EVERYMAN'S SCIENCE

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COVER PHOTOGRAPHS

Past General Presidents of ISCA

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EDITORIAL

INNOVATIONS IN SCIENCE AND TECHNOLOGY FOR INCLUSIVE DEVELOPMENT

India has used science and technology for social development right from the beginning of planned development. The first time when television programmes were beamed through satellite, it was for education and not just entertainment. No other country perhaps began the satellite-based transmission in this manner. Likewise, green, white and blue revolution essentially happened through application of science and technology along with appropriate policy and institutional interventions. Having said that, it must be acknowledged that a very large part of Indian population feels excluded from the benefits of S&T applications. This feeling of exclusion has to be overcome if the goal of inclusive development in the Decade of Innovation has to be met. Several strategies may include inclusive health, biodiversity based knowledge systems and grassroots innovations, mining the minds of masses for sourcing and sinking ideas, engagement with youth, handlooms and handicrafts innovation and diffusion, indicators of sustainability science, linking modern S&T with traditional arts and other artisanal goods, sustainable land use and climate change, learning from centenarians, mobilizing employment programmes for mapping the mind and resources and extending core support to S&T institutions for social inclusion and development.

The welfare of modern society depends to a large extent on the continuous advancement of scientific understanding of genetics, synthetic biology, neurosciences, material sciences, computer sciences, space science and advances in nanotechnologies. These have provided both a deeper understanding of the grammar of nature and new opportunities for industrial and economic development. Innovative engineering tools and new forms of manufacturing have also shown how to foster better communication, to improve access to information and how to use many resources more efficiently and with reduced environmental impact. These developments offer new opportunities to tackle major societal challenges; enhance economic prosperity and a fair distribution of wealth for all members of society; address climate change, energy and resource scarcity; stimulating advances in healthcare and reducing the impact of aging societies, and many other potential benefits. Knowledge, the development of technical and practical knowhow and the fostering of entrepreneurial spirit. Extraordinary advances have taken place in science new technologies in the last decades.

And yet, if knowledge from scientific research is to become the driver of a knowledge-based economy, how do we ensure that its evolution and development reflect not only a step forward into sustainable development but also meet societal expectations and concerns?

The term "inclusive" illustrates the need to gain public support for the necessary changes in technologies, production processes and societal transformations.

PUBLIC CONCERNS ABOUT SCIENCE AND TECHNOLOGY

In spite of the fact that India's fate depends on a prudent utilization of knowledge, most Indian societies face a growing distance between knowledge producers, users and citizens. Many innovative

applications of science and technology lack significant public support, regardless of what the balance of scientific evidence suggests about the level of risk associated with any specific application. In India people are still strongly in favour of science and its application (e.g. plant bio-technology).

Many people seem to be fixated on the risks and the uncertainties of new developments while commonly underestimating their potential for positive change and economic opportunities. Recent examples of public concerns on innovative products include, inter alia, the internet of things and smart cities (privacy); shale gas (risk assessment); GM food (socio-cultural concerns); dual use and biotechnology (biological threats); synthetic meat and animal cloning for food (safety and cultural concerns); personalised medicine, gene testing and DNA banking (benefits for society and socio-economic inequalities). Other concerns include carbon capture and storage (citizens raise safety concerns over storage facilities in their neighbourhood despite the fact that this technology is regarded as potentially beneficial to fighting climate change); smart energy meters (privacy issues); electronic health records (privacy and autonomy concerns), etc.

At the same time, social change associated with the advancement of knowledge has lost some of its attractiveness for at least two reasons ; due to lack of awareness and gap between scientific innovations and their applications in daily life.

This perception of a gap between those who produce and apply new knowledge and those who will be affected by the positive and negative consequences of these applications is exacerbated by new developments in knowledge generation and in the institutional settings where knowledge generation takes place. Due to the complexity, uncertainty and ambiguity of contemporary knowledge construction, knowledge claims are often contested and leave ample room for different interpretations. Knowledge often increases the experience of uncertainty rather than reducing it. This has led to the problematic belief, allegedly supported by post-modern thinking, that all truth claims are more or less arbitrary and driven by personal or institutional interests rather than factual insights.

CHALLENGES FOR IMPROVING PUBLIC UNDERSTANDING OF NEW DEVELOPMENTS IN KNOWLEDGE AND TECHNOLOGY

A principal challenge in science and technology information and education is therefore to convey a modern understanding of knowledge as a temporary, contested and multi-faceted body of truth claims and, at the same time, provide the assurance that it is the "fuzziness" of contemporary knowledge that leads to a successful and responsible application of knowledge in different societal domains. Uncertain knowledge is by no means arbitrary. It portrays reality much better than traditional deterministic models of the world. Complex models of reality have proven to be more successful than simple and unambiguous images of reality. Even with all the uncertainty and ambiguity associated with new knowledge, the implications of this knowledge have the power to make human interventions more robust, efficient and even sustainable.

Taking risks and exploring uncertain areas is thereby connected to creating new opportunities and to providing economic and social benefits to all. To convey this message about the nature of contemporary knowledge to all parts of the Indian population is first and foremost an educational task. In particular, the science curricula of schools need to be revised to reflect this new understanding of knowledge and provide guidance on how to handle complex questions in an appropriate -but still knowledge-based- manner. These attempts at revising school curricula need to be accompanied by additional efforts to launch programs on public engagement with science, knowledge and society.

To focus on scientific literacy only is not enough. We need to become familiar with the concept that knowledge, technology, organizational structure and patterns of behaviour are closely interwoven and constitute the main fabric of our modern, knowledge-based culture.

Secondly, we need new and effective programs to help people understand the rationale for comparing risks and benefits and for making prudent trade-offs between the different values about which we care.

The empirical analysis of people's attitudes towards changes in their environment, in particular new technological infrastructure, has shown that four factors are crucial for a positive position towards proposed changes:

- *Why do we need change?* This cognitive aspect includes the insight that the proposed change is going to provide the service that is associated with this change and that the concomitant risks can be managed by the societal institutions mandated to deal with these risks.
- *What is in it for me?* People need to be convinced that the proposed changes will have a benefit either for themselves or for others for whom they care. If the common good is invoked it needs to be articulated in the form of concrete advantages to those who will need the services. Abstract promises such as "it will improve the competitiveness of a country" are insufficient to serve this objective.
- *Does this limit my options?* People tend to reject innovations or changes if they believe that their personal range of options or their personal freedom is negatively affected. Loss of sovereignty or the perception of being dominated by others is powerful threats to self-efficacy and autonomy. Innovations such as smart grids or self-learning computers may be good examples where this feeling of being governed by others may easily evolve.
- *Do I feel personally engaged?* Changes always mean interventions into one's way of life. If these changes are seen as something alien in people's neighbourhoods they are likely to be rejected. A good example is the ownership of municipal wind parks. If they are owned by a distant company people often feel that they do not fit into the landscape in which they live. However, if the people in the community own the wind parks themselves, they may feel that these generators seem to match the community's heritage.

Meeting these four conditions for a positive attitude towards planned changes and innovations are moderated by trust. None of the four conditions can be met if there is insufficient trust in the decision making process and in the institutions or organisations that are involved in this process. If people do not trust the authorities even the best education or communication program will fail because the truth claims therein will appear as not credible. Since these claims are, as stated above, uncertain and ambiguous, it is easy to dismiss them as being interest-driven positions disguised as facts. In essence, building trust and confidence in knowledge-producing institutions is therefore crucial for creating the appropriate conditions for a positive general attitude towards knowledge implementation and planned changes.

Dr. Ashok Kumar Saxena

The highest possible stage in moral culture is when we recognize that we ought to control our thoughts.

— Charles Darwin

PRESIDENTIAL ADDRESS

QUALITY SCIENCE IN INDIA—ENDS AND MEANS

Prof. R. P. Bambah

I am very grateful to my fellow scientists for giving me the honour of presiding over this session. Since I am fully conscious of my limitations and lack of achievements, and the greatness of many stalwarts who presided over previous sessions, I have continually wondered how the community could have decided to give me this great honour. However, I have never doubted your generosity and grace. Thank you very much.

The Prime Minister gave the Science Congress the singular honour of releasing the Technology Policy of the Government of India at the 70th session of the Congress at Tirupati last year. The Congress is very conscious of the exceptional regard for the Scientific Community and its Council is devoting a full session to the discussion of the Policy and our response to it.

INTRODUCTION

The focal theme, for this session, as you all know, is "Quality Science in India—Ends and Means". During the discussions in the plenary sessions as well as the sections, I feel, a great deal of thought will be given to problems relevant to the future of Science and Technology in the Country. Although this focal theme was recommended by me in May 1982, before the Tirupati Session, it is a happy coincidence that many of the ideas and suggestions emanating from our discussions could form a suitable response to the Prime Minister's reliance on the Scientific Community for meeting the national Goals for Science and Technology.

Before independence the country had a small number of leading scientists and groups of people working around them. However, one could not say the country had an adequate base of Science and Technology. As a result of the conscious decision by the freedom movement and the first National Government, headed by Jawaharlal Nehru, that the welfare of our people lay in creating in the country a powerful base for Science and Technology, a few years before and more vigorously soon after the dawn of independence, various processes to achieve this objective were set into motion. A network of national Laboratories was set up, young people were identified for training in the leading institutions of the world, Institutes of Technology and Research Institutes were created, and a great programme of development of old and new universities was taken up. After more than thirty years of these efforts India has developed a respectable scientific base. But a time has come when one has to take stock and ask how we are going to use this base, to ask whether this base is adequate for the goals of the Society, which nourishes us, and to task what sort of priorities do we opt for and what sort of inputs and results do we plan for. All these, and other

* General President, 71st Indian Science Congress held during January, 1984 at Ranchi.

questions will, I hope, be discussed in various sessions of the Congress.

As is clear from the title of the Focal Theme, the focus of our discussions will be quality Science. It is very hard to give a precise definition for a concept like this. Perhaps the most viable way would be to follow Bertrand Russell and say Quality Science is what Quality Scientists do, and Quality Scientists are those whom the others accept as such. One could alternately say : I cannot say what Quality Science is, but I do know it when I see it However, when scarce resources are to be allocated. national priorities are to be fixed and long-term plans and commitments are to be made, one cannot get away with this. One will have to give more precise criteria for what is and what is not Quality Science.

FOUR CATEGORIES OF SCIENCE

It is obvious that the quality of every human endeavour is closely related to the objectives of such an effort. No work can be considered to have high quality if it fails badly to achieve the objective it set out to attain. On the other hand any effort, how-so-ever clumsy, that achieves its objectives cannot be dismissed as that of low quality.

Although it is diffcult to draw hard and fast lines between various types of Science, it will be convenient for the purpose of defining their objectives to divide Science into four categories :

1. Basic Seience,
2. Science for Development,
3. Defence Science, and
4. Commercial Science.

I shall take up these categories for further discussion in reverse order.

COMMERCIAL SCIENCE

The objective of Commercial Science is to maximize profits by finding cheaper methods of production, more effective methods of marketing and distribution, or making it possible to manufacture new products which have a high potential for consumption. The appreciation of work in this direction is through patents, royalties, bonuses, or other fiscal rewards. However, in a developing country, where consumer products may be scarce, huge profits can be made by using borrowed or obsolete technology and the incentive for innovative work may be lacking. It may in the short run be quite profitable for an entrepreneur to buy or borrow technology which may be on way out elsewhere, and use it here. Also, the available resources could be monopolised for use in the manufacture of products that meet the demands of an affluent minority at the expense of the needs of the bulk of people, who are not that fortunate. It may, therefore, be imperative for the community in R&D effort meant for developing indigenous capacity for the production at economic costs of the products needed for the welfare of the people. Also, it may be necessary to make commercial sector participate in the development of the infrastructure and industrial climate needed for self-reliance. It may also be necessary to develop a Public Sector for long range research and productive efforts to create an appropriate Industrial Base. The effort in this direction is not to be measured in terms of profits, but in terms of its achieving its goals of self-sufficiency and creation of high level technology. The efforts of the Public Sector in India in India, therefore, should be assessed in terms of its achievement or non-achievement of producing the right type of indigenous capacity rather than monetary profits.

DEFENCE SCIENCE

The objectives of Defence Science are again relatively clear—they are to help produce or adapt weapons and to devise means of communication, management and strategy to achieve maximum defence preparedness. The quality of such an effort is measured in terms of how it helps to equip the Defence forces to meet possible hostile action. Although for a country like India the prospects of

such a dilemma are rather remote, the Defence Scientists in more developed countries could face a crisis of conscience in that they may have to decide whether or not they participate in the preparation of some weapons, whose potential for danger to the human, or other, species is very great. Perhaps it is time for the world community of Scientists to draw up a code under which Scientists of various nations could underake not to take up work in certain areas of destructive Science. The whole world is living in great dread of a nuclear holocaust. It may be quixotic to hope for, but perhaps the scientists could come to a consensus that they will not do any further work on nuclear armaments.

DEVELOPMENT SCIENCE

When we come to Science for Development we come in a sense to the most difficult area. Theoretically every advance in human knowledge has potential for application to development. However, when one is asking for funds for Science for Development needs, one has to fix well-defined short-terms as well as long-term goals and every effort has to be evaluated in terms of those. Here Quality Science is a result-oriented one. Although originality is always admirable, in the Science for Development emphasis has to be on the results. Here one can beg, borrow, buy, or imitate the work done else where and adapt it to the solution of one's own problems. The work on Green revolution, that on Kalpakam reactor, the work that has gone into the ISRO programmes and that on nuclear energy are examples of Quality Science, although at the conceptual level at least one cannot claim much originality for it. In a country like ours, as long as Basic Health services are not available to each village, clean water has not been supplied, link roads not established, or education not provided to each child, scientists working or development cannot afford to be complacent. Work has to be done on problems relevant to our needs. Ideas may be borrowed, but applications have to be need-based. Also, one has to be careful to achieve self-reliance. Otherwise one can find that one's programmes get into jeopardy at very crucial stages. One has to be careful to distinguish between fashionable Science and meaningful Science.

If one borrows ideas or techniques they have to be adapted to one's own use. The development of integrated chips and efficient compact batteries have made it possible to store and retrieve information in compact packages. These are used in the more affluent countries for calculators, watches and video games, etc. Here we could perhaps adapt the technology to evolve small computers, which could store information about symptoms, diagnosis and treatment of common ailments. With such instruments available persons from rural background and high school level education could be trained to use these and act as medical technicians in rural health centres. The computers have, of course, to be programmed to warn the technician if a case gets beyond his capacity. If suitable communication can be established between the computer and more advanced health centres, perhaps proper treatment can be given even without the patient having to be transported to the more developed centre. In short the idea of barefoot doctors could become a viable one and basic health expertise could be provided to rural centres without having to train a large number of doctors who need long and specialised training.

Similarly the problem of the death of secondary and high school teachers with competence to teach Science and other subjects could be solved by producing compact programmes, which could give information to an ordinary teacher on the content and method of presentation of scientific facts and concepts. I believe such programmes are worth the consideration of scientists working in a country like ours, with problems relevant to the large mass of people in rural areas.

BASIC SCIENCE

Just as man cannot live by bread alone; for a better quality of life he needs art, literature, and

music, etc., which appeal to and develop his aesthetic sense and yearning for beauty of form and sound, a society that cares for science only for its utilitarian aspects misses the higher quality of life. Curiosity, love of beauty and urge to explore the uncharted demand aesthetically satisfying neat solutions, attacks on problems that have defied the great, search for insights that unify the diverse, and audacious new ideas that open up fresh vistas. They add lustre, beauty and a higher dimension to the achievements of human mind. These are the compulsions that make the great pursuit of Science for its own sake. The Science is independent of time and space. It has universal standards and has to be judged by standards very different from those of utility or applicability. Here one cannot admire repetitive or second rate work. Here one demands aesthetic solutions, unifying concepts, based on deep insight, and simplification of theories that can come only from deep understanding. This is the area in which old problems, unsolved for generations, stand as a challange to the human mind. Pure Mathematics, Theoretical Physics, Astronomy and recent developments in life Sciences are some of the areas where quality is to be judged by these exacting standards alone.

When Gerd Faltings recently made a major breakthrough on a 300 year old problem by providing the 60 years old Mordell conjecture, the report of *Newsweek* said : "Other than applications within Mathematics, the consequences of Falting's proof are hard to envision. Such an achievement in another Science could promise all sorts of spin-offs, as Einsten's relativity spawned atomic power and Crick and Waston's double helix bred genetic engineering. Falting's proof is an end in itself, an accomplishment the mathematicians liken to the four-minute mile. Falting showed it could be done, scoring a triumph for intellect". Every success like this is a tribute to the human spirit. When a problem, which had resisted the attempts by many great minds in the past over decades or even centuries, gets solved, the whole human race shares in the glory. One does not ask what applications it will have. When physicians look for Grand Unification, they are not motivated by any spin-offs or applications. The reason is a search for aesthetically satisfying simple patterns to explain complicated phenomena. When a Ramanujan appears in a country one does not ask how utilitarians his work is. One feels proud of the human intellect and is greatful to have some thing in common with him.

From an utilitarian point of view also no society can go on living on borrowed knowledge and ideas. For self-reliance one needs a capacity to roll back the Frontiers of knowledge, confidence to blaze new trails and audacity to put forth brave new concepts. A compulsion to explore, to know and to understand is imperative. "Also, no one can predict what scientific developments will provide in their train. It has been reported that President Roosevelt held a meeting in 1983 with some of the best scientists to help him envisage the possibilities. He is reported to have said : 'I want you to tell me what to expect'. After three days of intensive speculation, the scientists failed to predict atomic Power, Radar, Rockets, Jet aircraft and Computers, all of which were to burst upon the world in the next few years. They knew about exploratory research, but could not believe it would produce functional products so soon".

Although Science of this type does not know national boundaries, success in experimental side at least depends on the infrastructure of instrumentation, skills in maintaining sophisticated instruments, and in general the industrial base from which one can draw. In such an endeavour a country like ours has to take stock of its capacity and choose problems for which resources could be provided and for which one could have a natrural habitat, in which such work could be carried on at some advantage relative to better equipped Societies. The Kolar Gold Field experiment is a primary example of such an appropriate choice.

PHYSICAL RESOURCES

In the foregoing I have spelt out my ideas of the objectives of Science of various types. One can use these or other criteria to identify areas or problems worth studying. However, there would not be much hope for successful pursuit if one did not have the physical and human resources needed for the purpose. Therefore, we would have to make a realistic appraisal of the present and potential resources that could be available. It is possible that certain resources are available in such a plenty that meaningful work can be done at a large number of places. But it is more likely that we shall find the resources to be fairly limited. Hence one will have to evolve strategies for their optimal use. This may require the concentration of certain resources at certain selected places where they can be used to the greatest advantage. One may have to establish a culture of sharing in such a way that all scientists capable of suing a scarce facility have reasonable access to it. Even in more developed economics, the establishment of institutions like Argonne National Laboratory or CERN have resulted from a need to share rare and complicated equipment. Various groups of active workers will have to do some hard thinking and evolve methods of deployment and sharing of precious resources. Experience of VEC or regional computer centres could be useful.

It those cases where physical resources needed for imperative solutions are not available, we will need to work out plans for their development on an emergency basis in appropriate time intervals. Since the development of these vital resources may not be commercially profitable, this development may have to be taken up on a priority basis by national laboratories or other public institutions.

HUMAN RESOURCES

Even when one has identified the goals, fixed the priorities and made sure physical resources are available, real progress would be impossible unless one has the most crucial resource, that is human talent. For progress, it is necessary that the country has vital human resources consisting of great talent trained properly and motivated to undertake challenging tasks. In spite of the fact that our methods of training, employment and reward are least suitable for attracting the young to a career in Science, and we have been able to reach only a small segment of our population, it is a fact that a great ideal of scientific competence is available both in the country and among Indians working abroad. Even in a developed country like U. S. A. a sizable number of indian scientists and technologists are working at fairly high levels. It must be admitted, however, that the cases of winners of award like the Nobel Prize or even a membership of the National Academy of Sciences are rare. I would like to devote the rest of my address to the development of the vital human resources needed for scientific work at the highest level.

A DIGRESSION : RESEARCH FELLOWS' PLIGHT

Before taking up this theme in a systematic way I would like to make a degression to emphasise an immediate problem that is causing a great deal of worry to all of us. In recent years there has been a greater awareness of the role of teachers and necessity to give them better status and conditions. The so called U.G.C. pay scales have put the profession in a much better financial position than before. However, in all the calculation one has considered a Lectureship as the entry point and made the emoluments of a Lecturer comparable to those of people joining various other professons. However, the fact of the matter is that for a University teacher or scientist the point of entry is not a Lectureship or equivalent, but a Research Studentship. The age at which most people are inducted into the higher class services in other professions like Engineering, Medicine, Business Administration, Banking and I.A.S., etc. corresponds to that of a person who has recently taken a

Master's degree. This is the age at which a Research Student joins his reseach career. He normally takes four to five years before he becomes eligible for a University Lectureship. At present the emoluments of a Research Scholar are Rs. 600 to Rs. 700 per month (even this amount became available only very recently), while a person joining the other profession at that age gets at least twice that much. By the time the Research Student can take a Ph.D. and join the profession at the initial stage the emoluments of people in other professions have taken another quantum jump. This fact has had its effect in the recruitment of research students, and is bound to affect the quality of our scientists at later stages. We find that the better students are under great pressure from their families, who in our context, need economic support from their children, who at this stage have reached the age of twenty two or more, to opt for jobs in other professions. A Research student, who normally comes from a lower or a lower middle income group, is in no position to contribute to the family needs. Although some dedicated persons take up research studentship even at this handicap, the number of such people is small. Even among these the more enterprising take up Research / Teaching Assistantships in more affluent countries like U.S.A or Canada. The real brain drain occurs at this stage. From their stipends these people are able to contribute a sizable amount in terms of rupees to their family needs. Such scholars tend to stay on in the U.S.A. or Canada and provide a substantial support to their academic or scientific structures. The total effect is that our institutions are getting very few entrants of the right calibre. This is bound to badly affect the future of Science in our country and this is a problem that needs immediate attention. Unless we make the emoluments of a Research Scholar comparable to those of entrants in other professons with similar levels of achievement and age, and make sure their conditions of service stay comparable, any steps taken to improve standards of scientific endeavour will, I am afraid, turn out to be largely futile.

For development and utilisation of talent for scientific work, the obvious areas of concern are

1. Identification,
2. Training and Motivation,
3. Induction into the Scientific Manpower, and
4. Maximal utilisation

TALENT : PATTERN FOR IDENTIFICATION AND TRAINING

Because of the age group involved, immensity of the numbers and the vastness of the area over which they are distributed, one cannot envisage any effective methods of talent search at the primary stage. One can only hope more and more students from various sections will come into the school system. One can also hope the new technology for communication of information will make it possible for the ordinary teacher to use effective methods of arousing the curiosity and power of observation of the students under his charge. At the end of the primary stage those spotted by their teacher to have unusual talents could be brought into contact with experts at the District level, who would be looking for the gifted. As suggested by the U.G.C. Education Policy statement one could start pace setting schools at the District level. Those students who have been identified as gifted could be admitted to these pace setting schools, where enough support will be available, according to the means of the student, to make it possible for him to stay at the school as a resident scholar. Under the general principle that every gifted student has the right to a challenging education, which will not underestimate his potential, the standards of work and expectation at these institutions will be kept very high both for the students and the teachers. As is well known, a student reacts very strongly to the attitudes and capacities of his peer group. One hopes that under the influence of their peers, all equally gifted, these students will be ready for training at its most

excellent. Although healthy competition is desirable, it is a sad fact that the more accomplished of our Indian citizens find it difficult to work together. It is perhaps a consequence of our India citizens find it difficult to work together. It is perhaps a consequence of our examination system where too much emphasis is placed on relative rank and marks. An essential feature of the high level pace setting schools would be development of group activities and group endeavour, whereby one learns to work as a member of a team to achieve the highest potential of the group, as distinct from the individual. Since excellence is the sole motivation, there is no room for any reservations in these schools for the gifted. However, to compensate the more deprived sections for their handicaps resulting from historical injustice, members of the deprived sections could be allowed to compete for entry to these schools at higher age or after further preparation. They would in no case be inducted if they cannot cope with the high level work expected from all. This will not be fair to them and will also lead to a sense of failure and frustration.

After three or four years in such schools these students could compete for entry into the schools for the gifted at the next stage. This competition will, of course, be open to others also and it will be expected that not more than a third or fourth of these students will get into the second level pace-setting schools. Thus, although success in getting entry to the next level school will be a matter of prestige, failure will not necessarily mean lack of normal talent and these students, when they go back to regular schools, will probably be among the best there.

I would like to emphasise here that is not necessary to construct new buildings and infrastructure for these pace-setting schools. Buildings and equipment of some of the existing schools can be used for the purpose with the clear understanding that all staff of the school would be transferred to the general pool and great care will be exercised in the selection of the staff for these schools from the total cadre.

At the end of the Higher Secondary stage, through various processes of search and selection, an adequate number of gifted students in each state will be identified for intensive and demanding training at the University level. Here, as also in other competitions for training for the gifted, children from deprived sections could be allowed to compete at higher age or after higher level normal training, the general principal being that they have to have the same capacity as other students to meet the exacting demands of high training and peer group interaction they will be exposed to.

UNIVERSITY LEVEL

Having come to the stage of university education for the gifted we have naturally to ask what sort of arrangements will be adequate for desirable for them.

Our University system did a tremendous job in absorbing the huge expansion that has taken place in the number of students coming to higher education. Old institutions expanded and new ones came into existence to meet the demands and aspirations of the expanding population desirous of college level education. However, inevitably this has led to the induction of a great deal of mediocrity both in the teaching and the administrative side. Also, the student body is generally not motivated for getting and excellent education. The structure evolved in colinal days to meet entirely different needs had become so soft that it is futile to except any hard and worth-while decision from it. I will say more a little later about the University system as a whole. At the moment I would only like to point out that the type of education that the gifted are entitled to and the country needs will be extremely hard to provide in the existing institutions. Our experience of starting new universities for excellence has also been not too happy. In order to

learn from our mistakes it would be useful to take stock of some of these.

The gifted have a right to interaction with best scholars who are actively engaged in creative work. The faculty should be in the prime of their productive period. It is a sad fact that really creative life of an individual has a limited span, and we have to take account of this. I would like to emphasise again that there is no room for reservation in these institutions. As suggested earlier students from deprived sections could come to these institutions for undergraduate work even after taking a degree elsewhere. Till very recently some of the best undergraduate students who came to Oxford and Cambridge had already taken their degrees in other universities in U.K. or outside. Even Abdus Salam joined Cambridge as an undergraduate after taking an M.A. from Lahore. To compensate for the students from deprived sections coming to the system at a later age, the ages of employment and retirement for them could be suitably adjusted, so that they are not denied the top positions simply because they are older than people senior to them.

In the past when new institutions have been started huge finances have been spent on the construction of buildings, acquisition of basic equipment and library materials, as also on the administrative setup. By the time these steps are taken very meagre financial resources are available for the really important job of getting down to the business of first rate training for first rate people. Also if mistakes are made in the choice of the faculty, or if the people, productive at the time of their selection, cross their peak they stay on in these institutions and generally bring down the level of performance there.

HIGHER INSTITUTIONS FOR THE GIFTED

To take care of the university level training for the gifted I would like to suggest the following steps.

1. We should identify some of the existing institutions where adequate physical facilities like buildings, laboratories, and libraries, etc. are available. These should be taken over at the national level for use for first rate training for the gifted. All the staff, teaching, administrative, class III, class IV should be transferred to a common pool. which I shall describe later.
2. The faculty should be drawn from the total university system on a tenure basis keeping the following principles in view :
   (a) The faculty should consist to creative people at the peak of their creative powers, so that the bulk, say 70 per cent at least, should be in the age group 30 to 45.
   (b) No person will stay in an institution of this type for more than five years at a time; maximum number of times one could come to such an institution being two.
   (c) Twenty percent of the faculty will leave the institution every year to be replaced by fresh entrants. Those who have would revert to the general cadre, and, in exceptional cases, be sent to another selected school.
   (d) Adequate arrangements for housing, and compensation, in addition to the prestige and excitement of working in such a university, will be provided because of the adjustments that have to be made in one's pattern of family life and general living and working, especially for the experimental scientist.
   (e) People who win awards like Bhatnagar medal, Younger Scientists awards of INSA, ISCA, medals of the Indian National Science Academy, and Hari Om Trust etc. will be expected to work on the faculties of these institutes

for some time as a condition of the awards.

(It is clear that providing for tenure appointments in our present system will be full of many problems that will have to be tackled. Perhaps we shall have to think of an all India University service with the pattern of the existing all India services adapted to take into consideration the peculiar nature of the profession, including a need to insulate it from Government control or influence. The idea of a suitable Indian University System may have advantage for the general university set up also and could be helpful in strengthening national integration. I shall enlarge on this later in the address).

3. For academic and administrative decisions compact committees of experts, with 25 percent retiring every year, should replace the cumbersome machinery of Senates, Syndicates, etc. These committees should be authorised to take final decision on matters falling within their competence.
4. It should be desirable that no student takes two consecutive degrees from a single such institution.

I have given a bare sketch which could be filled in; the principal objective being a constantly renewing faculty at the peak of its creativeness and exacting standards of work from the faculty as well as the students.

CAREER OPPORTUNITIES

If the gifted are identified and trained properly, it is natural that all professions requiring leadership would like to have their proper share. For the scientific work, in order that we also have an adequate share, not only should be bring out the excitement and challenge of Science during the training of our students, but the society, as a whole, should also acknowledge its need for skilled scientific manpower by making the scientific career as attractive in material terms as any other. Although some highly dedicated and motivated people will come to the profession, no matter what material terms are offered, the bulk of the scientific endeavour of every society depends on a large number of competent people, who could do equally well in variour professions, and it is important that suitable incentives are provided to attract them. As already pointed out, we should, of course, realise that the initial stage of entry in Science is a Research studentship, and not a Lecturship or equivalent.

CONDITIONS OF WORK

After we have inducted the right type of people, we may still fail to make full use of their potential unless and ethos of cooperative endeavour at highest level has been built up. One would, of course, need equipment, office space, housing, etc. But more than that should be clear realisation that in a Scientific community people of different age groups, experience, skills and capacity have to complement each others' efforts. If this is recognised one could work out suitable administrative mechanism and ways of giving recognition to all the members of a team — the old ones, who are perhaps best equipped to set goals, identify problems, suggest methods, get the necessary equipment and the younger ones, who can provide hard work and fresh ideas and are better able to learn new techniques and absorb new ideas. When a breakthough occurs it should be clear that it could come through because of the total effort of all the individuals involved and not because of the eminence of one person or the brilliance of another.

UNIVERSITIES

I have dwelt in detail on the identification, training, induction and use of the scientific talent with an emphasis on the role of special institutions for the gifted. For the immediate future the creation of such universities appears to be imperative.

However, they will not survive as centres of excellence and will tend to regress to mediocrity if the general university system is allowed to drift.

"The first Indian universities were established more than 100 years ago in imitation of the London University, as it then was. They all began as purely examining bodies and continued to be so for quite some time. Most of the present universities inherited their structure and governance from those universities and have not been able to adapt to the present needs of 'seeking and cultivating new knowledge, of engaging vigorously and fearlessly in the pursuit of truth, of identifying gifted youth and helping them develop their potential to the full"". The so-called autonomy of the Universities is no real autonomy. The object of autonomy in the universities is to make it possible for its members to have a free flow of ideas and to engage in the pursuit of truth free from pressures from the establishment to whom these ideas may appear dangerous. The object is to enable the universities to serve as the "conscience of the Nation", "as a forum for the critical assessment of Society". In our system there is no such possibility. The only effect of this sham autonomy is to give powers, without accountability, to the politicians, posing as teachers, and to executive officers without any ideals. Also, under immediate presures the freedom to take decisions by the University officers and executive bodies, who in the present set up rarely reflect the best academic traditions, has led to many wrong decisions on almost all aspects of the University life—admissions, training, examinations, recruitment, promotions etc. I think it is time to take stock of the ethos in the University systems and try to evolve a new set up free of the present unwidely, expensive and useless structure.

It has been repeatedly pointed out that our system is examination dominated. If one analyses it carefully one finds that the whole system is geared to the determination that large segments of the student body are more mediocre than others. Instead of going through the ritual of holding final examinations, for a student, leaving the educational process, it is enough that the instituton, where he has studied, gives a certificate indicating the courses he has attended and his performance in the examination conducted internally by his teachers. For a job outside or admission to a higher course, the employer or the new institution can give its own test to determine a candidate's suitability for the job or the course he is applying for. In those cases where numbers seeking admission are large, objective type papers, testing only the level of information acquired by the candidates, can be used to sift a smaller number, who could then be given a more comprehensive test. Since various objective type papers could be distributed to the candidate at random and marked mechanically by computers, or even human agents, in a very short time interval, chances of cheating and other malpractices can be reduced. Since the educational process will not be involved in certifying a large number of candidates for degrees, the huge superstructure of Boards of Examinations, controllers of Examinations. Secrecy Sections and what not could be dispensed with and the energy released thereby could be used for more worthwhile pursuits.

Regarding the structure of the Universities, we should seriously give consideration to an All India University Service, insulated from the government through a Commission like the U.G.C, or the U.P.S.C, forming a common pool of academics and academic administrators of the national level. This pool could be used to supply the system so that each institution has both continuity and continuous change, a certain proportion of people being changed every year. This would avoid in breeding as well as our tendency to fall into a rut or divide into factions. The actual academic and administrative decisions would also be taken by compact committees of competent people, a fixed proportion of whose membership is changed every year. The

system will have academic autonomy so that academic decisions are taken by the people engaged in teaching and research themselves. It could have financial autonomy, if funds are allocated on a long-term basis and released periodically, without the Vice-Chancellors having to knock at the doors of the Finance Ministries every few months.

A working group of Universities could fill in various details and look at various alternatives. The Education Commission report is full of rich suggestions. The principal objective should be to evolve a system which would free our universities from mediocrity, parochialism, inbreeding, groupism, politicalisation in the worst sense of our teachers, and tyrannies of small Caesers. Also the system should gather the strength to tell the students that it is their right to get good education and it is the responsibility of the system to provide it to them. A federal system managed by the best of the academics, with a mechanism for continuity and continual change is needed. The system could also be provided with a mechanism to get people from different regions, communities and backgrounds, to work together in the academic process without giving them an opportunity to divide into factions. This would strongly support the goal of National Integration. This may also help realise the objective laid down in the Education Commission report of "concentrating scarce human resources to bring together in face fo face intellectual communion of goodly number of persons of high potentialities who by their contact, dialogue and communication, stimulate each other to put forth their best creative efforts". It will also enable the excellence generated in a selected number of universities to gradually spread to others, both because Faculty members will be continuously moving from the selected institutions to the general system and back, and because the students trained in the few universities for the gifted will eventually become available for participation in the general system. Since these people will have been selected by national processes, the ills resulting from narrow parochialism will be reduced.

CONCLUDING REMARKS

I hope the discussion in the plenary and other sessions will help clarify the direction in which Science in the country should develop. I am particularly looking forward to the session in which some younger scientists will be talking about their perspectives and aspirations. After all the future of Science in the country lies in the hands of the young. I hope it will be possible to set up various task forces with the help of the National Academies and Subject Bodies, to work out specific blueprints for various steps that should be undertaken. The reports of the Binational Conferences organised about ten years ago by the U.G.C. could be very useful.

DEDICATION

I would like to dedicate this address to Professors D.S. Kothari, S. Chowla, A. N. Ganguli, Hans Raj Gupta and A. E. Ross, who have in various ways influenced my attitude to my profession.

THE USE OF MIRACLE MARINE MASS OF ALGAE IN AGRICULTURE

Biswajit Pramanick*, Koushik Brahmachari*, Arup Ghosh** and S.T. Zodape**

Any advance in agricultural system that results in higher production should reduce the negative environmental impact and augment the sustainability of the system. One such approach is the use of bio-stimulants like seaweed extracts, the marine bioactive substances extracted from marine algae in agricultural and horticultural crops for enhancing the effectiveness of conventional mineral fertilizers.

INTRODUCTION

The use of marine algal mass i.e. seaweed has olden times. These, especially the large brown seaweeds were usually used by the coastal people to fertilize the lands adjacent to the sea shore. As wet seaweed is heavy so it could not usually be carried to the distant locations; although once, the Irish people of the West coast and the peasants of Brittany, France and many other countries felt so keen interest that the seaweeds were transported a few to several kilometres away from the sea beach. Commonly, drift *vis-à-vis* beach-washed seaweeds were accumulated, although the Scottish farmers sometimes cut *Ascophyllum* exposed at low tide. Someplace (Cornwall, United Kingdom), it was dug into the soil after mixing with sand and subsequent rotting. Again, somewhere (tropical place like Philippines) it had dual use-large quantity of *Sargassum* after gathering applied wet locally; otherwise, sun dried and transported to other places. Anyway, whatever may be the origin *vis-à-vis* procedures of application nobody could guess the future of seaweeds as miracle marine mass at that time.

The term 'Seaweed' is used incorrectly or misleadingly. So it is practically a perfect misnomer. In reality as these macroscopic, multicellular algae are of benthic marine origin, so from the point of view of their habitat the word 'sea' is correctly incorporated. But the term 'weed' is not at all coined perfectly. We know that weed is a plant entity that proliferates so profusely that it can economically harm its entire habitat like agricultural fields through competitive advantage for light, water, space and plant nutrients over agricultural crops. Even sometimes when a plant grows out of its own place it is called as weed e.g. a rice plant growing in a wheat field is of course weed to the wheat crop. So from the point of view of their nature and habitat they can not at all be called as 'weed'. The fixed and free-floating 'weeds' of the sea are utterly essential to innumerable marine creatures, both as food and habitat, they also provide many benefits to land-dwellers, notably those of human beings. Thus the term 'seaweed' can successfully be substituted to its other names like 'marine algae' or 'sea tangle'. Seaweed or marine algae include some members of red, brown and green algae. As these groups are not thought to have a common ancestor,

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the seaweeds are a polyphyletic group. The appearance of seaweeds somewhat resembles non-arboreal terrestrial plants. Some of such marine algal members are *Kappaphycus, Laminaria, Ulva lactuca, Haliotis tuberculata, Porphyra, Macrocystis pyrifera, Alaria esculenta, Lithothamnion corallioides, Phymatolithon calcareum, Ecklonia, Fucus, Andaria, Bryopsis, Sargrassum, Aschophyllum, Macrosystis, Palmaria, Gracilaria, Manostama, Enteromorpha* etc. The versatile utilities of these marine algae are making them popular day by day. Without mining into detail about the uses of these algae this article will be confined into their importance in the agrarian sector.

SEAWEEDS- WHAT ARE THERE IN IT

Seaweed is amply rich in carbohydrates; the vital building block of plant body and a good food source of many beneficial micro-organisms. Unlike conventional forms of fertilizers, being a wealthy source of natural plant hormones *viz*. auxins, at least two gibberellins, endogenous cytokinins etc; betaines; various vitamins like B_1 (thiamine), B_2 (riboflavin), B_{12} (cyanocobalamin), vitamin E (tocopherol), vitamin K and other growth-promoting substances vitamin C (ascorbic acid) as well as pantothenic acid, folic acid and folinic acid etc; alginic acids; antibiotics[1]; many macronutrients and almost all micronutrients in fully chelated form seaweed fertilizers are especially useful in organic farming. Chelating- a combination of mineral atom with organic molecules, makes microelements available to the crops. Such chelating properties are possessed by the starches, sugars and carbohydrates in seaweed and seaweed products. For this reason, these components naturally combine with iron, cobalt, copper, manganese, zinc and other microelements present in seaweed. Thus these trace elements in seaweed and seaweed products do not settle out even in alkaline soils, but remain available to the crops which need them. Alginic acid is a soil conditioner and the remainders are plant conditioner. All these are found in fresh seaweed or dried seaweed meal as well as liquid seaweed extracts.

SEAWEEDS IN SOIL MANAGEMENT

Soil application of seaweed makes moisture more available to the plant roots and enriches the soil by feeding myriad beneficial microorganisms such as bacteria and tiny fungi necessary for composting. As alginic acid is a soil conditioner, therefore, its presence in seaweed and seaweed products improves the water holding capacity of soil and facilitates formation of crumb structure.

Table-1

Chemical composition of *Kappaphycus* sap[7]

Nutrient	Amount Present	Nutrient	Amount Present
Moisture	94.38 g/100 ml	Iron	8.58 mg/100 ml
Protein	0.085 g/100 ml	Manganese	0.22 mg/100 ml
Fat	0.0024 g/100 ml	Nickel	0.35 mg/100 ml
Crude Fibre	0.01 g/100 ml	Copper	0.077 mg/100 ml
Carbohydrate	1.800 g/100 ml	Zinc	0.474 mg/100 ml
Energy	7.54 Kcal/100ml	Chromium	3.50 mg/100 ml
Sodium	18.10 mg/100 ml	Lead	0.51 mg/100ml
Potassium	358.35 mg/100 ml	Thiamine	0.023 mg/100 ml
Magnesium	116.79 mg/100 ml	Riboflavin	0.010 mg/100 ml
Phosphorous	2.96 mg/100 ml	Iodine	160mg/100ml
Calcium	32.49 mg/100 ml	Kinetin + Zeatin	31.91 mg/L
Indole Acetic Acid	23.36 mg/L	Gibberelin GA_3	27.87 mg/L

Alginic acid in the seaweed combines with metallic radicals in the soil to form a cross-linked polymer with immensely increased molecular weight. Virtually, the salts formed by alginic acids with soil metals swell when wet and retain moisture persistently. Alginates, the sponge-like starches found in seaweeds hold water droplets near the plant roots, making moisture available to the plants. The application of seaweed meal in sloppy land can check washing away of seedlings and nutrients into the ditch by improving the soil structure. It has been found that in exceedingly dry period, cultivation of second crop is possible only with the field application of seaweed fertilizer, other fields dry out completely[2]. This incidence validates the water-retaining capability of seaweed. This in turn leads to better aeration and capillary activity resulting in stimulation of the root systems of plants for further growth and thus stimulates the soil bacteria towards better activity. Acceleration in bacterial activity through the soil application of seaweed meal results in the secretion of organic chemical substances like polyuronides by them that ultimately condition the soil thoroughly. Practically, polyuronides are chemically similar to the soil conditioner like alginic acid having soil-stabilizing properties. Thus seaweed fertilizer provides conditioning agents to the soil in both the ways: alginic acid from the undecomposed seaweed in one hand and polyuronides from the soil bacterial secretion in another hand. As the bacteria involved in the decomposition of any undecomposed seaweeds or organic matter in the soil requires nitrogen to carry out such decomposition, they acquire nitrogen from the available source of the soil. Thus initial scarcity of the available nitrogen in the soil occurs[2]. For this reason, application of seaweed in the field initially diminishes the available nitrogen of the soil and then a noteworthy escalation of it occurs. So it should be kept in mind that during this period seed germination, absorption of nutrients and growth of the plant may be inhibited for one of fifteen weeks of total crop producing period[2].

SEAWEEDS IN CROP PRODUCTION AND ITS HEALTH MANAGEMENT

Soil or foliar application of marine algal products have been discovered to be the effective tools in maintaining proper plant health and escalating the productivity of agricultural crops without creating turmoil to the ecological balance. It has been noticed that pre-sowing or pre-planting treated seeds or seed pieces (propagating plant parts like sugarcane setts, potato cut tubers etc.) will germinate effectively and rapidly resulting in robust root growth and vigorous seedling at early stage. Simultaneously, higher survival rate of seedlings can also be achieved. Cuttings immersed in liquid seaweed solution produce profuse roots. Soaking plant roots in seaweed extract reduces transplant shock and expedites root growth. It prevents bud forming or opening at the wrong times, whereas encourages emergence of additional buds when applied at the very budding stage of plants. Frost and stress resistance, enhanced uptake of inorganic constituents from soil, reduction in storage losses of fruits, expansion of shelf life of fruits *vis-à-vis* vegetables and elongation of life of cut flowers are also some of the exclusive beneficial effects. Let the scientific causes behind these effects be discussed in a nutshell. It has already been discussed that seaweed fertilizers hold various phyto-hormones *viz.* auxins, gibberellins, cytokinins etc. and betaines. They have both growth stimulating as well as retarding functions. Seaweed can play an important role in the production of the plant's own auxins, because the enzymes formed with the help of trace elements from the liquid seaweed fertilizer play an important role in the formation of these auxins[3]. The gibberellins play the pivot role in stimulating of roots, growth, flower initiation, fruit setting, fruit growth, fruit ripening, abscission and senescence when applied exogenously. The cytokinins available in liquid seaweed extract initiate

and activate basic plant growth processes, enhances growth with better vigour through mobilising nutrients in the leaves. They also provide protection from marginal frost and retard the senescence in the plant. The betaines help the plants to fight against osmotic stress. They play vital role in the osmotic processes by helping the plants in increased water uptake even in dry condition. The antioxidants present in seaweed products effectively minimize rather prevent lipid oxidation in agricultural produces, retarding the development of toxic oxidation products, maintaining nutritional quality and prolonging the shelf life of such commodities. The seaweed sprays stimulate metabolic processes in the leaf and so help the plant to exploit leaf locked plant nutrients[2]. Spraying with seaweed extracts may feed and stimulate the bacteria performing photosynthesis at the leaf surface to a considerable proportion. Moreover, plants treated with seaweed products develop a resistance to pests and diseases[4,5]. Owing to the presence of ample amount of soil fungi and bacteria increased production of natural antibiotics occurs in the soil rich in organic matter. These antibiotics taking entry to the plants improve their disease resistance. Seaweed encourages this process and thus holds down the population of plant pathogens[2].

SOME CASE STUDIES

Several on station *vis-à-vis* on farm trials carried out by several universities including Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal in association with Central Salt and Marine Chemicals Research Institute, an institute of Council of Scientific and Industrial Research revealed that seaweed can produce spectacular results in plants. Application of liquid seaweed extracts increased yield by 26%, 39%, 57%, 61% and 20% of rice[6], greengram[7], soyabean[8], tomato[9] and okra[10] respectively. Superior yields after seaweed treatments were measured in watermelon[11], wheat[12], Potato[13] and grape[14]. Besides, quality characters of different crops like cereals, pulses, oilseeds and tuber crops are largely enhanced. It has also been found that use of seaweed as soil treatment substances results in strong and healthy growth *vis-à-vis* disease-resistance.

Thus seaweed extracts, the marine bioactive substances extracted from marine algae, without causing any negative environmental impact escalate the production of different agricultural and horticultural crops, improve crop quality and enhance the use efficiency of conventional chemical fertilizers. Now it has been undoubtedly understood that marine algal mass has sufficient potentiality in agricultural sector and for that reason it is gradually gaining market throughout India and abroad.

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NITROMETHANE : AN EMERGING ALTERNATIVE FUEL ADDITIVE WITH ASSOCIATED CHALLENGES

Shivani Tyagi and Anil Kumar*

Nitromethane is an organic nitro compound slightly viscous and polar in nature. It has wide applications in pharmaceuticals, explosives, fibers, pesticides and as a potential fuel additive because of its high anti-knock property and high combustion rate. Besides, there are associated risks in handling and storing nitromethane. The literature summarises the advantages and challenges associated with nitromethane as an alternative fuel.

INTRODUCTION

Environmental concerns on fossil fuels, smog, volatile organic compounds, carbon dioxide, carbon monoxide, particulates, free radicals and toxic chlorofluorocarbons have shifted the concern on the alternative fuel usage. The present review offers a critical focus on emission reducing potential, cost effectiveness and combination fuel. Due to increased usage and requirements of alternate fuel, search for new energy sources has become a matter of concern. Increased unregulated emission of exhaust gases from automobile has taken us towards global warming threat. As per reports, second generation fuels play a key role in meeting dearth of conventional fuel resources. The technology includes gasification[1], pyrolysis, torrefaction and other thermo chemical routes[3]. Methane and carbon dioxide are the products of second generation fuel, which can range from 60-70% and 30%, respectively. For the process, biomass and municipal waste can be used thereby making this process cost effective[2]. Nitration of methane can be done for the production of nitromethane. Gasification of coal converts it into syngas which can directly be used as fuel[12]. Although the production cost of biofuel is higher than the conventional fuels because of the limitations of up scaling and optimization of the technology. But the most favourable feature of the technology is reduction in green house gases ultimately reducing global warming. To implement efficient biofuel generation technology it is essential to upgrade thermo- chemical and enzymatic routes for biomass conversion. Besides, suitable agricultural area for biomass production is also required.

It is also unrealistic to use alternative fuel sources without modifying conventional engine structure. Emission Factor (EF) should be taken into consideration while designing engine for the machines and automobiles. The most promising propulsion system in vehicles is internal combustion engines and fuel cells with electric engines. There are a number of fuel additives used these days like oxygenates, ether, antioxidant stabilizers, antiknock agents and lead scavengers. It is basically used as fuel performance additives. Nearly four types of fuel additives are present in the market these days' *viz*. diesel fuel additives, gasoline additives, heating oil performance additives and biocids. Along with high performance and energy, these additives offer various other qualities like clean-up, de-hazing,

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anti-foaming, anti-corrosion, detergency, low cost and pleasant smell etc. Nitromethane is one of the fuel additives which are slightly viscous and polar. This is best for open-wheel circuit racing vehicles to maximize their acceleration and speed. It provides as much as 330 MPH speed limits in less than 3.8 seconds. As compared to gasoline and methanol, nitromethane has low energy density. Because of the presence of oxygen atom attached to carbon chains, stoichiometry of methanol and nitromethane is better than gasoline[9].

PROPERTIES OF NITROMETHANE

Nitromethane is basically a simple organic compound having the chemical formula, CH_3NO_2 and belongs to secondary explosives. It is slightly viscous and highly polar solvent. It is liquid at room temperature. Its crystal structure is used as prototype material to study energetic materials because of its simplicity[8]. Nitromethane is also called as 'Nitro' or just 'Fuel' and used in drag racing cars as top fuel. The top fuel is a mixture of nearly 90% nitromethane and 10% methanol. The presence of oxygen in nitromethane makes it better fuel because that does not need extra atmospheric oxygen for combustion. Only 1.7 kg of air is required to burn 1 kg of nitromethane. On decomposition, nitromethane releases carbon monoxide, hydrogen, nitrogen and water. Its laminar combustion velocity lies in the range of 0.5 m/s which is suitable for high speed engines. Its high heat of vaporisation of 0.56 MJ/kg provides cooling of incoming charge that is necessary for maintaining low temperatures. In drag racing engines, this property provides cooling without water jackets. Also the formation of hydrogen and carbon monoxide after combustion comes in contact with atmospheric oxygen at the end of exhaust pipe and is prone to ignition which ultimately leads to flames from exhaust pipe. Nitromethane also has explosive property which can be dealt with the use of ammonium nitrate which would act as oxidizer. It is atomic equivalent of uranium-238 and needs high temperature to burn. C-N bonds are lowest bond breaking moiety in nitromethane which is 59 kcal-mol/l making it reasonably energetic.

PRODUCTION OF NITROMETHANE

Industrial production of nitromethane involves reaction between propane and nitric acid at high temperatures[4]. It is exothermic reaction that produces nitroethane, nitromethane, 1-nitropropane and 2-nitropropane. Free radicals arise *via* homolysis of nitrite ester. These radicals undergo C-C fragmentation reactions and thereafter release mixture of products[3]. There is another inexpensive method to produce nitromethane which involves reactions between sodium chloroacetate and sodium nitrite in aqueous medium.

$ClCH_2COONa + NaNO_2 + H_2O \rightarrow CH_3NO_2 + NaCl + NaHCO_3$

Two patents for the nitration process of methane by vapour phase technique have been granted to Landon. He described the process at 1 and 0.005 sec exposure time under 1 to 50 atmospheric pressure in ferrous and non ferrous reactor. It was suggested that under favourable conditions, 9 moles of methane and 1 mole of nitric acid at 475° C and 0.18 sec exposure time is most suitable for nitromethane yield. This reaction has activation energy of 52 calories[5].

BIO-NITROMETHANE PRODUCTION

Gasification of biomass is one of the alternative methods for the production of nitromethane. Firstly Fischer–Tropsch process converts carbon monoxide into liquid fuel like methanol, acetic acid and mixed alcohols. Methane gas is diluted with mist of nitric acid spray and then pre heated. The ratio of methane, nitric acid and water vapor should be maintained. Heating temperature should be kept between 450 to 550° C in nitration process followed by washing and distillation.

NITROMETHANE AS FUEL AND COMPARISON

Nitromethane has combustion velocity of nearly 0.5 m/s .Typical air/fuel (A/F) ratio for nitromethane is 1.7 : 1 and energy content of 5000 BTU/lb. Gasoline on the other hand has A/F ratio of 12.8 : 1 and energy content of 18,500 BTU/lb. The high vaporization heat of nitromethane provides significant cooling at low temperatures. It generates nearly 2.3 times power in combination with oxygen[9]. Nitromethane decomposes into carbon monoxide, water, hydrogen and nitrogen without additional oxygen. It is used as fuel mixture because of its high power even in the absence of atmospheric oxygen and cause lower combustion speed. On combustion, it produces blue flame and can be used as rocket fuel.

Fuel	Energy content of fuel (BTU/lb)	A/F Ratio
Gasoline	18,400	12.8:1
Methanol	9,500	7.11
Nitromethane	5,000	25.08

Gasoline or petrol is a hydrocarbon mixture which is used in internal combustion engines. It is obtained by fractional distillation of petroleum. It is volatile and stable with Research Octane Number (RON) ranging from 86-95 RON. Specific gravity is between 0.71 to 0.77 Kg/l. Usage in high compression internal engines makes them to auto ignite and cause engine knocking.

Methanol is wood spirit, light, colorless, volatile and flammable liquid. It is polar and has antifreeze properties. It is used in internal combustion engines even in drag racers, supercharged engines and heavy tractor pullers also. Biomethanol has been suggested to be renewable source of fuel.

Dimethylether (DME) can be produced using black liquor gasification[6] and is one of the emerging alternative fuels best suited for petrol engine, diesel engines and gas turbines. It has high cetane number of 55. DME releases comparatively lesser particulate matter and toxic gases in the environment. It has maximum power of 245PS/2000rpm. It is also reported that DME with jatropha biodiesel can improve the performance of engine and reduces the emission level[6]. Disadvantage of DME is that it is less viscous and lubricant property is also low and due to which the engine is more prone for wear and tear.

ASSOCIATED CHALLENGES AND RATIONALE

Nitromethane is one of the more energetic explosive as compared to TNT. As low as 5 gallon quantity of nitromethane has hazardous range of 42 feet[11]. It should be stored at the room temperature at a place having resistance to shock as a result of rough handling. Nitromethane can tolerate high pressures when in contact with nitrogen instead of oxygen since nitrogen cannot support ignition. It is prone to detonation under adiabatic conditions and severe shock[11].

It is highly expensive and difficult to handle. As per regulations issued by the U.S. Department of Transportation (DoT), nitromethane has been classified as flammable liquid. Its exhaust releases nitric acid in vapour form which if inhaled, can cause hypoxic conditions for the driver. Increasing the nitro is directly proportional to increasing the compression ratio which every engine has its own[2]. Therefore, increase in nitro beyond this limit would cause harm to engine. To provide high energy to four stroke engines, three ways can be adopted *viz*. use of supercharges and turbochargers for more air, to increase displacement and lastly to use high energy fuel.

CONCLUSION

Here, authors emphasized on growing concern on upgrading technology for the production of biofuel has emerged with the judicial use of nitromethane as one of the alternative in top gear engines. Some of the conditions should be avoided

while using nitromethane like severe shock conditions, rapid compression and high heating. Nitro should not be distilled. During storage, relief valves with maximum bursting pressure of 100 psi should be maintained. It is recommended that nitromethane should be handled and used by trained personnel only. When compared with first generation fuel like gasoline and methanol, nitromethane is found to be more energy producing and has lesser environmental threat. Nitromethane engine requires upgraded valve and cooling system to tolerate high horse power generated. Therefore, it is recommended to mix 10% nitromethane, with 25% castor oil and 65% methanol- all by percentage volume[12]. There is a need to integrate process, operation and design to improve by-products and effectiveness of the system. Efforts must be done to use combination fuels for better performance.

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ASPIRATIONS AND ACHIEVEMENT OF HUMAN GENOME PROJECT AFTER A DECADE

Rekhamani Das and Jyotsna Devi

A Human genome Project was started in 1990 to sequence the entire human genome. The final draft of HGP was announced in 2003 representing about 90% of the human genome. The project has aided in developing better research and technology, particularly in our ability to sequence genes and better medical management.

With rapid growth of scientific knowledge and experimental method, human began to unravel another mystery, the discovery of the entire genetic make-up of the human body. A genome is an organism's complete set of deoxyribonucleic acid (DNA), a chemical compound that contains the genetic instructions needed to develop and direct the activities of every organism. The human (*Homo sapiens*) genome contains approximately 20,000 – 25,000 genes, stored on 23 chromosome pairs in the cell nucleus and in the small mitochondrial DNA. The haploid human genome contains a total of just over three billion DNA base pairs, which carry the instructions for making proteins. The functions of many genes in the human genome are yet to be fully understood. Thus the Human Genome Project (HGP) was designed to determine the entire sequence and develop the genetic and physical maps of the entire human genome.

A researcher named Renato Dulbecco first suggested the idea of such a project while the U.S. Department of Energy (DoE) was also considering the same project. Worldwide discussion about a HGP began in 1985 and the project was started in 1990[1]. It was coordinated by the U.S. Department of Energy and the National Institutes of Health. During the early years of the HGP, the Wellcome Trust (U.K.) became a major partner. With an estimated cost of 3 billion dollars, sources of funding also came from the National Science Foundation (NSF) and the Howard Hughes Medical Institute (HHMI)[2]. Under the leadership of James Watson, the first director of HGP, it was decided to focus the first 5 years of the HGP on the development of genetic and physical maps of the human genome, which would themselves be of great value to scientists hunting for disease genes. Watson was replaced by Francis Collins in April 1993, and the name of the Centre was changed to the National Human Genome Research Institute (NHGRI) in 1997. Although the United States made the largest investment, important contributions were also made by many countries, including Britain, France, Germany, Japan, China, and Canada. Soon some private biotech companies also entered the race of sequencing. In June 2000, both the private company and the international public sequencing consortium announced the completion of "working drafts" of the human genome sequence[3,4]. Two different papers were published in two different journals *'Nature'* and *'Science'*. HGP was expected to complete in 15 years but technological advancements in DNA

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sequencing method accelerated the expected date of completion to the year 2003. The final paper was published in '*Nature*' in 2003.

The first and primary goal of the HGP was to identify all the approximately 20,000-25,000 genes in human DNA, and to determine the exact sequences of the 3 billion base pairs. This information was to be stored in databases and transfer the related technologies to the private sector. This was thought to aid greatly in associating genes with particular diseases. A second critical goal was to map and sequence the genomes of several important model organisms : specifically, the bacterium *E. coli*, yeast, the roundworm, fruit fly, and mouse. This information would be helpful, because each of these organisms have been used for laboratory studies for decades. Being able to coordinate knowledge of their genomes with cellular and biological processes will certainly help our study of the human genome and its various functions. The third important objective of the HGP was to systemize and distribute the information it gathered. The sequence and map data was to be contained in publicly accessible databases on the Internet. The fourth and the final primary goal of the HGP was to study the ethical, legal, and social implications surrounding the availability of genetic information. Although this information can potentially and dramatically improve human health, it would raise a number of ethical, legal and social issues (ELSI) such as how this information would be interpreted and used, who would have access to it, and how can society prevent harm from improper use of genetic information. To address these issues, the ELSI Program was established as a part of the HGP. A full 5% of all funds appropriated for the HGP were earmarked for these kinds of considerations.

In the IHGSC international public-sector Human Genome Project (HGP), researchers collected blood (female) or sperm (male) samples from a large number of donors. Candidates were recruited from a diverse population. The donor identities were protected, so neither donors nor scientists could know whose DNA was sequenced. Mainly two Competing Strategies were followed to sequence Human Genome, i.e., hierarchical shotgun (Public human genome project) and whole-genome Shotgun (Celera project).

Major findings of the Human Genome Project are :

- The draft represented about 90% of the entire human genome. The remaining 10% of the genome sequences are at the very ends of chromosomes and around the centromeres.
- Human genome is composed of 3200 Mb that is 3.2 billion base pair.
- Approximately 1.1 to 1.5% of genome codes for proteins.
- Approximately 24% of the total genome is composed of introns that spit the coding regions, appear as repeating sequences with no specific function.
- The numbers of protein coding genes are in the range of 30000-40000.
- An average gene consists of 3000 bases, the sizes however vary greatly.
- Repeated sequences constitute about 50% of the human genome.
- Chromosome 1 contains the highest number of genes, while the Y chromosome has the lowest. Chromosomes also differ in their GC content and number of transposable elements.
- Genes and DNA sequences associated with many diseases such as breast cancer, muscle diseases, deafness and blindness have been identified.
- About 100 coding regions appear to have been copied and moved by RNA – based transposition.

- A vast majority of genome (~97%) has no known function.
- Between the human, the DNA differs only by 0.2% or one in 500 bases.
- More than 3 million single nucleotide polymorphism were identified.
- Human DNA is about 98% identical to chimpanzees.

Technology and resources generated by the Human Genome Project and other genomics research are already having a major impact on research across the life sciences. The potential for commercial development of genomics research presents U.S. industry with a wealth of opportunities, and sales of DNA-based products and technologies in the biotechnology industry are projected to exceed. The HGP has stimulated significant investment by large corporations and promoted the development of new biotechnology companies hoping to capitalize on the implications of HGP research.

Achievement of the Human Genome Project are starting to have profound impacts on biomedical research and promise to revolutionize the wider spectrum of biological research and clinical medicine. Scientists have estimated that chromosomes in the human population differ at about 0.2%. Understanding these differences could lead to the discovery of heritable diseases, as well other traits that are common to man[5]. Increasingly detailed genome maps have aided researchers seeking genes associated with dozens of genetic conditions, including Duchenne muscular dystrophy, retinoblastoma, cystic fibrosis, fragile X syndrome, neurofibromatosis types 1 and 2, inherited colon cancer, Alzheimer's disease, and familial breast cancer. Since medical treatments have different effects on different people because of genetic variations such as single-nucleotide polymorphisms (SNPs), the analysis of personal genomes may lead to personalized medical treatment based on individual genotypes[6]. Most analyses estimate that SNPs occur 1 in 1000 base pairs, on an average, in the human genome.

On the horizon is a new era of molecular medicine characterized by looking to the most fundamental causes of disease rather than concentrating on treating symptoms. Rapid and more specific diagnostic tests will make possible earlier treatment of countless maladies. Medical researchers now try to avoid environmental conditions that may trigger disease, and possible augmentation or even replacement of defective genes through gene therapy. DNA-based tests clarify diagnosis quickly and enable geneticists to detect carriers within families. Genomic information can indicate the future likelihood of some diseases[7]. As an example, if the gene responsible for Huntington's disease is present, it may be certain that symptoms will eventually occur, although predicting the exact time may not be possible. Other diseases where susceptibility may be determined include heart disease, cancer, and diabetes.

Understanding the human genome will have an enormous impact on the ability to assess risks posed to individuals by environmental exposure to toxic agents. Scientists know that genetic differences cause some people to be more susceptible than others to such agents. More work must be done to determine the genetic basis of such variability, but this knowledge will directly address the DOE's long-term mission to understand the effects of low-level exposures to radiation and other energy-related agents, especially in terms of cancer risk. Additional positive spin-offs from this research include a better understanding of biology, increased taxonomic understanding, increased development of pest-resistant and productive crops and livestock, and other commercially useful microorganisms.

Scientific American recently reported on what has transpired since the completion of the Human Genome Project ten years ago. When the HGP was first announced, many scientists said that it would

be the key to understanding disease and for developing cures. Ten years later, however, this has not been the case. The human genome project has aided in developing better research and technology, particularly in our abilities to sequence genes. It has also shown us that much of what we once considered junk DNA isn't really junk at all. Perhaps the key to disease is not necessarily found in the common variants in the genetic code. New research is demonstrating that the current view of disease may be too narrow. Data generated in this young program have helped scientists identify the minimum number of genes necessary for life[8]. Additionally, the new genetic techniques now allow us to establish more precisely the diversity of micro organisms and identify those critical to maintaining or restoring the function and interiority of large and small ecosystem. This knowledge can also be useful in monitoring and predicting environmental change.

Though the working draft of the human sequence represents a major milestone, a vast amount of additional work remains to be done to understand its function. It is necessary to complete the sequence analysis by closing the gaps and resolving ambiguities. The genomes of other organisms also will need to be sequenced. Consequences of the HGP for the practice of medicine are likely to be profound. It is hoped that genetic prediction of individual risks of disease and responsiveness to drugs will reach the medical mainstream in the next decade or so. The ethical, legal, and social implications of the research program have already fostered awareness of needs for intervention. Though expectation from HGP was very high, the result after a decade of completion of human genome sequencing is not as that was expected. It has been relatively straightforward, for example, to identify the 20,000 or so protein-coding genes, which make up around 1.5% of the genome. But knowing this, researchers note, does not necessarily explain what those genes do, given that many genes code for multiple forms of a protein, each of which could have a different role in a variety of biological processes.

The biggest effects of the genome sequence have been advances in the tools of the trade: sequencing technologies and computational biology. Technological innovation has sent the cost of sequencing tumbling, and the daily output of sequence has soared. However, cheaper and faster sequencing has brought its own problems. Many researchers feel ill-equipped to handle the exponentially increasing amounts of sequence data. There is also the lack of adequate software or algorithms to analyse genomic data. Thus there is a need for more bioinformatics experts, better software and a clearer understanding of how the differences between genomes influence human health.

After a decade questions arises, who should have access to personal genetic information, and how will it be used? Who owns and controls genetic information? How does personal genetic information affect an individual and society's perceptions of that individual? How reliable and useful is foetal genetic testing? How do we prepare healthcare professionals for the new genetics? How do we prepare the public to make informed choices? How do we as a society balance current scientific limitations and social risk with long-term benefits? Are genetic tests reliable and interpretable by the medical community?

Ten years after completion of the Human Genome Project (HGP), researchers from around the world are still making countless discoveries about the human genome. Still much more remains to be learned about life's operating system in order for genomics to be used productively to improve human health. The new challenge will be to use this vast reservoir of data to explore how DNA and protein work with each other and the environment

to create complex, dynamic living system. Genetic information should be used fairly by insurers, employers, courts, schools, adoption agencies, and the military, among others. Still, much more remains to be learned about life's operating system in order for genomics to be used productively to improve human health. There are still a number of technological, ethical, legal and social obstacles that must be addressed when advances of human research are incorporated into routine practice.

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YOGIC/YOGEVIC ENVIRONMENTALISM

M. Jaya Kumar Jacob

An unprecedented, unconditional love of life and life-forms is the ultimate panacea of deaths presently at global and local levels particularly due to the natural and anthropogenic causes. In Indian scenario human deaths reached high and alarming number recently. With a view to overcome this pathetic situation in India a new nationalistic and socialistic dimension of life-saver concept was identified namely Yogic/Yogevic Environmentalism, which is an unique journey of humans through their interior, exterior and ulterior spheres to reach a green paradise on Earth. This article focuses a symbiotic and synergetic relationship in-between the concepts of ancient yoga and recent environment.

Nature is always our Best teacher forever! Earth is our first Mother. Mother Earth is enveloped by the colorful garments of Environmental layers i.e. air, water, soil and life. The planet Earth is divine because it has enough to satisfy our daily needs and also meant for the goodness of all its living and non-living creatures from the beginning. But today the same planet Earth seems to be very violent dancing burning ball of solar family and become an in a dequate issue due to the irregular natural calamities as well as anthropogenic causes of pollution. The mass extinction of the species today tells us that man and his mindless activities are the main causes of pollution. Breath of life (O_2) and lifespan was shortened and the breath of death (CO_2) is increasing daily (400 ppm). Chemically both carbons and oxygens are very good elements by origin itself in the nature. But their combinations are more dangerous today to the environment causing global warming and ice cap melting. Most of these dangerous combinations are made by the super race of human beings only rather than nature.

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Hence the modern wise man out of his freewill and knowledge spoiling and polluting the life operating and life supporting environment and ecosystems. In the 21st century man is at high risk, becomes a victim and at last scapegoat to the wrath of nature and preparing for the self-extinction.

INDIAN PROBLEMS

Now India is facing critical problems like pollution, over population, poverty, rapes, illegal mining, over exploitation of natural resources, inequality, extremism and terrorism, acid attacks, scams, religious intolerance, caste conflicts, cyber crimes, corruption, farmer's suicides and deadly natural disasters than ever before[1]. These problems are prone to demolish and demoralise our country's democracy. In this pathetic situation, India's prestigious position in the world is utterly damaged and lost its previous name and fame. Here our ancient cultural heritage and civilization are in greater dilemma due to development in Science and Technology and its effects of modernization, industrialization, urbanization and psuedo political aspirations. Modern modifications in every field due to the technological advancement to cope up with the competitive world led us to

unconsciousness, mental agony and severe physical stress. Now India never needs patriots or rebels but only needs enthusiastic common citizens of this country to enable us to overcome these problems to lead peaceful, secured, harmonious and sustainable life[2].

YOGIC LIFE

In this turmoil the Semitic Telugu people of Andhra Pradesh State found a new, cognate and cohesive relationship in-between the Yoga and Environment concepts for the sake of delightful and blissful yogic life. The transformation of traditional yoga into modern conservative environmental ethic is to combat the transgressions of human conscience. Henceforth, freedom is taken to give a reintroduction to the ancient yoga concept which is free from all the previous ambiguities, sarcastic and pandemoniac meanings, mesmerising interpretations, delusions and misunderstandings[3].

YOGA CONCEPT

Yoga concept is resurrected from the death and decay postures of graveyard to regain the Nature's bounty and Earth's Green Glory by this new approach. Its original cultural meaning was exposed now to the entire world for kind consideration and its practice deliberately. We are not required to become austere, ascetics while we are in yoga now. Yoga is the diameter of birth and death Bio-cycle. Scholars like Arabindo Ghosh admitted that the whole life is Yoga when it is usefully spent. Hence Yoga teaches us about living simple and ordinary with extraordinary multi-talents. Yoga made us to live closure to the nature and lead eco-friendly environment with interconnected relationship with the fellow species - i.e. web of life.

Bhavanam Venkatram, the former Chief Minister of the Andhra Pradesh State once rightly said, 'According to the Yogic tradition, a religious teacher who is devoted to his personal god, a tiller of the soil who is wedded to his work and a research scholar who is in pursuit of truth may all be Yogis of the same order depending upon the level of their selflessness and sincerity. The great values of egalitarianism, eclecticism and humanitarianism which Hinduism had always cherished are now slowly giving way to the corrosive influence of authoritarianism preached by the Nazi and Fascist forces, not so much outside the Hindu fold but mainly inside itself. The father of the Nation had to sacrifice his life on the altar of this authoritarian tradition. We are yet to learn lessons from this and we cannot afford to slacken our vigilance in safeguarding our ancient values of sympathy, tolerance and understanding[4].

Henceforth, Yoga is not a lazy or crazy job but it is a divine dynamic duty of natural work division of fruitful, thoughtful and dignified labour of life. It is not a time waste or time pass occupation but it is a timely agenda of life. And it never needs our sixth sense or 3rd eye to open but need our common sense only. Yoga is an eye opener to the world which stimulates the body, mind and soul for divine action[5].

REINTRODUCTION TO YOGA

Yoga is a commonly known generic term for the physical, mental, and spiritual practices or disciplines which originated in ancient India with a view to attain a state of permanent peace of life. In the Semitic Hebrew language *Yogev* means farmer or cultivator that works in the land and causes it to flourish, *yagav* a husbandman, *yaagev* is field, *yegia* means toil, work, labour etc. After all, the word has etymologically nothing to do with the physical bodily exercises or asanaas even in the original Semitic Telugu yoga concept.

The word Yoga is a pure Semitic Telugu word, which was terribly plagiarized, hijacked from the non-aryan cultures by the selfish cultures and had acquired the most irrelevant and limited meaning as yoga – *asanaalu* meaning physical bodily exercises or positions, gymnastics or photogenic images. The scholars are slowly opening their eyes

and admitting that the yoga concept was pre-Dravidian and pre-Aryan.

The Telugu people use the word everyday with multiple applications since it was their cultural word example *Paryavarana-yogam, ud-yogam, santhana-yogam, upa-yogam, samsara-yogam, sam-yogam* etc. Every type of sincere and systematic labour, which eventually bears fruit, is yoga in the original Semitic Telugu Yoga concept. That's why the Telugu people always say *Yoga-abhyaasam* in their typical didactic way to tell the people that Yoga means practice or a systematic cultivation[5].

Therefore it must be correctly understood that any sincere labour that surely bears fruit in any field is Yoga. The ancient Semitic Telugu people groups who had contributed such a rich and fruitful concept to the yoga world must be greatly appreciated. In the ancient Semitic Telugu culture there was no room for laziness or lethargy. That tells us that Semitic Telugu people groups were very hard working, intelligent and scientific. All these labours were called Yogas. All the industrious people were known as Yogis. The hard working and vigorous Semitic Telugu women were known as Yogins. They work along with their husbands unlike the Aryan women who were forced to stay home and worship the husbands.

Any sincere practice in any field is Yoga. Let the ones who misinterpret yoga as mere bodily exercises explain the words like Gnana Yoga in their terms. They even teach that great people like Buddha got his enlightenment by merely sitting under a tree and meditating. If that is the way to acquire knowledge, why do the governments spend billions? Yoga is one thing and these meditation techniques and bodily exercises are another thing. Yoga covers peaceful sustainable lifestyle from 360 degrees.

The real yoga lesson surely gives 100% peaceful lifestyle to anyone who follows its course naturally and sustainably. All the great figures that inspired the world in human history that never and ever mentioned anything about any physical exercises in their biographies had become such great figures by following the natural course of Yoga. And on the other hand many so called mighty Goliaths that developed their physical bodies ended their lives with no peace. When we draw a picture of a person, we need to follow the natural proportions of the parts of the body of a natural person. We cannot draw a huge head to a tiny body and say that he is more intelligent. Life covers all the aspects of natural life and we need to live our total lives in a very living way. Otherwise we miss the mark.

To learn more about the original pre-Aryan Yoga traditions, one can refer to the book[4] in which Sri S. Malayandi, Director, Institute of International Palaeographical studies and historical research, Madras has quoted the eminent linguistic historian S.K. Chattterjee who said, "The North India contributed ritualism without any profound spiritual and mystic approach, but the deeper and more universal things like Yoga and Bhakti came from the Pre-Aryan background". This is the time for Telugu scholars to speak up about their egalitarian Yoga tradition.

THE ENVIRONMENT

The Environment is the sum of all external conditions affecting the life, development and survival of an organism. In real world everything that affects an organism during its life time is collectively known as its environment[6].

The Environmental protection is a burning common problem today and an urgent social need that we all know very well. Day to day Human activities are imbalancing nature and imposing more danger to the environment than by the natural disasters ever before. In this juncture it is proved that human intelligence and technological advancement is under great dilemma and facing

critical threat. From the beginning Man is the main polluter and most dangerous pollutant destroyer of the nature and the healthy environment, who is swallowing fellow species and weak cultures of his own species since from the inception and introduction to this world. No one could be vague in the awareness of his or her own existence. Everything else that hinders the scientific investigation is only good for the itching ears that meddle with the definitions.

More and more people are living in larger and larger cities now-a-days. These high-density communities pose a special challenge in the provision of potable water, clean air, waste disposal, transportation and recreational space. Modern communication has made the world a global village and has raised expectations in most of us for a better life. It will take enormous ingenuity, diplomacy and determination for the world's leaders and those who help them - scientists, engineers, lawyers, economists and managers - to guide development over the next century. To influence governmental policies on these matters, pressure groups have emerged that often put their case forward in a biased and exaggerated way. It is not surprising that on particular environmental issues reports appear that are diametrically opposed to each other. Day to day we are witnessing this in the popular press, radio, televisions, websites and in the scientific field. It becomes difficult at times to know what the truth is and whom we believe[6].

YOGIC ALIAS YOGEVIC ENVIRONMENTALISM

At this juncture the oriental contribution of Yogic alias Yogevic Environmentalism by the Semitic pedigree is the only solution which gives self glory, self satisfaction and universal bliss to the peasant and pedant Indians from their self made problems. This is the journey of unique union, divine destitute destination, utilitarian, unostentatious, unconditional love of life and unprecedented natural ultimatum. The peace loving, life promoting people i.e. Semitic Telugu people of Andhra Pradesh State are ready to share their views and show the path of light to hopeless and helpless innocent farmers (Body) and intelligent Indians (Mind) to rethink and work together to make India as a debt free with greater longivity nation by the evergreen supreme concept called the Yogic alias Yogevic Environmentalism - A password to the Green Paradise[7].

Yogic alias Yogevic Environmentalism is the most effective, simple and best adopted kibbutz model method to observe for the Environmental protection in cities. In this method every human being must work whole-heartedly and wilfully act as Environmental Yogi for the sake of healthy environment. Yogic alias Yogevic Environmentalism is not a billion dollar question, needs any pen, printed or paper but gives peaceful, non-violent, simple act of struggle for healthy existence of life. For a true Environmental Yogi or Yogic Environmentalist, his real human life starts when he starts a useful work and continues forever in the lives of others who enjoy the fruits of his labour.

EMPIRICAL ERGONOMICS

This nationalistic, socialistic way of Yogic life unites us and reminds us that we are all one and we are all belongs to one family, which leads us to oneness. A day is divided into three parts. All these parts are equally shared and exercised by the human Body, Mind and Spirit - Eight hours each. In this divine dignified division of labour every one must do eight hours bodily work (Agriculture), eight hours mind work (Education) and eight hours spiritual work (Rest/Sleep). Likewise experimentally by taking 50 weeks per year and 5 working days in a week as per daywise exercise will lead us to prosperity. Every citizen of this country if strictly follow this daywise and weekly natural nationalistic, socialistic cultural calendar concept proposed by the Yogic/Yogevic Environmentalism definitely India is going to fulfil the natural and environmental

criteria and enjoy the fruits of the divine dignified labour.

THE NATIONALISTIC WAY OF LIFE

There are thousands of agrarian laws developed by the Semitic Telugu sages in the field of agriculture (Sedyam) from the stage of sowing (Natlu) to the stage of cutting or harvesting (Kothalu) which made Andhra Pradesh state as fertile land (Sedya Bhoomi) and food bowl (Annapurna) of India. The original teachings of the first and foremost Telugu luminary Yoga Dakshinamurthy belonging to the egalitarian and humanitarian tradition were mostly in Ancient Telugu language which leads us to the vasudaika kutumbam - Universal family. Thoughout the human history, Yogic techniques have been practiced in the entire world, so it would be unwise to consider Yoga an Indian import. In fact, Yoga with its powerful living tradition for creating a sense of inner peace, harmony, and clarity of mind and body, is absolutely relevant to the modern world. In one family, the husband can be a farmer, the wife can be washer-women, the eldest son can be a barber, the second son can be a potter, the third son can be a metal worker and the fourth son can be a teacher or preacher of religion.To be simpler, with all kinds of needful occupations, the Telugu people are self sufficient and multi talented with arts, music, drama and singing. Whether shepherds, farmers, potter, tailors, tanners, weavers, barbers, washer men, metal workers, all are treated with equal respect[5].

CONCLUSION

In a view to avoid present human problems out of danger one has to think positively to save the life on earth. In this juncture our ancient Yoga philosophy and infant Environment concept if combined and studied together may help us to overcome our present situation. Both these disciplines are having multidisciplinary nature. For example Yoga is all about shaping inner beauty (Body, Mind, and Spirit) and environment is shaping outer beauty (Air, Water, Soil). Hence, if the life incidences coincide with the environmental conditions human life will be more meaningful and reach its ecstasy. Both Yoga and Environment had their own importance today to bring change in human life. Henceforth Yoga and Environment are having utilitarian and egalitarian aspects rather than authoritarian and religious monarchy. Yoga and Environment disciplines had their own layers and ways to promote lifespan in human beings on this earth. Two eyes give a very good sight as well as good vision than one eye[8].

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STROBILURINS : A NEW GENERATION OF NATURAL FUNGICIDES

V. Venkataravanappa, S. Saha, B. Mahesh and A. B. Rai

Strobilurins are an important class of agricultural fungicides extracted mainly from basidiomycetous wood-rotting fungi. These fungicides have novel mode of action. They inhibit mitochondrial respiration by binding at the Qo site as a target. They have a very good redistribution property and they move translaminarly as well as systemically in the plants vascular system and showed broad spectrum activity against a wide range of crop diseases. Besides controlling a range of crop diseases they also show different physiological effects such as growth enhancement, nitrogen assimilation and induced systemic resistance against various diseases.

INTRODUCTION

Fungal diseases represent a major threat to vegetable cultivation in India. To tackle this problem, fungicides are applied and strobilurins are the recent generation fungicides with a global presence. They are natural substances produced mainly by basidiomycetous wood-rotting fungi such as *Strobilurus tenacellus* (Pers. ex Fr.) Singer and *Oudemansiella mucida* (Schrad. ex Fr.) Hohn, or by the gliding bacterium *Myxococcus fulvus*. Strobilurin A, The first QoI molecule, was isolated from liquid cultures of *S. tenacellus* followed by strobilurin B, C, D and so on. Structurally, the basic common feature of all natural strobilurins is the presence of a methyl (E)-3-methoxy-2-(5-phenylpenta-2,4-dienyl) acrylate moiety, linked to the rest of the molecule at the α-position. They have therefore been named β-methoxyacrylates or MOAs. These natural compounds break down rapidly in light and are therefore not reliable for disease control. However, based on their structure knowledge and physical properties further modification was the replacement of the (E)-β-methoxyacrylate group with 2-methoxyimino-acetamide. This modification was marketed under the name metominostrobin which ushered a new era of fungicidal control.

BIOCHEMICAL MODE OF ACTION OF STROBILURIN FUNGICIDES

The fungicidal activity of strobilurin fungicides relies on their ability to inhibit mitochondrial respiration by binding at the Qo site (the outer, quinol oxidation site) of the cytochrome *bc*1 enzyme complex (complex III). This inhibition blocks the transfer of electrons between cytochrome *b* and cytochrome *c*1, leading to an energy deficiency in the fungal cells by halting the production of ATP and ultimately leading to fungal death. The strobilurin target, cytochrome *bc*1, is an integral membrane protein complex essential for fungal respiration. Cytochrome *b*, cytochrome *c*l and the Rieske iron-sulfur protein (ISP) form the catalytic core of the enzyme. The catalytic mechanism, called the Q-cycle, requires two distinct quinone-binding

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sites: Qo, the quinol oxidation site, and Qi, the quinone reduction site (Fig 1).

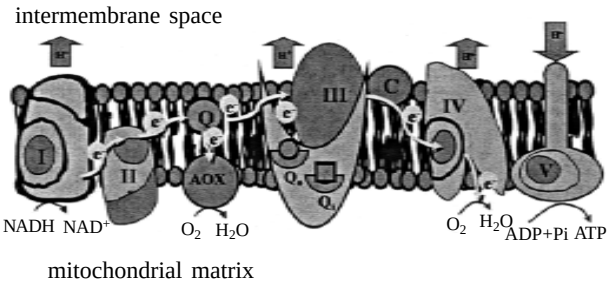

Fig 1. Schematic representation of the mitochondrial electron transport system. I, II, III and IV are the different complexes of the transfer chain. V is the ATP synthase complex. Q is the ubiquinone pool and C is the peripheral protein cytochrome *c*. The arrows inside the membrane indicate the direction of electron flow. The Qo and Qi binding sites of the cytochrome *bc1* enzyme complex (complex III) are delineated by a red circle and a square representing Qo- and Qi-inhibitor molecules, respectively. In some fungi, inhibitors of the respiratory pathway induce the synthesis of alternative oxidase (AOX), and enzyme that diverts electrons at the ubiquinone pool (Q), but generates much less energy.

MOBILITY OF STROBILURINS

The Strobilurins have ''greening effect'', a phenomenon that refers to delayed leaf senescence and an increased grain-filling period which results in an enhanced biomass and yield. The first hypothesis is related to the effects of strobilurins on non-disease-related physiological processes such as chlorophyll and phytohormone biosynthesis, stomatal aperture, water consumption in addition to modulation of nitrate reductase, photosynthetic and plant antioxidant enzyme activities. The second theory is related to the strong preventive activity of strobilurins, preventing the germination of pathogenic, non-pathogenic and saprophytic fungi and thereby preventing the initiation of energy intensive host defence responses. However, neither hypothesis has been unequivocally proven to be responsible for this phenomenon. It is possible that elements of both hypotheses contribute for this phenomenon. It is possible that elements of both hypotheses contribute to these ''unexpectedly positive'' yield benefits resulting from the use of strobilurins[3].

All the Q_0I fungicides exhibit *translaminar movement* (which means ''across the lamina'', or leaf blade). When these fungicides are applied on the surface of the leaf, most of the active ingredient is initially held on or within the waxy cuticle of plant surfaces. Some of the active ingredient ''leaks'' all the way through the lamina and quickly rebinds to the cuticle on the far side of the leaf blade. Thus, the fungicide can be found on both leaf surfaces even if only one leaf surface was treated. Translaminar movement can take one to several days to be fully effective.

Azoxystrobin belonging to the strobilurin groups, moves translaminarly as well as systemically in the plants vascular system. Fungicides such as kresoxim methyl and trifloxystrobin which are not true systemic in the plants but they are redistributed through other mechanisms such as ''mesostemics'', ''quasi-systemics'', or ''surface systemics'' (fungicides move as a gas in the layer of still air adjacent to the leaf surface called the boundary layer and they readily re-bind to the cuticle).

In terms of practical significance strobilurin fungicides are bound tightly to the cuticle, where most of the active ingredient can be found. Even though the active ingredient ''leaks'' into the leaf blade, it has such a strong affinity for the cuticle that it quickly re-binds with it when the chemical reaches the other side of the leaf. Consequently, at any one time, the dose of active ingredient actually present inside the leaf blade may be low, or too low to suppress the growth of fungi within the leaf. Furthermore, for a number of fungal pathogens, the germinating spore (which starts the infection process on the outside of the plant) is more sensitive to

strobilurin fungicides than the mycelium (the fungal life stage found inside the plant). Thus, the best use of strobilurin fungicides is to apply them before infection takes place.

SPECTRUM OF ACTIVITY

Strobilurins have broad-spectrum activity against wide array of fungal diseases caused by ascomycetes, Basidiomycetes, Fungi Imperfecti, and Oomycetes. They are used on a wide variety of crops are mentioned in the table 1.

PROPERTIES OF STROBILURINS :

1. Redistribution properties : The redistribution properties of strobilurins play an important role in delivering its board spectrum activity against diseases. Typically aroung 40% is taken up into leaves with in day after application, and approximately half of which enters the leaf within two hours of spraying[3]. The different redistribution properties of strobilurins are described in the table 2 :

Table 1. Different types of Strobilurins, their mode of action and disease controlled.

	Crops	Pathogenic fungi	Mode of action (MOA)
Azoxystrobin	Cereals, field crops, fruits, tree nuts, Vegetables, turf grasses, and ornamentals	Ascomcetes (eg powdery mildews), Basidiomycetes (eg rusts), Deutoromycetes (eg rice blast) and Oomycetes (eg downy mildew)	Inhibition of mitochondrial respiration, spore germination and mycelial growth
Kresoxim-methyl	Paddy, Chillies	Ascomcetes (eg powdery mildews)	Inhibition of mitochondrial respiration, spore germination, mycelial growth, and spore production.
Trifloxystrobin	Grapes, Pome fruits, Vegetables and ornamentals	Ascomcetes (eg powdery mildews on cucurbits, apple and rose, apple scab, pears black spot)	Inhibition of mitochondrial respiration.
Pyraclostrobin	Cereal fungicide	Ascomcetes (eg powdery mildews), Basidiomycetes (eg rusts), mn Deutoromycetes (eg rice blast) and Oomycetes (eg downy mildew)	Inhibition of mitochondrial respiration.
Metominostrobin	Rice	Sheath blight and blast	Inhibited mycelial oxygen consumption
Orysastrobin	Paddy	Sheath blight and blast	Inbibition of mitochondrial respiration
Picoxystrobin	Wheat, Barley, Oats, Pulses, Oilseeds	Powdery mildews and rust	Respiratory inhibitor
Dimoxystobin	Wheat, Oilseeds	Fusarium spp., Sclerotinia sp, Rhizoctonia sp	Inhibits mitochondrial respiration
Fluoxastrobin	Potatoes, Vegetables, Groundnut, Maize	Ascomcetes (eg powdery mildews), Basidiomycetes (eg rusts), Deutoromycetes (eg rice blast) and Oomycetes (eg downy mildew)	Deters fungal respiration

Table 2. Redistribution properties of different strobilurins

Activities	Azoxystrobin	Trifloxystrobin	Kresonim-methyl	Metominostrobin	Pyraclostrobin	Picoxystrobin
Uptake into leaf	low	very low	low	high	very low	medium
Vapour active	no	yes	yes	no	no	yes
Metabolic stability within the leaf	yes	low	low	no	yes	yes
Translaminar movement	yes	low	low	yes	low	yes
Xylem systemic	yes	no	no	yes	no	yes
Systemic movement of new growth	yes	no	no	yes	no	yes
Phloem mobile	no	no	no	no	no	no

ND = No data is available

2. Growth enhancement/Bioregulatory action : Several strobilurin fungicides are known to cause growth-promoting effects in certain plants. For example kresoxim methyl has a Auxin like activity as summarized in fig 2.

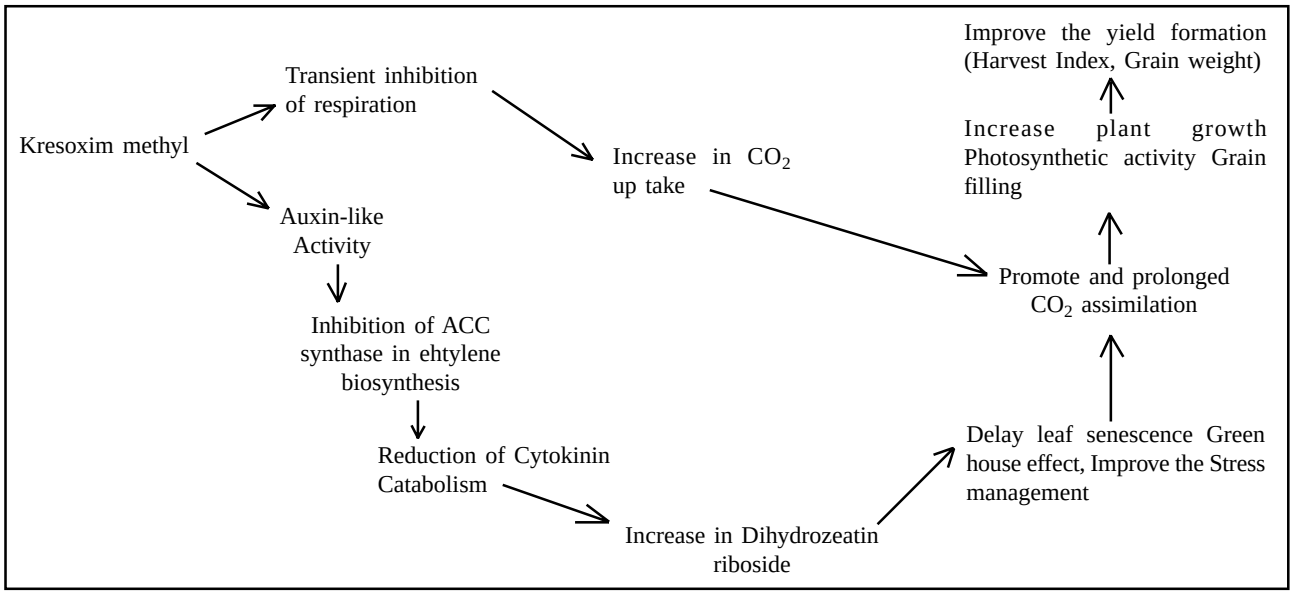

Fig 2. Bioregulatary action of kresoxim methyl in wheat, The arrows represent a direct or indirect effect of carbon dioxide assimilation and the metabolism of phytohormones and possible relation to growth and yield formation process[2].

3. Phytotoxicity : Azoxystrobin are known to cause phytotoxicity on apple and grapes and kresoxim methyl is phytotoxic to certain sweet cherry varieties but not others[1]. Tank-mixes of strobilurins with materials that solubilize he cuticle-oils, like surfactants certain liquid formulations of insecticides which could increase phytotoxicity potential of the strobilurins[1].

4. Resistance : All strobilurin fungicides share a common biochemical mode of action : they all interfere with energy production is the fungal cell. To be precise, they block electron transfer at the site of quinol oxidation (the Qo site) in the cytochrome bc_1 complex, thus preventing ATP formation. The mode of action of the strobilurins is highly sepcific. Of the millions of biochemical reactions that occur in the fungal cell, these fungicides interfere with very specific biochemical site. Thus, these we called site-specific fungicides. This is important because, commonly, just one mutation at that biochemical site (the target site of the fungicide) can result in a fungicide-resistant strain. If such a fungicide-resistant strain occurs, repeated application of strobilurin fungicides can lead to buildup of a fungicide-resistant pathogen subpopulation.

PHYSIOLOGICAL EFFECTS OF STROBILURIN FUNGICIDES ON PLANTS

a. Increase in absorption, reduction and assimilation of nitrogen in the plants

The application strobilurin fungicides can cause a small change at cellular level thereby reducing carbon-di-oxide (CO_2) emission in the treated plants, as the mitochondrial respiration is inhibition. Therefore the treated plant will switch onto the alternative oxidative (AOX) pathway, decreasing cellular levels of ATP and increasing [H^+] in the cytosol therefore resulting in an activation of NADH-nitrate reductase (NR). Activation of NR results, transitorily, in increase in the nitrite levels and may enhance

plant growth when Nitrogen assimilation is a level limiter. There is also an increase in the production of N *via* NR. In addition, for the nitric oxide synthase (NOS) process, there is an alternative pathway of Nitric oxide production in plants, NR product with NADH-nitrite as substrates.

b. Hormonal Changes

The application strobilurin kersoxim-methyl proved to inhibit the biosynthesis of ethylene through reduction of the activity of 1-aminocyclopropane-1-carboxylic acid (ACC)-synthase in plant tissue. This may lead less production of ethylene which may delay in the senescence of leaves and, as a result, to the prolonged photosynthetic activity of green tissue and a better management of stress[4].

c. Retarded senescence

The strobilurins decrease levels of formation of ACC and ethylene and increase the IAA (Indole acetic acid) in plants when they are externally applied on the plants surface. They were breaking down endogenous IAA into L-tryptophan in plants. Low levels of auxin are known to retard leaf senescence and also to favor production by stimulating formation of vascular tissue, division of assimilate formation of floral buds and fruit development[4].

d. Alleviates oxidative stress in plants

Under unfavorable environment conditions or stress conditions, strobilurins are capable of stimulating the formation of radicals, especially of reactive oxygen forms. During stress application, strobilurin will double the activity of antioxidative enzymes, such as superoxide-dismutases, catalases and peroxidases[4].

e. Induction of Resistance of Virus :

It is known plants involvement of mitochondria in the defense response induced by pathogens. The application pyraclostrobin on the plant, the primary mode of action fungicide in the plant is partial and transitory inhibition of the respiratory chain in mitochondria. This leads of activation of the alternative oxidase pathway (AOX), decrease in cellular levels of ATP and increase in $[H^+]$ in the cytosol there by resulting in an activation of NADH-nitrate reductase (NR). The activation of NR may increase the nitrite levels in the plant. There is also an increase in the production of N *via* NR. In addition, for the nitric oxide synthase (NOS) process, there is an alternative pathway of NO production in plants (Fig 3a). This NO in turn will stimulate the production of salicylic acid, which induced expression of the PR-1 genes and accumulation of PR-1 proteins will activate a cellular defense response in tobacco plants infected by TMV[4] (Fig 3b).

CONCLUSION

Strobilurins are an outstanding new class of agricultural fungicides that exhibit excellent properties in a number of areas, including human and environmental safety. Strobilurins fungicides have been extremely popular because of the benefits associated with their use. These fungicides have a very good redistribution property which moves translaminarly as well as systemically in the plants vascular system and showed broad spectrum activity against a wide range of crop diseases. Besides its direct effect on disease management, it also shows diverse physiological effects such as growth enhancement, nitrogen assimilation and induced systemic resistance against various diseases.

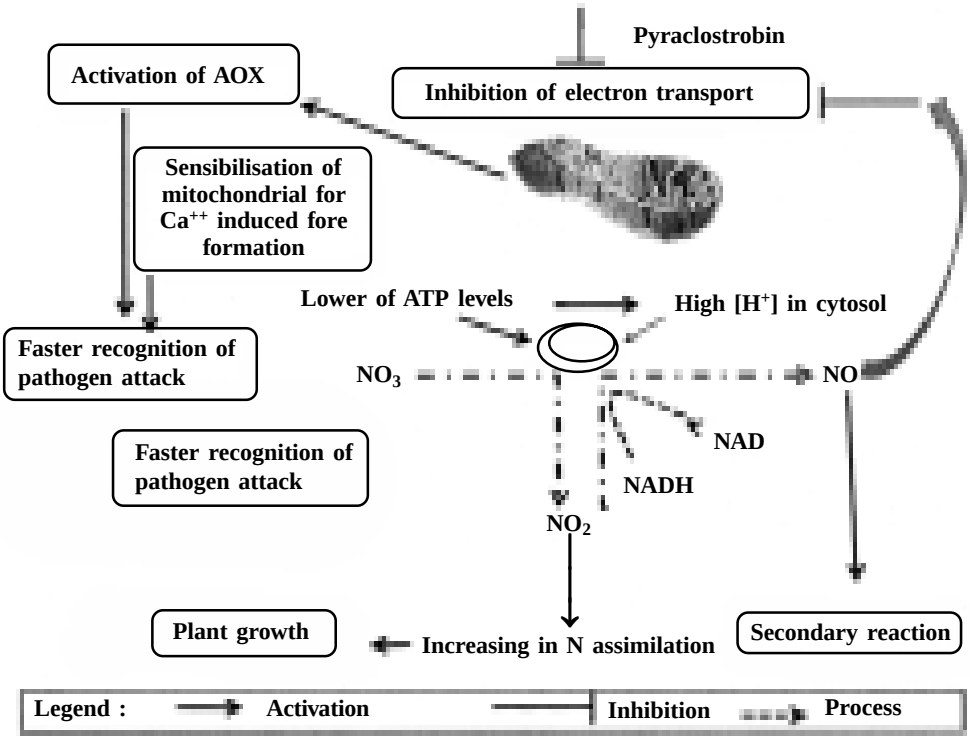

Fig. 3a. Primary biochemical reactions in plant cells.

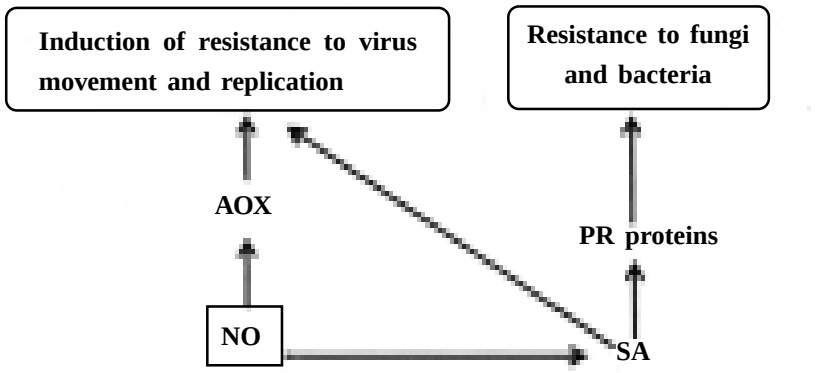

Fig. 3b. Influence of signaling in plant cells *via* nitric oxide (NO).

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EUTROPHICATION : A FORMIDABLE FOE

Amit K. Ghosh and Suman Sarkar

Eutrophication is an environmental hazard symbolizing the menace of water pollution. It is developing as a major global threat by spreading its malignant impact across a wide range of water bodies around the world. In simple words it is an increase in the concentration of nutrients like nitrates and phosphates to such levels that the overall primary productivity triggers a 'bloom' or excessive rise in phytoplankton populations. Several negative environmental effects like hypoxia/anoxia in the water bodies follow this that lead to severe reductions of fishes and other faunal elements.

INTRODUCTION

Eutrophication is a process whereby water bodies like ponds, lakes, slow-moving streams, coastal oceans and estuaries receive high concentration of nutrients, particularly nitrates and phosphates that stimulate excessive plant growth e.g., algae and various problematic plant weeds. This enhanced growth in the aquatic systems reduces dissolved oxygen level in water causing severe mortality. Nutrients can come from a variety of sources such as fertilizer runoffs, nitrogen deposition from the atmosphere, soil erosion and sewage treatment plant discharges. Ecologists use the adjective 'eutrophic' (= well feeding) to describe the biological systems into which there is a high input of otherwise limiting nutrients. On the other hand, 'oligotrophic' (= few feeding) implies the nutrient-deficient condition. Overall, the eutrophic aquatic systems receive relatively high nutrient load and can be clearly distinguished from the oligotrophic ones by their larger average standing crops (not only primary producers) along with other metabolic characteristics.

India was earlier known as the land of sacred rivers but now it is gradually becoming a land of polluted and toxic water bodies. One of the major factors behind this large-scale alteration is eutrophication that is reducing the cleanliness of water bodies in India and also the water systems across the globe. Water pollution is a serious problem in India as several of its surface water resources and groundwater reserves are already contaminated by biological, toxic organic and inorganic pollutants. In many cases, these sources have been declared unsafe for human consumption as well as for irrigation and industrial purposes. This illustrates that degraded water quality can contribute to scarcity of water as it limits its availability for both human use and the ecosystem. The concept of eutrophication was first introduced by C.A. Weber in the year 1907 to depict the nutrient conditions of the flora of German peat bogs[1]. The species requiring higher concentration of essential elements were described as eutrophent and those surviving at low nutrient concentrations as oligotrophent. Few years later in 1919, E. Naumann applied these forms to describe the Swedish water types and their phytoplankton as oligotrophic, mesotrophic and eutrophic based on the concentrations of phosphorus, combined nitrogen and calcium along with the density of associated phytoplankton populations[2].

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Water is not only a valuable economic resource but also the basic essentiality for all the living organisms on the earth. With rising global population, fierce expansion of industries and greater demands in agriculture, consumption of water has increased manifold in the last few years. In the year 1999 the overall demand of water was 552 BCM in India and by 2025 the expected demand will be 1050 BCM[3]. In India, the per capita availability of freshwater has dropped from over 5,000 cubic meters per year in 1947 to less than 2,000 cubic meters per year in 1997[3]. By 2025, this figure will fall further to 1,500 cubic meters per year, which is quite alarming[3]. Six of India's twenty major river basins are already below the water scarcity threshold of 1,000 cubic meters per year, with five more basins to be added to the list within the next three decades[4].

CAUSES OF EUTROPHICATION AND MAJOR LIMITING FACTORS

Natural eutrophication occurs over centuries as water bodies like lakes progressively get filled in with sediments. There are two different ways of entry of effluents causing eutrophication : canalized flow and the natural flow from drainage areas. Both need a special approach to work out the theoretical basis and practical measures for controlling anthropogenic eutrophy[5,6]. Urban sewage and industrial effluents are delivered into the rivers. This practice causing eutrophication has always been the primary one. Efforts are being made and techniques are being developed for controlling this menace. One of them is to set up a device for blocking the access of eutrophic matter to a water body by improving the facilities for sewage treatment and purification of industrial effluents. The conventional methods however fail to eliminate mineral compounds of nitrogen and phosphorus from waste waters, although numerous hydroengineering techniques are being developed (fabricated) for dealing with this problem.

Although related to nutrient enrichment in general, basic cause of eutrophication is an imbalance of nitrogen and phosphorus load with that of silica[7]. The main causes of eutrophication can be summarized as :

(1) Natural run-off of nutrients arising from the weathering of rocks and soil,

(2) Run-off of inorganic fertilizers (applied in agriculture) containing compounds of nitrogen and phosphorous,

(3) Run-off of organic manure from farms containing nitrates, phosphates and ammonia,

(4) Run-off from erosive activities following construction, mining activities and poor land use,

(5) Discharge of detergents rich in phosphates,

(6) Discharge of partially treated or untreated sewage containing nitrates and phosphates, and

(7) Experimental discharge of nutrients in water systems for aquaculture and ecological studies.

Aquatic ecosystems can be polluted in a number of ways but mostly by agents that are not produced under the natural conditions, e.g., powdered wastes, toxic chemicals like lead and mercury compounds, hot effluents like hot water, radionuclides (e.g., Thorium and Uranium Series Radionuclides) etc. Pollution can destroy the natural habitats for algal growth e.g., by blanketing the sediments and/or aquatic macrophytes like *Pistia* sp., *Spirodela* sp. and *Lemna* sp. with silt, coal mining wastes, wood pulp wastes etc. If the sediment load remains suspended for considerable time in the water it will reduce light penetration to the extent that the growth of the other members of the aquatic ecosystem in question is retarded or prevented. A case of depression in carbon fixation productivity has been evidenced in freshwaters where light is reduced by

pulp-mill effluents. The species present before and after were similar, but fixation was reduced from 338-369 mg carbon m^{-2} day^{-1} to 24-29 mg carbon m^{-2} day^{-1} that showed the considerable impact of eutrophication[8].

Nitrate is an important factor in controlling the occurrence and abundance of phytoplankton. An overall increase in nitrates in the aquatic ecosystems may be attributed to wastes, surface run-off water and nitrification of ammonia. Some observations till date have shown loss in the concentration of nitrates which may be due to the incomplete oxidation of free ammonia. When dissolved oxygen increased, nitrates also have shown direct relationship with pH, sulphate, calcium and phosphorus[9,10]. The maxima of nitrates in monsoon have been explained on the assumption that suspended particles might have accelerated the process of nitrification by providing a larger surface area for bacterial activity[8,11].

The quantities of phosphates observed in the eutrophication analyses vary a lot at the global scale, mainly due to the differential rates of death and decomposition of algae and other aquatic vegetation elements in different environmental settings. Experiments conducted by environmentalists like Welch and Hutchinson have reported the increase of phosphorus as a result of sewage contamination[8,11]. The concentration of phosphates was more in summers during which the blooms of *Microcystis* (cyanobacteria) were observed. It has been observed that the concentration of phosphates and phytoplankton density has a direct relationship with the amount of nitrates[12].

Supplies of light and nutrients determine the growth of algae and aquatic vascular plants. Therefore these resources can be considered as the limiting factors in causing eutrophication[8,11,12]. Light availability plays a key role in the growth and development of submerged aquatic vascular plants, which are usually rooted and can access sediments for nutrients. Phytoplankton abundance and species composition changes as a function of ratios between supplied nutrients and underwater light conditions. Some common species of cyanobacteria, known to produce various kinds of toxins, can regulate their buoyancy and often become common as turbidity increases. Apparently, subtle differences in ratios, such as nitrogen to phosphorus, or phosphorus to silicon, can alter competitive relations among algal species involved in bloom formation[11,12].

Eutrophication is unlikely to occur if nitrate and phosphate contents in water are low but even the nutrient-rich waters may not witness the incidence of eutrophication if other factors like temperature and current velocity are not favorable. The influencing factors of eutrophication are : (1) Excessive nutrients, (2) Slow current velocity, (3) Adequate temperature and (4) Microbial activity and biodiversity[13,14]. There are several opinions existing on the relationship of nutrient enrichment to eutrophication and algal blooms : (1) When phosphorus concentration in water is low, it may act as the limiting factor for eutrophication, (2) When phosphorus concentration in water increases rapidly, factors such as light, temperature, water depth, pH, waves or wind etc may become the operating limiting factor[8,12].

EFFECTS OF EUTROPHICATION

The major effects of eutrophication are : (i) a decrease in the species diversity and negative modifications in the dominating taxa of the aquatic system, (ii) increase in the biomass of toxin-releasing, harmful flora and fauna, (iii) increase in turbidity of water bodies, (iv) increase in rate of sedimentation, thus decreasing the lifespan of lakes and ponds, and (v) triggering of small to large-scale anoxia/hypoxia.

During the last 100 years, and particularly in the last five decades, the trophic levels of a large number of lakes and other water bodies have made rapid advancements[15]. Universally, the relative enrichment has been a direct consequence of social or cultural advances made by the growing human

populations. Factors like deforestation and the implementation of agriculture alter terrestrial nutrient cycles in favor of more labile components, larger proportion of which enter drainage water. Ploughing and the practice of applying modern inorganic fertilizers simply accentuate the trend. Fertilizers and pesticides used extensively in agriculture have entered the water supply through runoff and leaching to the groundwater table that in turn pose a hazard to human, animal and plant populations. Some of these chemicals include several extremely hazardous substances as considered by the WHO and which are banned or under strict control in developed countries. Studies on the Ganges indicate that the concentration level of certain chemicals *viz*., HCH, DDT, Endosulfan, Methyl Malathion, Malathion, Dimethoate, and Ethion are higher than the international standards[16,17,18]. Some of these substances have been known to bio-accumulate in certain organisms, leading to increased risk of contamination where these organisms are used for human consumption and a persistence of the chemicals in the environment over long periods of time.

The sudden availability of limiting nutrients such as nitrogen, phosphate and potassium, spurs the growth of aquatic plants and other organisms[11,12]. In short time the water body becomes choked with vegetation and the BOD level decreases. Decaying organic matter and partially decomposed matter accumulates on the river or lake-bed, thereby limiting the water's suitability for human consumption and other uses. A high level of fertilizer use has been associated with increased incidences of eutrophication in rivers and lakes in several of India's most important water bodies, such as the Hussain Sagar in Hyderabad[19] and Nainital in Uttarakhand[20].

NUTRIENT REMOVAL

The removal of excess nutrients from sewage effluents is feasible but involves modifications to most sewage plants which are designed to remove solids (primary process), followed by a secondary process, which involves either activated sludge or trickling filters to remove nutrients (nitrates and phosphates; approximate removal 30-50%). The original purpose of these processes is to reduce the Biological Oxygen Demand (BOD), for achieving suitable levels to prevent de-oxygenation of receiving waters. Removal of the nutrients left after the secondary treatment is possible by a variety of processes, one of which involves growth and harvesting of algae from the effluent. Others involve ion exchange, electrochemical methods, electrodialysis, reverse osmosis, distillation or chemical precipitations as tertiary processes.

THREAT OF EXHAUSTION

If the modern methods of utilizing water resources continue in future, the threat of the exhaustion will increase many times. The water resources are rapidly deteriorating owing to waste disposal into the rivers. A holistic approach is required for managing the water resources in spite of the thrusts arising from various sources like agricultural, industrial and domestic sectors[11,21].

A specific aspect of water pollution by man is a disturbance in the regimen of the inland water bodies known as cultural or anthropogenic eutrophication. This phenomenon which has become widespread in many countries over the last couple of decades is causing public concern and attracting the attention of scientists all over the world. The harm it does to the utility value of lakes and water reservoirs is a grave threat to the earth's water resources as illustrated by the evidences present in numerous publications on specific and technical subjects.

At the very same time, this phenomenon has become particularly widespread in the past few years, extending to a large number of lakes in many countries with highly developed cultural landscapes.

Wetlands and coastal areas have been severely affected by increasing development and pollution. Almost one quarter of India's population lives within 60 km range of the shoreline, mostly owing to the large coastal mega-cities like Chennai and Mumbai. As a result, industrial and domestic pollution has severely degraded estuarine and coastal environments. It has been estimated that over 20,000 million litres per day of mostly untreated domestic sewage reaches marine water bodies in the coastal areas of India[3,4]. Oil spills from tanker traffic in the Bay of Bengal and Arabian Sea have also adversely affected marine and coastal fauna e.g., economically valuable shrimps and coral species[22,23].

CONCLUSION

Environment is a true wealth for the entire humanity and we must protect it. A large number of factors including eutrophication are degrading our valuable environment and better approach from the human fraternity is required to protect the aquatic resources vulnerable to eutrophication. In addition to the tasks of controlling eutrophication and preventing its effects, the problem of forecasting its rates in different natural conditions with a varied character and anthropogenic activities, as well as an estimation of potential dangers to the aquatic environments is urgently required. High authenticity for such forecasts and estimates is needed to furnish the ground for legislative, administrative and public measures to control the process of eutrophication and the damage caused by it to the entire human race.

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Glossary

Anthropogenic Eutrophication - The process of eutrophication triggered by human cultural activities accelerating the hazardous process in thousands of water bodies across the globe.

Bioaccumulation - Accumulation of chemical substances viz., pesticides in an organism. It occurs when an organism absorbs toxic substances at a rate greater than that at which that particular substance is lost. Bioaccumulation refers to uptake from all possible sources of air, water and food etc.

Biomagnification – Sequence of processes in an ecosystem by which higher concentrations of particular element/chemical, are reached in organisms higher up the food chain, generally through a series of predator-prey relationships.

BCM - Billion Cubic Metres.

Distillation - A method involving separation of mixtures based on differences in volatilities in a boiling liquid mixture.

Epilimnion - The top-most layer in a thermally stratified lake and is warmer receiving the maximum sunlight with typically higher pH and dissolved oxygen than the lowermost layer hypolimnion.

Electrodialysis - A process involving transport of salt ions from one solution to another through ion-exchange membranes under the influence of an applied electric potential difference.

Estuary - A partly enclosed coastal body of water with one or multiple fresh-water bodies flowing into it along with a free connection with the open sea.

Hypolimnion - The dense, bottom layer of a thermally stratified lake lying below the thermocline i.e., the middle transition layer between the layer at the surface (epilimnion) and the deep one (hypolimnion).

Mesotrophic - Water bodies with an intermediate level of productivity i.e., greater than oligotrophic but lesser than eutrophic.

Phytoplankton - The autotrophic component of the planktonic community, phytoplankton obtains energy through the process of photosynthesis and dwell in the well-lit surface layer i.e., the euphotic zone of a water body viz., ocean, lake, river etc.

Redox Processes - All chemical reactions in which the atoms have their oxidation number (oxidation state) changed e.g., oxidation of carbon to yield CO_2, reduction of carbon by hydrogen to yield CH_4 or oxidation of sugar ($C_6H_{12}O_6$) in the human body through a series of complex electron transfer processes.

Reverse Osmosis - A filtration process that removes various large molecules and ions from solutions by applying pressure to the solution when it is on one side of a particular selective membrane.

HUMAN MICROBIOMICS-DECODING THE MYSTERIES OF OUR PERMANENT GUESTS

Latika Bhatia

The human body is inhabited by at least 10 times more bacteria than the number of human cells in the body. The various commensals include eubacteria, archaebacteria, and fungi, which together comprise human microbiome. These microbial assemblages are not only known to be vital for human health but also prevent the dangerous microbes from establishing a foothold. The gut is considered the primary site for cross-talk between the host immune system and microorganisms. Human Microbiome Project aims to identify a core human microbiome, a common set of commensal species that can be defined as a healthy microbiota. Indigenous microbiota are an essential component in the modern concept of human health, but the composition and functional characteristics of a healthy microbiome remain to be precisely defined.

INTRODUCTION

We have more prokaryotic organisms on or in our bodies than we have eukaryotic cells. In fact, only one out of 10 cells in our bodies is human. Analysis of human genome was only an introduction to the genetic composition of our bodies. Human and their commensal organism have evolved together over the last two million years and have gradually become dependent on one another. The various commensals include eubacteria, archaebacteria, and fungi, which together comprise human microbiome. The concept of human microbiome was first suggested by Joshua Lederberg, who coined the term "microbiome, to signify the ecological community of commensal, symbiotic and pathogenic microorganisms that literally share our body space"[1].

Humans and their resident microbes have coexisted for atleast a billion years during which animals began domesticating microbes and allowing them permanent residence. Human provide residence to numerous microbial communities comprised of hundreds of individual bacterial species. Almost every environmently exposed surface of our bodies is teeming with symbiotic microbes. Much of our understanding of the human microbiome comes from culture based approaches using the 16 S rRNA technology. However, it is estimated that as much as 20% to 60% of the human associated microbiome, depending on body site, is uncultivable, which has likely resulted in an underestimation of its diversity. The microbiota normally associated with the human body have an important influence on human development, physiology, immunity and nutrition. Also communities and mutualistic bacteria associated with the human body constitute the first line defense against infection by competitively excluding invasive nonindigenous organisms that cause disease. Commensal bacteria also have the ability to activate anti-inflammatory responses leading to beneficial effects on the host *via* TLR (Toll Like Receptors) signaling when the cascade

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to pro-inflammatory responses is lacking. Furthermore, investigators have postulated roles for microbes in human diseases not traditionally associated with infectious etiologies, such as cancer, autoimmune disorders, chronic pain states, and inflammatory bowel disease [2, 3].

WHY HUMAN MICROBIOME PROJECT ?

Following the publication of the human genome sequence in 2001, Julian Davies argued that although completing the human genome sequence was a ''crowning achievement'' in biology, it would be incomplete until the synergistic activities between humans and microbes living in and on them are understood. Relman and Falkow called for a ''second human genome project'' that ''would entail a comprehensive inventory of microbial genes and genomes at the four major sites of microbial colonization in the human body: mouth, gut, vagina, and skin''. In this direction, the International Human Microbiome Project (HMP) has been recently launched, with funding beginning later in 2008[4].

The HMP is a logical conceptual and experimental extension of the Human Genome Project. The HMP is not a single project. It is an interdisciplinary effort consisting of multiple projects, which are now being launched concurrently worldwide, including in the United States (as part of the next phase of the National Institutes of Health's Roadmap for Medical Research), Europe and Asia. The advent of highly parallel DNA sequencers and high-throughput mass spectrometers with remarkable mass accuracy and sensitivity is propelling microbiology into a new era, extending its focus from the properties of single organism types in isolation to the operations of whole communities[4].

Initial HMP efforts include sampling multiples sites of healthy volunteers to determine whether humans share core microbial diversity profiles. The goals of the HMP are to demonstrate the feasibility of characterizing the human microbiome well enough to enable study of the variation in the human microbiome (with population, genotype, disease, age, nutrition, medication, and environment) and its influence on disease, while providing both a standardized data resource and technological developments to enable such studies to be undertaken broadly in the scientific community. The HMP is a limited effort *per se*, but has the ultimate objective of creating broad opportunities to improve human health through monitoring or manipulating the human microbiome.

It is estimated that the human microbiota is composed of ~10^{14} bacterial cells, which is 10 times more than the total number of human cells. The largest and most complex is the one comprised by intestinal bacteria that includes as many as 10^{12} cells per 1 g of feces in the average human individual. Perhaps we should regard ourselves as 'superorganisms' together with the indigenous microbes and that the composite genome should be referred to as the human 'metagenome'. The 16S rRNA genes are directly amplified from the human metagenomic DNA using a broad- range PCR primers, and used to make libraries of clone. Each clone in a library represents a 16S rRNA gene from a prokaryotic organism. The clones are then differentiated through fingerprinting methods such as denaturant gradient gel electrophoresis (DGGE) or amplified ribosomal DNA restriction analysis (ARDRA) and the non-redundant clones are sequenced. In the recent years, either randomly selected clones or all the clones in a library are being sequenced. After sequencing, 16S rRNA genes are clustered into groups and a threshold of sequence similarity (> 97%) is established to distinguish species level phylotypes[5,6]. A large-scale 16S phylotype analysis (grouping only by 16S rRNA sequence similarity) was carried out for three human adult microbiota. The analysis of 13335 bacterial 16S sequences identified 395 phylotypes at the strain level using a threshold of 99% sequence identity (% ID) and a single archaeal phylotype (*Methanobrevibacter smithii*) within the three

samples. Members of the genera Bacteroides, Eubacterium, Clostridium and Ruminococcus were the major species found in the adult microbiota. Of the 395 phylotypes, ~80% represented sequences from species yet to be cultivated. This analysis also indicated high interindividual variations in microbial composition among the three samples.

One of the major goals of the HMP is to determine whether there is an identifiable 'core microbiome' of shared organisms, genes or functional capabilities found in a given body habitat of all or the vast majority of humans. The human intestinal tract harbors the most abundant, and among the most diverse, microbial community of all body sites. As in most mammals, the gut microbiome is dominated by four bacterial phyla: Firmicutes, Bacteroidetes, Actinobacteria, and Proteobacteria, which represent more than 1000 different molecular species or phylotypes. Remarkably, this phylotype composition can be specific and stable for each individual. Genome analysis of several Bacteroides strains dominant in adult intestinal microbiota indicated the richness of genes involved in polysaccharide metabolism, exemplifying the functional adaptation of intestinal microbes to gut habitats rich in polysaccharides, which are metabolized by bacteria to generate short-chain fatty acids such as butyrate, the major energy source for the host [7].

The HMP will address some of the most inspiring, vexing and fundamental scientific questions today. Importantly, it also has the potential to break down the artificial barriers between medical microbiology and environmental microbiology. It is hoped that the HMP will not only identify new ways to determine health and predisposition to diseases but also define the parameters needed to design, implement and monitor strategies for intentionally manipulating the human microbiota, to optimize its performance in the context of an individual's physiology [4].

METAGENOMICS AND THE ROLE OF HUMAN MICROBIOTA

Human microbiome has significantly enriched metabolism of glycans, amino acids and xenobiotics; methanogenesis; and 2-methyl-Derythritol 4-phosphate pathway-mediated biosynthesis of vitamins and isoprenoids. Thus, humans are superorganisms whose metabolism represents an amalgamation of microbial and human attributes.

It has not been possible to isolate vast majority (>95%) of microorganisms and culture them, as required growth conditions have not or cannot be reproduced in the laboratory. However, DNA sequences and metagenomics have now made it possible to analyse the entire human microbiome. Metagenomics is employed as a means of systematically investigating, classifying and manipulating the entire genetic material isolated from environmental samples. This is a multi-step process that relies on the efficiency of four main steps. The procedure consist of (i) the isolation of genetic material, (ii) manipulation of genetic material, (iii) library construction, and the (iv) the analysis of genetic material in the metagenomic library. The clones can be screened for phylogenetic markers or "anchors." such as 16S rRNA and *recA*, or for other conserved genes by hybridization or multiplex PCR or for expression of specific traits, such as enzyme activity or antibiotic production, or they can be sequenced randomly [8].

This metagenomics analysis begins to define the gene content and encoded functional attributes of the gut microbiome in healthy humans. Future studies are needed to provide deeper coverage of the microbiome and to assess the effects of age, diet, and pathologic states (e.g., inflammatory bowel diseases, obesity, and cancer) on the distal gut microbiome of humans living indifferent environment[9].

Every human body contains a personalized microbiome that is essential to maintaining health

but capable of eliciting disease. The oral microbiome is particularly imperative to health because it can cause both oral and systemic disease. The oral microbiome rests within biofilms throughout the oral cavity, forming an ecosystem that maintains health when in equilibrium. However, certain ecological shifts in the microbiome allow pathogens to manifest and cause disease. Severe forms of oral disease may result in systemic disease at different body sites[10].

The human vagina and the bacterial communities that reside therein, form a finely balanced mutualistic association. Previous studies indicate that indigenous bacterial populations play a key role in preventing colonization by "undesirable" organisms, including those responsible for bacterial vaginosis, yeast infections, sexually transmitted diseases, and urinary tract infections. Lactobacilli have been thought to be the keystone species of vaginal communities in reproductive-age women, both in the sense of being the dominant species and in the sense of being the species with the greatest impact on the vaginal ecosystem. These microorganisms benefit the host by producing lactic acid as a fermentation product that accumulates in the environment and lowers the pH to ~4.5.

Several of our physiological features, such as nutrient processing, maturation of the immune system, pathogen resistance, and development of the intestinal architecture, strictly depend on the mutualistic symbiotic relationship with the intestinal microbiota. The vast majority of bacteria in the human intestinal microbiota (> 99%) belongs to six bacterial phyla: *Firmicutes, Bacteroidetes, Actinobacteria, Proteobacteria, Fusobacteria and Verrucomicrobia*. The two dominant divisions are *Firmicutes* and *Bacteroidetes*, which represent together up to 90% of the total microbiota, with a relative abundance of 65% and 25%, respectively. *Actinobacteria, Proteobacteria, Verrucomicrobia* and *Fusobacteria* are the subdominants phyla with a relative abundance up to 5, 8, 2 and 1%, respectively.

The gut microbiome has co-evolved with humans and taken on some of the metabolic function necessary to human survival, such as vitamin biosynthesis and plant polysaccharide (starch and cellulose) fermentation. Genome of human gut bacteria contain a large repertoire of genes involved in acquisition and metabolism of polysaccharides. These genes are organized as polysaccharide utilization loci (PUL) that encode functions necessary to detect, bind, degrade and import carbohydrate species encountered in the gut habitat either from the diet or from the host glycans associated with mucus and the surfaces of the epithelial cells. Gut 'microflora' play crucial roles in the developing human organism, and contribute to immunological processes (e.g., inflammatory response), endocrinological functions, and homeostatic energy balancing such as energy extraction and fat storage. The microbiota favors systemic exposure to the lipopolysaccharides (LPSs), large glycolipids derived from the outer membrane of Gram-negative bacteria. LPSs can cause a condition of "metabolic endotoxemia" characterized by low-grade inflammation, insulin resistance, and augmented cardiovascular risk. Gut microbes are also implicated in the development of type 1 diabetes, through epigenetic effects on the innate immune system.

GUT MICROBIOTA AND OBESITY

Newer avenue of research is concerned with the role microbes in the gut play in obesogenesis, and what the interventions are that might alleviate such contributions Obesity is associated with phylum-level changes in the microbiota, reduced bacterial diversity, and altered representation of bacterial genes and metabolic pathways. These results demonstrate that a diversity of organismal assemblages can none the less yield a core microbiome at a functional level, and that deviations from this core are associated with different

physiologic states (obese versus lean). Modern research techniques such as FISH, flow cytometry, and quantitative PCR have suggested that infants with lower levels of *Bifidobacterium* and higher numbers of *Staphylococcus aureus* in their stool are at risk of subsequent obesity. Analysis of 16S rRNA datasets produced by the three PCR-based methods, plus shotgun sequencing of community DNA, revealed a lower proportion of Bacteroidetes and a higher proportion of Actinobacteria in obese versus lean individuals. Obesity was characterized by a higher proportion of *Firmicutes* and *Actinobacteria* with respect to *Bacteroidetes* and an overall reduced bacterial diversity. This reduced diversity suggests an analogy: the obese gut microbiota is not like a rainforest or reef, which are adapted to high energy flux and are highly diverse, but rather may be more like a fertilizer runoff where a reduced diversity microbial community blooms with abnormal energy input. Studies of lean and obese mice suggest that the gut microbiota affects energy balance by influencing the efficiency of calorie harvest from the diet, and how this harvested energy is utilized and stored. Obese (*ob/ob*) mice, with 50% more Firmicute activity in their guts, appear to digest more of their food and gain more calories from it, and the Firmicutes also regulate host metabolic genes. Probiotics may prove to be useful adjuncts in strategies to alleviate the huge burden of childhood obesity. Mice fed trans-10, cis-12-conjugated linoleic acid-expressing *L. plantarum* PL62 featured reduced adipose tissue and body weights, as well as serum glucose levels [11, 12].

PROBIOTICS AS BACTERIOTHERAPEUTIC AGENTS

Abundant communications and "microverses" are being transmitted between diverse microbial communities and different cell types in disparate locations within the human body. Commensal microbes may actively prevent gastrointestinal infections through production of antimicrobial factors, stimulation of the host immune system, or competition with pathogens for nutrients or host binding sites. Commensal organisms, which can inhibit the pathogens, a phenomenon known as pathogen interference, may be useful for therapeutic applications. Probiotics or beneficial microbes have proved to be important bacteriotherapeutic agents. Probiotics have been applied successfully in the context of gastroduodenal disease, specifically *Helicobacter pylori* infection. Multiple clinical trials demonstrated that a variety of probiotic strains can improve tolerability of *H. pylori* eradication therapy. Probiotics such as *Lactobacillus rhamnosus* GG, *L. reuteri*, *Bifidobacterium*, and the yeast "*Saccharomyces boulardi"* have also been reported to improve diarrhea and other symptoms of acute gastroenteritis. Probiotics have been investigated for their abilities to alleviate antimicrobial-associated disease including *Clostridium difficile* infection. Beneficial effects of probiotics include not only anti-pathogenic effects but they also impart immunomodulatory features, regulation of cell proliferation, the ability to promote normal physiologic development of the mucosal epithelium, and enhancement of human nutrition.

CONCLUSION

The human body is naturally colonized by a diverse array of micro-organisms whose metabolic activity is important for human physiology and health. The alimentry canal may be regarded from the point of view of bacterial process within it, as a singularly perfect incubator. Technology is now providing advanced sequencing techniques that are more cost effective and faster than ever, allowing for metagenomic analysis of microbial communities found in varied samples. Probiotics modulate immune responses, provide key nutrients, or suppress the proliferation and virulence of infectious agents. The human microbiome is in fact dynamic and often in flux, which may be indicative of the continuous interplay among commensal microbes, pathogens, and the human host. Defining the

complexity of the human microbiome in health and disease will enhance the understanding of multiple pathological mechanisms and facilitate the development of novel diagnostic tools and therapeutic interventions. The analysis of the microbiome and its genomes will pave the way for more effective therapeutic and diagnostic techniques and, ultimately, contribute to the development of personalized medicine and personalized dental medicine.

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RADIO FREQUENCY- A BLESSING OR A CURSE

Anandarup Chatterjee and Shyam Sundar Kar

This impact of radio frequency in the present world is unimaginable, yet not beyond criticism. Scientists have noted some adverse effects of this on human life. This paper tries to delve into these negative aspects of electromagnetic radiation to caution us against a disaster.

INTRODUCTION

In the recent time the radio frequency has turned out to be of immense importance both for its enormous utility and its adverse effects on the living world. Many of the recent inventions and research works are heavily dependent on radio frequency also called electromagnetic radiation. In this paper we have tried to highlight some of the basic features of radio frequency and have pointed out the perils of overuse or uncontrolled use of Radio frequency.

Some Facts : Electromagnetic radiation is a form of energy emitted and absorbed by charged particles which exhibits wave-like behaviour as if travels through space. Radio frequency is a rate of oscillation in the range of about 30 KHz to 300 GHz which corresponds to the frequency of electrical signals normally produced to detect radio waves. In order to receive radio signals an antenna is used. Since an antenna picks up thousands of radio signals at a time, a radio tuner is necessary to tune it to a particular frequency. This is done by a resonator which can amplify oscillations within a particular frequency band. Electrical currents that oscillate at RF have the special property that they can ionize air creating a conductive path through it. Exploiting this property by high frequency units, arc welding is done. Radio frequency radiation is also known as electromagnetic radiation.

Radio spectrum refers to the part of electromagnetic spectrum corresponding to radio frequencies. Different parts of the radio spectrum are used for different radio transmission technologies and applications. Radio Spectrum is government regulated in developed countries and in some cases is sold or licensed to operators of private radio transmission systems, e.g., cellular telephone operators or broadcast television stations. A band is a small section of the spectrum of radio communication frequencies.

A noteworthy property is that above 300 GHz, the absorption of electromagnetic radiation by Earth's atmosphere is so great that the atmosphere is effectively opaque for passage of signals through it until it becomes transparent again in the infrared and optical frequency ranges.

The following is a list of band names, providing frequencies and uses of the bands.

GENERATION OF RADIO FREQUENCY

The radio frequency energy is emitted from various sources. The present civic life is full of electrical and electronic products like mobile phones, microwave oven, stabilizers,, electric shavers, household remote controls, radars and transmission towers which emit invisible electromagnetic radiation (EMR).

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Band name	Abbr.	ITU band	Frequency and wavelength in air	Example uses
sub-hertz	subHz	0	< 3 Hz > 100,00 km	Natural and man-made electromagnetic waves (millihertz, microhertz, nanohertz) from earth, ionosphere, sun, planets, [*citation needed*] etc.
Extremely low frequency	ELF	1	3–30 Hz 100,000 km–10,000 km	Communication with submarines
Super low frequency	SLF	2	30–300 Hz 10,000 km–1000 km	Communication with submarines, Main power (50/60Hz)
Ultra low frequency	ULF	3	300–3000 Hz 1000 km–100 km	Communication within mines
Very low frequency	VLF	4	3–30 kHz 100 km – 10 km	Submarine communication, avalanche beacons, wireless heart rate monitors, geophysics
Low frequency	LF	5	300–3000 kHz 10 km – 1 km	Navigation, time signals, AM longwave broadcasting, RFID
Medium frequency	MF	6	300–3000 kHz 1 km – 100 m	AM (medium-wave) broadcasts, amateur radio
High frequency	HF	7	3–30 MHz 100 m 10 m	Shortwave broadcasts, citizens' band radio, amateur radio and over-the-horizon aviation communications, RFID, Over-the-horizon radar, Automatic link establishment (ALE) /Near Vertical Incidence Skywave (NVIS) radio communications, Marine and mobile radio telephony
Very high frequency	VHF	8	30–300 MHz 10 m – 1 m	FM, television broadcasts and line-of-sight ground-to-aircraft and aircraft-to-aircraft communications. Land Mobile and Maritime Mobile communications, amateur radio
Ultra high frequency	UHF	9	300 – 3000 MHz 1 m – 100 mm	Television broadcasts, microwave ovens, mobile phones, wireless LAN, Bluetooth, ZigBee, GPS and two-way radios such as Land Mobile, FRS and GMRS radios, amateur radio
Super high frequency	SHF	10	3–30 GHz 100 mm – 10 mm	Microwave devices, wireless LAN, most modern radars, communications satellites, amateur radio
Extremely high frequency	EHF	11	30 – 300 GHz 10 mm – 1 mm	Radio astronomy, high-frequency microwave radio relay, microwave remote sensing, amateur radio
Terahertz	THz	12	300 – 3,000 GHz 1 mm – 100 μm	Terahertz imaging – a potential replacement for X-rays in some medical applications, ultrafast molecular dynamics, condensed-matter physics, terahertz time-domain spectroscopy, terahertz computing/communications, sub-mm remote sensing

USES OF RADIO FREQUENCY

The radio frequency radiation, i.e., electromagnetic energy is used for multitude of purposes. Over the last century its use in communication industries has been overwhelming, particularly in radio transmission, television transmission, cellular phones and medical treatment. While the cellular service has become an inseparable part of our modern life, the instrument like Diathermy has turned out to be an unavoidable medical instrument for surgery. Radio frequency energy is normally used in medical treatments for minimally invasive surgeries. Using radio frequency bloodless operations (cutting and coagulation) are

done including the treatment of sleep Apnea. Magnetic resonance imaging (MRI) uses radio frequency waves to generate images of the human body. Various sensors used at different walks of life are almost inseparably connected with our every day life and research.

In the domestic arena, microwave ovens have become a part and parcel of the civic life. The remote control systems, televisions and FM radio are three of the most popular uses of high frequency EM wave.

THE GROWING PERILS

The uncontrolled use of radio frequency radiation in the form of mobile telecommunications, television transmitters, FM Radio Stations, household remote control systems has provided the modern civilization with a great peril looming large on human and plant lives mainly by its non-ionizing radiation. The mushrooming mobile industries in every corner of the globe with radiating steel towers have forced the general public to the continuous exposure of radio frequency radiation leading thereby to the undesirable permanent effects on human health and behavior. The alarming effects of radio frequency has been established beyond doubt as a significant cause of cancers of many types[2-5]. Not for the services of human civilization, the radio frequency energy is being abused to torture convicts, damage enemy potentials and change psychic state of enemy personnel.

We can classify the RF susceptible groups as follows :

(a) Pre-adolescent Children

Various studies have shown that the pre-adolescent children are more susceptible to the RF-radiation than the older ones because absorption of microwaves of the frequency used in mobile telephony creates head resonance, i.e., creates an object of the size of child's' head. The developing nervous system and associated brainwave activity in a child are more vulnerable to RF aggression by its pulses. The mitotic activity in cells of developing children area subjected to genetic damage. Experts say that the pre-adolescent children are susceptible to electromagnetic radiation due to their thinner skull and rapid growth rate.

Even at greater risk are the elderly and the pregnant women.

(b) Pregnant Woman

A pregnant woman and her foetus are vulnerable to electromagnetic radiations as these radiations continuously read with the developing embryo and the developing cells of the foetus. Though not conclusively inferred, it is said that deformation of the foetus in the womb of a woman can happen due to excessive use of cell phones and electrical gadgets like microwave ovens and remote control systems. Intensive research works are going in this direction in Europe and America.

(c) Patients with Pace-makers

The radio frequency has been observed to affect adversely the implanted pacemakers. The chance is very high that the electromagnetic radiation make the pacemaker malfunction and even stop functioning.

(d) The Elderly

As the human brain is the most vulnerable portion for radio frequency radiation, the entire nervous system of the elderly easily fall prey to this radiated energy resulting in neurological effects such as alzheimer, increase in ornithinede carboxylic activity, disorder of enzymes and free radicals that decrease the brain metabolism.

(e) The Small Birds

Ornithologists have pointed out that the entire biological system of the small birds like sparrows are being grossly affected by radio frequency radiations so much so that the reproductive power of such genre is being lost, expectedly leading to

extinction in the long run. The small birds like sparrows are fleeing from the areas covered by RF transmission towers.

(f) The Insects

The small insects like bee, which have brains are supposed to have been adversely affected by the RF radiation[6-9]. It is true that not many studies are there but the few studies so far made amply supports the above view.

(g) The Flora and Fauna

The botanists have started observing some peculiar metabolic changes in the flora and fauna in the recent times. They are attributing this to 'global warming and more emphatically on radio frequency radiation. The changes in the leaves, peculiar spots on the stems and leaves are thought to be special effects of this radiation[8–12]. The medicinal plants exposed to RF radiation are now under the danger of imbecility and erroneous results.

OUR STUDIES

Extensive studies have been done to relate occurrence of cancer due to RF radiation. Doctors from the United Kingdom issued warning urging children under 16 not to use cell phones to reduce exposure to radio frequency radiation[1-5]. Over 100 physicians and scientists at Harvard and Boston University Schools of Public Health have called cellular tower a radiation hazard. Thirty three delegate physicians from 7 countries have declared cell phone towers a public health emergency. The researchers have opined that RF radiation is wreaking havoc with normal biological cell functions. 'RF alters tissue physiology, says Dr.George Carlo, an epidemiologist who found genetic damage in a $28 million research program, paid for by the industry. In 1998 the Vienna resolution signed by 16 of the world's leading bio-electromagnetic researchers provided a consensus statement that there is scientific agreement that biological effects from low intensity RF exposure are established. The World Health Organization has reported - 'Many epidemiological studies have addressed possible links between exposure to RF fields and excess risk of cancer.'Dr. Robert Becker, author of 'The Body Electric and Crosscurrents, the Perils of Electro-pollution" has remarked," At present the greatest polluting element in the earth's environment is the proliferation of electromagnetic fields". "Radiation once considered safe, he said, is now correlated with increases in birth defects, depression, Alzheimer disease, learning disabilities, chronic fatigue syndrome and cancer. The incidence of brain cancer is up by 25% since 1973 in USA."

Forming a team of experts including physician, environmentalist and electronic engineers we conducted a survey of changing situations. We visited some of the remotest villages in the districts of Howrah, Hooghly, 24-parganas and Burdwan and examined one hundred twenty cases, some within and some others outside the RF-radiation zones and have noted the following :

(1) The skin-disorder of green cocoanuts exposed to direct RF radiation are much more than those where this radiation is less. Before induction of cell-phone towers in the villages there was no such skin-disorder.

(2) The number of sparrows in the cities and suburbs has declined alarmingly adding cause to ecological balance.

(3) The number of suicides and mental disorders is increasing in the areas covered under cell-phone towers

(4) Certain plants including medicinal plants are having metabolic changes in the areas under cell-phone network.

(5) The occurrence of lightning is on increase in the areas covered by RF towers.

(6) The size and shapes of certain fruits like tomatoes in the vicinity of towers have undergone deformation.

THE FUTURE MENACE

It is to be accepted that the medical treatment and the communication system prevalent in today's' world depends heavily on the use of RF radiation. It is difficult to accept life without television and radio. More difficult is to think of aviation without radar communication. Yet the hazards of this modern technology cannot be ignored. We can only think of imposing stringent controls over the use of this formidable blessing of science. The process of controlling has already been started in the developed countries. Use of mobile phones by under-sixteen's has been banned by law in U.K. Awareness campaigns have been intensified in USA, Europe and Australia but insignificant efforts are visible in the countries like India, Pakistan, Bangladesh, Africa and Latin America. Failure to control this will lead to extinction of many living species, flora and fauna and crippling of human civilization in near future due to ecological imbalance.

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KNOW THY INSTITUTIONS

CSIR-NORTH EAST INSTITUTE OF SCIENCE & TECHNOLOGY, JORHAT

THE HISTORY

The Special Committee of the Governing Body of CSIR recorded on September 15, 1954 that ".....There were special priorities of Industry and raw materials in Assam which required investigation. The inadequacy of communication between Assam and other parts of India made it necessary to put up a separate laboratory in Assam....." Consequently, the committee discussed for setting up of a third Regional Research Laboratory (RRL) in the country and the first in Assam. As a result on 18 March, 1961, Prof Humayun Kabir, the then Minister of Scientific Research & Cultural Affairs, Govt. of India laid the foundation stone of RRL, Jorhat.

BRIEF PROFILE

Nestled in the far flung north eastern part of the country, CSIR-NEIST (erstwhile known as RRL) was established under the aegis of Council of Scientific & Industrial Research (CSIR), New Delhi as a multidisciplinary laboratory. Its major thrust of R&D activities has been to develop indigenous technologies by utilizing the immense natural wealth of India in general and NE region in particular and thus contributing to the region's as well as country's industrial growth and economic prosperity. The North Eastern region of the country is bestowed with an abundance of material resources like petroleum, natural gas, minerals, tea as well as aromatic and medicinal plants and hence the laboratory was targeted to undertake research for development of knowhow for a wide range of industries and extension works. Over the years, the laboratory has generated more than 114 technologies in the areas of Agrotechnology, Biological Science, Chemical Science, Engineering Science, Geo-

science and Materials Science of which about 60% were commercial successes culminating in setting up of various industrial ventures throughout the country. Over the years, the laboratory also developed expertise in the areas like natural products chemistry, drugs and drug intermediates, VSK cement plant technology, agro-technologies, petroleum microbiology and petrochemicals, crude oil transportation, paper and paper products, beneficiation chemicals, ecology and environment studies, geotechnical investigations, foundation design engineering, soil and building materials, geoscience and seismic surveillance studies etc. After its glorious more than 50 years of existence since 1961, the Institute has come to bear the same significance and connotation in the entire North East India as that of the CSIR at New Delhi for the rest of the country.

THE R&D PROGRAMMES

Current research clusters

A. Chemical Sciences

- North East Exploration for Pharmaceuticals
- Environmental Research Initiative for paper and process industry
- Affordable Healthcare Agents
- CSIR Advanced Analytical Facility for North East
- Development of Sustainable Processes for Edible Oils with Health Benefits from Traditional and New Resources
- Catalysts for Specialty Chemicals
- Organic reactions in generating innovative and natural scaffolds
- Advanced Polyolefins
- Specialty Materials Based on Engineered Clays
- New Generation lubricants and additives.
- Natural products as affordable healthcare agents.
- Membrane and Adsorbent Technology Platform for Effective Separation of Gases and Liquids
- Inherently Safer Practices for Industrial Risk Reduction
- Development of Sustainable Waste Management Technologies for Chemical and Allied industries
- Biocatalysts for the Industrial Application and Green Organic Synthesis.
- Biomass to Energy.
- Affordable Cancer Therapeutics
- Molecules to Materials to Devices
- Open Source Drug Discovery

B. Biological Sciences

- Plant diversity : studying adaptation biology and understanding/exploiting medicinally important plants for useful bioactives.
- Therapeutics of chronic obstructive pulmonary disease (COPD)
- Bioprospection of plant resources and other natural products
- Introduction, Domestication, Improvement and Cultivation of Economically Important Plants.
- Nanomaterials : Applications and impact on Safety, Health and Environment
- Plant-Microbe and Soil Interactions

C. Engineering Sciences

- Engineering of Disaster Mitigation and Health Monitoring for safe and smart built environment.

D. Physical Sciences

- Probing the Changing Atmosphere and its Impacts in Indo-Gangetic Plains and Himalayan Region.

E. Information Sciences

- Comprehensive Traditional Knowledge Digital Library.

- CSIR knowledge gateway and open source private cloud infrastructure.

MAJOR ACHIEVEMENTS

The laboratory has focused R&D mainly in Bio-sciences, Chemical Sciences, Engineering Sciences, Earth Sciences, Material Sciences and Agro-technology & Rural development.

Besides attending to the national priorities, the laboratory has been engaged in ameliorating the socio-economic conditions of the rural folks through the inputs of S&T. In the rural development side also, its efforts for 'Lab to Land' activities, the laboratory has brought more than 5000 ha of fallow and waste lands in the NE states under the cultivation of various medicinal, economic and aromatic plants such as Citronella, Lemongrass, Patchouli, etc., and Mushroom with the agro-techniques developed by it involving 25,000 families of rural farmers, women folks and self employed youths.

PUBLICATIONS

In frontier areas of fundamental and applied research a total of 2925 research papers are published in journals of high national and international repute. The current average impact factor of the published papers stands of 2.931.

PATENTS ACQUIRED

Over the years CSIR-NEIST has also earned its name in the field of IPR with total 298 patents granted in India and 30 patents granted in abroad.

FACILITIES AVAILABLE

300 MHz NMR, GC-MS, LCMS, FTIR, CHN & Sulphur analyzer, Thermomechanical analyzer, surface area analyzer, interfacial tensiometer for liquid-liquid and solid-solid interfacial tension and contact angle preparative HPLC, Atomic absorption Spectrometer, Refrigerated centrifuge, XRD, Universal Testing machine for determining engineering parameters of materials, Elrich mixer RO5T suitable for micro-pelletization and mixing, High temperature electrical furnace, 1600°C, Light scattering detector, 50 It cap, Laser diffraction particle size analyzer, 0.04-2500 micron, Zeta potential analyzer with autotitration, Thermal analyzer for DTA, TGA & DSC, Atomic emission Spectrometer (ICP-AES), petro mineralogical microscope, pilot plant facility and SPD unit.

SERVICES

The laboratory offers the following services to the clients, entrepreneurs and user agencies.

(a) Consultancy & Testing services

Areas

- Cultivation of medicinal, aromatic plants
- Survey of medicinal, aromatic and economic plants
- Designing of distillation units and specialized fabrication works
- Geotechnical studies and foundation designs
- Seismic survey
- Hazard and safety analysis
- Environmental impact assessment and environmental management
- Preparation of TEFR

(b) Testing and analysis

Areas

- Quality assessment of water, food products, edible oils and spices
- Pesticides, fertilizer and soil
- Building materials, cement, iron & steel and timbers
- Oil & Petroleum products, coals and minerals
- Gems and stones
- Fibre, paper, boards and garments

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Conferences / Meetings / Symposia / Seminars

3rd International Conference on Reliability, Infocom Technologies and Optimization (ICRITO 2014), October 8-10, 2014, Amity University Uttar Pradesh.

Topics :

Quality and Reliability

- Quality Assurance
- Reliable and secure communications
- Software Reliability and Testing
- Infocom Systems Reliability
- Power Systems Reliability
- Reliability and Maintenance Models
- Fault Tolerance in Hardware and Software systems

Mathematical Modelling and Optimization

- Soft computing
- Financial Optimization
- Inventory Management
- Fuzzy Optimization
- Knowledge Management
- Supply chain management
- Stochastic Petrinets

Infocom Technology (IT)

- Free and Open source software
- Natural language processing
- Cloud computing
- Computer Architecture and Embedded Systems
- Artificial Intelligence and Experts Systems
- Data Mining and Data warehousing
- Mobile Adhoc Networks
- Network Technologies
- Convergence Technologies
- Human-Computer Interface
- Information and Network Security
- Mobile Computing
- Software Engineering
- Advances on Computing Mechanisms
- Software and Web Engineering
- ICT Act and Cyber Laws
- Rural Applications of IT
- E-Governance

Safety and risk analysis

- Risk Analysis
- Infrastructure Systems Safety and Risk
- Probabilistic Fracture Mechanism and Fatigue Analysis
- Probabilistic Safety Assessment

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5th International Conference on Stem Cells and Cancer (ICSCC-2014) : Proliferation, Differentiation and Apoptosis, 8-10 November 2014, New Delhi.

- Embryonic Stem Cells
- Induced Pluripotent Stem Cells
- Mesenchymal and Cardiac Stem Cells
- Hematopoietic and chord blood stem cells
- Neural stem cells
- Other stem cells
- Cancer stem cells
- Proliferation, differentiation and apoptosis of stem cells
- Proliferation, differentiation and apoptosis of cancer cells
- Clinical research and trials in stem cells and cancer
- Hematopoietic malignancies
- Myeloid leukemias
- Lymphoid leukemias
- Breast cancer
- Oral, head and neck cancer
- Cervical cancer
- Lung cancer
- Other cancers
- Cancer genomics and proteomics
- Cancer diagnostics and biomarkers
- Cancer therapeutics
- Immune systems in stem cells and cancer
- Nanotechnology applications in stem cells and cancer
- Ethical issues in stem cells and cancer research
- Molecular Biology of stem cells
- Molecular biology of cancer cells
- Molecular medicines for cancers
- Mathematical modeling and bioinformatics in stem cells and cancer
- Other topics related to stem cells and cancer

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Email : icscc2013@gmail.com

S & T ACROSS THE WORLD

OLDEST STAR PROVIDES HINTS ABOUT FIRST SUPERNOVAS

Studying one of the oldest known stars in the universe has given astronomers a closer look at what happened in the universe more than 13.7 billion years ago.

Named SMSS J031300.362670839.3, the star sits 6,000 light-years from Earth toward the outskirts of the Milky Way and lacks iron. Scientists thought that the high-energy explosions, or supernovas, of the universe's first stars would have seeded galaxies with this heavy element. But the old star's chemical composition and that of four others suggest that the explosions of the first stars were much lower in energy than those of giant stars today.

Any iron formed in those earliest explosions probably fell into the resulting black hole. That could explain why old, second generation stars such as SMSS J031300.362670839.3 have very small traces of iron, and it suggests that low-energy supernovas were more common in the early universe than originally thought, astronomers report February 9 in Nature.

NEARLY 1-MILLION-YEAR-OLD EUROPEAN FOOTPRINTS FOUND

Footprints impressed into hardened sediment along England's southeastern coast belonged to human ancestors that lived at least 780,000 years ago.

Footprints of ancient human ancestors at a Stone Age site on England's southeastern coast emerged briefly only to be eroded away by the sea. At least five individuals created the prints between 1 million and 780,000 years ago, say archaeologist Nick Ashton of the British Museum in London and his colleagues.

The footprints were discovered and photographed in May 2013, the researchers report February 7 in *PLOS ONE*. A low tide at England's Happisburgh site revealed that heavy seas had worn away layers of hardened silt, exposing a stretch of footprint-covered sediment.

Many prints contained impressions of the arch and heel. One print displayed toe marks. Lengths and widths of the ancient footprints corresponded to individuals who stood between 3 and 5.7 feet tall, suggesting that adults and youngsters strolled together. The foot sizes resemble those of possible Neandertal ancestors whose fossils, previously found in northern Spain, date to at least 800,000 years ago.

A waterlogged hominid footprint, shown above a camera's lens cover, emerged with dozens of others at an ancient coastal site in England as a result of erosion caused by strong waves.

Only 3.6-million-year-old hominid footprints in Tanzania and 1.5-million-year-old footprints in Kenya are older than the Happisburgh discovery.

REWRITING THE TEXT BOOKS : SCIENTISTS CRACK OPEN 'BLACK BOX' OF DEVELOPMENT

We know much about how embryos develop, but one key stage — implantation — has remained a mystery. Now, scientists from Cambridge have discovered a way to study and film this 'black box' of development. Their results — which will lead to the rewriting of biology text books worldwide — are published in the journal *Cell*. Embryo development in mammals occurs in two phases. During the first phase, pre-implantation, the embryo is a small, free-floating ball of cells called a blastocyst. In the second, post-implantation, phase the blastocyst embeds itself in the mother's uterus.

While blastocysts can be grown and studied outside the body, the same has not been true from implantation. And because embryos are so closely

connected to their mothers, implantation has also been difficult to study in the womb.

According to study author Professor Magdalena Zernicka-Goetz of the University of Cambridge: "We know a lot about pre-implantation, but what happens after implantation — and particularly the moment of implantation — is an enigma."

Scientists are interested in studying implantation because the embryo undergoes huge changes in such a short space of time.

"During these two days, it goes from a relatively simple ball to a much larger, more complex cup-like structure, but exactly how that happens was a mystery — a black box of development. That is why we needed to develop a method that would allow us to culture and study embryos during implantation," she explained.

Working with mouse cells, Professor Zernicka-Goetz and her colleague Dr Ivan Bedzhov succeeded in creating the right conditions outside the womb to study the implantation process.

To be able to support development, they created a system comprising a gel and medium that, as well as having the right chemical and biological properties, was of similar elasticity to uterine tissue. Crucially, this gel was transparent to optical light, allowing then to film the embryo during implantation.

This new method revealed that on its way from ball to cup, the blastocyst becomes a 'rosette' of wedge-shaped cells, a structure never before seen by scientists.

"It's a beautiful structure. This rosette is what a mouse looks like on the 4th day of its life, and most likely what we look like on the 7th day of ours, and it's fascinating how beautiful we are then, and how these small cells organise so perfectly to allow us to develop."

As well as answering a fundamental question in developmental biology, the new method will allow scientists to study embryo growth and development at implantation for the first time, which could help improve the success of IVF, and extend our knowledge of stem cells, which could advance their use in regenerative medicine.

The findings also mean developmental biology text books will need rewriting. "The text books make an educated guess of what happened during this part of development, but we now know that what I learned and what I teach my students about this was totally wrong," said Professor Zernicka-Goetz.