EVERYMAN'S SCIENCE

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

Past General Presidents of ISCA

1. Prof. S. K. Mitra	**(1955)**
2. Dr. M. S. Krishnan	**(1956)**
3. Dr. B. C. Roy	**(1957)**
4. Prof. M. S. Thacker	**(1958)**
5. Dr. A. L. Mudaliar	**(1959)**
6. Prof. P. Parija	**(1960)**

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CONTENTS

EDITORIAL

Demographic growth of a population is a natural process. Different characteristics related to this process have been used for decades to construct indices of quality of health of a country such as birth rate, mortality/morbidity rates, etc. Besides, attention was also focussed around antenatal/ postnatal care and so on.

Official records claim that standard of health in India has now improved. Gender-wise life expectancies at birth and later at the age of 60 years were 41.8 years, 11.8 years for males and 40.6 years, 13.0 years for females for the period 1951-61. The life expectancies have improved to 55.4, 14.6 for males and 55.7, 16.4 for females respectively for the period of 1981-85.

These improvements have gradually made an impact upon the structure of age - specific distribution of population in the country. If the range of age distribution is divided into three categories — "14 years or less", "15-59 years", and "60 years or more", –broadly corresponding to period of schooling, becoming adult or entering into work force and beginning of retirement— changes in proportional distribution of population are noteworthy. The percentages of male population in these three age—categories in 1950 were 38.4, 56.4 and 5.2 respectively which were estimated to become 22.5, 65.4 and 12.1 respectively in 2020. The same percentages for female population were 39.5, 54.4 and 6.1 respectively in 1950 which were estimated to become 22.5, 64.3 and 13.2 respectively in 2020.

Relative growth of the population of "60 years or above" is the striking feature among all these estimated projections. In fact, this slices (in 1950) was 8.0% of (global) population which has been estimated to increase to 14.8% by 2025. In India it was 5.6% in 1950 and expected to increase to 12.6% in the year of 2025. We are not, however, concerned with changes in demographic structure as such. Only a few selected salient features of these changes have been indicated, interfaces with which are bringing up new issues and alterations in social structure. We want to draw attention of the readers to this side of the story.

An explicit outcome of this demographic growth is the widening of a population segment, "60 years or above" labeled as "elderly" or "old-age" population. The age-line of "60 years", has been globally accepted as a divider of society into two parts-"elderly" and "non-elderly". This demographic divide, however, is of tremendous societal concern. Sociologically, it stratifies the society in two asymmetrically related strata—the stratum of "elderly" population which is dependent upon the "non elderly" stratum for various kinds of support, not merely economic, but physical, material, psychological, social and emotional as well, for life and living. The support system has different dimensions, namely, Psychological, Anthropological, Sociological, Health and Geriatric. All these dimensions have together formed a new area of study and research in social science referred to as gerontology. This area has already drawn attention of social scientists and social welfare related action planners.

Again, it is not a matter of mere epistemological concern. It involves a complex interface of different sociological theories related to social exchange ; traditional culture and value orientation ; distribution of resources, inequality and power ;

and social net works. Articulation and efficiency of the support system for life and living of the elderly operate on the basis of parameters of these theoretical dimensions. Since this segment has emerged in course of an on-going process of life-cycle after transition across an ageline, statistical and mathematical dynamic modelling of the structure of this flow becomes quite a challenging endeavour.

The purpose of this brief explication has been to "sensitise", so to say, academic alertness. Developments in one facet of the society may percolate through other facets and accelerate emergence of new areas of problem solving. We have explained how in such an "unanticipated" situation domain boundaries of different theories may become fuzzy or even get dissolved to constitute a mesh of theories as the plausible paradigm to study the nuances of the newly experienced societal experience.

Dr. S. Bandopadhyay

"The brain is wider than the sky."

—Emily Dickson

PRESIDENTIAL ADDRESS

TRIBUTE TO BASIC SCIENCES

DR. A. L. MUDALIAR* M.D., LL.D., D.SC., D.C.L. (OXON), F.R.C.O.G., F.A.C.S

Ladies and Gentlemen,

I am beholden to my colleagues of the Indian Science Congress for giving me this unique privilege of presiding over its 46th Session. During these several years many distinguished scientists have adorned this chair and it is with no sense of false modesty that I confess that this honour is one which I did not look forward to nor did I ever anticipate. I have ventured to accept your invitation, however, because of the conviction that the honour is one that is meant more to my profession, the medical profession, which it has been my great privilege to practice for the last fifty years. From another point of view, I felt that it gave me an opportunity to pay my humble tribute to the great part that Science has played in the progress of medicine within the last fifty years and to place before you the picture of how Medical Science has been influenced and guided by the great discoveries in the fields of the Physical Sciences, the Biological Sciences, the Technical and Technological Sciences. Never has this influence been more dominant than during the past quarter of a century when phenomenal and significant progress has been achieved in every branch of Medical Science, thanks to the achievements of scientists in the sister Sciences to which I have referred.

It is therefore with feelings of profound gratitude that, as a representative of the field of Medical Science, I pay my tribute to the great scientists who have made significant contributions in advancing the fields of knowledge of the Basic Sciences. I venture to express the hope that the Medical Sciences have also played some little part in stimulating those working in the fields of the Allied sciences. It cannot but be otherwise. Discoveries in one field of Science lead to repercussions in other fields of Science and the problems of one scientific discipline always stimulate research in other disciplines of Science. Today therefore one is forced to the conclusion that Science is indivisible, that no compartmentalism can possibly be conceived, that every new research in any field of the physical, biological or technolgical Sciences has its effect on the other and that therefore the reactions in the minds of those who are investigating problems in any one of these Sciences are considerable. At the same time, so enormous are the widening fields of research in these Sciences that one may well be lost in the contemplation of the amount of knowledge that is being made available every year which cannot possibly be comprehended by any single individual unless opportunities are given to realise at least the fundamentals of the great discoveries in the several branches of Science. From this point of view therefore it seems to me a very happy idea of the originators of the proposal to hold a Science Congress that they conceived the possibility of scientists interested in every branch of Science meeting at a common session and exchanging thoughts and experiences. The platform

* General President, Forty-sixth Indian Science Congress held at Delhi during January, 1959.

for Science, if it is to be utilised effectively and for good purpose, must in the main be a platform not only for recording new experiences, new discoveries and new trends in scientific thought but, what is equally important, it should be a platform for disseminating the knolwdge that has been gained in the different branches thereof, alike to the votaries of the respective Science as also in a large measure to everyone with a scientific bent and in the pursuit of scientific knowledge. It is thus that scientists will be able, with greater amount of success, to realise the way in which scientific discoveries could best be utilized and the manner in which problems in their own special fields could better be tackled with confidence. This will be made more obvious when I refer to the advances of Medical Science and the debt Medical Sciences owe to the discoveries in other fields, in the fields of Physical Sciences, Biological Sciences and Technological Sciences.

PROGRESS IN 20TH CENTURY

The 20th century has witnessed a remarkable progress in the field of scientific discoveries, so much so that Science has for the first time come into its own. It may be asserted with confidence that far more scientific work has been done in the last 50 years than in the whole period of the previous history of humanity. Although many epoch-making discoveries have been made in the past, their application for practical purposes and the rapid development of the associated Sciences has become a phenomenon of the 20th century, more than that of any other period. In the past, science was thought of as an accessory factor—interesting, occasionally exciting but perhaps not of much practical value. Few were prepared to consider that it had a direct bearing on the main stream of human endeavour and on the progress of historical events. The danger at present is the opposite, that of giving Science too much credit, whether for good or evil, in the tremendous, vastly disturbing kaleidoscopic changes that are taking place consequent upon wars and revolutions, so unfortunately frequent in this half century. The power of Science to affect the life of man for good or evil is no longer seriously in doubt. The problem now is rather that of finding the means by which Science can be directed to constructive and not to destructive ends.

Perhaps in no fields of Science could the constructive use of scientific discoveries be more clearly demonstrated than in the field of Medical Science. And it may be stated that it is only in this century that the influence of Science on Medical practice, derived from the 19th century pioneer work of Pasteur and others, began to make itself felt on a large scale. Medicine has increasingly become dependent on the important chemical and instrument industries. Pharmacy, far from being a collection of simple herbs or the combination of drastic mineral salts has become a scientific industry and one of no small importance even from the purely commercial point of view. No longer will the witches' cauldron portrayed in Macbeth be utilised even by the most ignorant of the population as a panacea for certain ills.

PREVENTION OF DISEASES

The outstanding development in Medicine of the 19th century centres round the prevention of diseases. The discovery of bacteria in relation to the causation of diseases has naturally led to a large number of investigations as to the best methods of preventing the growth and development of bacteria in the human system. This in turn led to better methods of treatment and to the surgical skill which was made possible by the use of anaesthetics. The health of the individual and of the community has been improved beyond all expectation by the adoption of numerous laws enforcing public health measures and the 20th century opened its medical practice ready to cooperate with other branches of knowledge in the new role that Science was destined to take in society.

One of the first responsibilities of a society is care for the health of its members. As has been already pointed out, during the opening decades of 20th century, medical practice has made progress comparable with that achieved in other branches and, in the realm of public health, Science has extended its interest to embrace every aspect of social life. Radium, X-ray and many electric treatments are witness to the influence of the new Physics on medicine. The skill in surgery has been increased beyond all expectation and Chemistry has added to the efficiency of antiseptic measures while one branch has produced important drugs capable of destroying some of the most harmful bacteria which took a heavy toll of life before.

MEDICINE AND WAR

Paradoxical as it may seem, it is the urgency for certain definite discoveries during a war that has led to a greater scientific effort in period of peace. It was during the war that methods of creating blood banks and serum banks were first initiated and tried. Today, lives of many thousand of persons have been spared because of these blood banks established in many a town in all civilized countries and largely contributed by voluntary donors. But the most spectacular event of the last war was the demonstration of the great potentialities of new drugs like Penicillin or insecticides like D. D. T. It was in 1928 that Fleming made the observation that some of his bacterial cultures were being eaten away at various spots in the petri dishes in which they were prepared and noted that this was due to a mould which had grown there and which seemed to be giving out some substance which killed the bacteria. It was not however till 10 years later that Florey and Chain started a systematic search for natural antibiotics, when Fleming's observation was put to use. By the time the clinical value of Penicillin was proved, the war came and gave a great impetus of further investigations. It was a concentrated effort in the fields of Chemistry, Biology and Medicine that led to the great use of this wonder drug, as it was called, to save literally thousands of lives.

The discovery of Penicillin is often quoted as an example that important discoveries come by chance. It is no doubt true that some great discoveries do come by chance. But chance is multiplied by providing opportunities for discovery in the first place and for development by interested people in the second. Once Penicillin was discovered, it was relatively easy to search through Nature for other substances which might have the same or better effects. Thus a whole new field of antibiotics was opened : Streptomycin, Aureomycin, Chloromycetin, Synermycin, Tetracycline, a bewildering array of antibiotics sometimes confusing and confounding to the medical practitioner.

During the second world war, it was clearly realised that disease had played a much greater part in the previous wars than any of the destructive weapons of warfare and that therefore the most paramount consideration should be to protect the forces against disease, especially in the tropical regions where war was waged, as well as the realisation that the consequences of wounds should be minimized as far as possible. This led to an all-round advance in sanitational medicine and surgery.

NUTRITION

It was realised early in the 20th century that one of the most neglected aspects of Medicine was that of dietetics. And as the Science of nutrition leapt into prominence, the study of the problems of nutrition and of nutritional disorders led to major scientific discoveries of the accessory food factors, the Vitamins. This naturally led to further investigation as to what kind of food people needed and how much to keep them healthy and alive. This in turn had a direct influence on the largest and most ancient industry, agriculture, and on the newly established food industries. Agriculture, far

from being the major human traditional occupation, is rapidly being transformed into an industry which is becoming more and more scientific in character : while in the field of Medicine, an attempt at a scientific control of human conditions is being undertaken so that, in future, health and not disease will be the chief concern. In view of the large concentration of the population in urban areas, it will be easily realised that the food needed for them can no longer come straight from the farm to the table. There is also the danger that adulterated foods and improperly prepared food-stuffs may result in great calamities on account of food poisoning. It has therefore become necessary in most countries to have stringent laws passed to observe rigid control over the production and distribution of food-stuffs. This has led to research and development in the Science of preparing and preserving food ; thus artificial refrigeration, hermetically sealed food production, pasteurization, sterilization and other scientific methods have now become the common means of ensuring supply of safe food-stuffs.

ROLE OF VITAMINS

In the past, many diseases were attributed, and quite rightly, to deficiencies in diet. Of these perhaps the most important was scurvy, the dreaded disease of sailors. But the study of those accessory factors so essential in food, the Vitamins, gave an immediate impetus to the study of Biochemistry and at last chemicals, that could be used and issued immediately for curative purposes in the shape of Vitamins, were discovered. Some of them are simple as Vitamin C, ascorbic acid, but others like Vitamin B are found to contain several different substances, each needed for carrying out some different function in the body. Science thus enabled us to posses the means of ensuring a healthy life as far as food could do it for the population of the whole if only the will to take advantage of the discoveries of Sciences were there. Yet it is unfortunate that today diseases due to Vitamin deficiency such as rickets, scurvy, beri-beri and pellagra are common in different parts of the world, either due to ignorance or poverty. And it is here that international organizations such as the Food and Agricultural Organization of the United Nations are doing much and can do a good deal more in this direction. It may be of interest to know that paradoxically enough the civilian population of many Europen countries, which were in the grip of the great war, were actually kept in better health during the war in spite of reduced gross diet because of a scientific approach to the qualitative contents of such diet ignoring the quantitative factor. It is needless to say that the health and activity of the armies in the field were likewise ensured by attention to these nutritive factors.

ROLE OF HORMONES

Of equal importance for the maintenance of health were minute quantities of substances produced inside the body itself by organs such as ductless glands. These were known as the hormones. And today a study of hormones is a most entrancing study and promises to lead to great results. Prominent among these hormones, are the aestrogenic and other ovarian hormones. Thyroxin and Insulin. Recent advances have shown the possibility of producing synthetic hormones or substitutes as in the case of diabetes. The original impetus for biochemical research came from Medicine. Ever since Pasteur discovered bacteria, there was always the hope that some chemical substances could be found that would kill the bacteria without adversely affecting the patient. The first success was arrived at by trying to see that chemicals that would colour bacteria for recognition purposes could also be used to destroy them. This was how the group of chemical substances known as Sulphonamides were produced in 1932 by Domagk who as awarded the Nobel Prize but was not permitted to accept it.

MEDICINE AND THE PHYSICAL SCIENCES

Medicine owes a great deal to the Physical Sciences as well. The developments in Physics led to the invention of a number of new instruments. For a long time, the ordinary microscope was the only instrument powerful enough to view some of the small animalcules which could not be seen by the naked eye. The use of the electron microscope was a great advance in the field of Microbiology. It enables us to see and reproduce on photographs the whole range of structure from those clearly visible in an ordinary microscope down to those of practically atomic dimensions. In the electron microscope, viruses and bacteriophages become visible and distinguishable for the first time and the finer nature of such tissues as muscle and skin begin to show something of why they have the peculiar and useful properties that they show in living organisms. The electron microscope can magnify up to 1 million times and thus a whole new Biology is coming into existence by the use of this instrument. Besides the electron microscope, some new modifications of the ordinary microscope have been made, stimulated by the competition of the electron microscope. The most important of these modifications are the phase and interference microscopes which enable cells to be studied alive when previously they had to be killed and stained. Next came the new ultraviolet and infrared reflecting microscopes which brought out details not otherwise visible and could also be used to study the chemical composition of cell structure.

The progress of Medical Science has always depended on the perfection of precision instruments of observation and control. Until very recently, these were not developed for the immediate needs of Biology. The most recent and most powerful adjuncts to biological study have also come from Physics—the valve amplifier to measure the minute currents and potentials in living system, the electron microscope referred to already and the use of isotopes and tracer elements which promises an interpretation of the actual process of transformation of chemicals in living systems. These and the electro-encephalograph for registering the drug reactions of the human brain have led to the coming of age of Biophysics. This does not mean that Biochemistry has become less important. In fact, the post-war period is witnessing a multiplication of antibiotic drugs and a rational approach to that large field of hormone therapy and pharmacology.

Radio isotopes have been used in the field of industry, Biology, Biochemistry and Medicine. Leaks in water mains and pressurised cables can be located by adding small amounts of radioactive materials which can be detected when they escaspe. Radio isotopes are proving indispensable in Biochemistry for example. Penicillin has been made active and its movement observed in the body of animals. Great progress has also been made in the treatment of surface cancers. Such examples make us realise that we are only at the beginning of the development of the utilisation of radio isotopes.

HAZARDS OF RADIATION

When Roentgen, then an obscure Professor at Wurzberg, first discovered X-rays in 1895, he little realised that this was a scientific discovery of great potentiality. The use of X-rays in the field of Medicine is well-known today, whether in the diagnostic or therapeutic processes, and consequently the medical profession has studied for long the dangerous ill-effects of radiation and the remedial measures by which people working in such plants should be protected. In the 20th century however a great figure—one of the greatest figures of the 20th century Physical Science—emerged in the person of Lord Rutherford. His discovery has, as is now known, been rapidly followed up in various fields by a large number of scientific workers in all parts of the globe.

PROGRESS OF SCIENCE IN INDIA

Although sporadic attempts were made now and then to establish institutes of Science for the fostering of research in some fields, yet it must be confessed that very little was accomplished owing to the great lack of well-equipped laboratories and incentives for scientific workers.

The whole picture has changed however after the dawn of Independence in this country. The Council of Scientific and Industrial Research was the spearhead to promote the starting of a large number of national laboratories for various scientific disciplines. The first of these laboratories were the National Physical Laboratory and the National Chemical Laboratory but separate laboratories have since been established for researches, both basic and applied, in several fields of scientific knowledge. Today, there are a large number of these laboratories spread over the length and breadth of this country. The work of these national laboratories covers a very wide field indeed. The laboratories afford excellent facilities for research with the most modern techniques and every attempt is being made to link up research with the problems of industry, so vital for the progress of our country. Besides the establishment of these national laboratories, a great step has been taken forward to encourage young men with scientific talents to pursue a career in Science untrammeled by any considerations of other avenues of employment. Many have been awarded foreign scholarships through Government and through various organizations to acquire modern techniques in the fields where such techniques have not yet been fully developed in our own country. Yet the attractions of other services like the administrative services, wherein a very large number of posts have been created, draw away some of the best among the graduates in Science who thus are lost to Science forever. It may be interesting to know that in ancient days Roman Engineering ranked with Roman Law in importance. The Emperor, Constantine, wrote in the 4th century : "We need as many engineers as possible. As there is a lack of them, invite to this study persons of about 18 years who have already studied the necessary Sciences. Relieve the parents of taxes and grant the scholars sufficient means." The appropriateness of similar measures being adopted in India need hardly be emphasized.

NATIONAL PROFESSORSHIPS

The institution of National Professorships for the first time has been hailed with approval by all interested in the future if this country. We are happy that the first National Professor to be appointed was none other than our esteemed countryman, Dr. C. V. Raman, who is so actively engaged in his research work today. It is a matter of considerable satisfaction to all that two more eminent sons of India, Dr. Krishnan and Dr. Bose, past Presidents of the Indian Science Congress, have been recently appointed as National Professors. The worth of a great scientist can never be measured in terms of the marketplace. Speaking of Faraday, Tyndal says that he might, with ease, have realised an income of £10,000 a year during the last 30 years of his life when he earned almost nothing by professional services. "Taking the duration of his life into account, this son of a blacksmith and apprentice to a book-binder had to decide between a fortune of £1,50,000 on the one hand and his undowered Science on the other. He chose the latter and died a poor man. But his was the glory of holding aloft among the Nations the scientific name of England for a period of 40 years." Lives of such great scientists as Faraday's are for ever a beacon light for the succeeding generations of scientific workers.

TECHNOLOGY AND SCIENCE IN THE PLANNING CONCEPT

Technology and science have been given a pride of place in the planning concept of modern

India and much of the success which has attended the efforts of those who tried to build up and develop these institutes is due to that dynamic personality and statesman who was once a student of Science and has been, fortunately for the country, Prime Minister and Guiding Star of India since the dawn of independence. Simultaneously with the development of the national laboratories, steps have been taken to provide greater facilities in the Universities for carrying on resarch, both fundamental and applied, and the generous grants recently given by the University Grants Commission—which it is hoped will be given in a larger measure in future—have been greatly appreciated by the Universities. Thus the Universities have, for the first time, been enabled to plan ahead and to organize research departments in many scientific disciplines and in other spheres of higher learning. All this however needs a much greater amount of emphasis in the educational pattern which must be adopted in conformity with the growing needs of a global concept of scientific advance. It is here perhaps that a greater amount of lee-way has yet to be made and if India were to progress and to keep abreast of the times, if it is to be independent not merely in the political field but, what is equally if not more important, in the scientific and creative fields of human endeavour, it is obvious that urgent meausres have to be taken to provide for the right type of education, scientific and otherwise, to train the young men in such a way that their creative talents will be stimulated and that the opportunities for their acquiring the knowledge so plentifully available today and not diminished by any limited idea of parochial or provincial patriotism.

THE LANGUAGE OF SCIENCE

The language that Science speaks is international and one must recognize that whatever may be the vehicle through which scientific thought can be conveyed, the use of this international language is absolutely essential if progress in Science in any country is to be speeded up. And so it is that a plea is made to those who hold a different viewpoint that under present circumstances and taking into consideration the urgent needs of the country, nothing should be done to hamper, dealy or embarrass the development of scientific education whatever may be the vehicle through which such education may be possible at present : what that vehicle should be, there could be no doubt in the minds of scientists.

RESEARCH IN FUNDAMENTAL AND APPLIED SCIENCE

It is hardly necessary to emphasize the fact that research both in fundamental and applied sciences should be encouraged in every manner possible. Occasionally there is a great deal of emphasis laid upon applied research to produce quick results : and, while it is conceded that Science in its larger and more comprehensive sense is to be considered in relation to what it can do for human welfare, nothing should be done to impede the progress of Pure Science as well. It was J. J. Thomson who said : "Research in Applied Science leads to reforms ; research in Pure Science leads to revolution." This fact has been demonstrated over and over again in all the great discoveries of Science. It is not always wise to emphasize the utilitarian point of view in any piece of research for, if that had been the main consideration, some of the greatest discoveries of the age which have stimulated many of the researches in Applied Science would never have been possible. When Archimedes ran through the streets of Syracuse shouting in Greek, "Eureka, Eureka," "I have found it, I have found it," he desribed the principle that every solid body lighter than a liquid in which it floats sinks so deep that the mass of liquid, which has the same volume with the submerged part, weigh just as much as the floating body. It might have meant nothing to that generation but we realise today that it is this principle of hydrostatics that is the basis of all problems of floatation and naval architecture.

Likewise when Professor Faraday demonstrated his famous experiment that when a magnet is brought suddenly near a coil of wire, a slight current of electricity is produced in the wire, even such a great scholar and statesman as Mr. Gladstone asked him the question : "After all, what use is it ?" "Why, sir," replied Faraday, "there is every probability that you will soon be able to tax it." And today, no Finance Minister could afford to neglect the revenue directly and indirectly obtained through taxing this great energy, electricity.

SCIENCE FOR ITS OWN SAKE

The plea, "Science for its own sake", has been put forward clearly and forcibly by Sir Edward Appleton in his Presidential Address to the British Association for the Advancement of Science in September, 1953. "I have long held the belief," said Sir Edward, "that the cost of scientific research is the price we must pay for our industrial progress. But we should be misleading the public as well as ourselves if we based our case for the general support of the pursuit of Science on its utilitarian aspects alone. I know that we can claim that many discoveries in Pure Science, which in their time had no obviously practical import, have later proved to be the foundation of major improvements in every material civilization. But even that is an argument of profit and loss and, to my mind, does not bring us entirely to the heart of the matter. I should like to go back beyond the achievements to the example of the scientist, be he amateur or professional—who is impelled solely by a passionate desire to explore and understand. That is what I mean by Science for its own sake—when knowledge and insight are sufficient rewards in themselves." A clear exposition of the principle "Science for it own sake" cannot be made.

SOME FAMOUS SCIENTISTS AND THEIR OCCUPATIONS

It is well also to realise that great discoveries of Science may some times be produced in unexpected quarters and by persons who may not be necessarily in the forefront of scientific workers. Men and women of different races, walks of life, temperaments and professions have become famous scientists. Leonardo da Vinci was an artist, Sir William Herschell a band leader, Lavoisier a tax collector and Priestly a clergyman : Marie Curie was a political exile, Joule a brewer, Edison a telegraph operator, Einstein a Patent Office Clerk. Faraday a book-binder, Halley a gourmet and Newton a recluse. Many are the names of persons in diverse avocations who could be cited as great scientific discoverers of all ages. In our country, the great genius, Ramanujam, the mathematical prodigy next perhaps only to Newton, was a clerk in the Port Trust of Madras. So lie buried amidst anonymity some of the great scientists who have made their names immortal. What these men and women have in common is a passionate devotion to Science. It has been aptly stated that genius flashes forth like a meteor unproduced and unpredictable. It is not limited to any race of people or to any particular latitude or longitude. It has often come up from obscurity and has flourished under poverty and persecution as well as under the smiles of fortune. At present, we can only hope and pray that it will come often in our country. Fortunately genius has a way of asserting itself in every age. We may feel confident that there will be future Aristotles, Galileos, Newtons, Faradays, Pasteurs, Freuds, Ramanujams and Einsteins to provide new insight into the eternal mystery of the universe.

SCIENCE AND SOCIETY

The relation of Science to society in health, in industry and in thought have been full of promise ; but it is a humiliating admission that the five decades of the present century have witnessed the catastrophe of two wars and of many smaller conflicts. Even the period following the cessation of hostilities in 1945 has been marked by conflict or international friction in many parts of the world—

Europe, Africa, and Asia. Yet during this time, scientific achievements have been so outstanding and so full of promise for the greater possibilities of human welfare than ever before.

The social need of the period requires scientific planning. The advances of Biochemistry and Chemotherapy have shown that on this side, Science is going to be more effective in human affairs than it has ever been in the past. The whole world can be changed more quickly now by some chemical discovery such as that of Paludrin for malaria. And today the world Health Organization, taking note of these significant advances, has launched boldly and wisely a programme of eradication of diseases rather than of control of diseases. The eradication of malaria is no longer a theoretical problem for it has been effectively proved that by modern methods of scientific investigation and application it could be accomplished. This naturally necessitates scientific planning so that individual scientists, often working in ignorance of the wider implication of their efforts to develop this or that field, may be guided to the more urgent needs of society so that the time lag may be saved with the saving of millions of human lives. The implication is not so much that scientists should be directed to this or that particular purpose but rather that a better system of scientific education should be adopted to a society consciously aimed at securing the maximum human welfare.

TRADITION AND SCIENCE

But the application of scientific remedies is not altogether easy in an atmosphere where ignorance and prejudice prevail. In Science as in politics, a break with tradition had always meant a liberation of human inquiry into hitherto closed fields. If Science does not progress as rapidly as it ought to and its beneficent influences do not reach the masses of the people, it is more often than not due to ancient customs and beliefs and to a certain extent, very naturally, to hesitation to discard such beliefs. The greatest difficulty of discovery is not so much to make the necessary observation but to break away from traditional ideas in interpreting them. From the time when Copernicus established the movement of the earth and Harvey the circulation of blood down to when Einstein abolished the ether, the real struggle has been less to penetrate the secrets of nature than to overthrow established ideas even though in their time they might have helped in some way the advancement of human knowledge.

War however produced the most outstanding example of the conscious use of Science in the 20th century industry, agriculture, medicine : and even Science itself began to be planned instead to being left to the chance of economic forces. This growing consciousness of the function of Science was one of the most characteristic features of the 20th century social relations. Science became fully, consciously and immediately what it has long been unconsciously considered, an essential part of production. It was something worth investing in, directly by setting up of research laboratories connected with various industries or indirectly by subsidising Universities where the workers for these laboratories could be trained and where basic research could be carried out. The number of research laboratories established in various large-scale industries and the many research projects which Universities are being asked to undertake in connection with industrial advances are proof positive, if such proof were indeed necessary, that Science can pay its way if it is properly utilised.

SCIENCE KNOWS NO FRONTIERS

Science knows no frontiers. Perhaps the best example of this is the observance of the International Geophysical Year which is noteworthy not only because of its intrinsic value and the popular interest evinced throughout the world in this venture but also because it is a supreme example of scientific cooperation among all nations

when, in other fields unfortunately, ideologies of a conflicting nature are so clearly manifest. It is becoming more and more appreciated that no discovery of Science can be hidden for long. At the international conference on the Peaceful Uses of Atomic Energy held at Geneva in August 1955, the President of the Conference, our esteemed friend, Dr. Bhabha, said : "Knowledge once given cannot be taken back." A significant statement coming from an outstanding scientist of the day. In the light of this fact, the feverish heat with which nations are trying to compete with each other in the race for some scientific discovery not necessarily of a nature that will be productive of good but unfortunately of a type that is more designed to destroy than to create or preserve seems indeed a tragedy too deep for words to describe.

SCIENCE FOR THE WELFARE OF HUMANITY

In another sense, all the secrecy and the mystery that surrounds some of scientific works would, on a correct appreciation of the position, seem to be love's labour lost. The scientist today is unforturately between two compelling forces, one trying to utilise the basis of the discoveries for the good of humanity and the other equally concerned and equally eager to utilise the great discoveries of Science to us which can only lead to the destruction of humanity with consequences too staggering even for the imagination to dwell upon. It was a realisation of this factor that led to scientists protesting, in season and out of season, against the abuse of scientific discoveries for destructive purposes. The biological warfare, that was once threatened led to a protest from scientists and, at the International Congress of Microbiologists held in Rome in 1953, the following resolution was passed. "The Sixth International Congreess for Microbiology, confident of interpreting the thought of all microbiologists, expresses its view that the Science of microbiology should have as its sole aim the welfare and progress of humanity ; that all microbiological research should be directed to this end ; and that all countries should adhere to the 1925 Geneva Protocol." May we not hope that in the sphere of atomic science as well, as similar declaration would be made : that all atomic energy would be used only for peaceful purposes and that every discovery would be turned to endeavours for the improvement of conditions of living of human society ; that the psychological warfare, which has unfortunately been continued for too long a period, would end and that the Commissions now in conference to concentrate upon how best to lessen international tensions would be given divine guidance such that humanity may be spared the horrors of world conflicts and the consequent deprivation of precious lives and the degradation of human society.

THE GREAT UNKNOWN

Spectacular as these great discoveries have been, yet every day witnesses a new epoch-making event which stuns the imagination of millions of people. It would almost appear as if this is just the beginning of a new era of unimaginable discoveries. As we scan the skies and behold the great doors of the secrets of nature unfolding, we are struck dumb with amazement and with humility. In Jean Paul Richter's beautiful dream, a man was called up into the vestibule of heaven and carried to universe upon universe in endless space, until his mind reeled before the transcendental distances which were still before him. Then the man sighed and stopped, shuddered and wept. His overladen heart uttered itself in tears and he said : "Angel, I will go no further ; for the spirit of man acheth with this infinity. Insufferable is the Glory of God. Let me lie down in the grave and hide me from the persecution of the Infinite, for end I see there is none." Then the Angel lifted up his glorious hands to the heaven of heavens, saying "End is there none to the universe of God. Lo! also is there no beginning."

POTENTIAL OF INSECTICIDAL GENES FROM PLANTS AND MICROBES IN INSECT PEST MANAGEMENT

R. Asokan* and Vageeshbabu S Hanur*

Intensive and extensive use of chemical pesticides has resulted in many control failures due to development of resistance and also many environmental hazards where insecticidal genes from plants and microbes become handy. Expression of these genes in economically important plants has conferred insect resistance and consequently in lesser pesticide application for sustainable insect pest management.

INTRODUCTION

Providing adequate nutrition for the ever increasing human population, calls for a two fold increase in protein of plant origin and a four fold increase of animal origin, which is rather a difficult task through conventional breeding methods. Approximately 37% of crops worldwide are lost due to pest and diseases and insects alone account for 13% of loss[1]. There are 67000 pest species that damage crops of agricultural importance and out of which 9000 species of insects and mites are important from agricultural point of view[2]. Intensive and extensive application of chemical insecticides has resulted control failures in addition to environmental hazards. Therefore there is an urgent need to look for ecofriendly alternatives where genes derived from plants and microbes play an important role. Although agrochemical industry is investing in the production of safer and more environmental friendly pesticides, still higher level of protection is required.

Plants are generally protected from insect and disease attack by many different defense mechanisms. However, the mechanisms responsible for the observed resistance are poorly understood as they are polygenic and involve complex biosynthetic pathways. But efforts are being made on manipulating the level of secondary metabolites like *ipt* (isopentenyl transferase gene) from *Agrobacterim tumifaciens* ; cyanogenic glucosides and glucosinolates and cyclic hydroxmic acids[3] etc. It is also possible to exploit some forms of wound inducible monogenic genes such as protease inhibitors and the constitutive ones like α-amylase inhibitors and lectins[4]. Researchers have been successful in transforming plants with insecticidal genes from microbial origin such as *cry* and *vip* genes from *Bacillus thuringiensis*[5], cholesterol oxidase gene from *Streptomyeces* sp for lepidopteran, coleopteran and dipteran, respectively[6].

The following are some of the insecticidal genes employed for insect pest management.

PROTEASE INHIBITORS (PIs)

The most widely studied types of serine PIs in plants are both typified by inhibitors isolated from soybean seeds and named after their discoverers : Kunitz and Bowman Brik family of inhibitors. Kunitz inhibitors are typically monomeric proteins containing a polypeptide of approximately 190

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amino acids with two intrachain disulphide bridges. Each molecule contains a single binding site which interacts strongly with the proteases against which the inhibitor is directed (usually a trypsin or chymotrypsin). Generally the distribution of proteins of this type seems to sporadic across a range of plant families (legume and cereals), with certain plant species such as winged bean accumulating Kunitz type of inhibitors in their seeds to a significant proportion of total protein, whereas many others contain only a small amount of or no detectable proteins of this type. The Kunitz inhibitors themselves belong to a super family which includes such as the sweet tasting protein, thaumatin and proteins induced by pathogens (PR proteins) which have sequence homology, but are functionally distinct since they do not inhibit serine proteases.

Bowman Brik inhibitors are common in seeds of legume species and are found in other families (such as cereals). These PIs are proteins based on a polypeptide of 7080 amino acids which form oligomers. The basic polypeptide unit contains a high proportion of cysteine residues and forms multiple intra-chain disulphide bridges (typically 7 per monomer) leading to a tightly folded and rigid conformation. The monomeric unit contains two binding loops with reactive sites and can inhibit two molecules of proteinases per molecule of the inhibitor. The two biding loops can have similar or different inhibitor specificities. These proteins can quite abundant in seeds making up as much as 1% of total seed protein.

A further family of serine PIs is found in seeds of Barley and other cereals and is termed as barley trypsin inhibitor family. These inhibitors are proteins of 11 to 14000 Mr which contain a single enzyme inhibitory site. Like Bowman Brik inhibitors they have high cysteine content. Potato and other members of the solanaceae contain two families of PIs, which are described as potato inhibitors I and II families from potato tubers. These are smaller polypeptides[7]. PI-II is an oligomeric protein containing subunits of 8,000 Mr and the major form is a tetramer which is indicated to have 39,000 Mr. PI-II has a low cysteine content and unusually for serine PIs disulphide bonds are not essential for activity. PI-II is a dimer with size of 12 kDa and has two reactive sites and five intra chain disulphide bridges per monomer. The members of cucurbitaceae family has PIs in their seeds and very small in size (29-32 amino acids) and are relatively cysteine rich. PIs in plants appear to form an example of what has been termed as convergent evolution, where proteins with similar functions have arisen from different precursors, but share a similar functional mechanism.

Transgenic Plants Expressing PIs

Wound inducible potato inhibitor II family was expressed in tomato, potato and tobacco. A 13 kDa bifunctional corn inhibitor was found to inhibit both trypsin like serine proteases and certain insect amylases and it was found to be effective than the monofunctional inhibitor[8]. Transformed tobacco and cotton plants with a *serpin* gene from tobacco horn worm and controlled potato white fly type B (*Bemisia tabaci*). Eglic C and Cystain and ecotins and alpha macroglobulin have broader sensitivities. Mutant forms of inhibitors should be created for greater affinity and sensitivity. Phage display of the libraries of the mutant inhibitors coupled with selection of a variant with desired properties.

PLANT LECTINS

Lectins are carbohydrate binding proteins of— non-immune origin that can agglutinate cells and bin glycans of glycoproteins, glycolipids and polysaccharides. The lectins usually mediate cell-cell, host-pathogen interations, serum glycoprotein turn over and innate immune responses[9]. Lectins are isolated from plant, animal, bacteria and viruses. Most lectin molecules contain multiple binding sites and thus can cross link oligo or polysaccharides. The first lectin was described

over a century ago was to have (from the castor bean, *Ricinus communis* L.) agglutinated red blood cells. Many belong to a homgenous family of proteins based on amino acid of approximately 220 residues, although totally different sequence types have been shown to have similar functional properties. A limited no. of insecticidal lectins have been identified by their protective role within the seed as typified by the bean lectins and winged bean, *Psophocarpus tetragonolobus* (L.) DC lectins.

Many lectins are localized within the cell where they may be present in considerable amounts but their role is largely unknown. They react with storage proteins and their affinities to the species own storage proteins are greater than that of foreign proteins. This led to the assumption that they are complex proteins and thus transform them into a compact insoluble state that renders them easier to storage than a soluble state would. Many lectins are toxic and may threfore protect the plant from plant being eaten away. The lectin of pea is toxic to *Calosobruchus maculates*. The agglutinin of castor plant contains a component that is highly poisonous for animals and man. Animal expriments with lectins showed that some lectins support cell division at low concentration (mitogens).

Role of Lectins in Insect Control

● **Cowpea weevil, *Callosobruchus maculates***

The lectins are PHA from *Phaseolus vulgaris* and caused no adult emergence on diets containing 5% PHA. Lectins with N-acetyl galactosamine/ galactose delayed the development of C maculates by 8.5 to 10 days at 1% level in the artificial diet. Lectin from *Allium sativum* and *Galanthus nivalis* has higher activity against weevil larvae at 2% level.

● ***Ostrinia nubilalis***

WGA and BPA and the lectin from castor were more effective and the LC50 for WGA and BPA was 0.59 mg/g and 0.73 mg/g of diet, respectively.

● ***Diabrotica* sp**

Four lectins from *Bendeiraea simplicifolia, Maclura pomifera, Artocarpus integrifolia* and *Codium fragile* reduced the weight by 70%. The lectin from *Erantheis hymalis* at 2% level caused 100% mortality.

ALPHA AMYLASE INHIBITORS

Protein inhibitors of mammalian alpha amylases abundant in cereal grains are also present in legume and other seeds. There are several distinct families with some being homologous to the Bowman Birk type protease inhibitors. Generally these inhibitors have relatively low molecular weight and some may inhibit both mamalian insect alpha amylases. Others are far more specific being efective against either one or the other. Although induced synthesis of amylase inhibitors by insect attack has not been reported, those purified from wheat and common bean are insecticidal toward coleopterans when incorporated in the artificial diets. Different types of alpha amylase inhibitors in wheat endosperm are differentially active against different lepidopterans. When tested in the artificial diet against a range of phytopahgous Lepidoptera and coleoptera the effects of wheat alpha amylase inhibitor in vivo ranged from little or no effect, to significant effects on the development and mortality. The alpha amylse inhibitors are related to PHA and Arcelin to the extent of 45 to 85% which are expressed from a single locus from the common bean, *Phaseolus vulgaris*. PHA and other alpha amylase inhibitors are found in both domesticated and in wild varieties and the arcelin is found only in the wild accessions. PHA has two homologous polypeptides of PHA-E and PHA-L and constitutive 4-8% of seed protein and the alpha amylase inhibitor comprise only of 1% of the total seed protein. Arcelin comprises of more than 30% of total seed protein. PHA binds to the glycans on the glycoprotein of intestinal mucosa of the mammals and the arcelins may bind to the peritrophic

membrane of insect gut and prevent the nutrient uptake or make it indigestible. These do not bind to carbohydrates. The alpha amylase inhibitors exhibit the activity of certain mammalian and insect alpha amylases but not plant enzymes. Hence it is considered as plant defense protein rather than a metabolic protein.

CHOLESTEROL OXIDASE

About 10000 filtrates from the microbial fermentation were tested for insecticidal activity against the major pests revealed that two *Streptomyces* culture filtrates killed the boll weevil larvae effectively[10]. Cholesterol oxidase has been isolated from *Pseudomonas fluorescens* also. Cholesterol oxidase has been found to be not active to newly emerged boll weevil, but oviposition is severely reduced, due to the poorly developed ovaries. Susceptible insects are from the orders of coleopteran, lepidoptera, hemiptera, diptera and dictyoptera.

CHITINASES

Chitin is the polymer of N-acetyl glucosamine in β 1 $\rightarrow$ 4 linkage that occurs as a structural component in cuticle, shells of arthropods, and cell walls of fungi, some algae, in nematode and in mollusks. Chitinases are defined as enzymes with specific hydrolytic activity against chitin. Some chitinases hydrolyse the related polymers such as cell wall polysaccharides having β 1 $\rightarrow$ 4 linked N-acetylglucosmine and N-acetylmuramates. Enzymatic cleavage occurs randomly at internal locations over the entire length of chitin microfibril. The final products are soluble low molecular weight multimers of GlcNAC-chitotetraose, chitotriase and chitobiose (predominant). These oligosaccharides are again acted upon by the β N-acetylglucosaminidase which cleaves off GlcNAc sequentially from the non-reducing end. Both enzymes are detected in insects, crustaceans, yeasts, fungi, bacteria, higher plants and vertebrates. Chitinases are involved in moulting digestion. The product of hydrolysis is regulated for the synthesis of new cuticle and often the old larvae ingest the old cuticle. Chitinases found in the gut have a digestive function in addition to their breaking down chitin present in the gut lining. In fungi chitinases apparently degrade and mobilize organic matter and to antagonize the growth of other fungi and in yeast it is important for cell wall separation. Insect resistance can be imparted by the degradation of vital structures such as peritrophic membrane, cuticle of insects, cell wall of fungal pathogens or elicit defense responses. Peritrophic membrane and exoskeleton of insects are the physiochemical barriers but entomopathogenic fungi use multiple extracellular enzymes including chitinolytic and proteolytic enzymes that help penetrate the cuticle and facilitate infection. Some insect venoms and nematodes utilize a chitinase to penetrate the peritrophic membrane to gain entry. Baculoviruses also produce chitinases to putrefy the cadaver of insects.

The insect chitinases are primarily associated with the moulting but also have some digestive function in the gut (Terra and Ferreira, 1994), M. *sexta* has less similarity of class I and II plant chitinases and limited similarity to class III and V plant and microbial chitinases. Chitinase is expressed just prior to larval-larval and larval-pupal moulting. The activity of this gene is regulated positively by ecdysteroids and negatively by juvanile hormones.

TRANSGENIC PLANTS EXPRESSING INSECT CHITINASES

The entire coding region of *M. sexta* chitinase under CaMV 35 S promoter with nos or pinII polyadenylation signal sequence was expressed in tomato and tobacco. The size of the chitinase expressed in the transgenic plant was 46 kDa instead of 85 kDa. When chitinase positive and negative plant leaves were provided to the first instar larvae of *Heliothis virescens,* the weight

recorded was 966 mg in the control and 177 mg in the insects that fed on the chitinase plants. Thus the feeding on the chitinase plant reduced the larval weight by more than 80%. Expression of chitinase + β N-acetylglucosaminidase degrades the chitin six times faster than that of either enzyme alone.

PEROXIDASES

Peroxidases are subclass of oxidoreductase that uses a H_2O_2 as an oxygen acceptor. The other peroxidases are guaicol peroxidase (plant), NADH peroxidase, cytochrome C peroxidase, catalase, glutathione peroxidase, L-ascarbate peroxidase and manganese peroxidase[11].

Plant perioxidases are monomeric proteins with a common heme (photophophyrin IX) group, bound ca^{2+} and some degree of glycosylation and also some forms need Mn^{2+} (which stimulates production of H_2O_2 from NAD(P)H. Peroxidases are cloned from tobacco, potato, horseradish, tomato, cucumber, Arabidopsis, wheat, barley rice and maize. Plant peroxidases have 42 distinct isoforms that vary between 30 – 70%. Peroxidases are grouped into anionic, cationic and neutral forms based on pI. There are no. of alleles for a particular peroxidase gene that occur in maize. Peroxidase from different plant species vary in substrate specificity.

Transgenic plants expressing peroxidase gene :

In tobacco expression of anionic peroxidase is loosely associated with the cell walls the lignifying vessels and the shoot epidermis of the immature plants. It is also expressed in endodermis and storage parenchyma of older shoots and roots. Over expression of peroxidase results in chronic wilting at the time of flowering, retarded growth, smaller compacted cells and brown rapidly in response to wounding. *Nicotiana sylvestris* and tomato have been transformed with peroxidase gene against *H. zea.* The susceptibility of peroxidase plant depends on the age of the tissue, type of the tissue and size and species of the insect tested.

INSECTICIDAL COMPOUNDS INDUCED BY THE REGULATED OVER PRODUC-TION OF CYTOKININS

Cytokinins are major group of plant growth regulators that modulate a number of physiological and biochemical processes e.g. flowering, leaf senescence, seed germination and stomatal function. Application of cytokinin results in the enhancement of secondary metabolites like anthocyanins, betacyanins, tannins, coumaris, scopoletins, scopolin, rhodoxanthin, berberins and indole alkaloids, gossypol, condensed tannins, flavinoids and anthocyanins and all the above are found to be toxic to the tobacco bud worm. *ipt* plays a vital role in cytokinin biosynthesis in all forms of life.

When *Manduca sexta* and *Myzus persicae* were inoculated to the *ipt* plant on an average the second and the thrid instar larvae consumed less than 60% of leaf material and the weight gain was reduced by 20 – 30%. After the tobacco horn worm feeding zeatin and zeatinriboside cytokinins were formed in the leaves. Cytokinin levels were raised by about 70 fold in comparison to the control (7 pmol/ g fresh weight).

ENGINEERING OF PLANT SECONDARY METABOLISM

The secondary metabolites are generally produced by multigene pathways despite their low molecular weight and apparent structural simplicity. For example the cyanogenic glucosides are coded by four genes, glucosinolates by six strucutral genes and DIBOA glucoside by four genes and rotenone by seven genes beyond flavinoid pathway. Pyrethrin needs several beyond phytodienoic acid pathway and at least two genes beyond isopentenyl pyrophosphate pathway.

A yeast *odc* gene under CaMV 35S promoter in *N. rustica* resulted in higher level of putrescine and

N-methyl putrescine and the nicotine content was increased up to two fold high. Leaf rbcS promoter with bacterial lysine decarboxylase (*ldc*) gene increased the anabasin content.

Engineering Glucosinolate–Cyanogenic Glucoside Pathway

Aldoxamine is the common intermediate to the pathways of three classes of plant defensive chemicals *viz*. cyanogenic glucosides, glucosinolates and nitroalkanes. Therefore the addition of late genes of glycosinolate pathway to a cyanogenic plant would lead to the production of both cyanogenic glucosides and glocosinolates. Papaya produces phenyl alanine derived cyanogenic glucoside (prunasin) along with the novel cyclopentenylglycine derived cyanogenic glucoside tetraphyllin B. Addition of early glucosinolate pathway genes to a cyanogenic plants would produce new cyanogenic glucosides. Conversion of a glucosinolate plant to cyanogenic would provide with it a new insect defense against those brassicae specialists that use mustard oil for oviposition or glucosinolate for feeding stimulant.

Cyclic Hexamic Acids (DIBOA and DIMBOA)

Series of progressively methoxylated 2,4-dihydroxyl-1, 4-benzoxanthin-3-ones : DIBOA AND DIMBOA (major chemical defense in maize, wheat and rye). BOA, MBOA, M_2BOA are less toxic abiotic decomposition products of hydroxamic acids. The cyclic hydroxamates are unstable wound released and is stored as low toxicity, stable glucosides, separated from a beta glucosidase located in plastids. BIMBOA is found to be toxic at 0.1 to 1.00 mM.

Unsaturated Amides

The various amide forming enzymes of piperidine biosynthesis are pieroyl–cOA, piperidine N-piperoyl transferase. The relatively unsaturated isobutyl amides are few enzymatic steps removed from the fatty acids of primary metabolism. The insecticidal activity of biosynthetic simplicity make them attractive candidate for the crop protection by genetic engineering.

CONCLUSION

Even though there is a scope for employing insecticidal genes derived from plants and microbes for insect pest management some of the concerns *viz*. potential toxicity of the introduced gene products to the intended consumers, accelerated development of resistance, possible environmental risks such as effect on parasites and predators and possible transgene escape are to be objectively assessed.

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DO YOU KNOW ?

Q 1. How do marbles get colored ?

Q 2. Compared to a Nagasaki-type Atom-Bomb how much energy does a hurricane release ?

ADULTERATION EVERY WHERE – LEARN TO LIVE WITH IT

K. P. Agrawal*

Several studies have shown that most of the edibles are adulterated or contaminated with infectious microbes, heavy metals, toxins, artificial additives, preservatives, colouring agents, emulsifying agents or chemical residues.

INTRODUCTION

Adulteration is the fast growing industry in India. Global market of adulteration and fake goods is 650 billion dollars which constitutes 9 percent of total trade (2007) : Indian market constitutes 30 percent of such trade. Urban markets are particularly flooded with fake and duplicate goods. You name any item : food or drinks, medicines or cosmetics, petrol or diesel, electronic or electrical, music or play, motor parts, books, stationary items, building material including postage stamps, currency notes or coins, we find ourselves surrounded by them. Adulteration in case of medicines is reported to the extent of 35 percent. According to a survey, most commonly used cosmetic, e.g. parachute oil, fair and lovely cream, vicks and dabur amla oil have more than 100 duplicates in the market. Goat, donkey and dog skins after treatment are sold as tiger skins. Plastic and bones of different animals are used to make nails and limbs of tigers and leopards. Camel bones are used to make counterfeit ivory. It is a well organized profession and has covered almost all the items of daily needs.

Adulteration is the most riskiest for life sustenance. It makes our existence unsecured. We are gulping slow poison through adulterated items. It is not consumer, even industry and government suffer equally because of adulterated, fake and duplicate goods. Adulteration starts at production level till it reaches to consumer level. It is of different kinds. The first, which contain natural toxin, e.g. kesari dal and harmful residues like pesticides in grains and vegetables and hormones and antibiotics in milk at production level. Second, the inadvertent adulteration where a product including food product has gone bad or its potency is lost (e.g. medicines) or is passed the expiry date. Third, the deliberately adulterated goods like adulteration with cheap chemicals in medicines and cosmetics. Fourth, the duplicates of popular brands with or without change in name. Fifth, the consumer is cheated not only in terms of quality but quantity also. Adulterants used in food items, drinks, drugs and medicines, cosmetics and beauty products including fuels, their adverse effects on health and protective measures have been discussed in the present communication.

FOOD ITEMS

It is difficult to get a food items, may be flour, pulse, oil, fruit, vegetable, milk, sweet, spices, tea, coffee, honey, bakery item, chocolate, beetal nut including fruit juice which is free from one or the other adulterants. Our dinner *thali* (containing dal, roti, rice, vegetable and salad) is also not safe.

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Even animal feed like cake as protein supplement for lactating animals is adulterated. 90 percent of un-branded/loose items are adulterated. Food contamination occurs from different sources, viz. overuse and illegal use of pesticides in agriculture, industrial sludge if not treated before use, air pollution and use of pesticides for storing. Every input from water to manure and from pesticides to preservatives contributes to contamination.

ADVERSE HEALTH EFFECTS

Health impacts of adulterants range from vomiting, abdominal pain, allergy, asthma, headache and even mental retardation, cardiac arrest and cancer is persistent. People dying after consuming adulterated food, children falling ill after eating food served in schools and thousands hospitalized after a wedding feast are common incidences. Food allergies are common due to adulteration with food additives. Use of banned pesticides like DDT and BHC for sprinkling on vegetables and fruits and also mixing with food grains as a preservative is rampant. According to an estimate, an average Indian eats about 40 times more pesticides through food than the average American or Englishman.

Pesticides and insecticides are used as food additives during production and post – production of different foods. Food additives are also used as coloring and flavoring agents, fresheners, preservatives and stabilizers during the manufacturing, processing and packaging of food items. The effects of food additives can be immediate or long—term. Common reactions are urticaria, runny nose, headache, asthma and bleeding, hyperactivity, irritability, contact dermatitis and skin eruptions. Long–term effects of food additives can result in damage to organs, birth defects and cancer. In spite of ban on use of several pesticides like aldrin, dieldrin, DDT and heptachlor, their use in food stuffs like cereals, pulses, oils, spices and meat products continues. Synthetic colors used in different food items are very harmful. Tartrazine, also known as FD & C yellow No. S, a yellow coloring agent can cause itching, urticaria, runny nose and asthma. Saccharin and cyclamate, used as artifical sweeteners cause cancer of urinary bladder in long – run. Nitrates and nitrites, used as preservatives in packaged meat may cause stomach and gastrointestinal cancers. Mono – sodium glutamate (MSG) used as food flavour enhancer causes severe headache, nausea and occasionally chest tightness, burning sensation and asthmatic attack. Long–term use results in damage to brain. Sulphur dioxide and sodium meta bisulphate are used in dry fruits, wines and beers to prevent discoloration and spoilage. Sulphur dioxide is also used as preservative for fruits and vegetables. It may cause breathing and heart problems. Adulterants used in different food items and their adverse effects have been described below.

FOOD GRAINS

Massive use of pesticides both at production and post – production level to protect food grains from the insects and pests is endangering the human and animal health. None of the pesticides is free from harmful effects. Mixing of kesari dal with pigeonpea dal is reported to cause lathyrism, a kind of paralysis. Coloring agents used in bad pulses especially tur dal and moong dal to make them appear good can cause allergic reaction and aggravate asthma.

EDIBLE OILS

Adulteration of costly oils (e.g. groundnut oil, mustard oil) with cheap oils (palmolein, palm and argemone) is a common practice. Palm oil after cleaning with chemicals is also mixed with deshi ghee. Use of palm oil increases incidence of heart problems. Vanaspati ghee has also been found adulterated with argemone. We all know mustard oil epidemics and last one was in 1998. The reason of epidemic was adulteration of mustard oil with argemone which caused severe dropsy. Essence of

allyl isothiocyanate for characteristic pungency and butter yellow to impart the typical color of mustard oil added to mustard oil are highly toxic, damages the liver and ultimately may lead to liver cancer in long – run.

FRUITS AND VEGETABLES

Most of the fruits and vegetables available in the market are adulterated and / or contaminated. Most commonly used contaminates are DDT, HCH, endosulfan, synthetic pyrethroids, carbamates, organophosphates, aresenic, lead, zinc, cadmium, copper and chromium and their health hazards are seizures, blood disorders, brain cancer (in children), breast cancer and movement disorders. Calcium carbide used for ripening of raw fruits like bannana, mango and papaya has a carcinogenic effect. High levels of heavy metals like lead, zinc and cadmium in vegetables grown in suburban area have hazardous effects on human health. Seasonal okra (Bhindi) looking exceptionally green is not natural. Similarly sparkling white cauliflower is also not natural. It is because of malathion which is a potential poison. A solution of copper sulphate is used to make vegetables look green and fresh and acetylene gas for ripening of fruits. Sparkling brinjal in the market is due to mobil oil. Sulphur meta bisulphite used to keep salad fresh is responsible for asthmatic attack. Massive use of pesticides to protect vegetables from insects affects the immune system and hormonal balance of the body. Oxytocin which has long been used for milk let down in animals is also used for fast growth and ripening of fruits and vegetables. It takes 24 hours for fruits and vegetables to ripe. Harmful effects of hormones on the body are well known.

SPICES

Spices like chilli, coriander, turmeric, aniseed, black pepper and asafetida, none is free from adulteration. A few adulterants are used to increase weight and others to give a good color. All adulterants are harmful. Spices in powder form have more chances to be adulterated. Spices like chilli powder and coriander powder are adulterated with rice husk colored in caster oil base. Red chilli powder adulterated with sudan-1 is a carcinogenic agent. Papaya seeds in black pepper and gum in asafetida is a common practice. Coconut powder is adulterated with suji, rice flour and sodium bicarbonate. These adulterants maintain whiteness of coconut powder. Use of low quality oil, sub-standard condiments, stale vegetables and decaying skins of lime in pickle preparation is very common. Tea, particularly loose tea mixed with saw dust, sand, iron fillings, used tea leaves besides several coloring and dyeing agents is a brisk business. Even catechu (kattha) is synthetically prepared.

MILK AND MILK PRODUCTS

Incidences of adulteration in milk and milk products are at increase over the years. Milk is adulterated at two stages : production and post–production. Use of hormones, viz. growth hormone to boost milk production and oxytocin for milk letdown is rampant. Both the hormones have adverse effects on animal and human health. Oxytocin affects fertility of animals whereas consumption of oxytocin induced milk may cause cancer and heart problems. High pesticide content in the food and water makes even mother's breast milk unsafe. Mother's milk in India has the highest DDT levels in the world. Milk from animals suffering from mastitis is highly infectious and can lead to asthma, allergy and diarrhea. Normally, milk from such animals should be discarded. Dairymen rather than discarding such milk, mix with other milk and supply to consumers. Ammonium compounds, NaOH, Na_2CO_3, $NaHCO_3$, Hydrogen peroxide, formalin, sodium sulphate and poster paints are common adulterants in milk for increasing the shelf life. According to a report from World Bank supported National Agricultural Technology Project, 27 percent milk samples

collected from Uttar Pradesh, Haryana, Delhi, Punjab and Rajasthan were found to be adulterated with one or more adulterant (s). Water is the common adulterant to increase the volume of milk. Adulteration of loose milk with water is very simple. Even polypacked milk is not safe from such adulteration. The ingredients used in the manufacture of synthetic milk are caustic soda, refined oil, common salt, sugar, urea and water. All the ingredients used for production of synthetic milk are harmful. Consequent use damages the intestines, makes them prone to diseases such as gastroenteritis, diarrhea and malnutrition. Children are more prone for such damages. The practice of synthetic milk preparation is wide spread and more prevalent in Western Uttar Pradesh, Haryana and Himachal Pradesh.

The source of adulteration of milk products are two fold : (1) use of adulterated milk and (2) adulteration during product preparation. Adulteration of skimmed milk powder with chalk powder is prevalent in many parts of the country. Antibiotics are added to milk and milk products to increase the self life. Consumption of milk and milk products adulterated with antibiotics can build up antibiotic resistant organisms in the body. Ingredients used in synthetic mawa (khoa) are refined oil or vanaspati ghee or any other oil, blotting paper, maida, suji, milk powder, potato, sweet potato, ground rice and chestnut powder. Much of the cottage cheese used in making rosogolla has muriatic acid which is used as toiletry item to sparkle the toilets. Soapy taste in ice cream is due to washing soda which causes gastric ulcers. A recent case of milk powder adulteration with melamine, an industrial chemical used in plastic industry was a big scandal in China. Chinese milk products like milk powder, chocolate, biscuits and butter are easily available in Indian market. The melamine causes illnesses including kidney stones. Two to three year old children are more prone to such ailments if they are fed with this chemical cocktail of milk powder.

SWEETS

Mouth watering sweets are also not safe. Use of sub-standard and non-edible oils for preparation of sweets is rampant. Synthetic mawa or mawa prepared from synthetic milk is an important ingredient in most of the sweets. Silver foil used for sweets adulterated with nickel, aluminum etc is very dangerous and sometimes may lead to cancer and memory loss. Excessive use of food colors particularly synthetic colors in sweets has harmful effect on the body. For example, metanil yellow used to color jalebis and ladoos may cause cancer in long – run. High nickel content in Indian chocolates, nearly 4-10 times more than the accepted levels may cause cancer. Hydrogenated vegetable oils (HVO) used in Indian chocolates may be the reason of high nickel content.

FOOD SAFETY MEASURES

Adulteration is an age old practice. As early as 400 BC, Kautilya had problems of adulteration. During the British regime, the adulteration was declared an offence under the Indian Panel Code. Independent India formulated the "Prevention of Food Adulteration Act" for safety of food items. Safety of food stuffs is an important issue. The pesent food safety measures, their shortcomings and what should be the approaches to avert this menace in future are given below :

1. At present, food quality through 'Inspector Raj' where a dozen of ministries are involved and in case of any dispute, they keep on passing the buck on each other. Therefore, it is important to have one empowered body, fix responsibility and accountability rather than involvement of several agencies.
2. The enforcing departments, which at present are ill equipped to tackle adulteration related problems, should be strengthened.
3. If anybody is suspected for adulteration in a food item, collect a sample from the concerned shop and send for testing in the designated laboratory.

4. The use of pesticides in agriculture and preservative to protect the food items from insects should be restricted. The banned pesticides should not be used. Only permitted food colors, dyes and preservatives in specified quantities should be used in foodstuffs.
5. Persons found to deal with adulteration and fake items should be strictly viewed under "Prevention of Food Adulteration Act".
6. More and more food products should be brought in the ambit of quality Agmark certification. At present, it is 10-15 percent only.
7. Food standards and regulations for manufacture, import, export, storage, distribution and sale should be developed.
8. Easy to use, portable, simple to perform home testing kits for detecting adulterants are available in the market. A provision of testing laboratory at least at block level should be made.

DRINKS

The main source of pesticides in soft drinks is ground water which most of the time is dirty and contaminated because of seepage of chemicals used in agriculture, heavy metals in industrial effluents and sewage water. Even potable water is unsafe and main cause of water borne diseases. We all know 'Pesticide in Cola' row of 2003. Pesticide contents in most of the cold drinks available in India is 30 to 40 times more as compared to European Standards. Spurious beverages (popular brand bottled with fake contents) and look alike brands beverages (i.e. brands similar to the popular brands, produced by local manufacturers) are widely available in the market. Most replicated brands are Pepsi, Fanta and Thums up while their look alike brands are Tipsi, Facta and Toss up respectively.

Not only soft drinks, the water that we drink, whether from the tap or bottled water, could be full of contaminants and pesticides as per the tests conducted by various agencies. Based on survey by Centre for Science and Environment, average contamination of bottled drinking water of different brands with pesticide residue was 23 times higher than BIS and the EU norms. In developed countries, there is one standard of drinking water, whether it is made available through the distribution network or in containers. It is most unfortunate that even after 60 years of independence, no standards have been worked out to define clean and potable water in our country. Standards in our country are limited to bottled water only. Even water, the so called 'elixir of life' could be the fatal sip is unimaginable but it happens in our country. One litre sealed branded water bottle costs almost equal to one liter of milk that a dairyman gets from consumer or milk vendor. Consumer does not mind even to spend Rs 10/- for a litre of water presuming it is hygienic and medically safe for consumption. Adulteration is at different levels first at bottling plant level, second at retailers' level that are indulged in seal tampering (refilling bottles with ordinary water) and third refilling of empty bottles with ordinary water.

After cola storm, the fruit juice, assuming that it is a healthy option for school going children was made available on shelves of many schools. But this assumption did not prove true. The tetra packs available in the market have a high glucose level and preservatives. Canned juices have only fruit essence and are not better than cold drinks in any way. According to a survey of fruit drinks in UK, about 60 percent of the drinks do not have fruits.

There is actually no mechanism to monitor what chemicals are being used, how frequently and in what quantity and for what purpose, these are being used. There is a need to devise a policy for safe use of chemicals. Use of most hazardous chemicals should be banned and new generation of chemicals which are less toxic should be used

rationally. Ground water is contaminated due to seepage of chemicals used in agriculture, heavy metals and industrial effluents and sewage water. Standards for water required for different purposes : potable and domestic including irrigation should be developed.

DRUGS AND MEDICINES

Flourishing fake drug market has been a serious issue in India. According to a ASOCHEM report, the fake medicines business has made its route throughout the country. Of 40,000 drugs markets in India, 25 percent deals with fake medicines. In Delhi alone, fake drugs account for Rs 400 crores. Why did medicines of different brands with same contents and quantity act differently? Why is it so that a few act faster, others show slow action and there are few that do not act at all? It is a clear indication that fake medicines are freely in circulation in the market. The fake drugs mostly include antibiotics, pain killers analgesics, tonics including life saving drugs. A few examples are novomax, ciprofloxacin, sporidex, fortum, practin, proxyvon, ampoxicin, norfloxacin, rantidine, crocin, cofnil, cofdex, cetzin, terramycin, becosule, combutol, ciproles – DS, althrocin and roxid. A number of the above mentioned drugs in spite of being banned all over the world are freely available in Indian market. According to a study conducted by the Indian Clinical Epidemiology net work (India-CLEN) and the All India Institute of Medical Sciences about 63 percent of injections are unsafe. The practice of reusing syringes for injections is most unsafe and may transmit blood-borne diesease such as HIV and hepatitis. On an average, one syringe is used 3 – 4 times in India. A quack uses the same syringe 20 – 25 times. According to a WHO report, about 1.3 million children die each year from syringe re-use.

Fake medicines are of two types : one, totally fake and two, sub – standard. Duplicates of branded medicines are available on a large scale in the market. Dealers not only manufacture fake tablets and capsules but also injections. The main approach of supplying fake injections in the market is by changing wrappers or labels of locally made injections with that of reputed companies. Their modus operandi is full proof. They purchase locally made injections from the market, replace their wrappers with the forged ones of reputed company, change the packing also and supply in the market as products of reputed companies.

Chalk powder, talcum powder, saw dust, salt, liquid jaggery, sugar, and several other things are used as base for making fake drugs. Several drugs also contain toxic metals like lead in dangerous proportions. Diethylene glycol, a much cheaper chemical in place of glycerol is used as solvent particularly in cough mixtures, injections, toothpastes and several other drugs. Diethylene glycol and glycerol both being similar in consistency and look are difficult to distinguish. Diethylene glycol being a potent toxin affects nervous system, sometimes leads to paralysis, respiratory trouble and kidney failure. Hundreds of people die because of diethylene glycol contamination in cough mixtures. Ineffectiveness of vaccines under different immunization programmes including sub-standard vaccine used under the "Pulse Polio Programme" is an established fact. The main reason of ineffectiveness of a vaccine is breakdown of cold chain during transporation.

There are several reasons of flourishing fake drug market in the country, namely : (1) According to WHO report, 270 essential drugs can take care of more than 95 percent of health problems of any country. Majority of the estimated 80,000 products with different proprietary names having active principles of just 270 essential drugs are either superfluous, irrational or useless. This is the main reason of flooding the market with fake drugs and create lot of confusion in deciding the drug, (2) Drug Control Authorities in our country are not

well equipped to analyse the efficacy of a drug and its harmful effects, (3) Sponsoring physicians and their families on trips to different places including foreign visits and offering gifts in cash or kind by drug dealers tantamount to influence doctors to prescribe even sub-standard drugs, (4) Because of similarity between fake and original drugs, it is difficult to distinguish them, (5) According to the Drugs and Cosmetic Act framed in 1940, faking drugs is not a cognizable offence, (6) The entry barriers for the industry are low. Any body can set up a pharma unit any where in the country and (7) Quacks being main promoters of fake drugs in the market, stringent actions should be imposed if they are found practicing and prescribing fake drugs.

HERBAL DRUGS

Like other drugs, herbal drugs are also not safe. Unchecked use of spurious herbal drugs leads to serious ailments. According to a report from All India Institute of Medical Sciences (AIIMS), about 40 percent of the drugs used for treating asthma are contaminated with corticosteroids. Liv-52 which is also prescribed by allopaths to patients with liver related ailments is not free from adulterants like steroids. Any drug contaminated with cortiocosteroids, may lead to suppression of immune system in the long – run. The cases wherein ayurvedic drugs are contaminated with antibiotics to treat infectious diseases are often reported. Ayurvedic bhasmas containing heavy metals like gold, lead and antimony destroy the protein (basic building blocks) in the white blood cells. Incompatibility with allopathic drug if any should be ruled out. Herbal drugs that claim weight loss may damage kidneys. Deaths and cases of heart attacks are reported if diet and weight loss pills are used over a long period. Herbal drugs, therefore must be used with the same precautions that apply to allopathic drugs. As licensing part is not stringent for ayurvedic drugs, anyone can obtain a license to manufacture ayurvedic drugs provided they are included in the 54 ancient texts notified by the government of India under the Drugs and Cosmetic Act (DCA). As there is no need to obtain license to sell ayurvedic drugs, many quacks make use of such leverage and play with the life of the people.

HOW TO WIPE OUT MENACE OF FAKE DRUGS

Several steps are required to wipe out the menace of fake drugs in the market, namely : (1) Fake drugs should be dealt under the antinarcotic act. Accordingly, the government should bring a bill to this effect and get it approved by act of parliament. (2) Those who are found associated with fake medicine business should be booked under Drug and Cosmetic Act and stringent actions like life imprisonment or even hanged to death should be taken. (3) Post–marketing surveillance of drugs which at present does not exist in our country should be introduced. (4) Sponsoring overseas or national visits of doctors and their families including offering of gifts in cash or kind by drug dealers should be banned. This is a kind of bribery and influence the doctor to prescribe even sub-standard drugs. (5) Pharmacentical companies should restrain from making tall claims for promoting their products. (6) Drug manufacturers must ensure that all the drugs have a leaflet giving details about the drug including its side effects. (7) No new product including ayurvedic product unless clinical trials using a good sample size have been conducted should arrive in the market. (8) The number of drug testing laboratories should be increased. (9) Supermarkets for drugs like the supermarkets for other grocery items should be opened. (10) The chemists/medical shops should follow the guidelines developed by drug control department, viz. (i) display of board indicating name, photo, a brief introduction and license number on each shop, (ii) pharmacist must wear white coat, (iii) issual of bill receipt to consumer and (iv) sale of medicines only against doctor's prescription.

PRECAUTIONS DURING DRUG PURCHASE

The customer should observe all the precautions during the purchase of medicines, namely : (1) Drug should not be bought from un-authorized shops/unlincensed vendors. (2) Do not accept substitute drugs recommended by the chemist without consulting the doctor. (3) Check that the drug you bought is the same prescribed by the doctor. (4) Check that the packaging is not tempered. (5) Do not self medicate and buy drugs only on prescription of qualified doctor. (6) Ask for a bill which has details of the batch and invoice number. (7) Ensure that the medicines bought are within the expiry date. (8) Ensure that the syringe used is from a sealed packet and destroyed after use.

COSMETICS AND BEAUTY PRODUCTS

With beauty conscious new generation, Indian markets are flooded with variety of beauty products. You will find beauty parlors at every nook and corner of streets. Everyone claims for herbal products and prompt results. At least 30 percent of these products are fake, sub-standard or duplicate of branded products. Their long–term use is harmful. As per WHO report, nail polishes are most dangerous beauty products. Creams available for fair complexion may cause skin cancer. Most of these creams contain petro – chemicals and animal lard. Porban, a chemical which is used in moisturizing cream and other body products for prolonging self-life has danger of breast and skin cancer. Other chemicals like sodium lorel sulfate and formaldehyde may cause skin allergy, asthma and headache. Even Mehandi, a natural herb of high order is not pure. Most common adulterant in mehandi for dark brown and black color is nickel. Swelling, itching, water discharge, appearance of bumps, brown and black marks on the skin are the reactions seen few hours after use of such mehendi. The presistent use could result in permanent skin damage. Phthalates like diethyl hexyl phthalate (DEHP) added in perfumes to help prevent loss of fragrance are responsible for genital abnormalities like undescended testicles and malformation of the urinary tract. Perfume users become victim of depression and lose smell power in the long – run. Majority of lipsticks and hair colors have heavy metals like lead, arsenic, copper, nickel, cobalt and chromium. Lead is also present in kajal and talcum powder. Many tooth powders contain nicotine. Lead is proven neuro-toxin. It causes learning and behavioral problems, impairs liver and renal functions and weakens the immune system. Arsenic causes digestive problems like nausea, vomiting and diarrhea. Long – term use leads to anemia and weakening of immune system. Nickel, cobalt and chromium cause digestive problems like nausea, vomiting and diarrhea, respiratory problem and eye irritation. Nicotine present in tooth powder may cause cancer.

How to wipe out fake and duplicate items from the market ? The consumers being worst-sufferers have a big role to play and must observe few precautions : (1) do not purchase heavy discounted items as branded products from reputed companies will not have heavy discount in price, (2) insist on a VAT invoice during purchase and (3) the people who have sensitive skin should avoid use of cosmetics. Other measures to be adopted are : (1) ensure that products of expired dates and discontinued lots are taken off the sale counters, (2) a comprehensive plan to get rid of look alike products from the market should be developed, (3) all companies should indicate the contents of their products and side effects if any, (4) the name on the level should simulate with the brand, (5) the product is not tampered and (6) customer must look for mandatory information specific to a particular brand.

FUELS

Petrol and diesel are commonly used fuels. Many of us have experience of clogging of engine

all of a sudden while driving. Adulterated petrol may be the reason. Aduteration of petrol is more as compared to diesel. The diesel being high in sulfur content if adulterated, the resultant emissions would be alarmingly more and this may be the one reason of less adulteration of diesel and second is its less cost as compared to petrol. If petrol and diesel of same emission standards are compared, diesel contains 200 ppm more sulfur than petrol.

Naphtha and other chemical solvents such as pentene, mineral turpentine oil, toluene, benzene and hexane are main adulterants of petrol. Kerosene being cheaper is also a common adulterant of petrol. A reddish yellow color dye is added to match the color of petrol. Manganese based octane enhancer, also called MMT which is used in petrol to improve fuel efficiency is reported to be a potent neuro-toxin when inhaled and also damage the vehicle. Adulteration of diesel goes better with kerosene or light diesel oil (LDO) used as industrial fuel.

No adulterant is safe for environment, engine or human health. Increased emission of carbon monoxide (CO), nitrogen oxide (NO), particulate matter (Pm) causes increased air pollution. Air toxins from adulterated petrol can lead to respiratory problem and even cancer. Adulterated petrol gives less power to the engine, mileage per liter and speed is also reduced. Adulteration some times causes the engine to clog. The life of the engine is reduced. There is also a risk of sudden combustion leading to an explosion. Maintenance cost goes high by 20 percent or more.

The menace of oil adulteration is serious and there is a need for holistic approach to curtail it. Imposing penalty fees and suspension of supplies to defaulters and black listing of firms who indulge in adulterated petrol sale are a few steps in this direction. Consumer should lodge a complaint wherever any adulteration in the oil is noticed. Concerned department should take action against the supplier who indulges in adulteration. Introduction of Euro – IV diesel, which has 50 ppm of sulfur, as opposed to 350 ppm in current diesel, may reduce the emission rate drastically.

DO YOU KNOW ?

Q 3. What is cacophobia ?

Q 4. What is the lowest point of earth ?

IRRADIATION OF FOODS : IS IT SAFE ?

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Food is one of the most important necessities in life. Fortunately, many advanced and several developing countries have abundant supplies of fresh, safe and nutritious foods. Yet, despite the many precautions and processes in place to ensure a safe food supply, microbial contamination is still a concern. There are a number of food processing tools available that provide additional protection for the foods we consume. One very promising tool is food irradiation, which is a process of imparting ionizing energy to food to kill microorganisms. Food irradiation is the process of exposing food to a controlled source of ionizing radiation for the purposes of reduction of microbial load, destruction of pathogens, extension of product shelf life, and/or disinfestation of produce.

The term irradiation often evokes fears of nuclear radioactivity and cancer among consumers. The process seems frightening because it is powerful and invisible. Consequently questions and concerns exist particularly about the safety or wholesomeness of irradiated food. The paper highlights food irradiation as a food safety measure and the issues of concern for consumers.

INTRODUCTION

Food irradiation is the process of exposing food to an ionizing energy to kill harmful bacteria and other organisms, and extend shelf-life. Irradiation is known as a cold process. It does not significantly increase the temperature or change the physical or sensory characteristics of most foods. An irradiated apple will still be crisp and juicy. Fresh or frozen meat can be irradiated without cooking it.

It is a safe process and has been approved by some 50 countries worldwide and applied commercially in the USA, Japan, and several European countries for many years. Approved irradiated foods include fruits, vegetables, meat, poultry, fish and seafood, roots and tubers, cereals, legumes, spices and dried vegetable seasonings.

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HOW DOES FOOD IRRADIATION WORK ?

When food is irradiated, it passes through an enclosed irradiation chamber where it is exposed to ionizing energy. This can be in the form of gamma rays from specific radioisotope sources, or X-rays or electron beams from machine-made sources. All three types of ionizing energy have the same ability to inactivate spoilage and disease-causing microorganisms without causing harmful changes to the food. In all instances, food remains uncooked and free of any residue.

Only certain ionizing energy sources can be used for food irradiation. Permitted gamma sources are the isotopes Cobalt-60 or Cesium-137. Cobalt-60 is used in food irradiation because it is widely available. Gamma rays are a form of electromagnetic energy, just like radio waves, microwaves, X-rays and even light. They have the ability to penetrate well into a food. More recently, electron beams (e-beams) have become available

as a source of ioinzing energy in the USA and other countries. E-beams offer extremely rapid and cost-effective processing, but in some cases sacrifice penetration depth depending on product density. Treament of food using either X-rays or electron beams are occasionally referred to as "electronic pasteurization" or "electronic irradiation" methods because they are derived from electricity.

Regardless of the source of ionizing energy, the food is treated by exposing it to the energy source for a precise time period. In the case of e-beam, food is irradiated in just a few seconds, while it takes gamma and X-rays considerably longer. The food is never in contact with the energy source ; the ionizing energy merely penetrates into the food but does not stay in the food. It takes very little energy to destroy harmful bacteria.

At these levels there is no significant increase in temperature or change in composition. Irradiation does not make food radioactive nor does it leave any residues. The levels of ionizing energy used to treat foods for pathogen reduction or disinfestation are measured in kiloGrays (kGy). A low-to-medium dose of 1-10 kGy is usually sufficient to render a product safe from harmful bacteria or insects such as fruit flies, while causing little or no effects on product quality or nutrition.

IS FOOD IRRADIATION SAFE ?

Yes. It is safe. Several extensive reviews of toxicological and other data by regulatory and health organizations, including FDA (1986), Codex Alimentarius Commission (CAC, 1983), and European Commission's Scientific Committee on Food (EC, 2003), have determined that food irradiated below 10 kGy is safe. Food has been irradiated in several countries for many years resulting in products that are safer for consumption than the untreated original foods. A number of compounds are formed when food is irradiated, just as there are when food is cooked or exposed to other processing methods. However, based on hundreds of scientific tests, there is broad agreement among scientists and health agencies that these compounds are not a human health issue. In fact, more chemical changes occur when toasting bread or barbecuing steak than when irradiating food.

Food irradiation provides an added layer of protection to food without significant changes to taste, nutritional value, color or texture. Since irradiation does not substantially raise the temperature of food or "cook it", taste and nutrient losses are small and considerably less than other methods of preservation, such as canning, drying or heat pasteurization. Carbohydrates, fats and proteins are the main components of food, and a wide array of research has shown that these nutrients do not change significantly during irradiation. Some vitamins, most notably the B vitamins, have some sensitivity to irradiation, but processors can minimize nutrient losses by irradiating food in an oxygen-free environment or a cold or frozen state.

WHAT ARE THE BENEFITS ?

The most significant public health benefit of food irradiation is that it stops the spread of foodborne disease. It greatly reduces or eliminates the number of disease-causing bacteria and other harmful organisms that threaten us and our food supply. Many of these organisms, including *Salmonella, Escherichia coli* (E. coli), *Staphyloccoccus aureus* (Staph), *Listeria monocytogenes, Campylobacter jejuni* and *Toxoplasma gondil* have caused many outbreaks of foodborne illness.

Although reduction of disease-causing bacteria is of greatest importance to public health and safety, there are other significant benefits of food irradiation. Irradiation can also help keep meat, poultry and seafood fresh longer by reducing the level of spoilage-causing microbes. It also allows consumers to keep certain fruits and vegetables fresh longer. For example, irradiated strawberries stay unspoiled for up to three weeks, versus three to five days for berries that are untreated.

For many developing countries, food spoilage is an ever-present and costly reality, often causing produce spoilage rates in excess of 40 percent. In

these countries, irradiation stands to benefit millions by helping more nutritious fruits and vegetables reach consumers. When grains and spices, fresh and dried fruits, legumes and condiments are irradiated, the process eliminates any insects that might be present and can replace the use of chemical fumigants, which could leave residues or harm the environment.

Benefits include increasing shelf life of meats[1,2] and fruits and vegetables[3] ; improving quality of fruits and vegetables ; providing a suitable alternative to chemical treatments (e.g., methyl bromide and ethylene oxide), specially for decontamination of fruits and vegetables and providing economic savings due to reduced incidence of illness. Despite these added benefits, this technology remains vastly underutilized in the food industry.

Potential Uses of Food Irradiation

Type of food	Effect of irradiation
Meat, poultry, fish	Destroys pathogenic organisms such as *Salmonella, Clostridium botulinum and Trichinae*
Perishable foods	Delays spoilage, retards mould growth, reduces number of microorganisms
Grain, fruit, vegetables, dehydrated fruit, spices and seasonings	Controls insect infestation
Onions, Carrot, Potatoes, Garlic, Ginger	Inhibits sprouting
Bananas, Mangoes, avocados, Papayas, Guava & other non citrus fruits	Delays ripening
Grain, dehydrated vegetables	Reduces rehydration time.

PACKAGING

The development of packaging materials that can visually denote an irradiated product or dose range, or detect adverse changes in a product would also be beneficial. The combination of modified atmosphere packaging (MAP) and irradiation has been reported to enhance desirable changes and improve safety of sausage[4], ground beef[5], turkey[6] fresh-cut iceberg lettuce[7] and romaine lettuce[8].

HOW IS FOOD IRRADIATION REGULATED ?

Over the past 40 years, several national food control authorities have extensively studied this food process under a variety of conditions and found it to be safe and effective. Irradiation is environmentally friendly since it reduces the need for harmful pesticides in produce disinfestation.

It is easy for consumers to determine if a food has been irradiated. Regulations require that irradiated food be labeled as such and often it may be accompanied by an international food irradiation logo. The current labeling includes statements such as "treated with radiation" or "treated by irradiation."

IRRADIATION FOR FOOD SAFETY ?

While food irradiation is an important process that promotes food safety, it is not a substitute for safe food handling by processors, retailers and consumers. Although food irradiation may kill many organisms in food that is already spoiled, it cannot suppress odors or other signs of spoilage, and thus cannot be used as a means to "hide" or "cover up" spoiled food. Bacteria and other microorganisms that produce bad odors or discoloration will still exist as a warning sign to consumers that a food has spoiled, even after the food has been irradiated. In addition, food irradiation goes hand-in-hand with modern Hazard Analysis and Critical Control Points (HACCP), a preventative food saftey management system accepted in many countries.

Consumers must practice safe food handling techniques, whether the food is irradiated or not. It is still possible for bacteria to multiply in irradiated food if it has not been refrigerated properly or if care was not taken to avoid cross contamination with harmful bacteria from other sources. Food irradiation is a safe and effective process that can be used to improve the safety of our food supply.

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DO YOU KNOW ?

Q 5. Why in the double rainbow colors happened to be in reverse in the second than the first one?

Q 6. Can a flying bird go past Mount Everest ?

FERROELECTRIC CERAMICS : REVISITED

M.R. Panigrahi* and S. Panigrahi,

Ceramic materials and single crystals showing 'ferroelectric behavior' are being used in many applications in electronics and optics. A large number of applications of ferroelectric ceramics also exploit properties that are an indirect consequence of ferroelectricity, such as dielectric, piezoelectric, pyroelectric and electro-optics properties. This review introduces the basic principles and characteristics of ferroelectric materials which show ferroelectric behaviour. Various applications arising from ferroelectricity and related phenomena in ceramics and thin films have been listed at the end.

INTRODUCTION

Ferroelectric effect is an electrical phenomenon whereby certain materials may exhibit a spontaneous dipole moment, the direction of which can be switched between equivalent states by the application of an external electric field. The term ferroelectricity is used in analogy to ferromagnetism, in which a material exhibits a permanent magnetic moment.

Ferroelectricity is a phenomenon which was discovered in 1921. The name refers to certain magnetic analogies, though it is somewhat misleading as it has no connection with iron (ferrum) at all. Ferroelectricity has also been called Seignette electricity, as Seignette or Rochelle Salt (RS) was the first material found to show ferroelectric properties such as a spontaneous polarization on cooling below the Curie point, ferroelectric domains and a ferroelectric hysteresis loop. A huge leap in the research on ferroelectric materials came in the 1950's, leading to the widespread use of barium titanate ($BaTiO_3$) based ceramics in capacitor applications and piezoelectric transducer devices. Since then, many other ferroelectric ceramics including lead titanate ($PbTiO_3$), lead zirconate titanate (PZT), lead lanthanum zirconate titanate (PLZT), and relaxor ferroelectrics like lead magnesium niobate (PMN) have been developed and utilized for a variety of applications. With the development of ceramic processing and thin film technology, many new applications have emerged. The biggest use of ferroelectric ceramics have been in the areas such as dielectric ceramics for capacitor applications, ferroelectric thin films for non volatile memories, piezoelectric materials for medical ultrasound imaging and actuators, and electro-optic materials for data storage and displays.

In this article, and effort is made to introduce the basic principles governing ferroelectricity and list the various materials which exhibit these properties. The processing of ferroelectric ceramics in general, with a few examples is described. Finally, a few important applications of ferroelectric materials are briefly discussed.

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GENERAL PROPERTIES OF FERROELECTRICS

(a) Crystal Symmetry

The lattice structure described by the Bravious unit cell of the crystal governs the crystal symmetry. Though there are thousands of crystals in nature, they all can be grouped together into 230 microscopic symmetry types or space groups based on the symmetry element[1,2]. Most of the crystals possess symmetry elements in addition to the repetitions expressed by the crystal lattice. The operation of any single symmetry element of the group leaves the pattern of symmetry unchanged. In studying the physical properties of crystals, only the orientations of the symmetry elements and not their relative positions are important. Hence, if only the orientations of the symmetry elements are taken into account, then the macroscopic symmetry elements in crystals reduce to a center of symmetry, mirror plane, 1-, 2-, 3-, 4- or 6-fold rotation axes and 1-, 2-, 3-, 4- or 6- fold inversion axes. A combination of these symmetry elements gives us the macroscopic symmetry also called as point groups. It can be shown by the inspection of the 230 space groups that there are just 32 point groups. As shown below, the seven crystal systems can be divided into these point groups according to the point group symmetry they possess.

We have,

2 space group in a Triclinic system : 1,1

13 space group in a Monoclinic system : 2, m, 2/m

59 space group in an Orthorhombic system: 222, mm2, mmm

25 space group in a Rhombohedral system: 3, 3, 32, 3m, 3m

27 space group in a Hexagonal system : 6, 6, 6/m 622, 6mm, 6m2, (6/m)mm

68 space group in a Tetragonal system : 4, 4, 4/m, 422, 4mm, 42m, (4/m)mm

36 space group in a Cubic system : 23, m3, 432, 43m, m3m

All ferroelectrics are pyroelectrics, but all pyroelectrics are not ferroelectrics

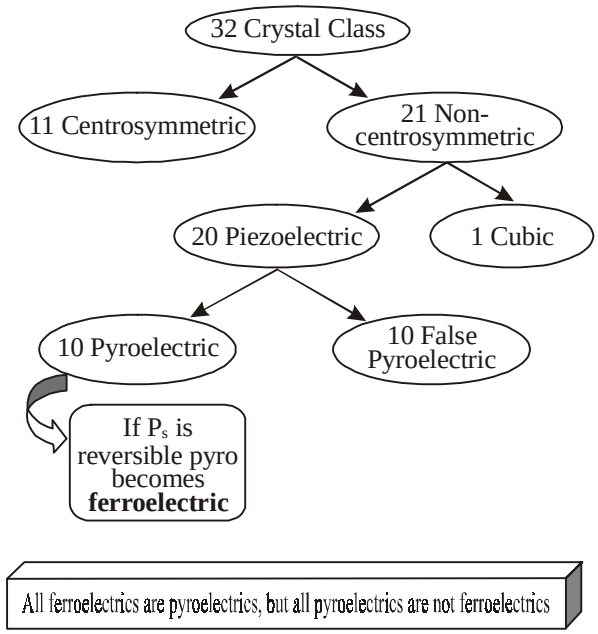

Fig.1 : Classification of crystal class

The thirty-two point groups can be further classified into (a) crystals having a center of symmetry and (b) crystals which do not possess a center of symmetry as shown in Fig.1. Crystals with a center of symmetry include the 11 point groups labeled centrosymmetric. These point groups do not show polarity. The remaining 21 point groups do not have a center of symmetry (i.e. non-centrosymmetric). A crystal having no center of symmetry possesses one or more crystallographically unique directional axes. All non-centrosymmetric point groups, except the 432 point group, show piezoelectric effect along unique directional axes. Piezoelectricity is the ability of certain crystalline materials to develop an electrical charge proportional to a mechanical stress.

Piezoelectric Crystal Classes : 1,2, m, 222, mm2, 4, –4, 422, 4mm, -42m, 3, 32, 3m, 6, -6, 622, 6mm, 62m, 23, -43m

Pyroelectric Crystal Classes : 1, 2, m, mm2, 3, 3m, 4, 4mm, 6, 6mm

(b) Spontaneous Polarization and Pyroelectrics Effect

The spontaneous polarization is given by the value of the dipole moment per unit volume or by the value of the charge per unit area on the surface perpendicular to the axis of spontaneous polarization. The axis of spontaneous polarization is usually along a given crystal axis. Although a crystal with polar axes (20 non-centrosymmetric point groups) shows the piezoelectric effect, it is not necessary for it to have a spontaneous polarization vector. It could be due to the cancelling of the electric moments along the different polar axes to give a zero net polarization. Only crystals with a unique polar axis (10 out of 21) non-centrosymmetric point groups) show a spontaneous polarization vector $\mathbf{P_s}$ along this axis. The value of the spontaneous polarization depends on the temperature. This is called the pyroelectric effect[3] which was first discovered in tourmaline by Teophrast in 314 B.C. and so named by Brewster in 1824. The pyroelectric effect can be described in terms of the pyroelectric coefficient λ . A small change in the temperature ΔT, in a crystal, in a gradual manner, leads to a change in the spontaneous polarization vector $\Delta\mathbf{P_s}$ given by,

$$\Delta P_s = \lambda \Delta T \qquad (1)$$

(c) Ferroelectric Domains and Hysteresis Loop

As described above, pyroelectric crystals show a spontaneous polarization $\mathbf{P_s}$ in a certain temperature range. If the magnitue and direction of $\mathbf{P_s}$ can be reversed by an external electric field, then such crystals are said to show ferroelectric behaviour. Hence, all single crystals and successfully poled ceramics which show ferroelectric behaviour are pyroelectric, but not vice versa. For example tourmaline shows pyroelectricity but is not ferroelectric.

Ferroelectric crystals possess regions with uniform polarization called ferroelectric domains. Within a domain, all the electric dipoles are aligned in the same direction. There may be many domains in a crystal separated by interfaces called domain walls. A ferroelectric single crystal, when grown, has multiple ferroelectric domains. A single domain can be obtained by domain wall motion made possible by the application of an appropriate electric field. A very strong field could lead to the reversal of the polarization in the domain, known as domain switching[4,5].

The main difference between pyroelectric and ferroelectric materials in that the direction of the spontaneous polarization is ferroelectrics can be switched by an applied electric field. The polarization reversal can be observed by measuring the ferroelectric hysteresis as shown in Fig.2. As the electric field strength is increased, the domains start to align in positive direction giving rise to a rapid increase in the polarization (OB). At very high field levels, the polarization reaches a saturation value (P_{sat}). The polarization does not fall to zero when the external field is removed. At zero external field, some of the domains remain aligned in the positive direction, hence the crystal will show a remnant polarization P_r. The crystal cannot be completely depolarized until a field of magnitude OF is applied in the negative direction. The external field needed to reduce the polarization to zero is called the coercive field strength E_c. If the field is increased to a more negative value, the direction of polarization flips and hence a hysteresis loop is obtained. The value of the spontaneous

polarization $\mathbf{P_s}$ (OE) is obtained by extrapolating the curve onto the polarization axes (CE).

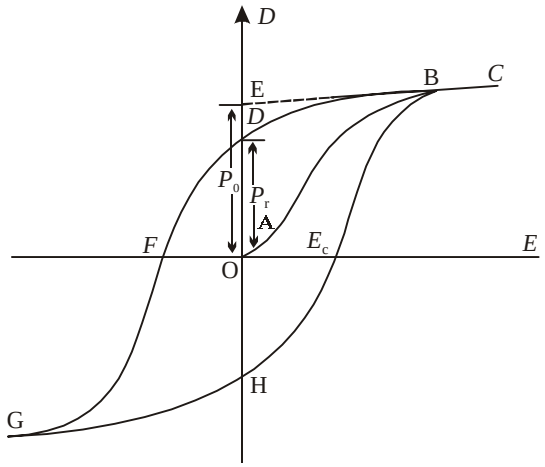

Fig.2 : A Polarization vs. Electric Field (P-E) hysteresis loop for a typical ferroelectric crystal

(d) Curie Point and Phase Transitions

All ferroelectric materials have a transition temperature called the Curie point (T_c). At a temperature $T > T_c$ the crystal does not exhibit ferroelectricity, while for $T < T_c$ it is ferroelectric. On decreasing the temperature through the Curie point, a ferroelectric crystal undergoes a phase transition from a non-ferroelectric phase to a ferroelectric phase. If there are more than one ferroelectric phases, the temperature at which the crystal transforms from one ferroelectric phase to another is called the transition temperature. Figure 3 shows the variation of the relative permittivity ε_τ with temperature as a $BaTiO_3$ crystal is cooled from its paraelectric cubic phase to the ferroelectric tetragonal, orthorhombic, and rhombohedral phases. Near the Curie point or transition temperatures, thermodynamic properties including dielectric, elastic, optical, and thermal constants show an anomalous bahaviour. This is due to distortion in the crystal as the phase structure changes. The temperature dependence of the dielectric constant above the Curie point ($T > T_c$) in ferroelectric crystals is governed by the Curie-Weiss law :

$$\varepsilon = \varepsilon_0 + C/(T - T_o) \qquad (2)$$

Where ε is the permitivity of the material, ε_o is the permitivity of vaccum, C is the Curie constant and T_o is the Curie temperature. The Curie Temperature T_o is different from the Curie point T_c. T_o is a formula constant obtained by extrapolation, while T_c is the actual temperature where the crystal structure changes. For first order transitions $T_o < T_c$ while for second order[6] phase transitions $T_o = T_c$.

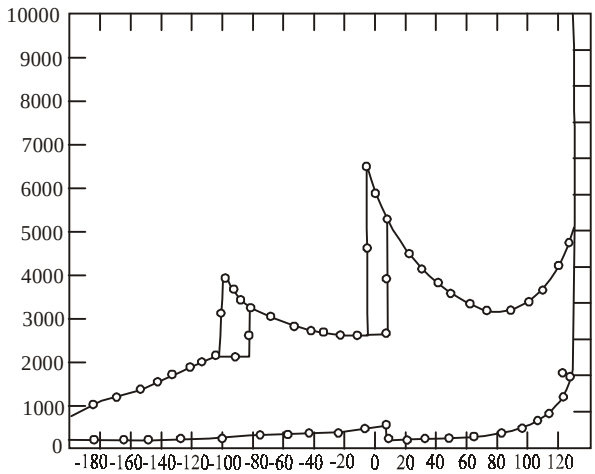

Fig.3 : Variation of dielectric constants (a and c axis) with temperature for $BaTiO_3$.

PROCESSING OF FERROELECTRIC CERAMICS

The final electromechanical properties of ferroelectric ceramic components greatly depend upon the processing conditions of the ceramic. Each step of processing has to be carefully monitored and controlled to get the best product.

The raw materials (metal oxides or metal carbonates) are first weighed according to the stoichiometric formula of the ferroelectric ceramic desired. The raw materials should be of high purity. The particle size of the powders must be in the

submicron range for the solid phase reactions to occur by atomic diffusion.

The powders are then mixed either mechanically or chemically. Mechanical mixing is usually done by either ball milling or attrition milling for a short time. Chemical mixing on the other hand is more homogeneous as it is done by precipitating the precursors in the same container.

During the calcination step the solid phase reaction takes place between the constituents giving the ferroelectric phase. Proper calcination at the right temperature is necessary to obtain the best electrical and mechanical properties[7,8].

After calcining, the lumps are ground by milling. The green bodies should have a certain minimum density before they can be sintered. The desired shape and a minimum green density can be provided by various techniques including powder compaction, slipcasting, and extrusion. The choice of the method depends on the type of powder used, particle size distribution, state of agglomeration, desired shape, and thickness of the particle.

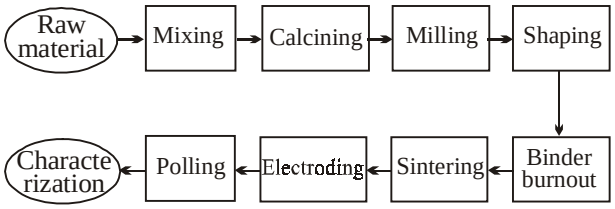

Fig.4 : Flowchart for the processing of ferroelectric ceramics

After shaping, the green bodies are heated very slowly to between 500-600ºC in order to remove any binder present. The binder burnout rate should be ≤1-2ºC/min in order to allow the gases to come out slowly without forming cracks and blisters in the ceramic part. After the binder burnout is over, the samples are taken to a higher temperature for sintering to take place. The sintering temperature and time should be optimum for proper densification to occur without abnormal grain growth. The sintering of oxide ceramics must be carried out in an oxidizing atmosphere or in air. For lead containing piezoelectric ceramics (PZT, $PbTiO_3$, PLZT, etc.) lead loss occurs at temperatures above 800ºC. In order to reduce the lead loss during sintering, the samples are kept in a sealed crucible with a saturated PbO vapor in it.

FERROELECTRIC DOMAIN

The dipoles within a single domain have the same orientation. In ferroelectric ceramics with fine grain sizes (< 1 μm) each grain is a single domain with the domain wall at the grain boundary. If the grain size is larger (>1 μm) then there could be multiple domains in a single grain. As schematically shown in Fig.5(a), when the ferroelectric ceramic is cooled after sintering, it does not show any piezoelectricity because of the random orientations of the ferroelectric domains in the ceramic. Piezoelectric behavior can be induced in a ferroelectric ceramic by a process called "polling". In this process a direct current (dc) electric field with strength larger than the coercive field strength is applied to the ferroelectric ceramic at a high temperature, but below the Curie point. On the application of the external dc field the spontaneous polarization within each grain gets oriented towards the direction of the applied field, as shown in Fig. 5(b). This leads to a net polarization in the poling direction. All the domains in a ceramic can never get fully aligned along the poling axis because the orientation of the polarization is restricted by the symmetry.

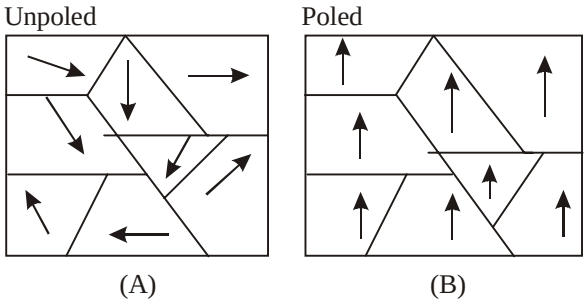

Fig.5 : Schematic of the poling process in piezoelectric ceramics : (a) In the absence of electric field the domainshave random orientation of polarization; (b) the polarization within the domains aligns in the direction of the applied field.

APPLICATIONS

Ferroelectric materials have been applied to a large field of applications because of their excellent dielectric, piezoelectric and ferroelectric properties. Some of the important applications are :

1. Multi layer ceramics capacitors.
2. Engine electronic control
3. Anti lock brake system.
4. Ferroelectric memories : As DRAM, SRAM, EEROM, FERAM, in the microwave domain.
5. Electro-Optic application : Ferroelectric thin film wave guides, ferroelectric thin film optical memory display.

Applications of Piezoelectric ceramics :

1. Medical ultra sound application.
2. Sensors and Actuators
3. Gas Ignitors.
4. Displacement transducers.
5. Accelerometers : Accelerometers is a device which gives an electrical output proportional to the acceleration.
6. Piezoelectric transformer : Low voltage to high voltage transformer can be done by using a piezoelectric plate.

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DO YOU KNOW ?

Q 7. Crocodiles have enormously powerful jaws that can be forced on a prey with tremendous force yet one can easily keep the jaws closed by clasping with bare hands, how ?

Q 8. The four corners of pyramids face in which direction ?

AQUAPORINS AT A GLANCE

Swapnil J. Paralikar

Aquaporins are proteins embedded in the cell membrane that facilitate and regulate the movement of water across cell membranes. They are found in various cells of the body, including the kidney. They mediate water reabsorption in the proximal tubule, and are necessary for ADH regulated water reabsorption in the collecting duct of the kidney. Diabetes insipidus, a disease characterized by polyuria is associated with defects in AQP-2 expression.

INTRODUCTION

A number of proteins are found in the cell membrane of every cell of the body.They facilitate the movement of ions and solutes both downhill (along concentration gradient) and uphill (against concentration gradient). Aquaporins are such protein channels embedded in the cell membrane, that facilitate and regulate the movement of water. They are "the plumbing systems of the cells."

DISCOVERY OF THE FIRST AQUAPORIN

Like a number of other great discoveries in science, aquaporins were discovered by a convoluted route in Dr. Peter Agre's laboratory at John Hopkins University, Baltimore, USA around 1989-1991. The lab had received a NIH grant to study the Rh blood group antigen. They isolated the Rh antigen, but another protein kept appearing. It was a 28 kDa protein abundant in red blood cells and kidney tubules, and also in plant tissues. Dr. Agre consulted his hematology teacher at North Carolina University, John Parker, who suggested it may be the long sought after water channel.

Agre then conducted a decisive and elegant experiment. He introduced the newly discovered protein (now called CHIP 28 –channel like integral protein with 28kDa molecular weight), into frog oocytes and kept these oocytes in water. These cells were swollen up, while the other oocytes (with no CHIP 28) were hardly so (Fig.2). Thus, it became established that this protein was both necessary and sufficient to explain the movement of water across the red cell membrane. Agre christened it Aquaporin-1 (water pore). Subsequently, the human genome nomenclature committee has accepted the nomenclature for all similar proteins.

The pioneering discovery and research by Agre and colleagues culminated in the 2003 Nobel Prize in Chemistry being awarded to Dr. Peter Agre. In 1999, together with other research teams, Agre

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reported the first three dimensional structure of aquaporins viz. aquaporin-1.

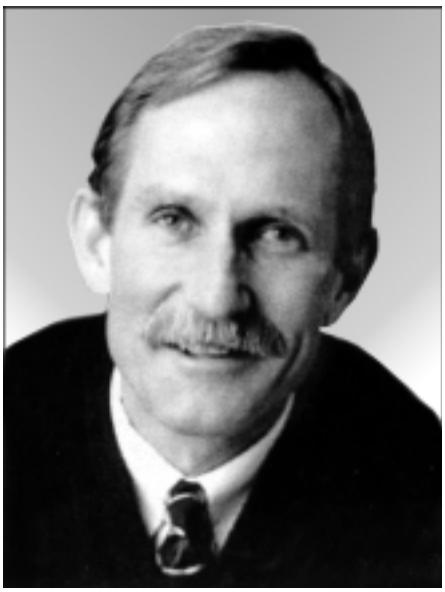

Fig.1 : Dr. Peter Agre
(From www.nobelprize.org)

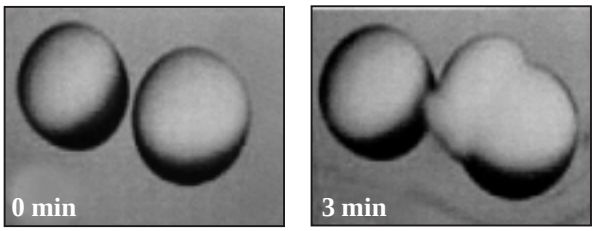

Fig.2 : Frog oocytes that contained the protein (CHIP 28, later christened AQP-1) are swollen up
(From www.nobelprize.org)

STRUCTURE OF AQUAPORINS

Aquaporins have six membrane spanning regions, both intracellular amino and carboxy terminals, and internal tandem repeats, that are due to an ancient gene duplication.

Of the five loops in AQP-1 (Fig.3), loops B and E dip into the lipid bilayer, and it has been proposed that they form 'hemichannels' that connect the leaflets to form a single aqueous pathway within a symmetrical structure that resembles an 'hourglass'.

Aquaporins form tetramers in the cell membrane, with each monomer acting as a water channel. The different aquaporins contain differences in their peptide sequence, which allows the size of the pore to differ. The resultant size of the pore directly affects what molecules pass through, with small pore sizes allowing only small molecules like water to pass through.

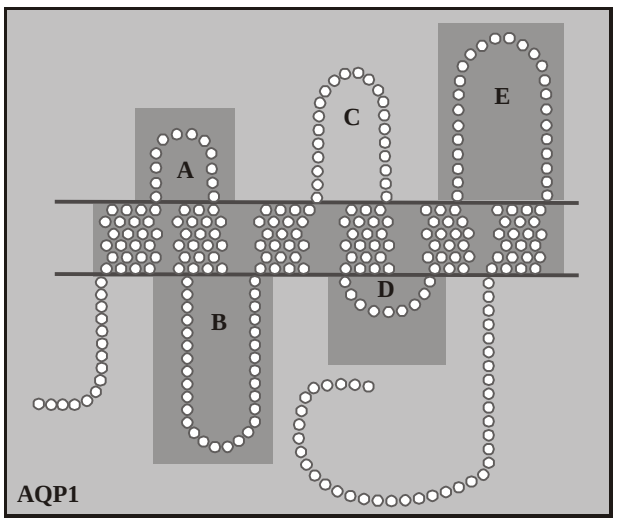

Fig.3 : Structure of AQP-1(www.wikipedia.org)

TYPES AND DISTRIBUTION OF AQUAPORINS :

The aquaporin family is divided into two groups on the basis on their permeability characteristics :

1. **The 'orthodox set' or AQUAPORINS**—permeable to water (include AQP-1, AQP-2, AQP-4, AQP-5, AQP-6, AQP-8)
2. **The 'cocktail set' or AQUAGLYCEROPORINS**—permeable to water and small solutes, especially urea and glycerol (include AQP-3, AQP-5, AQP-7, AQP-9, AQP-10).

- AQP-1 is expressed in various cells of the body including red blood cells and kidney tubules. The permeability of the red cell membrane to water is explained by the presence of AQP-1.
- AQP-2 is regulated by Anti-Diuretic Hormone (ADH), and is present in the distal nephron; it is also expressed in the testis.

- AQP-3 and 4 are present constitutively on the basolateral membrane in the late distal tubule and cortical collecting duct of the kidney. In addition, AQP-4 is present in the brain and other organs.
- AQP-6 is present in intracellular vesicles in the intercalated cell (acid secreting cell in the late distal tubule and cortical collecting duct).
- AQP-7 & 8 are expressed in the kidney and in various tissues like testis, adipocyte, placenta, heart, etc.
- AQP-5 & 9 are external aquaporins, expressed in various tissues of the body, but not in the kidney.

ROLE OF AQUAPORINS IN THE KIDNEY:

Aquaporins expressed in the kidney are AQP-1, AQP-2, AQP-3, AQP-4, AQP-6, AQP-7 & AQP-8 (Fig. 4). An overview of their role in the kidney is discussed below :

1. **AQP-1**

AQP-1 is expressed in the proximal convoluted tubule and descending thin limb of the nephron. At both these sites, it is present both on the apical membrane (the side facing towards the lumen) and basolateral membrane (the side facing towards the interstitium).

Table 1. DISTRIBUTION OF AQUAPORINS IN THE BODY

AQUAPORIN	Localization in Kidney	Subcellular Distribution	Extrarenal Distribution
RENAL AQUAPORINS			
Aquaporin - 1	Proximal convoluted tubule, descending thin limb	Apical membrane, Basolateral membrane	Multiple organs
Aquaporin - 2	Principal cell in late distal tubule and cortical collecting duct	Apical membrane, Intracellular vesicles	Testis
Aquaporin - 3	Principal cell in the late distal tubule and cortical collecting duct	Basolateral Membrane	Multiple organs
Aquaporin - 4	Principal cell in the late distal tubule and cortical collecting duct	Basolateral Membrane	Brain and multiple organs
Aquaporin - 6	Intercalated cell	Intracellular vesicles	?
Aquaporin - 7	Proximal tubule	Apical membrane	Testis, adipocyte
Aquaporin - 8	Cortex, medulla	Intracellular vesicles	Testis, epididymis, pancreas, liver, colon, heart, placenta
EXTRARENAL AQUAPORINS			
Aquaporin - 5		Apical membrane, Intracellular vesicles	Salivary glands Lungs, eye
Aquaporin - 9		Apical membrane	Liver, leucocytes, brain, spleen, lung, epididymis, testis

- In the proximal tubule, AQP-1 mediates transcellular reabsorption of water. About 67% of the filtered water is reabsorbed in the proximal tubule ; this is accomplished due to the presence of AQP-1.
- The descending thin limb is freely permeable to water just like a sieve. It participates in the process of forming a concentrated urine through the operation of the countercurrent multiplier system. This function is facilitated by the presence of AQP-1.

2. **AQP-2, 3 & 4 and the role of ADH :**

AQP-2 is expressed on the apical membrane of the principal cell in the late distal tubule and cortical collecting duct, on stimulation by Anti-Diuretic Hormone (ADH). An increase in extracellular fluid osmorality (solute concentration) stimulates the release of ADH from the posterior pituitary. ADH acts on the V2 receptor (vasopressin receptor, type 2) ; the resultant activation of the adenyl-cyclase-cAMP system results in the insertion of AQP-2 water channels on the apical membrane of the principal cell. AQP-3 & 4 are always present on the basolateral membrane. Thus a pathway is created for the passage of water-water entering the cell through the apical AQP-2 leaves the cell through the basolateral AQP-3 & 4. This reabsorption of water resets the extracellular fluid osmolarity.

3. AQP-6 :

AQP-6 is present in the intercalated cell in the cortical and medullary collecting duct. It is almost exlusively present in intracellular vesicles, with no expression in the plasma membrane. It is thus, an internal ion channel.

4. AQP-7, 8 :

- AQP-7 is present abundantly in spermatocytes. In the kidney, it is present in the brush border (apical side) of the proximal tubule.
- Although the exact function of AQP-8 is not known, it is present in intracellular domains in the proximal tubule and the collecting duct. It is also abundant in many other tissues.

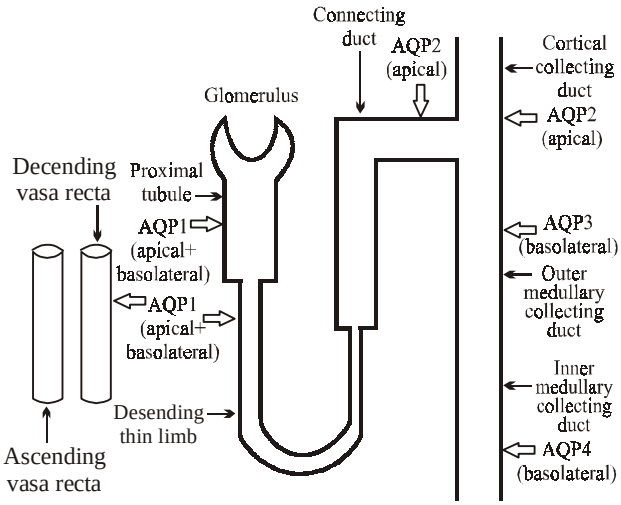

Fig. 4. Aquaporins in the kidney

AQUAPORINS AND DISEASE :

DIABETES INSIPIDUS

There are two significant forms of diabetes insipidus : central and nephrogenic.

- Central (neurogenic) DI is characterized by a defect in vasopressin production or release. This form of DI is rarely hereditary; it occurs as a consequence of head trauma or disease in the hypothalamus or pituitary. In experimental animals (rats) with central DI, decreased AQP-2 expression in the apical membrane has been demonstrated.
- Nephrogrenic DI is characterized by an inability of the kidneys to respond to vasopressin stimulation. The most common hereditary form occurs due to a mutation in the V2 receptor. It is an autosomal recessive condition, localized on the X chromosome. AQP-2 trafficking to the apical plasma membrane is impaired as a result of this mutation.

- Acquired nephrogenic DI occurs commonly after lithium therapy. Lithium is administered for the treatment of bipolar mood disorder (manic depressive psychosis). Lithium induced nephrogenic DI is characterized by decreased expression of AQP-2 in the apical plasma membrane.

CHRONIC HEART FAILURE

Severe chronic heart failure is characterized by defects in renal handling of water and sodium resulting in extracellular fluid expansion and hyponatremia. In experimental rats with congestive heart failure (CHF), an increase in the abundance of AQP-2 water channels in the collecting duct principal cells and increased expression of AQP-2 in the apical plasma membrane of these cells has been demonstrated.

CONCLUSION

The discovery of aquaporins by Agre and colleagues has allowed enormous progress into the understanding of how water is transported across the biological membranes and epithelial cells at the molecular level. It has also offered tremendous insight into how renal water handling occurs at the physiological level and in various disease states associated with severe derangement of body water balance.

Future research will focus on understanding the molecular mechanisms of aquiaporin action, identifying novel aquaporins and defining the role of each aquaporin in physiological and pathological states.

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CERVICAL CANCER PREVENTION STRATEGIES FOR DEVELOPING COUNTRIES – AN INDIAN PERSPECTIVE

P. Cheena Chawla*

Large scale screening efforts for detecting cervical cancer in sexually active women coupled with HPV vaccination for adolescent girls are poised to improve the reproductive health of women in developing countries

INTRODUCTION

Every year scores of women in India face the traumatic death sentence spelled out as 'cancer of the cervix'—a silent killer that targets women mostly living in low socio-economic conditions. It is unfortunate that India bears a substantial burden of cervical cancer in terms of incidence, mortality and morbidity, despite the fact that infection of cervix is fully treatable in the early stages. Out of the five lakh new cases of this disease detected every year worldwide, 1.2 lakh cases occur in India alone, which is only the tip of the iceberg as these women represent the reported hospital cases with mostly fatal form of cervical lesions. The hard truth is that a majority of Indian women have never had a preventive pap smear test done due to socio-economic and cultural inhibitions. This hints towards the fact that due to low resource settings and healthcare inequity in the country, thousands of women in India with treatable precancer lesions in the cervix remain undetected till the disease becomes fatal. Unfortunately, out of about 2.5 lakh deaths occuring worldwide due to cervical cancer each year, 0.8 lakh women are from India. In this light, formulation of firm government policies to promote cervical cancer screening as well as the introduction of the HPV vaccine in the Indian healthcare system assumes great significance.

The need of the hour is to control and prevent cervical cancer in India through a comprehensive advocacy program, presuading women to accept screening while mobilizing the government machinery for facilitating the introduction of the HPV vaccine in India through the country's routine public health services. This health education drive needs to be focused at information dissemination on both cervical cancer screening and precancer treatment in the early stages and promotion of HPV vaccination for adolescent girls.

CERVICAL CANCER SCREENING

Cervical cancer is a disease that can be prevented through both primary prevention and early detection using screening techniques. However, any large scale cervical cancer screening approach is confronted with a broad array of clinical, social, and cultural issues as the causative agent of this cancer is a sexually transmitted viral infection. Research worldwide has clearly shown that cervical cancer is invariably caused by human papilloma virus (HPV) infection of cervix. Although HPV

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infection becomes undetectable quickly in most women, a constant exposure to certain carcinogenic types of HPV surely increases the risk of progression of cellular changes to the precancer stage followed by untreatable cervical cancer. Besides poor genital hygiene, women with compromised immune system are more likely to have persistent HPV that makes them more susceptible to developing cervical lesions.

The other challenges that impede the successful implementation of any cervical cancer screening program in a developing country are logistics and infrastructure inadequacies, cost concerns, poor follow-up, and socio-cultural constraints. Besides, there is an issue of addressing concerns of women who are tested positive, as they often want to know how they got the infection, how it can be treated, and how to prevent transmission of the infection to their partner.

Broadly, any strategy for cervical cancer screening needs to address certain key issues that include the age of the target population to be screened; screening coverage and frequency; the use of a single or combination-screening methodology; besides considering treatment options for women diagnosed with different stages of cervical lesions.

A host of screening techniques are now available for early detection of cervical cancer that have varying test characteristics and economic considerations. Cervical cancer prevention programs in both developed and developing nations generally have relied on conventional cytological testing using the Papanicolaou (Pap) smear test. For a Pap smear, a trained nurse/doctor obtains a sample of cells from the uterine cervix and this is examined for cellular changes (dysplasia) known to precede the development of cervical cancer. Such screening programs can be expensive, prone to error, and logistically difficult to implement—particularly in developing countries with poor resouce settings. Besides, cultural barriers and personal inhibitions pose hindrance to participation of otherwise healthy women in such cytology-based screening programs.

MODERN TECHNIQUES FOR DETECTING HPV

New diagnostic methods for cervical cancer screening are based on molecular technologies that detect HPV DNA in cervical/vaginal samples. As there are specific types of HPV that are causative agents of cervical cancer, namely HPV-16 and HPV-18, the strength of a diagnostic test lies in not only detecting the HPV-DNA in a cervical swab sample but also in specifically pinpointing the HPV types(s) present in each specimen.

HYBRID CAPTURE TECHNOLOGY

Developed by the Digene Corporation (now Qiagen), this technology detects specific HPV-DNA sequences, using signal amplification. The first-generation Hybrid Capture Tube (HCT) test was granted US FDA approval in May 1995, followed by the more advanced Hybrid Capture II (HCII) assay that was US FDA approved in March 1999. Both assays detect 'high-risk' HPV types. Once samples are taken, they can be stored at room temperature for two weeks, at 4ºC for one additional week, and at –20ºC for up to three months.

FAST/CARE HPV

The *care* HPV test, specially designed for low-resource settings, is based on the technology of Hybrid Capture II developed by Qiagen in partnership with Program for Appropriate Technology in Health (PATH). Seattle. The cervical swab samples can be self-collected. The test results are available in 2 to 3 hours. The test requires no running water and instrumentation can be powered by a rechargeable battery. Up to 90 samples can be processed together.

In 2007, the clinical accuracy of *care* HPV test was assessed on cervical samples obtained from

2530 women aged 30 to 54 years in two hospitals in Shanxi, China. This test has been shown to produce rapid, and accurate results, besides it is also simple to run, requires minimal infrastructure and is affordable for public-health programmes in low resource countries. Similar programmes to demonstrate the utility of care HPV are already underway in various settings in India, Uganda, and Nicaragua.

CBG (CATCH BY GENE) TECHNOLOGY

Developed by a team of Korean scientists, this is a colorimetry assay based on DNA hybridization that uses a mixture of probes for specific detection of 15 high-risk types of HPV in cervical swab samples. Since the samples can be kept for two weeks at room temperature, it is suitable for large scale screening as samples can be collected in bulk and tested later. The samples can be even stored for an additional week at 2-8ºC. Besides, this test is cost effective as compared to Hybrid Capture II.

BIOMARKER STRIP TEST

In yet another development in molecular diagnosis of cervical cancer is the designing of a strip test for an oncoprotein named E6, which is a specific protein expressed by cells of the cervix that are infected with a high-risk HPV type. PATH partnered with Arbor Vita Corp. (Sunnyvale, U.S.A.) to develop this AVantage HPV E6 test for detecting elevated levels of the E6 oncoprotein. In 2005, this test was ready for clinical testing and was found suitable for large scale screening in developing countries. The test results are obtained within 30 minutes.

These new biochemical screening tools for detecting cervical cancer are being increasingly recognized as potent technologies for improving the reproductive health of women in many countries. In United Kingdom, for example, the National Health Services' Screening Committee has recommended that patients with borderline smear results called ASCUS (a typical squamous cells of undetermined significance) must undergo an HPV test to help determine the appropriate clinical management strategy. Even in the United States, HPV testing is being increasingly integrated into cervical cancer screening protocols.

SAMPLE COLLECTION

A critically viewed issue in HPV testing in developing countries is the method of obtaining specimens. HPV diagnostics have used various methods for specimen collection, including self-collected samples (using urine, vulvar swabs and vaginal swabs) and samples collected by a doctor/ trained nurse (vaginal/cervical swab and cervical brush specimens). In fact, several studies have evaluated the efficacy of different specimen collection techniques. For example, in a Canadian study HPV screening with self-collected vaginal, vulvar, and urine samples was compared with physician-collected cervical samples, and then all the women were examined with colposcopy. The sensitivity of physician-collected samples for detecting cervical lesions was 98.3 percent, while the sensitivity of self-collected samples was 86.2 percent for vaginal swabs, 62.1 percent for vulvar swabs, and 44.8 percent for urine specimens. Self-sampling methods were found to be acceptable to women, with urine being the most preferred specimen.

In a similar study conducted in South Africa, self-collected vaginal swabs for use with the Hybrid Capture II test were 66 percent sensitive in detection of cervical cancer. Similar results have been obtained in studies employing self-collection methods conducted in rural Uganda. However, an integral part of all these investigations was that self-collection of cervical/vaginal specimens seriously required proper educating of women on the mode of sample collection. The most common approach requires a woman to insert a swab into the vagina, rotate it several times, and then place it

into a transport tube. Surely, self-collection of samples, would greatly benefit large community based screening programs in low-resource settings, as women would be at ease to provide the sample without requiring a gynecological examination.

Is it indeed notable that the cervical cancer screening efforts, using different approaches, directly translate into reduction in mortality from cancer of cervix. Nordic counties have conducted organized cytology screening programs, which have reported rapid reduction in incidence of cervical cancer in Iceland. In five countries (viz., Denmark, Finland, Iceland, Norway, Sweden and British Columbia), studies have demonstrated the efficiency of cytology screening programs. According to World Health Organization recommendations (1992), every woman should be screened once in her lifetime, preferably at age 40 and above.

Resource constraint has been a major hurdle in organizing screening programs. It has been estimated that in India, even with a major effort to expand cytology services, it will not be possible to screen even one-fourth of the population once in a life time in the near future. Moreover, deficiencies in record keeping in cytology laboratories and cancer registries make the administrative monitoring and evaluation activities exceedingly difficult. To counter these limitations, select screening options may be tried like camp approach, hospital-based screening and high-risk screening.

In the camp approach, one can sensitize a small group of women who come for screening but it cannot make much impact on the incidence or mortality as it is a limited activity. Several hospital-based screening programs have been conducted in India, especially where a cytopathology department is well equipped to conduct the test. High-risk screening involves screening high-risk individuals who have had some signs of cervical infection, abnormal bleeding etc., detected in the gynecology outpatient departments. Due to limited funds and lack of resources, these screening efforts in India have not been absorbed in the country's healthcare system as a continuous activity.

LOW COST SCREENING

Many aspects of visual inspection of cervix with acetic acid (VIA) make it an attractive approach for use in low-resource settings. It is a simple approach with minimum reliance upon infrastructure. Results of the procedure are available immediately for initiating treatment in the same visit. However, the prerequisite for VIA is the availability of doctors and trained nurses who can carefully examine the cervix for any abnormal lesions. The same is true for visual inspection with magnification (VIAM), using a lightweight monocular telescope called gynoscope and a magnivisualizer. Another method of visual inspection after application of Lugol's iodine (VILI) over the cervix and vagina, results in staining the normal squamous epithelium (that contains glycogen) dark brown/yellow, while cancer cells do not stain.

In a cluster-randomized trial in Tamil Nadu, India, conducted by the Screening Group, International Agency for Research on Cancer (IARC), France, it was evident that VIA screening, in the presence of good training and sustained quality assurance, was an effective method to prevent cervical cancer in developing countries.

It is amply clear that all visual methods of detecting changes in cervix are simple, inexpensive and require minimal infrastructure, although health professionals require some training for conducting the test. Another major logistic advantage of the visual tests is the immediate availability of results to start treatment. No doubt, before the more advanced HPV-DNA detection methods come in vogue, VIA-/VILI-based screening programs could be integrated into the primary care health services in developing countries, making screening and treatment accessible to as many women as possible.

In 1999, Jhpiego worked in Thailand and Ghana to pioneer the single visit approach (SVA) for low-resource settings, which basically involved the detection of precancerous cervical lesions using the VIA method and then providing cryotherapy treatment to women found positive.

Interestingly, Groesbeck Parham, Lusaka, Zambia has recently introduced a low-cost mobile technology combined with VIA, called digital cervicography, which facilitates both patient and provider education and rapid distance consultation. While examining the cervix with naked eye, the nurse takes a digital photograph of the cervix using a hand-held, battery-operated digital camera. The digital images can be displayed and enlarged on a bedside monitor for detailed examination of surface morphology of cervical abnormalities. Besides, the results of the examination can be discussed with patients for purposes of educating them and taking their informed consent if treatment is required. These images could be even electronically transmitted to off-site experts for rapid distance consultation, if required. A similar approach could be employed in screening campaigns using VIA/ VILI method in India.

One of the largest randomized controlled trial of the three screening methods for cervical cancer in a low-resource setting was carried out in rural India by a team comprising Dr. Rengaswamy Sankaranarayanan, Head of the Screening Group at IARC, France, Dr. Bhagwan Nene and colleagues from the Nargis Dutt Memorial Cancer Hospital (NDMCH), Barshi, India and Dr. Surendra Shastri and colleagues from the Tata Memorial Centre (TMC). Mumbai, India. In this effort, a large randomized controlled trial in the remote district of Osmanabad in Maharashtra State, India was undertaken, involving 131,806 healthy women aged 30-59. About 32,000-34,000 women were randomly alloted to receive either a single round of screening by HPV testing or VIA or Pap smear. Women found positive on any of the screening tests were investigated with colposcopy and biopsies and those with cervical pre-cancer and cancer received appropriate treatment. The results showed no significant reduction in advanced cancers or cervical cancer deaths following VIA or cytology screening, while a significant reduction in advanced cervical cancers and deaths followed a single round of HPV testing in this low-resource setting.

MAKING HPV VACCINATION A REALITY

In parallel with the focus on cervical cancer screening, it is imperative to assess the Indian health system for working out the feasibility of introducing the HPV vaccine through the country's routine health service mechanism. The idea is to design a successful strategy for HPV vaccine delivery, in scores of public health centres, through the National Immunization Programme of the Govt. of India.

For making HPV vaccination a reality in India, it is important to gather information on the current routine vaccine delivery systems preferred by various communities, besides mapping the vaccine infrastructure that encompasses collection of data on vaccine supply, storage, distribution and outreach systems for making the vaccine accessible to the Indian populations. Moreover, the various resources namely, manpower, equipment, education material etc., required at national, district and village levels for delivering the HPV vaccine need to be assessed.

The existing institutional strucutres like public health centres and local school premises in a given area could be identified to assess their suitability as centres for delivering the HPV vaccine. Merck & Co. in collaboration with the Indian Council of Medical Research (ICMR) has started clinical studies on Gardasil in 2007, targeting about 40,000 Indian women in two phases. These multi-centric Indian trials are focused at assessing whether the Gardasil vaccine is safe and equally efficacious for women in a tropical country.

With the recommendation of the Advisory Committee on Immunization Practices (AICP) of the US Centers for Disease Control and Prevention supporting universal administration of three doses of Gardasil vaccine in girls 11 or 12 year of age, concerted efforts need to be made for immunizing adolescent girls in India where cervical cancer tops the list of cancers that affect women. However, unless the HPV vaccines are subsidized, they cannot reach the Indian populace, for their cost is between $400 and $500 for the three doses. Another possibility is vaccination of much younger age group (< 9 year) as it can be then easily incorporated into the existing national immunization programmes. Interestingly, cilinical trials to study the safety and efficacy of giving younger girls two doses of gardasil instead of the current 3-dose regimen are already on in British Columbia, Quebec and Nova Scotia.

Understandably, to reduce the current high burden of cervical cancer in low-resources settings of India, organized screening strategies need to be designed keeping in view the feasibility and cost effectiveness of the techniques employed for their implementation on a large, community scale. In parallel with the screening efforts, it is imperative at this moment to address the issue of the affordability of HPV vaccines.

For achieving these targets, concerted advocacy efforts would play an integral role to sensitize not only the general public, but also the health professionals and the policy makers. After all, huge funds are already being spent to treat advanced cases of cervical cancer in India, in addition to the hardships of families when the mother dies against the cost of screening and pre-cancer treatment. It is only when the twin strategies of effective cervical cancer screening for sexually active/older women and HPV vaccination for adolescent girls are implemented countrywide that the ultimate dream of protecting Indian women from the onslaught of cervical cancer could be realized.

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SOMETHING TO THINK ABOUT

WHY AND HOW SOME PEOPLE BECOME SUPEROLDS ?

Hem Shanker Ray

In India it is common for elders to bless youngesters by saying 'chiranjivi bhava', i.e. 'live forever'. This, of course, is only a wishful thinking, because our scriptures mention only about half a dozen immortals and that list is final. In that list are some who were blessed to live forever in glory e.g. *Hanumaan* and *Bibhishana* (not in so much glory !) and some like *Aswathama* and *Kripa* were cursed to live on and on in shame. Mythologies of many cultures mention people who enjoyed great life spans. Very specific is the Genesis chapter of the Holy Bible where life spans are recorder for Adam and his descendents down to Noah. In years the figures given are : Adam–930, Seth–917, Enoch–905, Kenan–910, Mahalel–895, Jared–962, Methuselah (the champion)–969, Lanch–777 and then Noah who became father of three sons at the age of 500 and was 600 when the Flood came on earth. In the Indian mythology also many sages were said to have enjoyed long longevity.

All through history man has searched for immortality and even fountains that bestowed perpetual youth. When the mighty Gengis Khan grew old, he summoned numerous famous physicians and ordered them to restore his youth and vigour and also ensure immortality. The doctors tried out many potions but each was put to death when the expected results were not there. Eventually an old, renowed medicine man was brought from a remote region of China. He bowed to the great Khan and said humbly but frankly, 'Lord, I can at best try to make you feel better. I can never make you young and immortal. I believe nobody can, or else, he would have tried the potion on himself first.

That statement did not make the Lord joyful but the man was set free. In recent times Swami Yogananda, in his celebrated book The Autobiography of a Yogi, wrote about one Babaji who is more than 400 years old and apparently deathless. There is a sketch of his likeness too in the book.

There is a general agreement that under ideal conditions, the maximum possible life span of man is about 120 years, something Mahatma Gandhi had desired for himself. There is the will documented case of one Jeanse Louis Calment of France who died in 1997 at the age of 122. She is the record holder.

Many of us have seen people who are in their nineties and many politicians and celebrated authors have reached the century mark. During the acceptance speech of the Democratic party's nomination for the U.S. President, Barak Obama talked about one 106 year old supporter, a lady who was shown on the television talking very coherently. One of the tallest Indian writers in English, a very short and frail man, Nirad C. Choudhury started the second volume of his autobiography when he was 97 declaring that it was about time because he might not cross 100. He finished his book on time.

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The subject of superolds has been discussed in a recent issue of *Science* (www.Science mag. org) by Mitch Leslie (Searching for the secrets of the superold. *Science* vol. 321, Sept. 26(2008), pp. 1764-65). We consider some facts and issues discussed in that article.

Even though there are always a good number of persons who unfortunately take their own lives, the vast majority would rather continue to live as long as possible and there are in every society some who manage to remain healthy and grown older compared to others. Superolds are those who cross the century mark. It has often been a problem to firmly establish the actual age because, for older people there is no reliable scientific method for this. Elderly persons and their children often add a few extra years to draw more attention just as very tall or short dwarfs add or substract a few inches in their claims. The Guiness Book people, who are forever searching for oddities and records, have a standard procedure for authenticating age claims.To weed out pretenders they go for three types of verification : proof for date of birth and, if a person is no more, proof for date of death ; continuity documention i.e. identify cards of organizations when employed, driving license, marriage certificate, etc. which mention date of birth and other corroborative evidences. In the case of some trees, the age can be found by counting the rings in the trunk but we are not trees !

There is no doubt that better nutrition, comfortable life style and improved medicare are helping to enhance the overage life span. In fact, even wild animals in captivity live much longer than in the wild. Surgical procedures being developed for replacing damaged vital organs will play an important role in the near future through cloning of organs using results of stem cell research. Cloning of the entire human body, dreamt of by the rich and famous, however, will be, even if successful, a futile attmept for immortality because the new body will have a new brain with its own experiences and awareness. Moreover, the soul will be different too.

Factors that surely cut down life spans would include the following : unnatural deaths due to natural calamities, fatal accidents, murder, etc., infectious diseases, a reckless life style with excesses of food, alchohol, sex and drugs, lack of proper medicare, lack of exercise, unhappy family life, negative outlook in life and, of course, a family history of short life spans. There is the well known story of a Maharaja, known for his fabulous wealth, tall physique and handsome looks, who died rather young in the middle of the last century. His doctors could not diagnose the disease as he lay dying until an old Vaid pronounced correctly, His Highness is dying of boredom, there is nothing new he can think, of doing with his wealth, women and wine.

The factors that would prolong life should be obvious—a life of discipline, moderation in diet and drinks, regular exercise, clean air and water from a scenic environment, cheerful lifestyle with family and friends, a rewarding occupation and proper medicare. Again it helps to have ancestors who lived long lives.

There are many people today who were born in the 19th century, some living in anonymity in remotest corners of earth. They have somehow survived famines, natural disasters, epidemics, depressions, wars, Alzheimer disease and heart and lung problems. Some experts believe that these people just 'happen to be superolds'—a necessary tail in statistical distribution of age according to the Gaussion distribution. However, no one can deny that super-age cannot be simply accidental and, thus, scientists are searching for the secrets that, 'if revealed, may help others live longer.

It is estimated that, in the advanced countries, about 7 in 1000 people reach the century mark. Every extra year thereafter becomes increasingly

difficult to achieve as nearly fifty percent of the survivours drop off each year. Thus, eventually there will be less than one in a milion reaching 110. To understand the secrets of this longevity the oldest among the superolds need to be medically examined both before an after eventual death. The most important research will relate to survey of their genomes for longevity promting DNA sequences. As Watson and Crick said way back in 1953, 'There is no vital spirit, it is a molecule'.

There are many new research schools studying this subject on the basis of surveys. In the U. S., a country which keeps reliable records, some 139 persons were above 110 in 2002 and they were receiving social security payments. More details have been made available in the website www. grg.org by a Gerontology Research Group. The website mentions that in Sept. 2008 there were 10 men and 68 women in 12 countries who were between 110 and 115. As has always been well known women often outlive men. Frail widows of India, who hardly eat anything while they go about doing routine household chores, generally outlive other members of her generation.

That limited food intake prolongs life has been shown to be true even for rats. Thus, we can say that you can only eat so much, it is your choice to consume all that fast or go slow with daily rations and live longer. Fasting is undoubtedly good for health and longevity. Yet this alone is not sufficient.

It is believed that many superolds exist in remotest regions of China, Mongolia, Russia and the Alps, specially in the mountaneous areas that have pristine air and clear water. They enjoy regular exercise and stay fit too. Perhaps there are around 30 persons in the range 110–119.

Amongst the superolds, osteoporosis and cataracts will be common yet nearly half can live on their own. Cardiovascular diseases, diabetes and Parkinson's disease are uncommon. Somehow centurians delay the stage when they become disabled.

Superolds do not perish from typical scrouges of old age such as cancer, heart disease, stroke and Alzheimer's disease. Mostly they eventually die from a condition of protein amassing and clogging blood flow vessels, forcing the heart to work harder and eventually fail.

Extreme survival runs in some families, some 12-14 extra years for men and 8-10 for women as compared to the normal folk. This, surely, is not simply due to superior genes, because in many families there remain traditions of healthy diet and exercise habits which also contribute to life span. Those who are vegetarians often remain free of some ailments suffered by non-vegetarians. It is not possible to clearly distinguish between genetic and environmental factors. However, everybody should accept that 'discipline' in life is important. This implies self denial of some pleasures at least most of the time if not always. Luck generally favors not only those who are brave but also those who exercise control on their desires.

Living long, unfortunately, does not necessarily mean living healthy. Superolds, in particular, can become a liability and some amongst them perhaps look forward to dying peacefully during sleep.

KNOW THY INSTITUTIONS

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL-SCIENCES, NAINITAL

Aryabhatta Research Institute of Observational Sciences (ARIES) is an autonomous institute devoted to research and development in Astronomy & Astrophysics and Atmospheric Sciences. The Institute is funded by the Department of Science and Technology (DST), Government of India.

RESEARCH OPPORTUNITIES AT ARIES

The 50-year old State Observatory at Nainital was reincarnated on 22nd March 2004 at ARIES. The Observatory came into existence at Varanasi on 20th April, 1954. The Observatory was later moved from the dust and haze of the plains to more transparent skies of Nainital in 1955, and to its present location in 1961 at an altitude of 1951m at Manora peak, a few km south of the Nainital town.

ARIES is situated at quiet and picturesque hills with interesting walks through its forest providing great views of Himalayas. The campus hosts rich variety of the Himalayan flora and fauna and occasional sightings of rare birds and wild life. The primary objective of ARIES is to provide national optical observing facilities to carry out research in the frontline areas of Astronomy and Astrophysics, and Atmospheric Sciences. The main research interests are in solar astronomy, stellar astronomy, star clusters, stellar variability and pulsation, photometric studies of nearby galaxies, Quasars, and transient events like supernovae and

highly energetic Gamma Ray Bursts. The optical observations carried out at ARIES are well recognised both nationally and internationally. The longitude of ARIES (79º East) locates it in the middle of about 180-degree wide longitude band having modern astronomical facilities between Canary Islands (20º West) and Eastern Australia (157º East). The observations, which are not possible in Canary Islands or Australia due to daylight, can be obtained by ARIES. Because of its geographical location and existence of good astronomical sites, ARIES has made unique contributions to many areas of astronomical research, particularly those involving time critical phenomena. For example, the first successful attempt in the country to observe optical afterglow of Gamma Ray Bursts was carried out from ARIES. A large number of eclipsing binaries, variable stars, star clusters, nearby galaxies, Gamma Ray Bursts, and supernova have been observed from ARIES. In past, new ring systems around Saturn, Uranus, and Neptune were discovered from the observatory. Recently, for the first time a direct correlation between the intranight optical variability and the degree of polarisation of the radio jets in Quasars was established based on the observations from ARIES. In coming years, the Institute plans to setup new observational facilities in the Himalayan region.

Facilities : ARIES presently hosts five optical telescopes of sizes 15 cm, 38 cm, 52 cm, 56 cm, and 104 cm. These telescopes are equipped with modern instruments like cooled CCD camera, spectrophotometer, and filters etc. The 104 cm telescope, known as the Sampurnanand telescope, has been the mainstay of the photometric, spectrophotometric and polarimetric observations. The instruments available are Cassegrain plate holder, Meinel Camera. Near infrared and photoelectric photometer, a spectrum scanner, and optical multichannel analyser.

The multiwavelength radiometer and GRIM spectrometer are routinely used to study aerosol characteristics and in turn the radiation budget of the atmosphere. The Institute has inhouse workshops to meet the requirements of electronic, mechanical, and optical maintenance of the instruments. ARIES has a modern computer, centre and a well maintained library with more than 10,000 volumes of research journals and an excellent collection of books on astronomy. The VSAT facility at the Institute links the observatory with rest of the world through Internet.

ARIES also promotes research using observations taken at other wavelengths like Xray, ultraviolet, and radio. It is proposed that ARIES will help in building up of a user community for the upcoming observing facilities like ASTROSAT, the first multiwavelength Indian astronomical Satellite to be launched in coming years, and the existing facilties such as Giant Meterwave Radio Telescope (GMRT) of the Tata Institute of Fundamental Research (TIFR) near Pune and the new 2 meter optical Himalayan Chandra Telescope (HCT) of the Indian Institute of Astrophysics (IIA) at Hanle in Leh.

Considering the aspirations of the Institute, ARIES will maintain and upgrade its existing facilities, and design and fabricate new equipments to carry out observations in the frontier areas of astronomy. For this purpose, the Institute plans to set up a 1 meter class and a 3 meter class optical telescope at Devesthal, which has advantage of having dark skies and excellent observing conditions. It is also planned to set up a 1m class micropulse LIDAR system to carry out research on the atmosphere of Earth. ARIES also participate in science popularization programs for students and common people.

Ph. D./PDF Programme : ARIES offers fellowships to pursue Ph. D. in Astronomy & Astrophysics and Atmospheric Sciences. ARIES

selects students as research scholars via the JEST exam and also via the NET and GATE exams. The timings of these exams are usually announced via advertisements in newspapers and via posters at most major educational institutes in the country. The minimum qualification is an M. Sc. degree in Physics or a BE/BTech degree. The selection is based on the score in the written test (JEST, NET or GATE) and an interview, which is usually held in late June or early July. Research scholars are expected to submit their theses within five years of the start of their programme. Research scholars are paid Rs 8000/- p.m. for the first two years and Rs. 9000/- p.m. afterwards.

Research scholars are also eligible for a contingency grant on yearly basis, and accommodation in the campus and catering facilities at nominal cost. ARIES promotes research scholars to participate in national and international meetings and conferences.

ARIES offers postdoctoral fellowships and visiting positions to work in any branch of Astronomy & Astrophysics, Atmospheric Sciences, Engineering and Instrumentation, or Software development. Exceptionally bright and highly motivated candidates can be considered for regular staff positions.

Short term Visits : Students with an outstanding academic record and an aptitude for instrumentation or software development can spend a few months in ARIES any time of the year. Students will work under supervision of one of the staff members in the Institute. Exceptionally bright students with engineering background can be considered for regular postitions.

Student Training Programme : A few bright students in different semesters of the B. E./B. Tech./M. Sc. courses can spend 23 months in ARIES to work with one of the scientists in the Institute on topics related to Astronomy & Astrophysics, Atmospheric Sciences or Instrumentation.

Summer School : ARIES organises summer school every year for 46 weeks. The school is aimed at providing introduction to Astrophysics and Atmospheric physics to young graduate students in their M. Sc/B.Tech programs. The school consists of lectures and a short term project The exact timings of these schools are announced via posters at major educational institutions in the country.

Evening Programs : The observatory is open to public in the evenings for night sky viewing using one of the telescopes at the Institute. Visitors can also attend the slideshows and view the picture gallery describing celestial bodies. The timings of the show may vary according to the season. The details of the show can be obtained on the Institute contact numbers.

Areas of Research :

- Solar Astronomy and Solar System : Sun, Solar activity, comets, asteroids, and planets.
- Stellar Astronomy : Stars, star clusters, stellar variability, pulsation, ages of the stars and their spectral properties.
- Interstellar Matter : Gas (atoms and molecules) and dust between the stars and in the interstellar clouds.
- X-ray Astronomy : X-ray emitting binary stars.
- Extragalactic Astronomy : Nearby galaxies, Optical follow up of Gamma Ray Bursts (GRB) and Supernova, Active galaxies, Quasar luminosity variability.

- Atmospheric Sciences : Aerosols–characterization and thermal budget, Mesophase and thermosphere dynamics, Coupling processes between different atmospheric regions.

The event of a supernova explosion in the galaxy M74 was recorded on February 6th, 2002 at ARIES. The event was related to the death of a star.

Contact :

For more information please contact :

Aryabhatta Research Institute of Observational-Sciences (ARIES) Manora Peak, Nainital 263 129,

Tel : + 91 5942 235136/235583

Fax : + 91 5942 235136

Email : sagar at aries. ernet. in

ANSWERS TO "DO YOU KNOW ?"

1. White marble is re-crystallisation of limestone ($CaCO_3$), onyx marbles are deposition of $CaCO_3$, green marbles are not true marble being hydroxyl magnesium silicate called serpentine. The pink marble contain manganese oxide and the yellow marbel gets the colours from hydrous oxide of Iron. So colour comes from infiltration of impurities from surrounding soil.
2. In ten minutes a hurricane releases more energy than all World's nuclear energy combined.
3. Fear of ugliness.
4. Dead sea—one fourth mile below sea level–so saturated with salt that no living creature can survive and dense enough for people to float, like on mattress.
5. For the second rainbow, smaller number of rays are reflected twice inside a drop of water before they exit.
6. Doubtful. The flying birds bearded Vulture (Gypseus burbatus) and Alpine chough can go as high as 7.300m. and 8.200m respectively.
7. The muscles used in opening jaw are very weak as compared to that used in closing the jaws.
8. North South East, and West.

97th Indian Science Congress

ISCA AWARDEES : 2009-2010

ASUTOSH MOOKERJEE MEMORIAL AWARD

*Dr. T. Ramasami, New Delhi**

C. V. RAMAN BIRTH CENTENARY AWARD

No Award

SRINIVASA RAMANUJAN BIRTH CENTENARY AWARD

Dr. Rajinder Jeet Hans-Gill, Chandigarh

JAWAHARLAL NEHRU BIRTH CENTENARY AWARDS

Dr. Montek Singh Ahluwalia, New Delhi

Dr. Sudha Nair, Chennai

M. N. SAHA BIRTH CENTENARY AWARD

Prof. S. M. Chitre, Mumbai

P.C. MAHALANOBIS BIRTH CENTENARY AWARD

Prof. Manindra Agrawal, Kanpur

P.C. RAY MEMORIAL AWARD

Dr. Ganesh Pandey, Pune

H. J. BHABHA MEMORIAL AWARD

Dr. Anil Kumar, Pune,

J.C. BOSE MEMORIAL AWARD

Prof. N. K. Gupta, Delhi

VIKRAM SARABHAI MEMORIAL AWARD

Dr. K. Radhakrishnan, Thiruvananthapuram

B.P. PAL MEMORIAL AWARD

Dr. Lalji Singh, Hyderabad

JAWAHARLAL NEHRU PRIZE

No Award

MILLENIUM PLAQUES OF HONOUR

Dr. R. Gadagkar, Bangalore

Dr. D. Datta, Mumbai

EXCELLENCE IN SCIENCE & TECHNOLOGY AWARD

Dr. Srikumar Banerjee, Mumbai

B C GUHA MEMORIAL LECTURE

Dr. Malavika Vinodhkumar, Chennai

RAJ KRISTO DUTT MEMORIAL AWARD

Dr. V. S. Chauhan, New Delhi

PROF G.P. CHATTERJEE MEMORIAL AWARD

Dr. Siddhartha Ray, Kolkata

PROF. R.C. MEHROTRA MEMORIAL LIFE TIME ACHIEVEMENT AWARD

Prof. R. Ramamurthy, Tirupati

M. K. SINGHAL MEMORIAL AWARD

Prof. Satya Deo, Jabalpur

SECTIONAL AWARDS

PROF. HIRA LAL CHAKRAVARTY AWARD

Dr. Gitanjali Yadav, New Delhi

PRAN VOHRA AWARD

Dr. Anirban Ray, Kolkata

PROF. UMAKANT SINHA MEMORIAL AWARD

No Award

PROF. K.P. RODE MEMORIAL LECTURE

Dr. Satyananda Acharya, Bhubaneswar

DR. B.C. DEB MEMORIAL AWARD FOR SOIL/PHYSICAL CHEMISTRY

No Award

DR. B.C. DEB MEMORIAL AWARD FOR POPULARISATION OF SCIENCE

No Award

DR. (MRS.) GOURI GANGULY MEMORIAL AWARD

No Award

PROF. SUSHIL KUMAR. MUKHERJEE COMMEMORATION LECTURE

Dr. A. K. Singh, New Delhi

PROF. S. S. KATIYAR ENDOWMENT LECTURE

Dr. Sudhir Sopory, New Delhi.

PROF. R.C. SHAH MEMORIAL LECTURE

No Award

YOUNG SCIENTIST AWARDS

M.P. Raghavendra, Mysore

Mahua Gupta Choudhury, Shillong

Priyanka Singh, Sagar

I. Ravikumar, Kolkata

Chandrani Singh, Hyderabad

Subimal Ghosh, Mumbai

Divya Bajpai, Jabalpur

Gaurav Gupta, New Delhi

Kantesh Balani, Kanpur

Arabin Kumar Dey, Kanpur

Debasis Pore, Kolkata

Suneel Kateriya, New Delhi

Sunil Kumar Singh, Varanasi

Siddharth Tiwari, Lucknow

Sangram Keshari Lenka, New Delhi

BEST POSTER PRESENTATION AWARDS

AGRICULTURE AND FORESTRY SCIENCES

Kalpana P., Visakhapatnam

Mini Abraham, Chalakudy

ANIMAL, VETERINARY AND FISHERY SCIENCES

K. Ramachandran, Thiruvananthapuram

P. S. Kudnar, Aurangabad

ANTHROPOLOGICAL AND BEHAVIOURAL SCIENCES

Roshna C. R., Kerala

Abhiyan Viplan, Noida (U. P.)

CHEMICAL SCIENCES

Kalpana Chaturvedi, Agra

Antosh Kumar Varma, Raipur

EARTH SYSTEM SCIENCES

Sinam Reena Chanu, Imphal

R. K. Ching Khel, Imphal

ENGINEERING SCIENCES

Ranjit G. Nair, Tezpur

V. K. Sharma, New Delhi

ENVIRONMENTAL SCIENCES

Ruchi Gupta, Delhi

S. H. Basavarajappa, Mysore

INFORMATION AND COMMUNICATION SCIENCES

Arun Gangrade, Ahmednagar

Ranjana Zinjore, Jalgaon

MATERIALS SCIENCE

Anna Dilfi K. F., Kochi

S. K. Sinha, Kharagpur

MATHEMATICAL SCIENCES

A. K. Singh, Dhanbad

H. S. Ramananda, Mangalagangotri

MEDICAL SCIENCES

Rejiya C. S., Thiruvananthapuram

Rosy Mondal, Assam

NEW BIOLOGY

S. Arunima, Thiruvananthapuram

S. Binu, Thiruvananthapuram

Bhavna Dubey, Kolkata

PHYSICAL SCIENCES

Hubert Joe, Thiruvananthapuram

T. V. Padmakumar, Thiruvananthapuram

PLANT SCIENCES

Jeremy Dkhar, Shillong

Mariet Jose, Trivandrum

INFOSYS TRAVEL AWARDS FOR SCHOOL STUDENTS FOR 2009-2010

1. *Aditya Sinha, Rewari*
2. *Sachith Joseph Cheruvtur, Ernakulam*
3. *Yukti, Yamuna Nagar*
4. *Gaurav Chhabra, Yamuna Nagar*
5. *Sonia Kamboj, G. S. S. S. Alahar, Yamuna Nagar*

Conferences / Meetings / Symposia / Seminars

3rd International Symposium on Applied Sciences in Biomedical and Communication Technologies (ISABEL 2010) November 07-10, 2010, Rome, Italy.

ISABEL 2010, Organised by The University of Rome 'Tor Vergata". The theme of the conference is Sustainable Communication and Biomedical Technologies.

Aim : The inter-disciplinary approach is becoming an increasing need in scientific and industrial communities. The most evident example of such a need is represented by the strong interconnection between biomedical and communication engineering. On the one hand, ICT can provide new tools for making health care system more efficient and responsive in order to supply in-the-home and mobile healthcare solutions. On the other hand, many of the most recent advances in communication technologies—from algorithms to the electronics and materials—are "bio-inspired". Moreover, it is increasing the awareness of the great potentials offered by the synergistic combination of many disciplines (e.g., mathematics and physics, biology and chemistry) in both biomedical and communication engineering. This conference aims at creating a stage where researchers, scientists and business people can discuss and share ideas at the frontiers of life sciences, pure sciences and engineering. The global interest towards a sustainable Planet is forcing the industrial and scientific worlds to seek for "sustainable" engineering solutions in order to preserve the natural environment and efficiently exploit the energy, which is a limited resource. Hence, from 2010 onward, ISABEL will also look upon the application of sciences in biomedical and communication engineering so as to develop novel technologies and solutions that can make our lives "greener".

Contact : Simone Frattasi, The University of Rome "Tor Vergata, Rome, Italy. Website : http:// www.isabel2010.it

3rd International Conference of Science & Technology : Applications in Industry and Education, December 16-17, 2010, Penang, Malaysia.

ICSTIE 2010 will be held in Penang, Malayasia, organized by the Department of Computer and Mathematical Sciences, UITM Penang. This is a forum for discussion and exchange of scientific ideas and latest research achievements in the fields of science and technology. Deadline for abstracts/proposals : 15 July 2010.

Contact : Rozita Kadar, The Department of Computer and Mathematical Sciences, UITM Penang, Malaysia, Asia, **Website :** http://www.icstie.com

S & T ACROSS THE WORLD

INNOVATION CENTRES FOR CLEAN TECHNOLOGIES

The approval of India's technology transfer proposal to establish a global network of climate innovation centres for developing and deploying clean technologies at the just concluded climate change talks in Copenhagen should cheer businesses. 'In its submission to the UNFCCC, India had suggested that climate innovation centres be located in various parts of the world for undertaking development and deployment of clean technologies suited to their respective regions. The centres would do so by forging private and public sector partnerships. The centres would undertake R & D after identifying the local needs and appropriate technologies capacity building to enhance their faster absorption. The Indian Institute of Technology, Delhi and UK-based Carbon rust have estimated that five regional centres would entail and initial investment of $2.5 billion, and potentially trigger an investment of $2.5 billion by the private sector.

While the centres may not deliver breakthrough technologies in geo-engineering or carbon capture and storage, they are expected to deliver utilitarian technologies like development of cleaner cooking ranges and deployment of energy efficient lighting solutions, catering to the existing market and beyond. Today, the global low carbon and environmental goods and services sector is estimate to be worth more than $4 trillion. It comprises technological solutions for tackling pollution of air, water and land ; renewable technologies for small hydro, wind, solar etc and low-carbon technologies for construction, transport and energy sectors. *(The Financial Express, Dec. 14, 2009)*

INFLATABLE HEAT SHIELD

An inflatable heat shield designed to slow and protect spacecraft as they blast through the atmosphere at hypersonic speeds, has been successfully tested at NASA. The 1400 lb Inflatable Re-entry Vehicle Experiment (IRVE) was vacuumpacked into a 15-inch diameter payload "shroud" and launched on a small sounding rocket from NASA's Wallops Flight Facility. The 10-feet diameter heat shield, made of severaql layers of silicone-coated industrial fabric, inflated with nitrogen to a mushroom shape in space several minutes after liftoff. The key focus of the research came about six and a half minutes into the flight, at an altitude of about 50 miles, when the aeroshell re-entered Earth's atmosphere and experienced its peak heating and pressure measurements for a period of about 30 seconds. An onboard telemetry system captured data from instruments during the test and broadcast the information engineers on the ground in real time.

(Network World, Aug 17, 2009)

REGULATION OF RNA FATE

University of Wisconsin–Madison researchers have discovered that the RNA degradation, which when improperly regulated can lead to cancer and other diseases, can be launched in an unexpected location. The Wisconsin team also found that CRD-BP, a protein activated in colorectal and other cancers, can prevent RNA from degrading in the newly identified spot. The finding may have broad implications for cancer research as well as biology in general.

The finding is important for the proto-oncogenes, or precursor cancer genes, but it may be even more important for the thousands of other genes and proteins that are regulated in a similar way as advocated by associate professor of dermatology at the UW-Madison School of Medicine and Public Health.

(Science New, Aug 1, 2009)

FLARNESSING TREE POWER

Scientists at University of Washington (UW) have developed electrical circuits that run entirely from power in trees. A study last year from the Massachusetts Institute of Technology (MIT) found that plants generate a voltage of upto 200 millivolts when one electrode is placed in a plant and the other in the surrounding soil. Those researches have since started a company developing forest sensors that exploit this new power source. The UW team sought to further academic research in the field of tree power by building circuits to run off that energy. They successfully ran a circuit solely off power for the first time.

The system could provide a low-cost option for powering tree sensors that might be used to detect environmental conditions or forest fires. The electronic output could also be used to gauge a tree's health.

(University of Washington, Nov 5, 2009)

SMALLEST ARTIFICIAL HEART PUMP

Doctors in Germany have successfully implanted the world's smallest artificial heart pump, billed as more effective and unobtrusive than earlier devices. "It can fully replace the function of the heart's left ventricle and works particularly quietly and effectively," said the director of the cardiac surgey division of the University Hospital of Heidelberg Matthias Karck. The device can also help patients bridge the time until a heart donor can be found for a transplant. The pump is the fifth generation of the socalled DeBakey Heart developed by the late US cardiac surgeon Michael DeBakey in the 1990s. It can be worn adjacent to the ailing heart and allows for external electronic monitoring and adjustment.

The first recipient, a 50-year old woman, received the 92 gm pump made of plastic and titanium recently and is leading a nearly normal life with it at home.

(Science & Technology, Aug 18, 2009)