) Environmental Sciences (8) Information and Communication Sciences & Technology (including Computer Sciences) (9) Materials Science (10) Mathematical Sciences (including Statistics) (11) Medical Sciences (including Physiology) (12) New Biology (including Biochemistry, Biophysics and Molecular Biology and Biotechnology) (13) Physical Sciences and (14) Plant Sciences.
3. Four copies of the bio-data of the candidate including full name and address (with Phone, mobile Number, Fax and E-mail) along with the date of birth (duly supported by an attested copy of the certificate), research experience and membership number etc., should be appended to the full paper.
4. Work should have been carried out in India and this has to be certified by the Head of the Institution from where the candidate is applying.
5. The candidate should give an undertaking that the work which is being submitted has not been published in any journal or presented in any other Conference/Seminar/Symposium or submitted for consideration of any award.
6. In case of a paper by more than one authors, the candidate (young scientist) has to be acknowledged by the other author(s) (in terms of a certificate) as having made the major contribution. A Young Scientist could present only one paper in any one Section (and not a second paper with the same or related work in any other Section).
7. Full paper will be assessed for their content and at the most **six** Young Scientists in each section will be invited to make oral presentation of their papers in October at Thiruvanthapuram. The selected scientists will be provided admissible travelling and daily allowances by the ISCA.
8. The final selection for the awards will be done by a duly constituted committee and the awards will be given at *97th Indian Science Congress* to be held at Thiruvanthapuram from January 3-7, 2010.
9. The last date for receiving papers is **31st May, 2009**.
10. *All correspondences should be made to :* **The General Secretary (Hqrs.), The Indian Science Congress Association, 14, Dr. Biresh Guha St., Kolkata-700017. Tel. Nos. (033) 2287-4530/ 2287-5323 Fax No. 91-33-2287-2551, E-mail : iscacal_2004@yahoo.com/iscacal@vsnl.net Website : http://sciencecongress.nic.in**

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