EVERYMAN'S SCIENCE

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

Past General Presidents of ISCA

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

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EDITORIAL

CAREERS IN THE NETWORKED WORLD

In this age of globalization and networking, it is not possible for anybody to remain insular for long. Thus the work practices of the west are slowly creeping into India too. An anecdote may be in order. One of the foremost management gurus of the world, Charles Handy, gave a talk at the Taj Bengal in the early 2000's. Handy started with a formula :

$$\frac{1}{2} \times 2 = 3$$

It was the guiding philosophy of the western world, he said. It means, "Get rid of $\frac{1}{2}$ of your employees, double the salary of the remaining and your output will be trebled". The audience full of the corporate czars of Calcutta nodded.

A corollary of the above, said Handy, is that the trend in the west is now on outsourcing work or subcontracting by the corporate. People have to become entrepreneurial to earn a living now. The days of 9 to 5 jobs are under threat like never before. All one needs now is a laptop, an ISDN connection, a table at home and most importantly, ONE'S BRAINS to survive.

For students with a knack for science, teaching and research have always been a most enjoyable career option. Simplistic additions in the sciences apart from the traditional disciplines of physics, chemistry, mathematics, zoology, botany etc may be made thus :

The world of the Inanimate–Computer, IT and Communications (Silicon Based)

Of the 103+ elements in the periodic table, two of the most abundant ones found naturally on the face of the earth have had the greatest influence in profoundly changing the way we live. The first is Silicon, which gave us the transistor, the integrated circuit, and large scale integration, the backbone of the computer revolution.

Computers have been with us for well over half a century. The first mainframe computer in the UK, named "Baby", developed at the University of Manchester Institute of Science and Technology before the Second World War, is on show at the Museum of Science and Industry in Manchester. It is a valve-based system, extremely bulky, occupying a large room, a misnomer for its nickname! For students struggling to do Ph. D. in the olden days, computing meant trudging to the computer center with a heavy deck of punched cards under the arm to submit for the job. Provided there were no punching errors in any of the cards, some output would be obtained in the next day. None of the present generation of students have seen or may have heard about the old Mainframes, e.g., the IBM 360/370 machines, which gave way to the desktops, laptops and now onto the palmtops. Languages have proliferated from the mother, FORTRAN into BASIC, COBOL, PASCAL, C, C++, Java et al. Internet has made our life simultaneously easier and difficult. E-mail has made communication easy. But all of us have to struggle with the mountain of junk mail every time we open our e-mail accounts. We also do not know how to cope with the huge volume of data floating on the web. This has given rise to a new area–DATA MINING.

Information Technology as an independent discipline has come into focus over the last decade or so. This is primarily the study or use of systems (esp. computers, communications etc) for storage, retrieval, processing and dispatch of information. It is finding widespread use in industry and leisure activities alike. A huge industry has spawned in Japan and UK–in Computer Games and Graphics–and has made inroads into Animation so much so

that animated movies like Lion King, Finding Nemo and Ice Age were multimillion–dollar hits. UK has a huge industry catering to Hollywood's demands. Virtual Reality and Multimedia promise to revolutionize the way we look at the world and see and feel everything around us.

WAP, Mobile phones, GPS, Blackberry–are changing the way we operate. Already airplanes fly by wire. Intelligent cars are being developed to be self-driven, by radar and GPS. We will be mere passengers!

The World of the Living-Biotechnology, Molecular Biology etc (Carbon Based)

Let us now look at the second element alluded to above, the humble Carbon. It is at the heart of the molecules that make life. We have all heard about the newer disciplines of biotechnology, molecular biology, genetics and so on.

The first recorded use of Biotechnology was by the Franciscan monks in wine making. Addition of yeast to aid fermentation of grape juice into wine made for an invigorating drink. No one really knows how long ago this took place. Since the elucidation of the structure of DNA by Watson and Crick in the 1950s, the science of Molecular Biology has matured. Now we have the Human Genome project looking into the genetic makeup of all of us on the face of the earth trying to find common threads. Drug design, stem cell research and gene splicing, *in-vitro* fertilization techniques, cloning etc are all part of the multibillion dollar global industry.

Fundamental physical phenomenon married to computing has given medical sciences a new look. Applications of advanced systems in medicine–NMR, CT SCAN, PET etc also require trained manpower. A new field, Medical Transcription, has also opened up, catering to the western medical system.

New ways to make smart materials

In the area of materials science & technology, Nanotechnology is a new entrant. Its potential is yet to be fully realized. Composite materials are finding use in diverse fields starting from high temperature applications like the space shuttle and guided missile systems to racing cars and tennis rackets. Advanced superalloys and shape memory alloys are finding applications in fields previously unheard of.

We should not forget the traditional industries too. So long as we live in cities and travel by road, air or sea, demand for civil engineers, mechanical engineers, electrical engineers, metallurgists, mining engineers, aeronautical engineers, marine engineers, architects, town planners & so on will be there. However they will be expected to be multi-skilled to succeed in the workplace.

One of the tenets of education is that it should provide skills for future citizens to be able to earn livelihoods. Science (and the allied field of technology) as has been discussed above needs a lot of trained manpower to advance. It is one of the fields in which a stimulating and sometimes lucrative career can be had. However, we should not frown upon the humanities, the creative arts, the fine arts, commerce and business which are equally viable career options. In fact, a case has be made out for literature and the arts for providing us with the finer raisons de etre for living. Without food for the soul, which literature and the arts provide, life may seem too pedestrian.

Parents should not be clouded in their judgment for choosing careers for their wards. A youngster securing 80% marks in Physics, Chemistry and Mathematics at the Higher Secondary/ISC stage while scoring nearly 70% in English may not be temperamentally suited for an engineering career. He or she may have a knack for literature and for him/her a degree in English followed by a Masters' in Mass Communications or Journalism may be a

more endearing and rewarding profession. I have come across very successful professional people who are not at all happy doing science or technology, but nevertheless having to do in order to earn a livelihood for the family. In their hearts, they pine for the fine arts. They were pushed by their parents into doing science/technology while they wanted to follow their heart and go in for the arts. Also, as disposable incomes grow in the hands of the workforce, leisure activities have come to the fore worldwide. And another career option has opened up in the Hospitality Industry. Hotel management, air hostess training etc could also be equally enjoyable for the right minded individuals.

And finally, whatever career one pursues, it should be chosen with care, keeping a person's inner calling in mind. The chosen career should be pursued with devotion, with passion and with steadfastness for success in the workplace and in life.

Dr. Ambar Ghose

"Every great and commanding movement in the annals of the world is the triumph of enthusiasm.

—R. W. Emerson

PRESIDENTIAL ADDRESS

THE PRESENT CONCEPT OF THE PHYSICAL WORLD

DR. H. I. BHABHA*, F.R.S

I express my gratitude to my scientific colleagues from all parts of India for the honour they have done me by electing me to a preside over the 38th Session of the Indian Science Congress. A peculiar accident of fate has brought about that the Congress over which I am to preside is being held in this Institute, where I worked for six years from 1940 to 1946 during the period of the last war and I have great pleasure in recording that they were six very happy and fruitful years in my life.

I also wish to express on behalf of all of you, and myself our great appreciation of the fact that our Prime Minister has decided to be present with us on this occasion. That he flew to Bangalore yesterday, and will fly immediately after this meeting to Bombay and thence to England on a mission of prime importance, is a measure of his great personal interest in the development of Science in India. Were it not for this, scientific development would receive much less encouragement and support than it does, in spite of the fact that only Science and technology can solve the immense problems facing the country, the problems of food shortage, low standard of living and illiteracy.

The multitude and variety of the pheomena of Nature, which still fill us with astonishment, must have bewildered and awed primitive man. It is not strange that he should have sought, on the one hand, to gain some control over them by investing them with anthropomorphic personality which could be influenced by entreaty and prayer, and on the other to alter his immediate physical environment so as to provide some little shelter or margin of safety against the more hostile acts of nature. This urge eventually led to the early civilizations and the later developments following from them. These civilizations depended on a considerable body of parctical knowledge acquired empirically, and some highly developed arts and crafts. A few crucial inventions such as that of the horse harness in China, or of the zero in Mathematics in India, had a profound influence on their historical development. But with a few notable exceptions, scientific activity in the modern sense did not begin till the Italian renaissance.

Towards the end of the fifteenth century Leonardo da Vinci wrote in one of his manuscripts which is now in the library of the Institut de France (G 96 v),[1]

> "There is no certainty where one can neither apply any of the Mathematical Sciences nor any of those which are based on the Mathematical Sciences"

This was not the mere expression of a specialist extolling his own subject, and I quote this sentence because it was written by one who is recognised as perhaps the most versatile genius the world has known, one who had a greater mastery of all the variours arts and sciences of his time than anyone since. It expresses the new spirit of the times, a

* General President, Thirty-Eighth Indian Science Congress held during January, 1951 at Bangalore.

spirit which was to lead eventually to that vast development which is Modern Science and technology. "The Mathematical Sciences" for Leonardo consisted of what had been handed down of Greek Mathematics, while by the Sciences based on the Mathematical Sciences he understood the applications of Geometry to Optics and Mechanics. What Leonardo wished to emphasize, I feel, was that as long as an observations of a natural phenomenon remained couched in qualitative terms it would not be definite enough to build on, and only by introducing accurate measurement and quantitative relations into it could one be certain that it was right or wrong within the limits of accuracy of the measurements. Some four centuries later Lord Kelvin was to say.

> "When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind."

Once this general approach received fairly wide acceptance, the development of Science in the modern sense was inevitable.

It was found quite soon that certain properties, which could be stated in terms of exact measurement, were common to many objects. In certain cases, therefore, it became possible to state a general property without specifying the particular object to which it belonged. Such general properties could then be regarded as laws or regularities of nature which all objects of a certain type satisfy. One such regularity or law of nature was the one discovered by Archimedes, that the loss in weight of a body immersed in water is equal to the weight of the water displaced. Archimedes was indeed one of shining forerunners of Modern Science. It is nevertheless interesting to note that his law is a law in statics. Laws involving the motions of objects were to come much later. An example of a dynamical law is the regularity discovered by Galileo, that all heavy bodies fall the same distance under gravity in a given interval of time irrespective of their weight. Other regularities of the same type, but which involve more complicated relations between the objects, are the three laws of Kepler on the motion of the planets.

It is important to note that laws or regularities of nature of the type just mentioned are merely empirical statements of properties observed to be common to a large number of objects. They are all unconnected with each other. In order to connect up such regularities with each other it may be necessary to formulate certain more abstract principles or postulates from which the various observed regularities can be deduced.

Newton's fundamental laws of motion exemplify this new approach. Consider his first law, which reads.[2]

> "Every body continues in its state of rest, or of uniform motion in a right line unless it is compelled to change that state by a force impressed upon it."

Assuming that we understand intuitively what is meant by rest or uniform motion in a right line, we may well ask ourselves what is meant by an impressed force. It we turn to the definitions which Newton has placed a few pages at the beginning of his *Principia*, we find the answer in Definition IV :

> "An impressed force is an action exerted upon a body, in order to change its state, either of rest, or of uniform motion in a right line."

Expressed in this way Newton's first law would appear to be a tautology : One states that a condition A exists unless interfered with by the existence of B. While B is defind to be present when the condition A is interfered with. It is not the purpose of this discussion to minimize in any way Newton's achievement which is one of the greatest monuments in the history of Science, but to understand the real nature of his laws. Let us

assume that force can be defind in some other way than in the above definition so as not to make the first law a tautology. One might then imagine the first law to be a statement which we arrive at from direct observation through some process of induction. For example, in commenting on his first law Newton writes.

> "Projectiles continue in their motions, so far as they are not retarded by the resistance of the air, or impelled downwards by the force of gravity. A top, whose parts by their cohesion are continually drawn aside from rectilinear motions, does not cease its rotation, otherwise than as it is retarded by the air. The greater bodies of the planets and comets, meeting with less resistance in freer spaces, preserve their motions both progressive and circular for a much longer time."

The inference in that one may conclude by induction that if we could take a body into space to a very great distance from all other material bodies then it would either remain at rest or move in uniform motion in a straight line. We know today that such an induction cannot be made, and may indeed not even be true for the actual world. While it is possible mathematically to assume a world in which Newton's laws are strictly true, it is equally possible mathematically to think of worlds in which they are not. This analysis shows us that strictly speaking *Newton's laws of motion and gravitation are abstract mathematical statements which he quite rightly calls axioms*. And if they came to be regarded as objectively true it is because the behaviour of objects which could be deduced from them by mathematical reasoning agreed with our direct observations. For example, one could deduce from Newton's laws the regularity observed by Galileo concerning the fall of bodies, the three regularities observed by Kepler on the motion of the planets, and a host of other phenomena. Quite appropriately, his epoch-making work was called "*The Mathematical Principles of Natural Philosophy*."

"The great importance of the contributions of Newton to the development of Physics is that it introduced a new approach into Science. It led to the acceptance of the position that the ideas which are to be regarded as fundamental for the understanding of nature are certain abstract concepts or postulates which cannot be proved directly, and not the directly observable regularities of nature which can be deduced from them. This position was accepted because it allows one to order different empirically found regularities of nature into a unified logical scheme which would not otherwise be possible."[3]

"A consequence of this approach is that any newly discovered fact of nature which does not fit into the existing scheme of Physics may necessitate a complete change of the fundamental postulates. Since, however, the old postulates were such that a very large body of observed facts about nature could be deduced from them, it follows that they must still have a restricted validity under certain circumstances, and be deducible as approximations from the new postulates. Although, therefore, every new discovery which does not fit into the old scheme necessitates a complete change of the fundamental postulates, the change is always from a certain set of concepts to a set of more general concepts. As one goes deeper and deeper into the understanding of nature by coordinating all the known facts into one scheme by the use of wider concepts as the basic postulates the old fundamental postulates become, in a sense, a part of the superstructure, taking a place in between the new fundamental concepts and the directly observed regularities of nature.

As an example of this process of generalization of the basic concepts, one may recapitulate the well-known development from the pre-relativity concepts of an absolute space and an absolute time to the more general concepts of the unified space-time of the theory of relativity. In pre-relativity, Physics, in recognition of the arbitrariness of the orientation of the three axes of the frame of

reference, the natural laws were formulated so as to be invariant for all rotations of the space axes. Time, on the other hand, was assumed to be absolute and the same for all observers. However, in consequence of the observation that the velocity of light *c* is the same for all observers in uniform motion relative to each other, the idea of absolute rest has had to be discarded leading to the principle of relativity, which demands that the laws of nature should be so formulated as to have the same form for all observers moving relative to each other with uniform velocity. Stated mathematically, the special theory requires that the fundamental equations shall be invariant for all transformations of the Lorentz group, where as in pre-relativity Physics the laws were only invariant for all transformations of the three dimensional rotation group, which is a subgroup of the Lorentz group."

The above example also serves to show how the basic concepts of a theory may be radically changed, while still retaining most of the notions of the earlier theory, but recognising them to be of limited validity, true not universally but only in certain circumstances. Thus, the absolute distinction between a time interval and a space interval in pre-relativity Physics is replaced theory by the absolute distinction between time-like and space-like intervals, while the notion of the absoluteness of time of the earlier theory is seen to be approximately correct in the new theory for a group of observers moving relative to each other with velocities small compared with that of light.

A widening of the basic concepts automatically reduces the amount of arbitrarines in the theory. For example, in pre-relativity theory the force between two bodies could be taken to be entirely arbitrary. In relativity theory, on the contrary, the force has necessarily to be conveyed through the medium of a field. The basic differential equtions which any field has to satisfy in relativistic theory are drastically restricted in their variety by the same requirement of relativistic invariance, so that there is a very limited freedom in the choice of the form of the force which can be exerted between two particles.

When a Science reaches an advanced stage, as Physics undoubtedly has today, the facts which can be discovered by direct observation become more and more meagre. We may expect, for example, to be able to discover by experiment the masses of the various types of elementary particles, the different processes which they undergo, their general behaviour in passing through substances of different types and so on. It is, however, inconceivable that an equation like the Dirac equation could be deduced by direct observation in some such way as Maxwell deduced the questions of the electromagnetic field. There is, therefore, no other path open to us but to proceed along the lines I have indicated above. In such an advanced stage however we have certain compensating advantages. We have a number of theories to fall back upon with the knowledge that each correctly describes a large body of experimental evidence in certain circumstances. We can, therefore, attempt to proceed by evolving new theories which reduce to the prviously known ones in the circumstances in which the latter are known to be correct. As I have stated on a previous occasion then "The aim of Theoretical Physics must be to find a complete set of mutually consistent mathematical postulates or axioms from which the properties of nature, meaning thereby the result of every conceivable experiment, can be deduced in the form of a series of theorems. It is, however, necessary in order to achieve the last step of comparing the mathematical statements of the theorems with the results of observation that the basic mathematical postulates must be supplemented by a set of presciptions about the interpretation of the mathematical formalism. It is clearly not sufficient that the postulates should be consistent and their correctness from the point of view of Physics can not be demonstrated by an agreement between the deductions and the results of experiment."[4]

It is most important to distinguish this approach from the one which assumes that one can arrive at the laws of nature by pure thought and epistemological reasoning. The latter approach has neither met with much success, nor proved particularly fruitful in promoting an understanding of the physical world. In our approach, on the contrary, we recognized that it may be possible to build many logically consistent theories which have nevertheless nothing to do with the actual structure of the physical world. Theories in Pure Mathematics provide many such example. If any set of axioms or postulates can claim to correspond to reality it is becasue the deductions from them stand the test of agreeing with the results of experiment.

We must turn now to review the development of our picture of the physical world resulting from recent discoveries. It had already been established by the end of the last century that the multitude of substances in nature are all made up by the chemical combinations of a certain number of basic substances called the chemical elements. The smallest unit of a given chemical element was called an atom. The combinations of these atoms, either of the same element or of different elements gives rise to chemical compounds, which compose the body of all the substances that we meet in nature.

Investigation on the conduction of electricity through gases led Thomson towards the end of the last century to the discovery of the fact that this conduction could be attributed to a particle of negative charge having always the same ratio of charge to mass irrespective of the substance under investigation. Moreover, this mass was some thousand times smaller than that of a positive ion. Subsequent researches have established the fact that there is a smallest unit of negative electricity, smaller sub-divisions of it not being found in nature, and that all negative electricity appears in integral multiples of this smallest unit, which is now denoted by e. Thus it came to be established that there was a type of particle, called an electron, which always possessed the same negative charge e and the same mass m, which was somehow contained in atoms, and whose behaviour was responsible for the phenomenon of electricity.

Since an atom is an electrically neutral body, it follows that if electrons are contained in it, then it must also contain an equal amount of positive charge. It was not clear at the time how the electrons and the positive charges of electricity were distributed in an atom. For example, were the electrons embedded in a uniform medium of positive electricity, rather like plums in a cake ? Or were they like planets revolving round a sun of positive charge ? The answer to this important question was furnished by Rutherford in 1911. He showed by a study of the scattering of α-particles that the true picture of the atom was to consider it like a solar system in which the electrons move like planets round a heavy centre called the nucleus in which all the positive charge and most of the mass of the atom is concentreated. Since the negative charge inside the atom depended on the number of electrons in it and was an integral multiple of e, the positive charge on the nucleus had likewise to be an integral multiple of e. It was soon established that the number of units of positive charge on the nucleus determined the chemical properties of the atom, and that there were 92 such chemical elements ranging from the lightest, hydrogen, to the heaviest, uranium, with 1 to 92 positive units of charge on the nucleus respectively.

The mass of the nucleus of the lightest element, hydrogen, containing just one unit of positive electricity, was found to be always precisely the same, and some 1840 times the mass of the electron. Since this nucleus of hydrogen never broke up into smaller fragments, it became convenient to regard it as a new type of fundamental entity, a new elementary particle, called a proton.

Further researches showed that the mass of any atom was always almost precisely an integral multiple of the proton, which its charge was a

smaller integral multiple of the mass of the proton, these facts led one at the time to accept a picture of the nucleus which made it appear to be made up of protons and electrons only. The number of protons was sufficient to make up the mass of the nucleus, while a certain number of electrons were added inside the nucleus to neutralize the charge of some of the protons and make the total positive charge equal to the actual charge of the particular nucleus. Thus round about 1930, our picture of the physical world appeared to be remarkably simple. The whole material world was thought of as made up of just two types of elementary particles, protons and electrons. By suitable arrangements of these one built up the atoms of the chemical elements. And from suitable arrangements of the latter every other material thing that was found in nature. Light, or in more general terms, electromagentic radiation, or photons, and gravitation, were the only two other physical entities found in nature.

A scientist at that time could have thought, as many did think, that when one knew the mathematical laws governing the behaviour of these four elementary types of physical entities, the protons, electrons, photons and gravitation, one would know everything of a fundamental nature that there was to know of the physical world, and Physics in principle would be a subject which had reached its destination. The subsequent development of the last twenty years shows us how far this belief was from the truth. It shows in a striking manner that however great the successes of a theory, unless this success is complete and total, it is always possible that something very important may have slipped through the net. The apparently small but persistent difficulties or inconsistencies in a theory, or small discrepancies between theory and observation, may be essentially unbridgeable within the framework of the basic concepts of that theory and yield the clue to new ideas.

What were these difficulties of which I have spoken ? In order to make a body spin about itself like a top we have to impart to it energy and something called angular momentum. It is found that like electricity, which occurs in nature only in integral multiples of the basic unit *e*, so angular momentum also occurs only in integral multiples of a basic unit which is just Planck's constant divided by 4π, that is $h/4\pi$. Spectroscopic analysis has shown that the two elementary particles, the proton and the electron, each possesses an intrinsic angular momentum or spin of on unit which arises, so to speak, from its spinning about itself like a top. On the other hand, angular momentum which arises from one body moving bodily round another is always an even integral multiple of the basic unit, that is either zero or two or four etc. times $h/4\pi$. Spectroscopic analysis shows that the spin of a nucleus containing an odd number of heavy particles, that is an odd number of protons in our picture is always an odd multiple of the basic unit much as if the electrons in the nucleus did not contribute to the spin at all, unlike the electrons outside the nucleus each of which must contribute an odd number of units due to its intrinsic spin and its bodily motion. Secondly, both protons and electrons satisfy a law which the theoretical physicist calls Fermi-Dirac statistics. It can be shown then that a nucleus containing an odd number of protons plus electrons must also satisfy the same statistics so that is a molecule composed of two such atoms only certain spectral lines must appear and not others. Experiment again shows that the statistics of such nuclei appear to depend only on the number of heavy particles in the nucleus and not on the total number of protons plus electrons in our picture. In fact all the nuclei seem to behave as if the electrons which were supposed to be in them only manifested their electric charge but neither their spin nor their statistics. A bold attempt to face this difficulty would soon have led one to the view that nuclei were not composed of protons and electrons but rather of protons and some hitherto unknown particle having to a very high degree the same mass as the proton, the same spin and satisfying

the same statistics. A particle of this description was discovered by Chadwick in 1931 and was called neutron. It had to be accepted as a new elementary particles and not a composite structure made up of a proton and an electron for the same reason that prevented us from thinking consistently of the nucleus as being made up of protons and electrons. It immediately led to the acceptance of the picture that all nuclei are composed of only two types of particles, protons and neutrons. The number of types of elementary particles was thus increased by one.

The acceptance of the neutron as an elementary particle, however, introduced a new feature into our concept of the elementary particles. For it had been known for a long time that certain nuclei, as example those of the radioactive elements, emit electrons every now the then. One can only fit this fact into the picture by assuming that when such an electron is emitted from the nucleus it is in fact newly created in the process and that simultaneously a neutron in the nucleus changes into a proton. Thus we have to admit the possibility that while the elementary particles are not composite, and that as long as they exist they are immutable with absolutely constant properties, nevertheless there are occasions when one or more such particles can disappear altogether with the simultaneous creation of another set. For example, a neutron may disappear and give place to a proton and an electron. Since the neutron, proton and electron all have a spin $h/4\pi$ and the bodily motion of these particles can only contribute an even multiple of $h/4\ \pi$ the conservation of angular momentum and statistical properties comples us to postulate that there must be yet another elementary particle called, a neutrino by Pauli, which possesses no charge, a mass negligible compared with that of the electron and a spin of one unit ($h/4\pi$).

In 1931, Anderson reported a photograph which seemed to be that of a particle of the same mass as an electron and having one unit of positive instead of negative electric charge. The experimental advance of making the cosmic rays themselves take their own photographs instead of taking photogaphs at random in a Wilson Chamber then enabled Blackett and Occhialini soon afterwards to discover a new phenomenon called cosmic ray showers. Although cosmic rays are a relatively rare event Blackett and Occhialini showed that very frequently many such rays occurred in a shower and subsequent work has demonstrated that such showers of particles are produced by cosmic rays when they pass through matter, as for example sheets of lead placed in the Wilson Chamber. Blackett and Occhialini showed that their showers contained not only the usual electrons but a comparable number of electrons with the opposite charge. With this, the existence of the positron, as this new particle was called, was established.

The existence of the positron could be understood immediately in terms of an equation for the electron which Dirac had put forward in 1928 and which combined in it for the first time the ideas underlying the theories of relativity and quantum mechanics. Dirac had already shown that certain apparent difficulties in his theory could be understood as expressing on the one hand the existence of a particle of equal but opposite charge to that of the electron and on the other the possibility of pair of such positive and negative particles being created by the materialization of energy or of their annihilation with the transformation of their mass energy into radiation. Subsequent experiments have fully confirmed the correctness of these basic processes predicted by the theory. Nevertheless, a consequence of this theory was that no electron or photon of even the highest energy could penetrate large amounts of matter, while a growing body of evidence from cosmic ray experiments indicated that particles which looked like electrons did in fact penetrate great thicknesses of matter. Thus, there seemed to be evidence that quantum theory failed for very high energy electrons, while at the same time there was no theory to explain the phenomenon of the cosmic

ray showers. It was only when the Cascade Theory put forward by Heitler and the present author showed that the existence of cosmic ray showers and the behaviour of the soft component of cosmic rays in the atmosphere and in dense substances could be explained on the basis of quantum theory was it possible to conclude that the electron-like tracks of particles which did not behave completely like electrons nor like protons must be due to a new type of partcile having an intermediate mass. Thus, the existence of a new particle called the meson, with a mass some 204 times that of the electron came to be established in 1938.

A particle with a mass of this order or magnitude had already been envisaged by Yukawa in 1935 in an attempt to explain the short range nature of nuclear forces, that is the forces between two particles in the nucleus of an atom, as for example a proton and a neutron. The observed mesons, therefore, came to be regarded as the agency responsible for nuclear forces, and in accordance with this picture the beta decay was then considered as due to the decay or virtual mesons emitted by nuclei. Research carried out since the end of the war has the demostrated that the picture was again not as simple as it was then supposed to be. Firstly, although the decay of mesons into electrons has been confirmed by experiment, more accurate experiments have shown that the electrons are emitted with a continuous distribution of energies and not with a sharply defined energy as originally supposed. This inevitably leads to the conclusion that in the process of the decay of a meson into an electron not one but two neutral particles must be emitted.

Secondly the identification of the observed cosmic ray mesons with the particles responsible for nuclear forces inevitable requires them to have a strong interaction with nuclei, whereas the mesons observed in cosmic rays were seen to penetrate large amount of matter with but a very weak interaction with nuclei. A serious attempt to face this difficulty might easily have led one to the conclusion that the particles responsible for nuclear forces were not in fact the observed mesons. This conclusion was, however, not accepted until the studies by Powell and his group of the tracks of cosmic ray particles in special photographic plates had shown that there are in fact two types of mesons with two different masses, and that the one type decays into the other with a period of about one hundred-millionth part of a second. The two types of mesons are now known as pi and mu mesons respectively. The meson generally seen in cloud chamber photographs are the mu mesons whereas the pi mesons are the ones which are now identified as being responsible for nuclear forces. In accordance with this picture one would have to attribute and even integral spin (in units of $h/4\pi$) to pimesons. The mass of pimesons ; or pions as they are called in short, as determined from a study of the density of the tracks they produce in special photographic plate appears to be in the neighbourhood of 286 times that of the electron.

More recent experiments with the large cyclotron at Berkeley and elsewhere have led to the discovery of yet a new elementary particle a neutral pion, that is a pion with practically the same mass as the charged point but with no electric charge. Although such a neutral pion interacts strongly with nuclei, nevertheless it cannot be observed directly in a photographic plate or in a cloud chamber due to the fact that it does not posses an electric charge and therefore does not ionize. Despite this, however it has been possible to ascertain its mass with very great accuracy. The reason is that a neutral pion decays spontaneously in a time of the order of a hundred million-millionth part of a second into two gamma rays. Experiments at Berkeley have shown that when a negative pion hits a proton the latter is transformed into a neutron with the emission of a quantum of radiation carrying away the entire mass energy of the pion, that is some 140 million electron volts. But there is another alternative which can result from this collision, namely the conversion of the proton into neutron with the emission of a

neutral pion. The neutral pion then decays immediately into two photons with roughly half the energy of the original pion namely seventy million electron volts. However, the neutral pion that is emitted decays while in motion thus resulting in a certain spread in the energy of the two gamma rays. From this spread one can calculate the kinetic energy of the emitted neutral pion and from this again the difference in mass between the neutral and the negative pion. In this way one finds that the mass of a neutral pion is only a few electron masses less than that of a charged pion.

Rossi has shown that in cosmic rays some two-third of the total energy is converted into charged penetrating particles while one-third disappears into neutral charged particles. Since charged pions can have a positive or a negative charge, it follows from this that the interactions of a positive, a negative or a neutral pion with a nucleon are roughly of the same magnitude.

I now come to particles whose existenceis highly probably though not absolutely certain. In 1947, Rochester and Butler in Blackett's laboratory reported certain unusual events which they had observed in a Wilson Chamber. They occasionally saw the tracks of charged particles which seemed to show an abrupt change in their direction in the gas of the chamber. They showed that it was difficult to interpret these tracks as due to scattering the gas for two reasons. Firstly no recoil nucleus in the gas was visible. Seocndly it would be difficult to understand why a particle should have such a great likelihood of collision while passing through the rarified medium of a gas and yet pass through dense matter like a lead plate without suffering any collision at all. They put forward the explanation that these forks were due to the spontaneous decay of a charged particle into another charged particle and a neutral one. Experiments at present being carried out at Pic-du-Midi and Jungfraujoch are rapidly producing further evidence that this interpretation is correct. It would be consistent with the present evidence to interpret the charged particle resulting from the decay as a pion. Whether all the original particles are of the same type is not a question that can be answered at present. Most of the particles appear to have a mass in the neighbour-hood of 800 times the electron mass. But there is some indication that there may also be particles of this type with masses more than a thousand times that of the electron. Rochester and Butler and more recently Butler and his collaborators have also produced evidence to show that neutral particles of corresponding mass exist which seem to decay into two charged particles in the same ways.

Lastly one should mention the case of a particle observed by Powell and his group and called by him a tau meson, which came to the end of its range and emitted three mesons of which one is certainly a pion.

We see now that at least nine different types of elementary physical entities exist in nature, while the existence of two more is almost certain. While experiments may give us information about the masses of these particles, their mutual interactions and the processes in which they take part, it seems inconceivable that an experiment would enable us to deduce directly the mathematical equation describing the behaviour of any such particle. We can only hope to set up the mathematical equations governing the behaviour of these particles by taking as our guides certain well-known principles, as for example the principle of relativity and the ideas underlying quantum mechanics. Even such a clearly defined property as the spin of an elementary particle is not something we can hope to measure directly in the case of particles like the meson but must infer it from considerations of the processes in which they take part, by comparing the behaviour of particles of different spins as predicted by theory with the experimental observations.

The circumstance that there are a dozen different types of elementary particles in nature would lead us to expect that there may be many more, and indeed with out present knowledge we cannot

exclude the possibility that there may be an infinite number of them. This does not mean, however, that we shall never be able to obtain a complete description of them all. There are, for example, an infinity of lines in the spectrum of hydrogen and yet we possess today not only a formula which in one neat expression contains the energies of all these lines but also a mathematical theory which allows us to calculate all the stable states of the hydrogen atom, other properties such as the scattering of electrons by atoms, their creation by photons, and even more complicated properties like the nature of the chemical bond between two hydrogen atoms. It is, therefore, quite possible that with increasing knowledge we may be able to find the formula which gives us the masses of all the elementary particles and the general principles which will allow us to deduce the equation satisfied by a particle of any particular mass.

Lorentz at the beginning of this century regarded the charge of an electron as a property of the electron and tried to explain its mass as due to the energy of the electromagnetic field associated with that charge. The idea that the mass of the elementary particle is wholly of field origin has had to be abandoned today because we know a number of elementary particles all having the same electrical charge but different masses. On the other hand one is faced with the fact that whenever the electromagnetic field interacts with any other type of physical entity, be it an electron, a meson or a proton, then the measure of this interaction, namely the charge of the particles, is always the same. From a phenomenological point of view, therefore, we would be more justified today in considering the electric charge *e* of an elementary particle as a property of the electromagnetic field rather than of the particles, while considering the mass of the particle as an intrinsic property of the particle, unconnected with its interaction with the electromagnetic field. Our approach to this problem today should therefore be just the opposite of that of Lorentz. If the electric charge *e* is to be considered as a property of the electromagnetic field, as I have suggested, then since the only unit associated with the field in which it could be measured is the square root of Planck's constant multiplied by the velocity of light, we should consider this ratio, or its square e^2/hc to be an intrinsic property of the electromagnetic field. The dimensionless constant e^2/hc would then appear to be a number associated with the electromagnetic field and not a universal constant of nature, of the same status as Planck's constant *h* or the velocity of light *c* which enter into the description of other elementary particles.

It is clear that we are now penetrating into a new level of nature which was practically unknown some twenty years ago. I have pointed out earlier that although there may be an infinite number of types of elementary particles, nevertheless this fact in itself does not necessarily force the conclusion that we will never be able to describe nature fully or to explain the physical world exhaustively. On the other hand we can not be certain with our present knowledge that a complete mathematical theory of the physical world can be faced with a situation in which we could never hope to give an exhaustive description of everything there is in nature, but only to extend with the flow of time the region which we had explored and understood.

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SAFFLOWER-AN ANCIENT WONDERFUL CROP

Shraddha Purey and N. C. Sharma*

Safflower has been grown in past mainly for ornamental, medicinal and cosmetic purposes. Presently, this crop has become important mainly due to edible oil, which is obtained from its seeds. The oil is polyunsaturated which is helpful in lowering blood cholesterol. It is specifically relevant to India being the largest producer of safflower in the world.

INTRODUCTION

A wide range of plants have been under cultivation for various purposes. There are more than 6000 such crop species, but only a few are used as staple crops. In spite of major contribution of these crops, contribution of some minor species cannot be ignored. Safflower (*Carthamus tinctorius* I..) is one such oldest crop. It continued to remain a minor crop grown on small plots for growers' personal use. Ethnic names of safflower are-Kusum (derived from Sanskrit word "Kusumbha"), Zaffrone, Alazor, Azafran, Benibana, Qurtum, Heang Lan, Hung-Hua, Hung Lan Hua, etc[1]. It is native to the old world and it occurs naturally in Mediterranean Region, North Eastern Africa and South Western Asia to India. It is cultivated in India mainly for oil (obtained from seeds) and reddish-orange dye (obtained from flowers). The seeds are also used as birdseed. From the ancient times, safflower flowers had been used in preparations of Ayurvedic medicines in India, Europe, Japan and China. Its medicinal uses in China became more widely known all over the world, because it is grown there in large scale exclusively for flowers (which are used to cure many diseases and as tonic tea). This led to revival of this ancient crop in last few decades. Based on the geographical distribution, anatomical and biosystematic information, a new classification system has been proposed by Lopez-Gonzalez[2]. Accordingly newly circumscribed genus *Carthamus* contains only annual species with 2n = 20, 22, 24, 44 or 64 including allopolyploid species. The genus *Carthamus* has been subdivided into sections, viz. Section **Carthamus** (24 chromosomes), Section **Odonthagnathius** Hanelt (20-22 chromosomes) and Section **Atractylis** Reichenb with presumed chromosome number x = 11). Section Carthamus has 12 pairs of chromosomes (2n = 24) and includes following species viz. *C. curdicus* Hanelt, *C. gypsicola* IIj., *C. oxyacanthus* Beib., *C. palaestinus* Eig, *C. persicus* Willd. and *C.tinctorius* L. Section **odonthagnathius** (DC.) Hanelt has 20 or 22 chromosomes and include following species : C. *boissieri* Halacsy, *C. dentatus* Vahl, *C. divaricatus* Beguinot and Vacc., *C. glaucus* Bieb., *C. leucocaulos* Sm. and *C. tenuis* (Boiss. & Bl.) Bornm. Section **Atractylis** Rechenb., with presumed basic chromosome number of 11, including species viz *C. lanatus* L., *C. creticus* [*C. baeticus* (Boiss. & Reuter) Nyman] and *C. turkestanicus* M. Popov.

Knowledge of species relationship is essential for crop improvement. The wild and weedy relatives

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of *Carthamus tinctorious* L. have been investigated to ascertain the cytogenetic and taxonomic relationships between them. But still information is lacking about the donor parents of *Carthamus tinctorious* and the genetic distances among possible donors in relation to the recipient. A number of wild species such as *C. persicus* (syn. *C. flavescens*), *C. lanatus, C. oxyacanthus* and *C. palaestinus* were identified as good sources of resistance and tolerance to various disease and pests[3]. Some characters like drought hardiness and resistance to alternaria leaf blight are partly incorporated into varieties, which are used for cultivation through repeated back-crossing and selection methods to develop varieties which are under cultivation.

USES OF SAFFLOWER

The whole plant of safflower is useful. The seeds yield polyunsaturated edible oil, which lowers blood cholesterol. Its oil is also used in paint and varnish industry. The flowers are used for extracting carthamin dye (yellow or orange), which gives natural colour to food products, cosmetics and clothes.

Extract of florets is used in treatment of cardiovascular diseases. It also relieves pain, eliminates blood stasis, hypertension, spondylosis, angina, constipation, hyper cholesterlemia, menstrual problems and also helps in conception. It is also used as laxative diaphoretic, diuretic, sedative, nervine, purgative, antispasmodic and antirheumatic. It is excellent for curing stomach ailment. It helps in digestion and increases appetite. It also relieves renal colic problems. Tender shoot and leaves are used for preparing vegetables. Dried straw and stalks are used as fodder and as fuel for biomass gasifiers to produce energy and char for soil conditioning.

CHARACTERISTICS OF CROP

Safflower is a drought tolerant crop. Its tap root can penetrate upto a depth of three meters, if subsoil temperature and moisture permit. It is salt tolerant too. Safflower is self-pollinated with some cross-pollination. Dense root structure can improve soil tilth and porosity. Roots also add to organic matter, improving soil water holding capacity.

Safflower is grown in many countries such as Australia, Bulgaria, Canada, China, Ethiopia, Germany, Mexico, Romania, Russia, Slovenia, Spain, Switzerland, Turkey and the United States of America. India is the largest producer of safflower in the world with a production of 1.57 lakh tones (2002-2003) with average productivity of 450 kg/ha[4]. In India it is mainly grown in Maharashtra, Karnataka and parts of Andhra Pradesh, Madhya Pradesh, Orissa, Bihar, etc. Maharashtra and Karnataka are two most important safflower growing states.

It is grown in rabi i.e. winter season from October/November to March/April. It is also grown as an intercrop with cereals such as wheat and sorghum. Safflower seeds have hard covering. Therefore, before sowing seeds either a moist farm seed bed should be prepared or seed soaked in water should be sown. After this, irrigation is not needed. Germination will not begin until soil temperature exceeds 5ºC. Each seed germinates and produces a central stem that does not elongate for two-three weeks and develops leaves near the ground in a rosette stage. Safflower is a thistle like annual herb. It has strong central glabrous-branched stem which grows to a height of 30-90 cm. The leaves are alternate, sessile, ovate-lanceolate with or without spines on the margins. Flowers are yellow or orange arranged in heads of about 2.5-25 cms across. Safflower is very susceptible to frost injury from stem elongation to maturity. The slow growth of seedlings in early winters often results

in weedy crop. The strong central stems with variable numbers of branches, grow from 30 cm to 1 m or more depending on environmental conditions. This crop is drought resistant since it has tap root that can grow up to 3 m if subsoil temperature and moisture content are suitable. Stiff spines develop on leaf margins of most varieties at about the flower bud stage so it becomes difficult to walk through the fields and later on picking flowers. Branches usually produce 1-5 flower heads, which are about 8-10 mm in diameter and are usually yellow or orange in color. Seed oil content is usually between 25-45%. Seeds are enclosed in the head even after maturity, which prevents shattering before harvest and it also prevents bird damage. Safflower is ready to be harvested when most of the leaves turn brown and very little green remains on the bracts of the latest flowering heads. The stem should be dry, but not brittle and the seeds be white. It can be thrashed manually. This crop should be harvested as soon as it matures so as to avoid seed discoloration or sprouting in the head due to rains.

Viability of seed is maintained best by storing it at low moisture and low temperature. In dry environment safflower seeds are stored with 6-7% moisture (moisture should not exceed 8%). Based on the International Board for Plant Genetic Resources guidelines, medium term storage can be accomplished by storage at 4ºC and 30% relative humidity. Long-term storage can be affected at –20ºC.

ENVIRONMENTAL REQUIREMENTS FOR SAFFLOWER

This crop responds best in areas with warm temperature and sunny dry conditions during the flower and seed filling periods. Yields are lower under humid or rainy conditions because seed set is reduced and the occurrence of leaf spot and head rot disceases increases. So areas where heavy annual rainfall is recorded or it is more than 38 cm, its cultivation is not recommended.

It grows best in deep fertile, well-drained loam soil with good water holding capacity. It can also grow in coarser—textured soils of lower water holding capacity, when it is properly rainfed and moisture content is adequate. Depending on severity, soil salinity lowers germination and decreases seed yield and oil percentage. It can be grown on fallow land or in rotation with small grains. Soil tests are necessary to correctly determine whether any additional soil nutrients are required. The amount of fertilizer needed for safflower production depends on the yield goal ; its position in rotations and other crops used in rotation. Safflower roots are deeper than other crops which help plant to utilize nutrients that may be positionally unavailable to other crops such as corn, sunflower, etc.

TYPES OF VARIETIES

There are two types of safflower varieties viz. with spines e.g. JSF–1, Nira etc. and without spines such as JSI–7, JSI–73, NARI–6, NARI–NH–1 etc. Spineless varieties are preferred as their flowers can be easily hand picked at the time of harvesting. Safflower is poor competitor with weeds, so weed control program is required for its cultivation.

FUTURE PROSPECTS

There is need to develop new varieties of safflower which are spineless and resistant to diseases. Germplasm banks should be set up containing genotypes with resistance to various diseases and having high adaptability. Wild species which are closely reated to cultivated varieties should be targeted for incorporating resistance to various diseases. Development of high yielding hybrids using mechanisms like genetic male sterility etc. merit due consideration which may pay rich dividends.

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DO YOU KNOW ?

Q1. What is cacaphobia ?

Q2. There are some plants which have no leaves. What are they called ?

IS ALGAE OIL FUEL OR NUTRITION ?

Scott D. Doughman[1,2] and Srirama Krupanidhi[1]

Very high levels of triglyceride poly unsaturated fatty acid side chains may be the obscure reason that even after 20 years of extensive studies, algae research has yet to strike oil for fuel commercialization. Poly unsaturates can accelerate oxidation, polymerization, and gum formation during combustion. On the other hand, *C. cohnii* and *Schizotrichium* sp. microalgae omega-3 oils have been sold in the open market for many years as bioactive nutraceuticals. Thus, the near term value of microalgae oil may not be cheap fuel. Currently, the value has been realized as vital nutrition.

INTRODUCTION

Edible vegetable oils are now commonly converted to biodiesel by chemical modification. This places upward pricing pressure on food oil resources. Much excitement has been created around algae oil production for biodiesel. First, algae oil would not compete with food oil. Second, algae oil promises the potential for high yields of oil from a renewable resource. However, not a drop of algae oil biodiesel has been sold, mainly due to one unique biological property, i.e. very high levels of poly-unsaturated fatty acids.

Not all oils are created equal and the concept of algae oil for biodiesel is assumed valid by many non-scientists and scientists alike. But even after 20 years of extensive studies, algae research has been unable to solve the problem of fuel commercialization. This may be because algae oil generally fails the certification indicators for levels of triglycerides, moisture, insolubles and unsaturation. These quality controls are included in the strict European and US biodiesel standards[1]. Polyunsaturates can accelerate oxidation, polymerization, and gum formation upon combustion. Breakdown and precipitation of insolubles during storage is another concern. Because algae are not a seed crop, the oils have a lower total triglyceride percentage and higher moisture content. Algae oil for fuel simply does not yet pass the test.

Fortunately, the abundant poly unsaturated fatty acids in certain edible algae oils are long chain fatty acid omega-3s. Omega-3s are nutritional medicine and are becoming increasingly important for treating one of the largest nutritional deficiencies on the planet[2]. Omega-3 deficiency, due to modern dietary habits is spreading along with excess weight gain, which continues to expand around the world[2]. Microalgae are the origin and the source of omega-3 long chain fatty acids in Nature, not animals or fish. In fact, commercialized algae omega-3 products have already been approved by the FDA as food additives, especially for infant formulae and dietary supplements. *C. cohnii and Schizotrichium sp.* microalgae omega-3 oils, for example, have been sold on the open market for many years.

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IS ALGAE OIL FOR BIODIESEL A RED HERRING ?

The high lipid content of many microalgae classes has prompted extensive studies of their potential as producers of liquid fuels similar to those made from plant oils such as soy beans. From 1978 to 1996, the U. S. Department of Energy's Office of Fuels Development funded a program to develop renewable transportation fuels from algae. The main focus of the program, known as the Aquatic Species Program (ASP), was the production of biodiesel from high lipid-content algae grown in ponds, utillzing waste CO_2 from coal fired power plants[1]. Over almost two decades of this program, tremendous advances were made in the science of algae metabolism and the engineering of microalgae production systems[1]. Finally, cost effectiveness and suitability issues led to the end of these studies. The biochemical properties of algae oil are not likely to be suitable for engines. High levels of poly-unsaturated fatty acids are inherent to algae and this is one of the least recognized reasons why the National Renewable Energy Laboratory (NREL) dropped their algae oil for fuel research in 1996 (Personal Communication).

> Warm and cold water marine algae are "*organisms that often contain high levels of polyunsaturated fatty acids, which would perform poorly as a feedstock for biodiesel because of their low oxidative stability and tendency to polymerize during combustion*"[1,3].

Now private funding agencies and venture firms alike are making financial choices on unproven concepts. With rising fuel prices and foreign oil dependence, the theoretical concept of algae oil biodiesel is wished for and marketed ahead of validation. Recent corporate efforts, such as by Global Green Solutions, have readily proposed that their proprietary bioreactor technologies will overcome all of the problems 20 years of academic research could not solve. Aquaflow Bionomic Corporation claims to have made the world's first sample of biodiesel from algae. Certainly algae oil conversion to biodiesel is easily achieved, but making it is not the problem, stability, operability, and certification are problems. Solazyme announced it would start supplying algae oil to biodiesel maker Imperium Renewables of Seattle, USA– which recently filed for an IPO. The quantities are not yet disclosed, but it's the first commercial algae oil supply deal involving industry-leading companies. Certainly, micro-deals like this get publicity, yet the feasibility issue is often overlooked.

Different strains of algae synthesize a wide range of hydrocarbons. However many of these product forms are not suitable for biodiesel, which requires triglycerides with mainly saturated fatty acids as side chains, such as in animal tallows. Thus, what is good for our heart is not good for our engine. *B. braunii* algae often form extensive blooms and has been found to synthesize high amounts of hydrocarbons with oil contents reported up to 75% of dry weight[4]. Yet, the 'type A' *B. braunii* produces predominantly n-alkadienes and trienes, whereas 'type B' forms acyclic and cyclic triterpenoid hydrocarbons. Because of high oil production capabilities, this feature alone has led to extensive studies of the 'type A' strain as a potential renewable source of liquid fuels, but these efforts have gone without success.

Non-petroleum diesel fuels are commonly blended from cracked feedstocks, a. k. a. "seeds" that may also contain reactive poly-unsaturates. Below is a summary graph of oil sources indicating

ranges of double bonds per fatty acid chain, referred to as the average double bonds per fatty acid **(Figure 1)**.

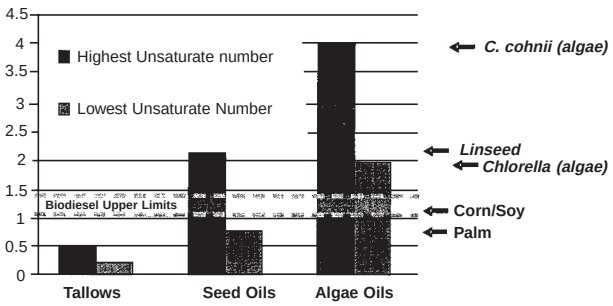

Fig. 1 : Average Double Bonds per Fatty Acid

[The Y-axis shows the average number of double bonds per fatty acid. Tallows have few double bonds and are ideal for biodiesel. Tallows fall consistentily below the range of biodiesel standards in terms of the upper limits for unsaturation. Some seed oils like palm oils are ideal while others like linseed oils contain high levels of poly-unsaturates. Finally, algae oils consistently contain very high levels of poly-unsaturates. *Chlorella* for example has an average of 2 bonds per hydrocarbon, significantly above the standard limits.

BIOACTIVE MOLECULES FOR NUTRITION

Marine algae are a rich source of nutrition and of novel bioactive compounds which may find application in human and animal medicine and in agriculture. Nutritional uses of certain algae may prove most successful and valuable. Dietary fatty acids produced by a few species of edible microalgae accumulate high amounts of long-chain polyunsaturated fatty acids. The omega-3 polyunsaturated fatty acids (PUFAs), eicosapentaenoic, docosahexaenoic and the omega-6 arachidonic acid are of particular interest as they are essential for human and animal nutrition[2].

The natural sources of omega-3 long chain fatty acids are not animals or fish, but algae. Fish obtain long chain omega-3s from algae and through the marine food chain. In fact, commercial omega-3 products have now been approved by the FDA for nutritional supplementation of docosahexaenoic acid (DHA) in infant formulas and as a complement with prenatal vitamins. Martek Biosciences Corporation currently produces the algal DHA by heterotrophic culture of the dinoflagellate *Crypthecodinium cohnii* for infant formulas and as a dietary supplement. In addition, the *thraustochytrids, Schizotrichium* and *Thraustrochytrium*, are also grown for use as sources of these fatty acids in aquaculture feeds. *Schizotrichium* oil is sold in dietary supplements as life's DHA(TM). Eicosapentaenoic acid production from the diatom *Nitzschia* is under study[5]. Microalgae oil as a nutraceutical, or nutritional medicine, can also bypass most regulatory affairs restrictions as a natural product and is "generally regarded as safe". Thus, cultured omega-3 oil availability over-the-counter means omega-3 DHA is available to the public in a 100% vegetarian form and contains up to 40% long chain omega-3 lipids[2].

Living microalgae feeds play important roles in shellfish farming. So far, only live algae fulfil the nutritional requirements of shellfish. Although, feed substitutions have been developed, shellfish production still relies on live microalgae. Farmed fish can also benefit from algae[6]. Salmon may be produced using feed organisms fed algae, boosting omega-3/omega-6 ratios and reducing pollutant exposure from ocean caught feeds. Livestock feed may increase the use of algae for omega-3s nutrition. Chicken eggs and meat, pork, beef and milk products all include higher omega-3 levels when animals are supplemented. Aside from fatty acids, microalgae have been suggested as possible

commercial sources of other products, such as carotenoids, tocopherol (Vitamin-E), sterols, polysaccharides and plant growth regulators[7].

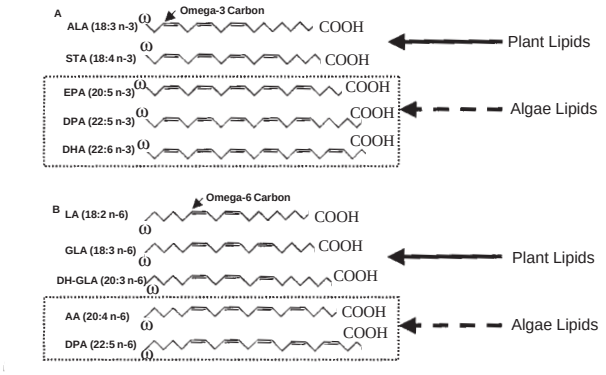

Fig. 2. Omega-3 and Omega-6 Fatty Acid Structures (PUFAs).

[*(A) Omega-3 fatty acid include ALA (alpha-linolenic acid), STA (stearidonic acid), EPA (eicosapentaenoic acid), DPA n-3 (docosa-pentaenoic acid n-3), DHA (docosahexaenoic acid).*

(B) Omega-6 fatty acids include LA (linoleic acid), GLA (gamma-linolenic acid), DH-GLA (dihomo-gamma-linolenic acid), AA (arachidonic acid), DPA n-6 (docosapentaenoic acid n-6).]

[The conventional designations are as follows : # of carbons and # of double bonds with the first double bond from the end, the omega, stated as n-3 or n-6 ; thus for DPA n-3 the fatty acid is given as (22 : 5 n-3) and for DPA n-6 it is given as (22 : 5 n-6). Additionally, the arrows in A and B point to the omega-3 and omega-6 carbon, respectively.]

Figure 2 shows the omega-3 and omega-6 poly-unsaturated fatty acids in plants and algae. Although algae may include the entire lipid spectrum, many algae produce the longest omega-3 and omega-6 chains. Plants cannot make omega-3 fats that are longer than 18 carbons long. Omega chains in algae may provide chloroplast membrane functions during cold climate conditions for over-wintering or dormancy. Plants make hydrocarbons with 3, and up to 4, double bonds on the longest C 18 chains, but double bond averages are less than 2 per fatty acid. Algae will make hydrocarbons with up to 6 double bonds on the longer C 22 chains, often averaging greater than 3 double bonds per fatty acid. The ideal for biodiesel is less than 1 double bond per fatty acid.

Are Omega-3s drugs ? The online Molinspiration software evaluated the smile format of each, alpha-linolenic acid (ALA) and DHA fatty acids for example, as potential lead bioactive compounds. These satisfied four of the five attributes featured in the Lipinski's Rule of 5, a quantifiable test based on the observation that most medications are relatively small lipophillic molecules. All attributes except water solubility were satisfied, suggesting omega-3s by themselves are good lead nutraceutical drugs candidates. This happens to be the way doctors view the benefits of omega-3 fatty acids.

CONCLUSIONS

The value in microalgae oils is most likely not cheap fuel, at least any time soon. However, aquaculture is an emerging resource for cultured nutritional products and feeds. The relatively untapped and little studied algae resources available may prove to be the answer to some of the planets current non-sustainable practices in food and feed industries, particularly as fish stocks in the oceans are increasingly depleted. In addition, grain fed cattle and chickens produce low omega-3 containing milk and eggs making algae animal feed supplementation a beneficial practice for human nutrition. We need the modern nutritional solutions. Microalgae have already provided some of the answers.

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DO YOU KNOW ?

Q3. What does the word Addis Ababa mean ?

Q4. Tauromachy refers to which sport ?

PEDIATRIC DENTAL CARIES AND INFECTION

Lali Growther*, Rekha. R**

The article focuses on dental caries and infection in children. Bacteria like *Streptococcos mutans* and *Lactobacillus* are causative agents of caries. These produce acids from the carbohydrate in the diet, which erode the tooth enamel, which ultimately leads to infections like abscess and cellulitis, when treatment is not proper. The role of fluride is highlighted along with future trends of treatment. In spite of the current emphasis on preventive dental health, many children are still affected by dental caries and dental infection. The untreated dental caries usually leads to dental infection. Proper preventive measures, that include a healthy diet and regular dental examination, can lead to a happy and healthy smile.

INTRODUCTION

Archeological evidence has shown that dental caries is an ancient disease dating far into prehistory. In the 1890s, WD Miller conducted a series of studies that led him to propose an explanation for dental caries that was influential for current theories. He found that bacteria inhabited the mouth and they produced acids which dissolved tooth structures in the presence of fermentable carbohydrates. An estimated 90% of school children world wide have experienced caries. The disease is most prevalent in Asian and Latin American countries and least prevalent in African countries.

DENTAL CARIES

It is a lifestyle dependent infectious disease. They are very common and begin with acid on the tooth. The acid is made from the bacteria in dental plaque. The plaque bacteria feed on sugars and starches from the diet and change them to acid. This acid eats into tooth enamel, or the outer layer of the tooth and dentin, the major part or core of the tooth. The tooth then gradually dissolves and the bacteria move into the damaged tooth structure.

WHAT CAUSES DENTAL CARIES ?

The oral bacteria responsible belong mostly to *Streptococcus mutans* and *Lactobacilli*. These bacteria metabolize sugars and produce destructive lactic acid and produce a sticky dental plaque. The acid dissolves the mineral structure (hydroxyapatite crystals) of teeth. A continuous loss of tooth mineral will eventually lead to cavity. The caries producing bacteria can be "passed on" from mother to infant as early as 10 months of age. The danger of infecting infant's teeth is increased if the mother already has the caries disease herself. Sucrose, a type of sugar, is therefore an important contributor to dental caries. The newly erupted teeth of infants are most susceptible to caries as they are not yet fully hardened (calcified).[1]

SIGNS OF DENTAL CARIES

The first sign is a white spot "lesion" on the enamel surface of the front teeth. These are white chalky areas, close to gum line caused by bacterial acid and directly precede irreversible loss of tooth structure. Active cavities usually have a golden-brown colour.[2]

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HOW DOES FLOURIDE PREVENT CARIES ?

Fluoride inhibits the ability of bacteria to metabolize sugar. It inhibits the break down of carbonated hydroxyapatite by bacterial acid. Fluoride contacting a tooth forms a layer of calcium-fluoride like material on the surface of the tooth enamel. When acid from oral bacteria accumulates on the teeth, fluoride is released from this protective layer, which aids in hardening the enamel.

HOW CAN PARENTS PREVENT DENTAL CARIES ?

- Parents can modify oral hygiene techniques, depending on the child's age.
- Parents should not put children to sleep with a bottle containing any liquid other than water.
- Should help brush their children's teeth every day after meal.
- Should provide healthy balanced meals for children.
- Children should have their first dental health evaluation by the age of 12 months, or within 6 months of eruption of first tooth.

FUTURE TRENDS IN CARIES PREVENTION

- Chemotherapeutic methods, which may include application of fluoride varnish and chlorhexidine gel on teeth.
- Vaccines against dental caries. It would give a child an improved Ig A or Ig G response to cariogenic bacteria.
- Molecular probes to measure the level of cariogenic bacteria in child's mouth.
- Fluorescence and ultrasonography for earlier detection.
- Laser treatment of teeth to inhabit the progression of dental caries.

BABY BOTTLE TOOTH DECAY

Baby bottle tooth decay is a condition that occurs when a child's tooth enamel is gradually damaged by over exposure to sweetened liquids in a baby bottle. Most often the child's upper front teeth are damaged.

Children who drink liquids regularly from a sippy cup or who eat excessive amounts of sugary foods, are also said to have baby bottle tooth decay if they develop early cavities.

CAUSES OF BABY BOTTLE TOOTH DECAY

Baby bottle tooth decay is the result of damage to the tooth enamel caused by long term exposure to almost any type of liquid apart from water. The sugars from such liquids-including cow's milk, breast milk, formula, fruit juice, punches and gelatin cling to teeth for a long period of time. Bacteria feed on these sugars, which in turn produces acids that attack tooth enamel.

Saliva is a protective fluid that helps to neutralize acids in the mouth and cleanses the teeth. Saliva production drops during sleep. If a child is allowed to fall asleep with a bottle of milk, formula or other sugary liquid, the protective effects of saliva on the teeth are reduced.

SIGNS AND SYMPTOMS

During early decay, the teeth may be sensitive to temperature changes and sweets. Teeth may become pocked, pitted or discolored and small white spots or lines may appear near the edges of the gums. Over time, these patches may become brown or chipped. A child's top front teeth are the most likely to be affected. Baby bottle tooth decay tends to spread rapidly and all primary teeth are at risk.

PREVENTION

- Children should not receive sugary drinks before naps or bed time.

- Never dip a pacifier in any sweet liquid.
- Do not fill a baby bottle with sugar water or soft drinks.
- Baby's gums should be wiped with a clean gauze pad after every feeding.[3]

DENTAL INFECTIONS IN CHILDREN

Dental infections are distressing experience for a child and the parents. The first indication is usually a dental pain—often spontaneous. The offending tooth will often hurt during the night. Any child with dental infection needs to be promptly evaluated and treated by dentist.

TYPES OF INFECTIONS

There are two types of infection :

(a) ***Acute infection (facial cellulitis)***

This is a serious and painful problem, the child may have a swollen face, or elevated temperature, appear sick and be dehydrated. This infection can spread to other parts of the body such as the deeper structures of the head and neck.[4]

(b) ***Chronic infection (dental abscess)***

This problem usually takes longer to develop and less serious than a facial cellulitis. A dental abscess feels soft to touch, because it is pus-filled. Often a small localized, swelling is seen on the gums next to the offending tooth. The offending tooth may be loose or painful to touch.

A dental abscess is an infection of the mouth, face, jaw or throat that begins as a tooth infection or cavity. Bacteria from a cavity can extend into the gums, the cheek, the throat, the tongue or even into the jaw or facial bones to make a very painful episode, when tissues become inflamed. Pus collects at the site of the infection and will become progressively more painful until it either ruptures and drains on its own, or is drained surgically.

***Causes of Dental Abscess* :**

It is due to direct growth of bacteria from an existing cavity into the soft tissues and bones of face and neck. An infected tooth, that has not received appropriate dental care, can cause a dental abscess to form. The infection then may spread to the gums and adjacent areas and become a painful dental abscess.

Symptoms of Dental Abscess :

Symptoms typically include pain, swelling and redness of the mouth and face and sometime difficulty in fully opening the mouth or swallowing. An advanced infection presents nausea, vomiting, fever, chills and diarrhoea.

Causes of Dental Infection :

Deep dental caries can infect the dental pulp (the centre of the tooth) and cause a tooth to die (pulp necrosis). When an infection of the dental pulp invades the supporting bone or adjacent areas of the face and neck, it results in true dental infection. Dental infection is caused by a number of bacteria acting at the same time that may be aerobic or anaerobic. The first bacteria "on the scene" are usually the aggressive aerobic bacteria. They cause the development of cellulitis, which is a hard, red, tender, warm and rapid swelling enlargement. From the fourth to the seventh day of an infection, the anaerobic bacteria–which cause a deeper infection, become more numerous. This causes a central, softened area to develop, which is called a necrotic abscess. This abscess contains pus which consists of dead tissue, live and dead bacteria and white blood cells.

Complications of Dental Infection :

(a) The affected child may be dehydrated and in pain.

(b) The child's body temperature may exceed 101 degrees F, which is indicative of a severe infection.

(c) Trismus may develop. This is the inability to open mouth widely. It is caused by inflammation of the chewing muscles.

(d) Deep (facial space) infections of the face, head and neck can quickly produce life threatening complication.

Treatment :

Removing the source and cause of the infection. This may be by removing (extracting) the offending tooth or conserving the non-vital tooth *in situ*. Any accumulated pus needs to be drained from the infected area. Antibiotics are also used.

CONCLUDING REMARKS

Dental care of a child should focus on prevention and detection of any dental problems. It should include education about oral hygiene, preventive measures and treatment of any problem. After most of the baby teeth have come in at about 3 years of age, the child should begin regular dental visits. Most children who go to the dentist at this young age do not develop a fear of the dentist.

Children should be encouraged to do regular brushing and flossing of the teeth. The good news is that we can prevent dental caries and infections in children by providing a healthy diet, minimizing the consumptions of sweets, cleaning teeth at least twice a day, and getting early dental examinations, children can enjoy a happy healthy smile.

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DO YOU KNOW ?

Q5. The weight of adult human brain is around 1200 gram. What is the average weight of an infant's brain.

Q6. What was depicted in Independent India's first postage stamp ?

VERMICOMPOST : MAY BE USED AS A POTENTIAL BIO-FERTILIZER

T. Samanta*

For sustainable development in agriculture, it is essential to improve the soil organic carbon status that has deteriorated under intensive chemical farming. Among the several bio-fertilizers, farmers may use vermicompost on account of its simple preparation technology, favourable climatic support and easy availibility raw materials. Farmers can use vermicompost by mixing with chemical fertilizers almost in every agro production for increasing the effectiveness of the chemical fertilizer. It performs better in floriculture, horticulture, houseplants, potting soil, fruits and vegetables productions. However, for any application, better result can be obtained if farmers apply the estimated amount after knowing its per cent of organic carbon and C : N ratio.

INTRODUCTION

It is true that we have alleviated hunger from the world by introducing the components of 'Green Revolution' technologies viz. high yielding varieties (HYV) seeds, fertilizers, pesticides and farm machineries. India's food production has also improved significantly due to the successful implementation of this technology since mid 1960's. In spite of this remarkable achievement, recently, farmers are facing problems in harvesting crops for stagnant productivity and associated hazards of the technology. As it requires a huge amount of chemical fertilizer, pesticide, insecticide and even water, chemicals accumulate gradually into the soil that causes the deterioration of soil fertility and environmental quality. A review of over 300 published reports showed that most of the environmental impact indicators which have decreasing trends are floral diversity, faunal diversity, habital diversity, landscape, soil organic matter, soil biological activity, soil structure, soil erosion, nitrate leaching, pesticide residue, CO_2, N_2O, CH_4, NH_3, nutrient use, water use and energy use. However, organic farming system performed significantly better in all the above factors and performed worse in none[1]. For eradicating these ill effects of modern agriculture, peasants are considering growing food without chemical fertilizers and pesticides throughout the world. Meanwhile, the global organic-food market has already crossed 31 billion US $ by 2005 with an average annual growth rate of 20–25%. Though the production cost in the organic farming is slightly higher, yet it will be sustainable alternative on account of its biological, ecological and environmental supportive natural approaches. Government of India has already constituted a 'Task Force' to popularise the organic farming. According to the opinion of the task force, the application of organic manure is the only option to improve the soil organic carbon for sustenance of soil quality and future agricultural productivity[2].

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VERMICOMPOST AS A BIO-FERTILIZER

Efforts are required to grow crops and vegetables by using organic manure, which may come from microbial fertilizer, bio-fertilizer and also vermicompost. Among these, use of vermicompost as an organic manure is important, because of its ability to release nutrients slowly and the technology for its preparation being very simple. In rural Bengal, traditional concept of using bio-fertilizer in agriculture has become completely absent in modern approach of farming on account of inputs of machineries and rejection to consider animal husbandry as a component of farm management. Nevertheless, as a tropical zone, the climate is suitable for composing huge green manure, bio-solids, crop residues and even food processing wastes. Our attitude of frequent and injudicious use of chemical fertilizer, pesticide and herbicide in farm practices has destroyed the soil micro, meso and macro fauna[3]. Even earthworms that decompose the agricultural wastes naturally and supply organic manure in the form of cast, have also left from our fields now. Hence, the percentage of organic carbon in the harvested soil gradually decreases to such a minimum level that hampers the exchange of plant macronutrients. At this juncture we can reintroduce the earthworms into our field by preparing and using vermicast as a source of bio-fertilizer. It is biologically active mound containing thousands of bacteria, enzymes, remnants of plant materials and animal manures which were not digested by the earthworm. An important component of this dark mass is humus which is a complicated material formed during the breakdown of organic matter. It also provides many binding sites for plant nutrients e.g. calcium, iron, potassium, sulfur and phosphorous. It dissolves slowly rather than allowing immediate nutrient leaching. It has excellent soil structure, porosity, aeration and water retention capabilities, which can insulate plant roots from extreme temperatures, reduce erosion and control weeds[4].

LOCAL EFFORTS

Earthworms play a variety of important roles in agro-ecosystem. Their feeding and burowing activities ingest organic matter into the soil. They can easily decompose agricultural wastes, several domestic wastes, even any green plant material. So they can also be used to manage the agricultural waste, municipal soild waste, livestock manure and wastewater for its higher consumption and decomposition abilities. There are 2,200 earthworm species found all over the world. Therefore, the selection of earthworm species is important in terms of their breeding rate and cast formation ability. Out of these species two important species namely *Eisenia foetida and eudrilus eugenia* are generally considered for vermicomposting, because of their higher breeding and cast formation rate. (Annexure–IA). The technology for preparing vermicompost is so simple that it can be imparted to the farmers knowledge for their own purposes[5]. Now-a-days several standard projects for preparing vermicompost are available in CAPART (Council of Advancement of Peoples Action and Rural Technology), New Delhi and elsewhere. In West Bengal, this technical know-how is currently available from following centers : (i) Farmers Training Institute, Kalyani, (ii) Matar-Benay Trust, Hatsimul, Burdwan, (iii) Nimpith, Narendrapur. South 24-Paragana and (iv) Visva-Bharati, Santiniketan in spite of this readily available managing technology, the use of vermicompost as a bio-fertilizer in agriculture is not so familar to our farmers community. Therfore, farmers need a motivation for using vermicompost as a bio-fertilizer to increase the soil organic matter (SOM) and also to provide binding sites for the inorganic plant nutrients. The author and a small group of

activists are engaged in the preparation of vermicompost and motivation work for the last five years under Paschim Banga Vigyan Mancha at Matar-Benay Trust campus, Burdwan (Figures 1 & 2)

Fig. 1 : Vermicompost pit at Matar-Benay Trust campus, Burdwan, West Bengal

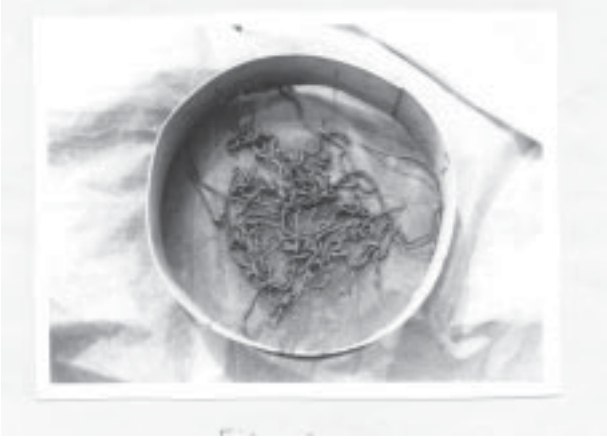

Fig 2 : Earthworms : Eisenia Foetida

CHEMICAL QUALITY AND PRECAUTIONS

Casting contain 5 times the available nitrogen, 7 times the available potash and 5.5 times more calcium than that found in 15 cm of good top soil. Moreover, vermicomposting adds valuable attributes viz. water retention, texture, nutrient availability and an ability to fight soil-borne plant disease like root rotten[6]. In spite of these advantages, the use of vermicompost either in pure or mixed with chemical fertilizer as a farm manure, is still rare because the technology has not gone into farmers' concept. Aforesaid activists group in 'Matar-Benay Trust' campus has been experimenting the use of vermicompost in different crop production for the last five years. Out of curiosity the author has collected eight different vermicompost samples from different farmers, farmers' co-operative and NGO's and estimated its percentage of carbon content and NPK values in '*Shibaprasad Bandyopadhyay Maati Parikshagar*' (soil testing laboratory) at 'Matar-Benay Trust campus, Hatsimul. Burdwan West Bengal. The results obtained are shown in the Table-1 below.

Table–I

Percentage of Different Macronutrients in Eight Vermicompost Samples

Sample	pH	% of Organic Carbon	% of Nitrogen	& of P_2O_5	% of K_2O ?
1	6.60	3.83	0.40	0.074	0.301
2	6.56	3.25	0.33	0.220	0.220
3	6.54	2.66	0.27	0.160	0.280
4	–	13.06	1.41	1.502	0.258
5	7.22	15.30	1.60	0.405	0.960
6	8.75	6.85	0.68	0.040	1.400
7	8.53	3.64	0.36	0.100	0.570
8	6.98	2.78	0.30	0.095	0.210

Table-I reflects the estimated results of eight different vermicompost samples which show a very high variation of carbon content (2.66 to 15.3%) and also the percentage of nitrogen content in the vermicompost sample, which is obvious. But the problem is whether farmers know the percentage

of carbon content and C : N ratio of the used vermicompost sample or not. Therefore, the nutrent content, particularly the C : N ratio of each vermicompost sample should be measured before applying it into the field even if the vermicompost is indigenously prepared by the farmers themselves. Values of C : N ratio can be improved by using different animal manure as a feeding material to the earthworms, instead of using cow-dung only. In order to project this idea, some relevant data[7] regarding the animal manure are shown in the Table-II.

Table–2

Approximate Dry Matter and Fertilzer Nutrient Composition of Various Types of Animal Manure

Type of livestock	% of Dry matter	Nutrient (Rg ton^{-1} in raw waste)			
		NH_4–N	Total-N	P_2O_5	K_2O
Swine	18	2.72	4.54	4.08	3.63
Beef cattle	15	1.81	4.99	3.18	4.54
Dairy cattle	18	1.81	4.08	1.81	4.54
Poultry	45	11.79	14.97	21.77	15.42

Table-2 indicates that certainly the percent carbon content, C : N ratio and NPK values of the vermicast will be higher by using the poultry litter as feeding material. This trend of higher NPK values is also reflected in the vermicast NPK values (Table-1). Intensive care is required for protecting the vermicompost pit from ant, birds, rat and direct sunlight. Shortly a large number of vermicompost products are coming into the market packed within beautiful containers without mentioning the percentage of organic matter and C : N ratio. Where as the farmers are now being advised to use vermicast as an organic manure to increase the effectiveness of the chemical fertilzer also, hence for the optimum benefit from the organic manure, information regarding bio-fertizer should be authenticated or verified thoroughly.

VERMICOMPOST APPLICATION

It has been established that the earthworms are one of the most useful and active agents in introducing suitable chemical, physical and microbiological changes in the soil, thereby directly increasing the fertility of the soil[8]. Vermicompost should be used, after checking its nutrient content and mixing with the chemical fertilizers in suitable proportions. Institute of National Organic Agriculture (INORA) has applied the vermicompost in different proportions with chemical fertilizer in sugarcane production at different places of Maharastra, Gujarat and Karnataka. It has been established that 1 : 1 vermicompost and chemical fertilizer ratio is most effective in sugarcane production. In a certain region of New Zealand, grass production became doubled after introducing some European earthworm species. Hidalgo et. al of Mississippi State University have shown that the mixture casting with peat moss at the ratio of 1 : 1, 2 : 1 and 3 : 1 performed better in all growth parameters of Marigold production[9]. They have also shown that earthworm casting increases the germination rate in seeding development of Cucumber nicely. (Annexure-IB) In Bangalore, India, earthworms successfully decomposed residuals from sugar factory and turned them into a soil nutrient which enabled 50% reduction in the use of chemical fertilizer. Earthworm castings are the best imaginable potting soil for houseplants as well as gardening and farming. It can also be used as a planting soil for trees, vegetables, shrubs and flowers[10]. It was also observed at the 'Matar-Benay' Trust campus that vermicompost performed better in flowers, vegetables, fruits and nursery productions. It can also be used, by mixing with chemical fertilizers, in any agro-production for raising the effectiveness of the chemical fertilizer.

ACKNOWLEDGEMENT

Author is grateful to Shri A. Sanyal, Coordinator of the soil-testing laboratory at 'Matar-Benay' Trust

campus, Burdwan and Smt. T. Samanta for help in preparing the manuscripts.

Annexure

I A. These worms can consume any organic waste to an amount of even 2-5 times their body weight. After using only 5-10% of the ingested materials for their growth, they excrete the rest amount in mucus coated form as worm cast.

Vermicomposting is, therefore, the technology of composting wide ranges of organic wastes with the help of epigeic group of earthworms which generally resides in the soil surface and feeds upon various organic materials.

[*Ref* : Gaur, A. C. and Singh, Geeta. In Tandon, HLS (ed) Recycling of Waste in Agriculture. F.D.C.O. pp. **31**-47, 1995.]

I B. Bhattacharya and Chattopadhyay while studying occurrence of beneficial microorganisms in cowdung under conventionally decomposed and vermicomposted condition, observed vermicompost to contain considerably higher concentration of phosphate solubilising bacteria as well as nitrogen fixing bacteria. Since existing microbial population generally fails to remain active in tropical soils due to lack of energy required for their activity, regular application of these vermicomposted wastes is likely to improve the biological properties in addition to its positive effects on physico-chemical condition of the soil leading to their higher productivity levels.

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CONCEPT AND APPLICATIONS OF QUANTUM DOTS

Rishabh Jaiswal*

The evolution over the last two decades of the nanocrystals are known as quantum dots. The growth of this revolutionary new tool from electronic materials science, involving marvelous innovations with limitless applications will enable use of this material across many industries to far-reaching biological applications. It will allow researchers to study cell processes at the level of a single molecule and may result in new and better ways to diagnose and treat cancers.

This paper defines some of the technologies and usages related to quantum dots. Many key areas employing them are discussed with possible commercial applications/developments in future. The technologies are of immense practical use and have the potential to replace many conventional, inefficient processes. The key to the adoption of quantum dots is the continued reduction in cost of the application developed using it along with augmented output and efficiency.

INTRODUCTION

A Quantum Dot is made from a semiconductor nanostructure (an object of intermediate size between molecular and microscopic (micrometer-sized) structures) that confines the motion of conduction band electrons, valence band holes, or excitons (bound pairs of conduction band electrons and valence band holes) in all three spatial directions. The confinement can be due to electrostatic potentials (generated by external electrodes, doping, strain, impurities), the presence of an interface between different semiconductor materials (e.g. in core-shell nanocrystal systems), the presence of the semiconductor surface (e.g. semiconductor nanocrystal), or a combination of these. A quantum dot has a discrete quantized energy spectrum. The corresponding wave functions (a mathematical tool used in quantum mechanics to describe any physical system) are spatially localized within the quantum dot, but extend over many periods of the crystal lattice. A quantum dot contains a small finite number (of the order of 1–100) of conduction band electrons, valaence band holes, or excitions, i.e., a finite number of elementary electric charges.

DESCRIPTION OF QUANTUM DOTS

Small quantum dots, such as colloidal semiconductor manocrystals, can be as small as 2 to 10 nanometers, corresponding to 10 to 50 atoms in diameter and a total of 100 to 100,000 atoms within the quantum dot volume. Self-assembled quantum dots are typically between 10 and 50 nm in size. Quantum dots defined by lithographically patterned gate electrodes, or by etching on two-dimensional electron gases in semiconductor heterostructures can have lateral dimensions exceeding 100 nm. At 10 nm in diameter, nearly 3 million quantum dots could be lined up end to end and fit within the width of human thumb.

Quantum dots can be contrasted to other semiconductor nanostructures :

1. *Quantum wires*, which confine the motion of electrons or holes in two spatial dimensions and allow free propagation in the third.

*Lucknow, India

2. *Quantum wells*, which confine the motion of electrons or holes in one dimension and allow free propagation in two dimensions.

Quantum dots containing electrons can also be compared to atoms : both have a discrete energy spectrum and bind a small number of electrons. In contrast to atoms, the confinement potential in quantum dots does not necessarily show spherical symmetry. In addition, the confined electrons do not move in free space, but in the semiconductor host crystal. The quantum dot host material, in particular its band structure, therefore plays an important role for all quantum dot properties. Typical energy scales, for example, are of the order of ten electron volts in atoms, but only 1 millielectron volt in quantum dots. Quantum dots with a nearly spherical symmetry or flat quantum dots with nearly cylindrical symmetry can show shell filling according to the equivalent of Hund's rules (a simple set of rules used to determine which is the term symbol that corresponds to the ground state of a multi-electron atom) for atoms. Such dots are sometimes called "artificial atoms". In contrast to atoms, the energy spectrum of a quantum dot can be engineered by controlling the geometrical size, shape, and the strength of the confinement potential. Also in contrast to atoms it is relatively easy to connect quantum dots by tunnel barriers to conducting leads, which allows the application of the techniques of tunneling spectroscopy for their investigation.

Like in atoms, the energy levels of small quantum dots can be probed by optical spectroscopy techniques. In quantum dots that confine electrons and holes, the interband absorption edge is blue shifted due to the confinement compared to the bulk material of the host semiconductor material. As a consequence, quantum dots of the same material, but with different sizes, can emit light of different colors.

Quantum dots are particularly significant for optical applications due to their theoretically high quantum yield. In electronic applications they have been proven to operate like a single-electron transistor and show the Coulomb blockade (the increased resistance at small bias voltages of an electronic device comprising at least one low-capacitance tunnel junction) effect. Quantum dots have also been suggested as implementations of qubits (a unit of quantum information) for quantum information processing.

One of the optical features of small excitonic quantum dots immediately noticeable to the unaided eye is coloration. While the material which makes up a quantum dot defines its intrinsic energy signature, more significant in terms of coloration is the size. The larger the dot, the redder (more towards the red end of the spectrum) the fluorescence. The smaller the dot, the bluer (the more towards the blue end) it is. The coloration is directly related to the energy levels of the quantum dot. Quantitatively speaking, the bandgap energy that determines the energy (and hence color) of the fluoresced light is inversely proportional to the square of the size of the quantum dot. Larger quantum dots have more energy levels which are more closely spaced. This allows the quantum dot to absorb photons containing less energy, i.e. those closer to the red end of the spectrum. Recent articles in nanotechnology and other journals have begun to suggest that the shape of the quantum dot may well also be a factor in the coloration, but as yet not enough information has become avilable. Furthermore it was shown recently that the lifetime of fluorescence is determined by the size. Larger dots have more closely spaced energy levels in

which the electron-hole pair can be trapped. Therefore, electron-hole pairs in larger dots live longer and thus these large dots show a larger lifetime.

The ability to tune the size of quantum dots is advantageous for many applications. For instance, larger quantum dots have spectra shifted towards the red compared to smaller dots, and exhibit less pronounced quantum properties. Conversely, the smaller particles allow one to take advantage of quantum properties.

APPLICATIONS OF QUANTUM DOTS

Being zero dimensional, quantum dots have a sharper density of states than higher-dimensional structures. As a result, they have superior transport and optical properties, and are being researched for use in diode lasers, amplifiers, and biological sensors. Quantum dot technology is one of the most promising candidates for use in solid-state quantum computation. By applying small voltages to the leads, one can control the flow of electrons through the quantum dot and thereby make precise measurements of the spin and other properties therein. With several entangled quantum dots, or qubits, plus a way of performing operations, quantum calculations might be possible.

Another cutting edge application of quantum dots is also being researched as potential artificial fluorophore for intra-operative detection of tumors using fluorescence spectroscopy.

PHOTOVOLTAIC CELLS

Quantum dots may have the potential to increase the efficiency and reduce the cost of today's typical silicon photovoltaic cells. According to experimental proof, quantum dots of lead selenide can produce as many as seven excitons from one high energy photon of sunlight (7.8 times the bandgap energy). This compares favourably to today's photovoltaic cells which can only manage one exciton per high energy photon, with high kinetic energy carriers losing their energy as heat. This would not result in a 7-fold increase in final output however, but could boost the maximum theoretical efficiency from 31% to 42%. Quantum dot photovoltaics would theoretically be cheaper to manufacture, as they can be made using simple chemical reactions.

BIOLOGY

In modern biological analysis, various kinds of organic dyes are used. However, with each passing year, more flexibility is being required of these dyes, and the traditional dyes are often unable to meet the expectations. To this end, quantum dots have quickly filled in the role, being found to be superior to traditional organic dyes on several counts, one of the most immediately obvious being brightness (owing to the high quantum yield) as well as their stability (much less photodestruction). For single-particle tracking, the irregular blinking of quantum dots is a minor drawback. Currently under research as well is tuning of the toxicity.

MEDICAL IMAGING

These new nanoscale materials have increased intensity of flourescent light emission when illuminated with excitation radiation, have longer lifetimes for fluorescing, and provide a much broader spectrum of excited colors than that obtainable with conventional materials. One application of these properties–the increased brightness–is illustrated in the figures below. QDs are bright, photostable fluorophores that have a

broad excitation spectrum but a narrow Gaussian emission at wavelengths controllable by the size of the material. QDs allow for efficient multicolor imaging of biological samples and should be especially useful for fluorescence imaging in living tissues, where signals can be obscured by scattering and competing intrinsic emissions.

Experiments that are more recent have also shown that with appropriate surface coatings the QDs may be made stable for *in vivo* (through skin) imaging for periods up to four months. That QD surfaces can control serum lifetime and patter of deposition suggests many medical uses. Finally, due to the high stability of amp-coated QDs, experiments using molecules and cells tagged with QDs and injected into animals may permit antigen trafficking and cellular migration over very long time scales, with unprecedented sensitivity and resolution. Other researchers have developed new coatings that make QDs appear as protein-like entities and thus are not seen by live cells as toxic.

LED

Also exciting to note are several inquiries into using quantum dots as light-emitting diodes to make displays and other light sources : "QD-LED" displays, and "QD-WLED" (White LED). In June 2006, technical success was achieved in making a proof-of-concept quantum dot display. Quantum dots are valued for displays, because they emit light in very specific gaussian distributions. This can result in a display that can more accurately render the colors that the human eye can perceive. Quantum dots also require very little power since they are not color filtered. A LCD display, for example, is powered by a single fluorescent lamp that is color filtered to produce red, green, and blue pixels. Thus, when a LCD display shows a fully white screen, two-thirds of the light is absorbed by the filters. Displays that intrinsically produce monochromatic light can be more efficient, since more of the light produced reaches the eye.

QUANTUM COMPUTER

Scientists have designed a scheme to create one of the fastest quantum computers to date using light pulses to rotate electron spins, which serve as quantum bits. This technique improves the overall clock rate of the quantum computer, which could lead to the fastest potentially scalable quantum computing scheme of which the scientists are aware. On a single semiconductor chip, the researchers combine fast single-bit rotations and fast two-qubit gates, both of which are optically controlled. In quantum computing, the orientation and phase of the electron spin serve as the bit state, and the gates are responsible for performing reversible operations on input data to produce output data. The semiconductor chip is a square millimeter in size, and consists of a loop of cavities–together, this apparatus is called a "loop-qubus." Each cavity holds a quantum dot, which is a small piece of semiconductor that contains, in this scheme, a single electron. By focusing optical pulses at individual quantum dots, the electron spins rotate, changing the state of the bit.

CONCLUSION

Hence we see that quantum dots offer immense possibilities in electronics, quantum mechanics, medicine, biology and numerous other fields yet unexplored. The exploration of these avenues might open new doors of technology which can be fascinating, and at the same time, useful beyond

our current imaginations. A look into such things will definitely create vistas of a totally different kind thus providing a novel, unseen approach to even the most common things such as the ubiquitous Incandescent Light Bulb. The commercialization of such research and developments some day might provide general users with many items of daily use far more efficient than the ones we have today.

REFERENCE

1. National Nanotechnology Initative, USA www.nano.gov
2. Quantum computing with optically controlled eletrons, *Science Physics Tech New* www.physorg.com
3. Medical imaging report by UCLA, CNSI www.cnsi.ucla.edu

SOMETHING TO THINK ABOUT

WHY DO WE GET HEADACHE ?

Hem Shanker Ray*

The significance of headache in the human society cannot be overemphasized. Absenteesm in the industry and offices due to headaches results in loss of production, upsets plans and can seriously affect routine work. Headaches cause disharmony in social groups and even in conjugal life. The only gainers are the doctors and the pharma industry.

The worst thing about a headache is that only the owner of the head knows what is bothering him. The only proof of a headache normally is the statement of the person. It is likely that no two headaches are alike, splitting or nonsplitting. Skeptics opine that if there is a headache then once in a while the headache is a natural occurrence. It is not known if animals develop headache too. They do suffer a great deal of provocation to develop one though–specially when they are confined in the zoos for the entertainment of mindless humans.

Ordinary headaches, the painful experience that hits many occasionally, are different from the serious thing called migraine which is a more serious medical problem. The ordinary variety is not unique, there are different kinds each of which is created by a different trigger mechanism. It can come from a head cold, hang over from an overnight drinking session, indigestion, stress of work, too much worrying, perhaps even quarrel with a spouse. Too much of thinking does not necessarily hit one with a headache or else this world will be devoid of scientists and philosophers. There can be many other causes of headache. A famous oversexed U. S. President once confided in private that he always developed a terrible headache if he did not have a woman for more than three days. Actually, any problem can lead to a headache and perhaps that is why problems themselves are often called headaches. The world is full of headaches because it is full of problems !

The underlying reason of a headache is always some disorder in the body or the nervous system caused by physiological or psychological reasons. The cause can be traced back to the physical or neurological origin if the headache is dissected for clear understanding. For this, a self report procedure is a must. Recurrance of the headache can be prevented only if the root cause is eliminated. Painkillers which affect the nervous system can at best provide temporary relief only.

Squeezing the head by a towel, pulling the hair and other desperate measures only help changing attention from one pain to another. During a headache the pain is felt by the sensitive covering of the brain and large veins and arteries which drain fluid from that organ.

Our sinus, teeth, ear as well as muscles can all cause headache by radiating pain to these sensitive organs and contracting the muscles that span the neck and the base of the skull. Most headaches are

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said to be dilation of arteries in the skull that can cause hunger and hangover. Emotional trauma can cause instantaneous headache by contracting muscles over the back and lower part of the head. So, a headache is a sympton of multiple disorders with multiple causes.

The reader may not be any wiser about headaches after reading this write up. And that is, because a headache remains a headache.

INFOSYS FOUNDATION-ISCA TRAVEL AWARD

The Organizing committee of 96th Indian Science Congress (ISC) invites standard application on plain papers from students up to Class XII for the above award under the following two chategories :

Category 1. **Five awards :** Each awardee will be given a Plaque, Merit Certificate, local hospitality and TA (Train Fare–A. C. III Tier) for attending the Indian Science Congress Session at North-Eastern Hill University (NEHU), Shillong (Meghalaya)–January 3rd–7th, 2009.

Category 2. **Five awards :** Each awardee will be given a certificate of merit, local hospitality and TA (Train Fare – A.C. III Tier) for attending the Indian Science Congress Session at North-Eastern Hill University (NEHU), Shillong (Meghalaya)–January 3rd–7th, 2009.

The applicants will be required to submit a write up on **"What developments in science during the last two years have influenced him/her and why ?"** in not more than 500 words along with their applications to :

Prof. R. Lalthantluanga

Local Secretary, ISC Secretariat

NEHU, Shillong–793022 (Meghalaya)

E-mails : nehuisca2009@yahoo.co.in; isca@nehu.ac.in

Last date of submission : 31st Oct. 2008

KNOW THY INSTITUTIONS

INDIAN GRASSLAND AND FODDER RESEARCH INSTITUTE, JHANSI

The Indian Grassland and Fodder Research Institute (IGFRI), Jhansi was established by Government of India in 1962 for organized research in the field of grasslands and cultivated fodder crops. In April 1966, the administrative control of the Institute was transferred to the Indian Council of Agricultural Research. The All India Coordinated Research Project on Forage Crops (AICRP-FC) has been functioning since 1970 to coordinate multi-location testing of varieties and production technologies in forage crops under different agroclimatic regions of India.

THE MISSION

To generate and disseminate technologies for enhanced productivity and quality of forage and livestock in socio-economic and environmental perspectives.

THE VISION

To evolve cultivars, production, processing and utilization technologies for maximizing productivity of forage and feed to meet the requirement of livestock in ecofriendly manner.

INFRASTRUCTURAL FACILITIES

The Institute office-cum laboratory building has one administrative wing and six laboratory wings. The administrative wing houses the Director's cell, administrative and accounts unit, library, two conference halls and one committee room. In the six laboratory wings, there are 63

sitting rooms and 25 laboratories which include Soil Science, Animal Nutrition, Organic Chemistry, PGR, Cytogenetics, Plant Protection, Plant Physiology & Biochemistry, Tissue Culture, Biotechnology, Molecular Biology and Soil Biology besides two central facilities, *viz*., Central Instrumentation Laboratory and Central Analytical Laboratory. The laboratories are equipped with latest equipments like GC, HPLC, Atomic Absorption Sepctrophotometer, UV visible spectrophotometer, Stereo zoom research microscops, Leaf area meter, Image analyzer, Flame photometer, Kjeltec, Fibertec, Flow cytometer, Lypholizer for freez drying, Gel dicumentation system, PCR machines, GIS system, etc for frontline research.

The Institute also has well furnished 5 suite VIP Guest house, 10 suite Scientists' home and 25 double bedroom training hostel. There is a separate Medical unit with attending male and female medical officers alongwith para medical staff. A nationalized bank, primary school, vehicle shed, garages, printing press *etc*. are also available in the institute campus. The residential campus, *Krishi Nagar* has 182 quarters of various types. An auditorium with modern audio and visual gadgets with 250 sitting capacity is under construction.

ARIS Cell and Library

The ARIS Cell is equipped with central LAN/ WAN based Computer, LINUX/UNIX services, besides 60 Pentium workstations/nodes with internet facility are available for the users. The e-mail and the INTERNET connectivity are provided through SGI (*SUSE Redhat Linux 9.0*) server.

The Institute's library has 9535 books, 4968 bound journals and more than 1750 reports/ bulletins. The library presently subscribes 65 national and 44 international journals. CAB, AGRIS and AGRICOLA databases are available through CD server.

Research Farm

The Institute is spread over 500 ha area which includes central research farm, office and residential campus. The farm has varying topography with peculiar Bundelkhand *rakar*, *parwa* and *kabar* type of soils. The experimental fields and grazing area are well developed representing typical grasslands, semi-arid and irrigated ecosystems. The central research farm also has different field laboratories like Seed processing, Post harvest technology, Veterinary and Artificial insemination laboratory. The livestock complex at central research farm has 40 Tharparkar cows, 18 Gir, 17 Sahiwal, 74 crossbred cows, 41 Murrah buffalo, 37 Bhadawari buffalo, 192 Jalauni sheep and 150 Bundelkhandi goats. The regional centers located at Dharwad, Avikanagar and Plampur have farm area of 32, 80 and 4 ha, respectively. The Farm operation and service unit (FOSU) at Jhansi is well equippd with farm tractors and implements and a workshop for minor repairs and maintenance.

RESEARCH ACHIEVEMENTS

Varieties Released

188 varieties of 30 fodder crops, range grasses and range legumes have been released and notified through AICRP (FC).

Basic Research

Apomixis Research : Reproductive pathways of apomictic seed development has been studied in *Pennisetum* and *Panicum* utilizing flow cytometry, ovule clearing and molecular markers. Dissection of apomixis into components were sucessfully achieved in these crops. Genetic studies indicated independent inheritance of these components which has been demonstrated for the first time in these grasses. This information could be used in manipulating apomixis in cereals.

Seed quality testing : For seed quality test of various range grasses, soaking of *Paspalum*

notatum, Bracharia brizantha, Sehima nervosum and *Setaria sphacelata* seeds in 0.5% tetrazolium solution for 2 hours at 35ºC was found suitable for staining and further evaluation.

International Collaboration : The Institute has completed several projects with International collaboration, *viz*., UNDP Project on forage production and management, IDRC silvipasture operational research project for Bundelkhand region, Indo-UK collaborative project on forage production and ACIAR supported project on *Stylosanthes*. Besides, IGFRI also had collaboration with ICRA for training and capacity building of scientists and research prioritisation.

International Symposium/Conferences : The IGFRI in collaboration with RMSI organized 3rd International Rangeland Congress (1988) and International Conference on Sustainable Development of Degraded Land through Agroforestry in Asia and Pacific (1994).

Externally Funded Projects : 38 externally funded projets supported by various national funding agencies like AP Cess Fund, DBT, DST, NDWB, NDDB, etc. have been completed. AT present 15 such projects in the field of biotechnology, crop improvement, DUS testing and plant animal interface are in operation.

Germplasm Collection, Evaluation, Conservation and Documentation

Germplasm Holding (5657 Nos.)

The above germplasms have been deposited in the national gene bank at NBPGR for long/ medium term storage and IC number of 1521 germplasm lines have been obtained.

Germplasm catalogues have been prepared for Berseem, Oats, Maize, Stylosanthes, Cowpea, Teosinte, Clusterbean, Bajra, Napier-Bajra hybrids, Guinea grass and Siratro.

Thrust Areas for XI Plan

- Collection of germplasm, evaluation and conservation.
- Development of transgenics for improved nutritive value and tolerance to various abiotic and biotic stresses.
- Development of linkage map and identification of markers linked with biotic and abiotic stresses ; isolation and characterization of genes responsive to stress tolerance.
- Nutrient use efficiency and physiological and biochemical characterization of stay green forage lines.
- Developing suitable production systems for optimizing forage productivity under irrigated and rained conditions including perennials.
- Updating and enriching the existing data base using remote sensing data and GIS technique at local, regional and national level.
- Improvement and management of natural grasslands and meadows through control of bushes and weeds, controlled grazing and reseeding.
- Silivipasture/hortipasture system modelling studies for different agro-climatic zones.
- Development of seed quality control standards in range grasses and legumes.
- Post harvest practices for grasses, crop residues and forages and their nutritional and feeding evaluation.
- Nutritional mapping of crop residues in different agroclimatic zones.
- Development of efficient feeding systems for different categories of livestock.
- Rumen manipulation, contaminants of feeds and their environmental implications.

RMSI : The Range Management Society of India, established in 1980 is based at IGFRI, Jhansi to advance the cause of research on rangeland, wasteland ecosystem and agroforestry. The society publishes the journal 'Range Management and Agroforestry' twice a year and has organized 10 national seminars/conferences on aspect of forage improvement and management.

Complete Feed Block : The complete feed block is densified (4 to 8 times) ideal feed for livestock which can be well stored in feed and fodder bank.

HUMAN RESOURCE DEVELOPMENT

The training infrastructure has been created to meet the training requirements of all levels of extension functionaries, farmers and farmwomen. Various trainings are organized on fodder production technology, silvipasture & grazing management, livestock feeding, forage seed production, etc. sponsored by institute and other national and international agencies. All categories of staff, administrative, technical and scientific were given training during 2006-07.

For details Contact : Director, Indian Gasoland and Fodder Research Institute, thensi

Conferences / Meetings / Symposia / Seminars

National Seminar on Environmental Management in Mining & Allied Industries, EMMA–2008, November 7-8 November, 2008, organized by Department of Mining Engineering Institute of Technology, Banaras Hindu University, Varanasi.

The Objective of the Seminar is to provide a forum for exchange of ideas and discussion among policymakers, managers, entrepreneurs, planners, administrators, practicing Mining engineers, Geo-Environmentalist, Scientists and technologists concerned for development of mining industry. To promote result oriented R & D programmes for developing eco-friendly technologies which can lead to sustainable Development. To identify areas which need urgent attention, to reduce damaging effects of mining. To formulate recommendations of appropriate policies, directives and guidelines to usher to growth of mining industry.

The theme of the seminar are :

A. Global Environmental Issues

B. Topographical changes, Land damages and Deforestation

C. Case Studies on Management Practices

E. Solid waste management in Mining and Mineral based Industries

F. Acid Mine Drainage

G. Ground water Resource Management

H. Air Qualities in Mines and Allied Industries

I. Environmental Impact Assessment and Modelling

K. Underground Mine Environmental and Safety at work places

L. Enabling Technologies for Environmental Management

Apart from the discussion of papers contributed by the experts and research workers, a number of keynote speakers will be invited, covering a range of discipline dealing with various themes of seminar.

Contact : Prof. N. N. Karmakar, Chairman & Chief Convenor (EMMA–2008), Head, Dept, of Mining Engineering, Institute of Technology, Banaras Hindu University, Varanasi-221005. Telefax : 0542-2369442 E-mail:ne+karmakar@rediffmail.com

National Conference on Biofunctions, Biodiversity and Plant Resource Utilization, Jan 30—31, 2009

The need of this conference is born out by the fact that in order to meet the basic demand of our ever increasing population, we have to produce progressively more and more food, feed, medicine, fibre etc. and that too from decreasing per capita arable land, water and other resources. The challenge before the scientists is to achieve sustainable increase in the productivity and output while conserving the earth's finite

natural resources for future generation. This conference intends to take stock of the current status of knowledge and findings in the fields of Biofunctions and Biodiversity to formulate performance oriented action plan to ensure sustainable utilization of plant resources.

Technical session would be on :

1. Biofunctional stress.
2. Biotechnological approach in crop improvement.
3. Biodiversity-Biofunctions relation.
4. Biodiversity-Climate link.
5. Plant biofunctional modeling.
6. Phytochemicals in nutraceutical plants.
7. Utilization of plant resources for food security.
8. Ethnobotany.
9. Sustainable utilization of plant resource.
10. Climate change and plant metabolism.
11. Radiation biology

Abstract may be submitted latest by 20 Nov 2008.

Contact : Dr. V. N. Pandey, Dept of Botany, DDU Gorakhpur University, Gorakhpur-273009 (U. P.) Mobile : 9450885374 e-mail : bbpru2009@gmail.com

International Symposium on Marine Ecosystems Challenges and Opportunities, MECOS 09, organized by Marine Biological Associations of India, 9-12 February, 2009, Kochi, India

The Marine Ecosystem is key to the survival of life on earth. In order to protect the ecosystem of the ocean, we need to build an integrated framework that transcends all relevant organizations. The objective is not only to save the ecosystem, but also to utilize the service opportunities provided by various resources. There are several such opportunities in the area of food and medicine production, which could be advantageously utilized through frontier areas of science such as biotechnology, mariculture etc. The Symposium would provide an excellent platform to discuss these issues to transform challenges into opportunities.

Technical session would be on :

A. Ecosystem Service
B. Management Strategies
C. Ecosystem Assessment
D. Opportunities
E. Ecosystem Health
F. Economic Restoration

A special session will be held on Impact of Climate Change on Marine Ecosystem.

Contact : **Dr. N. G. Pillai**, Convener/Dr. K. S. Mohamed, Co-Convener, MECOS 09,
P.O. Box 1603, Enarkulam North, P.O. Kochi-18, Kerala Tele Fax 91-484-2394909, E-mail : mbai@rediffmail.com

S & T ACROSS THE WORLD

AFLATOXIN-FREE CHILLI

Built on a turnkey basis by the National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram, a 20-ton/day fresh chilli processing plant was recently inaugurated by the Union Minister of State for Commerce, at Byadagi, Karnataka.

The facility created in the heartland of the chilli trade, symbolizes the synergy of two governmental agencies putting together their resources for a common goal-finance by STCL and technical support by CSIR.

The first of its kind in India, the chilli processing plant will produce world class quality, toxin-free chilli with high colour, to meet stringent international standards. The washing of the fresh chilli prior to processing will ensure the removal of surface mud, dust and pesticides, if any.

Unlike the conventional process of sun drying the fresh chilli, which takes 10 to 12 days and results in loss of carotenoids, development of aflatoxins, and accumulation of dust, bird droppings, etc. This facility will process the garden fresh chilli to the end product within a few hours of reaching the factory thus helping to preserve its colour and freshness.

(CSIR News, Apr 2008)

LIGHTER AEROPLANES

Aeroplane fuselages and wings are currently made of small pieces held together by thousands of metal fasteners. These fasteners constitute a considerable proportion of the weight of the aeroplane and a lighter aircraft means that less fuel would be required.

Now, Australia's CSIRO, in collaboration with an Australian company Quickstep Technologies, has developed an advanced composite material that could eliminate the need for these fasteners. The material is made up by coating sheets of carbon fibre with special polymers. Layers of these sheets are then joined together to make a strong, durable, easily moulded material. Large sheets of these composite polymers are then bonded together in what looks like a giant sandwich maker.

One of the advantages of this process is that it has the potential to make large integral structures, such as whole wingpieces, resulting in lower capital investment, savings in time and reduced costs of production.

(www.csiro.au, Jun 27, 2008)

ALZHEIMER'S DISEASE

Researchers in Ireland have unlocked new insights into Alzheimer's disease, which may help in the development of advanced drugs to combat the illness.

The researchers have found a cascade of molecular events that lead to the onset of the disease. The accumulation of a particular protein called amyloidbeta in the brain has been identified to be the factor responsible for the initiation of the disease, which directly alters the structure and functions of the brain cells.

These findings, which have been published in the latest edition of '*Nature Medicine*' suggest a potential new target for the development of drug therapies, to fight the irreversible and degenerative disease, which afflicts nearly 30 million people each year world wide.

The progression of Alzheimer's disease is tortuously long and debilitating, extorting a huge emotional and economic cost and it constitutes a major personal and societal tragedy.

(Biotechnology Ireland, Jun 27, 2008)

NEXTGEN NANOWIRES

Scientists in Canada have cleared a major hurdle facing the nanotechnology revolution by developing tiny nano-sized wires on silicon chips. The team focused on a class of molecules called block copolymers which naturally form into horizontal lines on surfaces.

They found that if trenches are etched about 30 nanometers in depth into silicon and block copolymers are added, the molecules automatically align themselves according to the etching, thereby integrating chip technology with nanotechnology.

(National Research Council Canada, Jun 27, 2008)

ANSWERS TO "DO YOU KNOW ?"

A1. The Fear of Ugliness.

A2. Aphyllous Plants.

A3. New Flower.

A4. Bull Fight.

A5. About a quarter, i.e 300 gram.

A6. The Indian tri-colour Flag-Price Two and half Anna.

भारतीय विज्ञान कांग्रेस संस्था

14, डॉ० विरेश गुह स्ट्रीट, कोलकाता 700 017, भारत

THE INDIAN SCIENCE CONGRESS ASSOCIATION

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

Telegram	:	SCICONG : CALCUTTA	Fax	:	91-33-2287-2551
Telephone	:	(033) 2287-4530, 2281-5323	E-mail	:	iscacal@vsnl.net
Website	:	http://sciencecongress.nic.in			iscacal_2004@yahoo.com

Terms of Membership and Privileges of Members :

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

1. **Member :** A person willing to be enrolled as new Member has to pay an annual subscription of Rs. 200/- **along with an admission fee of Rs. 50/-** (for foreign* U.S. $70) only. The annual subscription of a Member shall become due on the 1st April of each year. Anyone who fails to pay the subscription on or before the *15th July* in any year shall lose the right of voting and / or holding any office of the Association for that year. A Member failing to pay the annual subscription by the end of March of the following year shall cease to be a Member.

   Members may contribute papers for presentation at the Science Congress. They will receive, free of cost, reprint of the Proceedings to Session of any one section of their interest and also the bi-monthly journal of the Association "Everyman's Science".

2. **Sessional Member :** Sessional members are those who join the Association for the Session only. A Sessional Member has to pay a subscription of Rs. 250/- (for foreign U.S. $60) only.

3. **Student Member :** A person studying at the under-graduate level may be enrolled as a Student Member provided his/her application be duly certified by the Principal/Head of the Department. A Student Member shall have the right to submit papers for presentation at the Session of the Congress of which he/she is a member, provided such papers be communicated through a Member, or an Honorary Member of the Association. He/she shall not have the right to vote or to hold any office. A Student Member shall not be eligible to participate in the Business meetings of the Sections and the General Body. Subscription Rs. 100/-

4. **Life Member :** A Member may compound all future annual subscriptions by paying a single sum of Rs. 2000/- (for foreign U.S. $ 500) only. Any person who has been continuously a member for 10 years or more, shall be allowed a reduction in the compounding fee of Rs. 50/- for every year of such membership, provided that the compounding fee shall not be less than Rs. 1,200/- (for foreign U.S. $ 12.50 and U.S $ 300 respectively). A Life Member shall have all the privileges of a member during his/her lifetime.

**Admission fee of Rs. 50/- is needed only for becoming a new annual member and not for sessional member / life member / Institutional member / student member / donor.*

5. **Institutional Member :** An Institution paying a subscription of Rs. 5,000/- (for foreign U.S. $ 2,500) only, can become an Institutional Member of the Association. It shall be eligible to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional Member shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress Session as also a copy of the Association's journal "Everyman's Science".

6. **Donor :** Any person paying a lump sum of Rs. 10,000/- (for foreign U.S. $5000) only, can become a Donor of the Assocaiation. An ***INDIVIDUAL DONOR*** shall have all the rights and privileges of a member during his/her lifetime. An Institution paying a lump of Rs. 50,000/- (for foreign U.S. $25,000) only, can become ***INSTITUTIONAL DONOR*** of the Association, which shall have the right to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional / Individual Donor shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress as also the Association's journal "Everyman's Science".

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

B) Members of all categories are entitled to railway Concession of return ticket by the same route with such conditions as may be laid down by the Railway Board for travel to attend the Science Congress Session provided that their travelling expenses are not borne, even partly, by the Government (Central or State), Statutory Authority or an University or a City Corporation.

C) Members of all categories are entitled to reading facilities between 10.00 a.m. to 5.30 p.m. on all weekdays (except Saturdays & Sundays) in the library of the Association.

D) Members of all categories may use Guest House facilities, Lecture Hall hiring at the rates fixed by the Association from time to time.

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

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

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E-mail : iscacal@vsnl.net
iscacal_2004@yahoo.com

APPLICATION FORM FOR MEMBERSHIP

To
The General Secretary
The Indian Science Congress Association
14, Dr. Biresh Guha Street,
Kolkata-700 017

Stamp Size Photograph

Dear Sir,

I like to be enrolled as a Member / Life Member / Donor / Sessional Member / Student Member / of The Indian Science Congress Association.

I am sending herewith an amount of Rs. ..... in payment of my subscription by Bank Draft / Money Order / Cash for Membership / Life Membership Subscription / from the year 1st April 200 ..... to 31st March 200 .....

I am interested in the following section (Please tick any one).

SECTIONS

1. Agriculture and Forestry Sciences
2. Animal, Veterinary and Fishery Sciences
3. Anthropological and Behavioural Sciences (including Archaeology and Psychology & Educational Sciences)
4. Chemical Sciences
5. Earth System Sciences
6. Engineering Sciences
7. Environmental Sciences
8. Information and Communication Science & Technology (including Computer Sciences)
9. Materials Science.
10. Mathematical Sciences (including Statistics)
11. Medical Sciences (including Physiology)
12. New Biology (including Bio-Chemistry, Biophysics & Molecular Biology and Biotechnology)
13. Physical Sciences
14. Plant Sciences

(Please type or fillup in Block Letters)

Name (in block letters) : _____ _____ _____
SURNAME FIRST NAME MIDDLE NAME

Academic Qualifications :
(Evidence to be submitted)

Designation :

Address for Communication :
(including State, City/Town and Pin code)

Phone No. & e-mail

Permanent Address :

Yours faithfully

Date : Signature

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