EVERYMAN'S SCIENCE

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EDITORIAL

ENTERIC DISEASE AND PREVENTION : WHERE WE STAND ?

In the context of public health concerns across the globe, enteric infections, particularly diarrheal diseases probably constitute one of the foremost causes of infectious morbidity and second cause of infectious mortality worldwide. Recent data show that diarrhoeal diseases alone account for 1.5 million deaths among under 5 children worldwide. Unfortunately, India is one of the major contributors to this global burden of enteric diseases. Though there is a decline in mortality due to diarrhoeal diseases due to better antibiotic use and advent and utilization of oral rehydration therapy, still the burden remains quite high, still it remains one of the principal causes of morbidity and mortality especially in children.

Enteric bacterial infection is major cause of diarrhoea throughout the world specially in developing countries. In developing countries, enteric bacteria and parasites are more prevalent than virus and typically peak during the summer months. Recent studies show that *Vibrio cholera*, *E. Coli*, *Shigella*, *Campylobacter Jejuni* are major pathogens accounting for moderate to severe diarrhoea in developing region in under 5 age group. Typhoid is also an important bacterial enteric disease occurring in the developing world. Among the viral organisms, rota and norovirus are the main pathogens for the under 5. But in reality, always there are multiple pathogens causing the diarrhoea as a syndrome. Thus when we think of calculating the burden and its causative agents and management, it has to be kept in mind that there is an existence of multiple pathogens which may have synergism among each other.

Among the enteric diseases, in current scenario in India, rotavirus infection and cholera need special mention in terms of morbidity and mortality and require immediate attention. As far as rotavirus infection is concerned, it causes more than half a million deaths, most of the deaths coming from the sub Saharan Africa and resource poor Asian regions. Recent estimates show that approximately 1 child in 242 will die from rotavirus infection by the age of 5 years. Children around one year of age are most vulnerable to rota, thus on time vaccination is imminent. A more recent analysis shows that India alone accounted for 22% of global rota viral deaths.

Another important concern is emergence of cholera across the globe. Recent outbreaks in Cuba, Haiti, and Zimbabwe show that it can cause enormous loss of human lives and can spread like wild fire to new areas and has the tremendous potential of causing outbreaks. Thus it can win over the existing public health infrastructures and thus affecting huge economic and other resource loss for a nation. An estimate done in mid 2000 shows cholera causes a loss of around 100 million dollar in resource poor African countries alone. It is endemic in India, stays in the environment especially in coastal areas, that's why the lower Gangetic plain is called homeland of cholera. But it's a pity that despite an estimated annual burden of 2–4 million cases we only react, when there is a large outbreak.

Control of cholera and other infective enteric infections like typhoid depend on the long-term strategy of improving water quality and sanitation systems as done in western world. This improvement will definitely reduce the burden, but it is difficult to achieve in this resource poor setting, thus enteric

vaccine strategies can always be an important preventative approach along with a range of other intervention efforts.

This concept of newer novel strategies like vaccination along with conventional measures of water and sanitation has become more meaningful, in the light of development of drug resistance across the globe, posing more complication in prevention and treatment. Recently, Strategic Advisory Group of Experts on Immunization (SAGE) from the World Health Organization's (WHO's) recommended the use of oral cholera vaccine and stock pile in case of epidemic as well as in endemic situation. At the same time, rotavirus vaccines are also recommended for its use, but vaccine supply continues to be an issue for the countries in most need because of economic constrains. Prioritizations may help, but should be done very carefully and logically.

To have an effective and meaningful impact of any preventive strategy, an ongoing robust surveillance and thorough knowledge on local need and disease epidemiology is called for. It is highly desirable to have a constant communication, collaboration and involvement of local stakeholder for enhancing the durability of any direct and indirect effect of preventive strategy including vaccine implementation.

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Nothing is so fatal to the progress of the human mind as to suppose that our views of science are ultimate; that there are no mysteries in nature ; that our triumphs are complete, and that there are no new worlds to conquer.

—Sir Humphry Davy

PRESIDENTIAL ADDRESS

IMPACT OF THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY ON ENVIRONMENT

A. K. Sharma

On our planet, the milieau of nature embraces innumerable life forms inhabiting air, soil and water, created billions of years ago, of which human beings form an integral component. The environmental balance is a product of natural evolution, the history of which may be traced back to the evolution of life. The birth and death of organisms, their life systems, diseases, interrelationships, in the background of natural phenomena like earthquake, lightning and erosion, form a complex of nature in which the equilibrium between living and non-living is maintained through natural selection. Man himself, though a product of evolution, yet has created an environment of his own. This man-made environment is the outcome of his cultural evolution, which has far outstripped his biological evolution, defying often the forces of natural selection. His inventive genius, skill and efforts, have given him protection against natural calamities and provided him freedom for his creative ideas. With the help of tools and techniques of Science and Technology, he has fashioned an environment suited to his own purpose and satisfaction. Forests have been cleared, pastures have been created, cultivation has been extended and made extensive, drainage system has been altered and the pattern of productivity of the natural world has been changed.

Discussions and disputes on environment mainly centre around this man-made world and its environment as created by human agency. Industrial revolution is aimed at improving and maintaining human existence, in increasing comfort, and safeguarding national interests; green revolution is geared to the elimination of poverty and hunger, progress in transport and communication technology to making life more comfortable. All these benefits accrue from cultural evolution. But, during this process of development, emanating from tremendous strides made in Science and Technology, a range of byproducts and disposable materials have been discharged into the environment. A very high proportion of such products is extremely harmful not only to the human system but to the biological world as a whole. This process, otherwise termed as pollution, is the ultimate consequence of the disturbance of natural equilibrium caused by man and his technology. It has unfortunately been a corollary of progress in technology.

In the last session of the Indian Science Congress, the focal theme was *Energy Strategies for India* — a theme chosen in view of the global impact of energy shortage. With the progress of our knowledge in science and refinements in technology, there has been a logarithmic increase in our reliance for energy requirements on non-renewable sources of biological origin like fossil fuel. The energy shortage, looming large over our horizon, is mainly due to this complete dependence on such natural sources. The use of fossil fuel has disturbed the natural environment to a significant extent and is a major factor responsible for atmospheric pollution.

* General President, 68th Indian Science Congress held during 3-7 January, 1981 at Varanasi.

Plants have the unique property of utilizing solar energy and carbon dioxide from the air to form carbohydrates — the storehouse of energy. Oxygen released in the process in the atmosphere at the same time helps in the purification of air. This inherent natural mechanism for maintaining the oxygen level of the air has been seriously disturbed by effluents like carbon monoxide and other compounds, emanating from the use of petroleum.

This year's focal theme on *Impact of the Development of Science and Technology on Environment* has therefore been selected mainly with a view to apprise the scientists and planners about the strategies to be formulated in future to meet the requirements of energy and other sectors of national planning without causing serious environmental disturbance and pollution hazards.

PROBLEMS

The contributions of Science and Technology to our daily existence and *vis-a-vis* to the environment are indeed too well-known to be listed. As man himself forms a part of his own environment, an individual free from hunger and poverty and living in an atmosphere congenial for creative ideas certainly contributes to the enrichment of his social and cultural environment. From this standpoint, the impact of Science and Technology can hardly be overestimated. Leaving aside the developed countries, in India alone the rapid industrialization of the past decades has certainly ameliorated to a very marked extent the poverty of her people, providing jobs to millions. The remarkable achievements in the field of agriculture, ushering in an era of green revolution, have been able to solve the food problem to a significant extent. If one compares the situation a decade back, the scenario in Indian agriculture was completely different. India is now one of the countries exporting foodgrains to other countries of the world. In the field of medicine, certain diseases, considered to be incurable earlier, have been contained to a remarkable extent, well-known examples being Kala-azar, malaria and smallpox. Achievements have led to an increase in the longevity of man and the death rate has decreased substantially.

In addition to original discoveries emanating from Science and Technology in India, the import and application of appropriate technology have also led to the eradication of diseases, to the growth of industry, to improvements in agriculture, transport and communication and several other sectors involved in national welfare. Since the dawn of independence, with full patronage from the government, Science and Technology have made a steady progress and have been able to attain coveted peaks in different spheres of activity. Technological advances have facilitated a gradual revolution of our agricultural practices leading to high productivity and stability of major crops. The impact of our industrial advance has been tremendous, resulting in self reliance in the manufacture of basic and consumer goods. Innovative and appropriate technologies have been introduced in villages and small-scale industries in boosting the economy of the rural population. In space research, the efforts of our scientists have achieved spectacular success, the impact of which in communication, weather forecasting and agriculture is already gaining momentum. Advances in electronics have been very significant and Indian scientists have paved the way for peaceful use of atomic energy. All these discoveries have been responsible for nurturing healthy human beings, themselves the essential components of human environment.

It is not the objective of the present address to deal with the progress of Science and Technology in India, which are indeed too numerous to be enumerated.

But as has happened in the Western World, in the past such achievements have not been safeguarded with adequate containment measures, resulting in an upset of the natural ecosystems. The outcome of rapid industrialization and urbanization through the construction of barrages and dams, the

indiscriminate use of fertilizers and pesticides needed to sustain high-yielding varieties in agriculture, has been the depletion of forests, over-congestion, waste accumulation — all in totality leading to a drastic pollution of the environment.

In assessing the sources of pollution in this subcontinent, the principal factor appears to be overpopulation. Due to the monstrous rate of increase in population, there has been a heavy demand on natural resources including the soil, air and water; the floral and faunal wealth, resulting in a serious disbalance in the ecological system. Deforestation — a major factor for pollution — is the direct result of the demand on natural resources. The mechanics for the production of energy has been responsible for the discharge of byproducts, affecting simultaneously human health and environment, in all the principal cities and industrial centres of India, the air is contaminated with a high level of chemical pollutants. The problems of sanitation, impurities in water and food grain, affecting human health due to chronic exposure are some of the major contributors to environmental pollution. The saying that "God helps those who rise early", is undoubtedly applicable to our urban population since the availability of pure air is restricted mostly to the early morning hours.

It is true that deep concern is expressed in various circles for maintaining the environmental balance and regeneration of forests, but simultaneously there is large-scale degradation of forests as remarkably evidenced in the Sutlej-Beas link project and various other projects undertaken at the national level. The country at present loses almost 6,000 tons of subsoil annually through erosion. Flood affected areas have been nearly doubled (from 20 million to 40 million hectares) in the last ten years, in our mining operations, as well, both in the private and public sectors, the land is continually stripped bare of trees as well as of the rich soil containing humus. Only barren land and mineral wastes are ultimately left which do not normally allow the growth of any trees. The responsibility of reclaiming the land, planting of metal resistant vegetation; or in other words, bringing the land to its original fertile state, is left to the mercy of the forest or agriculture department, which in the majority of cases either due to lack of funds or initiative, is reluctant to undertake this responsibility. It is indeed an irony that the users depart after exploitation, leaving the task of recovery to other agencies. Moreover, a large part of our forest vegetation is utilized as fuel by the villagers unless an alternative source of fuel is provided, the idea of preservation of forest would mainly be an academic exercise, in general, the devastation of land is carried out in a systematic fashion in the names of resource exploitation, rehabilitation of the landless and the poor, and lastly national interest with respect to balance of trade.

CATEGORIZATION OF POLLUTANTS

Amongst the different pollutants affecting our environment, two categories may be clearly recognised, namely — natural and synthetic. Of the natural pollutants; lead, mercury, sulphur dioxide, carbon dioxide and carbon monoxide are the most common compounds, several of which are also the consequences of human life processes, being produced in faeces, urine and body decomposition. There is always a systematic increase of such pollutants with increase in the number of human beings and livestock. Added to this, are the non-biological pollutants arising as a sequel to fuel combustion, such as aerosols, including metals and organic acids.

On the other hand, there is a vast array of synthetic pollutants which are continuously increasing with urbanization and industrial growth, They include pesticides, detergents, pharmaceutical and cosmetic products as well as plastics. Several of these compounds are extremely stable and persist in the environment for a considerable period with the potentiality of causing long-range environmental hazards. The petrochemicals, which are widely used

in pharmaceutics, plastics, textiles and food additives, unlike most other natural chemicals, do not undergo rapid decomposition. They can withstand the attack of natural forces like micro-organisms, sun, wind and water. A waste plastic bottle can outlive the pyramids of Egypt or the civilization of Mahenjodaro and Harappa. There is a serious concern among the environmentalists about the effects of such compounds which are the products of advances of Science, and more precisely, technology. Since during the history of evolution, the biological world has never been exposed to these effects, any possibility of the occurrence of inbuilt immune system or genetic types resistant to these effects, is rather rare in nature.

The different pollutants, both natural and synthetic, can be classified according to two different parameters, though several authors have used other criteria as well. One of the parameters is the *source.* It includes those obtained through fuel combustion; industrial use; of domestic or institutional origin, like kitchen wastes, hospital wastes, laboratory wastes etc., agricultural wastes, e.g. fertilizers and pesticides and of microbiological and fungal origin such as aflatoxin and mitotoxins. The other parameter is the *pattern of use.* It involves uses in industry encompassing catalysts, solvents, stabilizers, preservatives, coolants, lubricants, detergents, insulation materials; *uses in the domestic sector,* such as, construction material, food additives, *uses in agriculture and horticulture* as well as *in transport.* There is, however, considerable overlap in between the different types of uses, the most common example being the preservatives and detergents which are used both in industry as well as in domestic sector.

MECHANICS OF DISTRIBUTION

The mechanics of dissemination of pollutants causing damage to the environment, arising out of rapid advances of Science and Technology, are manifold. The use of fertilizers and pesticides in agriculture; drugs for human health; smoke; industrial effluents; sewage; indiscriminate use of land and water; discharge of diesel and petrol fumes from automobiles; radiation; mining; construction of roads, dams and barrages without taking proper precaution, result in the depletion of forest, erosion and last but not the least, the growth of noxious weeds. Floods and drought are the two facets of the effect of deforestation, arising out of loss of vegetation cover. It is indeed ironical that the so-called progress is associated with pollution. Its direct and indirect effects are the principal sources of pollution in air, lakes, rivers, seas and soil leading ultimately to the depletion of flora and fauna. The initial effects are on human health. Of greater significance is the genetic damage to human system. The number of endangered species of living organisms (20,000 to 30,000) is on the increase; erosion has become a common phenomenon; floods are recurrent and newer diseases are gaining importance. Crop epidemics have become common due to replacement of natural heterogeneity through high-yielding homogeneous races evolved by refinements in Science and Technology.

A significant level of pollution having serious impact on human health occurs in the field of aerobiology. The pollen grains and spores of different organisms cause allergic diseases. Such pollutants may be ascribed to the inadequate rural and urban planning, leading to planting trees with allergy-inducing pollen. These plants, when propagating under natural conditions in a forest, create no pollution hazards.

An important consequence of the high rate of industrial growth, sophistication of equipments and explosion of population is pollution through noise. In the developed countries, the situation is very alarming and the condition in the developing countries is gradually worsening. Noise can be classified under physical pollutants, specially affecting populations in the neighbourhood of airports, factories and busy highways. It leads to serious irritation and stress on the nervous system

affecting mental and physical stability. The commotion created in Europe and the United States with the launching of Concorde aircraft is still fresh in the human memory.

MARINE POLLUTION

Pollution of the sea is principally attributed to effluents discharged from countries surrounding the oceans, even though the effects of atmospheric changes from inland areas are contributory factors. In general, discharge and outflow into the oceans from the agricultural, domestic and industrial activities are responsible for increasing marine pollution, the optimum level being reached in countries bordered by seas, the best example being provided by Malayasia in the Far Eastern region. It will be worthwhile to monitor the extent of marine pollution in India at the peninsular belt, especially in the coastal regions of Vishakhapatnam, Trivandram, Cochin, Goa and Bombay. The oceans of Europe and North America have a higher sulphur content than those of Asia, Africa and South America due to the differential growth of industry. Most of the sulphates owe their origin to fuels releasing sulphur dioxide in the atmosphere.

Of the different types of synthetic organic compounds in industry, the halogen derivatives pose the most serious danger to the marine resources. There are two categories of such compounds — one of low molecular weight with one or two carbon atoms, mostly utilized as intermediaries in the synthesis of chemicals such as, refrigerants, cleaners, and another set of high molecular weight including pesticides and poly-chlorinated biphenyls. The principal limitation of their use is due to their high toxicity to biological systems and production in large quantities.

Important pollutants of the ocean include, amongst others, heavy metals, halogenated hydrocarbons, carbon dioxide, petroleum, artificial radioactivity and ultimately litter. A glaring and fatal example of marine pollution through heavy metals was recorded amongst the residents on the shores of Minamata Bay in 1953 and Niigata islands in 1965 both in Japan, due to the release of mercury in the ocean through inland channels. Among the fishing community, a high incidence of severe neurological disorders, followed by death, was recorded. Both human beings and other mammals inhabiting that region were seriously affected, the cause being ultimately traced to contaminated fish being used as food. Methyl mercury chloride was identified as the causal toxin, as a byproduct of the manufacture of polyvinyl chloride resin, octanol and dioctol thalate with acetaldehyde as the initial material. The pollution was traced to the accumulation of mercury in the effluents as well as to methyl mercury chloride in the marine organisms. The mixture of short-chained hydrocarbons, as waste byproducts in the manufacture of vinyl chloride, has been shown to be responsible for the death of flora and fauna in the North Seas as well. The possibility of such low molecular weight compounds affecting natural fermentation, which may ultimately result in the retardation of non-biological activity, cannot be ruled out.

Lead, of the other heavy metals, produces the maximum toxic effect. It is principally derived from coal and oil. Atmospheric lead is deposited on earth in the form of rain. Similarly zinc, iron, cadmium, manganese, copper, nickel and silver are often found in sea water and the extent to which these metals cause hazards to marine ecosystem is not yet fully established.

Of the high molecular weight compounds, highly toxic after-effects are produced by the degradation products of DOT and other organochlorine and organophosphorus compounds used as pesticides in agriculture and mosquito control. DDT and its more active residues, ODD and DDE, are generally transported from agricultural fields, tanks or through vaporization from plants and soils. Their atmospheric transport, mainly through rains, is much more rapid than that through the rivers. In the

United States, it has been recorded that the atmospheric fluxes transport 24,000 tons of such chemicals per year as compared to 3,700 tons through river transport.

The use of fossil fuel and its combustion contribute possibly the greatest amount of pollution to the atmosphere and consequently to the ocean. Thermal combustion results in the emission of such gases as sulphur dioxide, carbon dioxide, carbon monoxide, nitrogen oxide, hydrocarbons as well as many volatile and particulate compounds.

The more significant effects of artificial radiation emanating from nuclear devices are manifested in the oceans, following discharge of radioactive wastes. The isotope ruthenium 106 — a product of the radioactive discharge is found to occur in a concentrated form in the marker seaweed *Porphyra,* which is often used as an ingredient of pudding. Since fishes are the primary targets of such isotopes, an assay of these organisms for heavy metals is utilised for affording protection against undesirable effects. The International Commission for Radiobiological Protection has identified standards for the acceptable levels of radioisotopes in biological systems. The parameter for determining this level varies with different radioisotopes and parts of the body where they accumulate. As methyl mercury can cause disturbance in the nervous system, its concentrations in hair and blood are measured following chemical ingestion. With ruthenium, the target is the gastrointestinal tract and as such the parameter for permissible level is determined in the contents of this tract.

In order to frame an environmental policy, maintaining the marine ecosystem, preventing human health hazards, without jeopardizing industrial and agricultural growth, it is desirable to find out the extent to which such pollutants can be tolerated by the ocean, maintaining its normal biota, it is also essential to identify the chain reaction that the material may initiate, after its discharge into the ocean. For coastal factories, submarine pipelines for the discharge of effluents at a certain depth, below the surface of the sea, are desirable, as recommended by the National Institute of Oceanography, Goa (NIO, Ann. Rep. Oct. 1980). Therefore a complete ecosystem analysis, with special reference to the effects and contribution of each component, should be undertaken. The absence of a planned approach to this problem would lead inevitably to drastic marine pollution and consequent repercussions on life in the ocean and on the land.

FRESHWATER POLLUTION

Freshwater pollution mainly of the rivers and lakes, is generally caused by runoff from house drains, street disposals, sewage, fertilizers, herbicides and debris. There is a threshold limit up to which the biological systems can absorb water and degrade the wastes through biochemical action. Beyond that threshold point, the situation reaches a level beyond management. Since pollution of rivers and lakes ultimately leads to groundwater pollution, influencing the source of drinking water, the effect assumes enormous proportions. Sewage disposal, even after treatment, may result in biological production of a large number of undesirable forms with harmful side-effects and large-scale destruction of the water ecosystem. Several industrial wastes too, contain high proportions of substances lethal to desirable forms of life. Such contaminated water cannot be utilized for drinking without extensive treatment for purification which again imparts an undesirable odour.

Pollution of water is caused by organic as well as inorganic pollutants. The former is contributed principally by sewage and industrial wastes and latter mainly by industrial wastes. Organic pollution of water can be removed to a great extent by suitable treatment. Methods for convenient treatment of inorganic pollutants are however expensive and damage through such pollutants may persist for long periods. In fact, uninhibited growth of industries producing brackish wastes is adversely

affecting the water resources in the inland areas of the different States. There is a need for measures making special precautions obligatory for industries, in the inland and coastal beds. Brackish wastes cause less damage as compared to those of inland areas.

POLLUTION OF LAKES

In India, both eutrophic and oligotrophic lakes are found. In the former, due to heavy supply of nutrients, a high rate of biological growth, inducing algae, occurs as compared to the latter where the nutrient supply is less. The Dal lake in Kashmir is an example of heavy eutrophication due principally to sewage discharge leading to extensive vegetational growth and choking at certain sites. If suitable measures are not adopted at present, the Dal Lake will ultimately become a myth after some years, comparable with Loktak Lake in Manipur. Pollution through inorganic effluents is making rapid progress in the Sagar Lake dividing Hyderabad and Secunderabad. Due to the heavy growth of industries in and around this lake in the last two to three years, the entire water surface has become extremely malodorous and turbid in appearance. Growth of water hyacinth, which thrives remarkably well under polluted conditions, has caused most of the lake to be choked.

POLLUTION OF RIVERS

The principal industries, discharges from which are harmful to the river systems in India, are textiles, paper pulp, sugar distilleries, vegetable oils, coal washeries, petrochemicals and tanneries. The after effects of indiscriminate use of herbicides and pesticides in agriculture have already been mentioned.

It is also a common practice in India that any substance which cannot be burnt or buried is discharged into the river. The coastal areas are the dumping grounds of the wastes, including garbage, oil and dredging wastes. The Ganga is regarded as one of the most polluted rivers of the world and the area surrounding Calcutta on the river Hooghly is a major pollution centre. There are more that 159 industries flanking both sides of the tidal river belt. In the 120 km distance from one end of greater Calcutta to another, there are almost 270 outlets of untreated water to the river Hooghly. The high rate of pollution of water has been responsible not only for causing damage to the human system but has immediate harmful effects on plankton, fish eggs and larvae.

Environmental pollution in areas around Calcutta and Howrah has reached such alarming levels that existence of populations in such areas may be regarded as a miracle. According to the survey of the National Environment Engineering Research Institute substation at Calcutta, the entire 140 sq. km Metropolitan areas, covering both banks of the river Hooghly are exposed to serious ecological dangers. All the waterworks intake points are loaded with faecal contaminants. Some of the organisms produced are even resistant to dechlorination. Hooghly's raw water quality in much worse than the fourth grade unfit water as specified by the World Health Organisation. Air and water all over the area are continuously being polluted and unless serious measures are taken at present the conditions would become hostile even to all forms of life.

Similarly, the river Damodar, flowing through the coal area in Bihar, poses serious problems. Several factories, including Sindhri fertilizers and Bokaro thermal power units, are located on its banks. From the Fertilizer Corporation alone, the daily discharge of wastes contains alkalis, chromates, ammonia, cyanide, phenol and naphthalenes. River Sone near Dalmianagar is another pollution centres where wastes from factories producing paper, chemicals, sulphuric acid, cement and sugar and discharged into the water. In the river Gomti in Uttar Pradesh near Lucknow, the 35 km stretch continually receives wastes from paper and pulp factories and city sewage. The river Yamuna in Delhi is polluted by DDT factory wastes. The

acidic water is extermely toxic and poisonous and needs at least 8,000 times dilution to eliminate its immediately harmful effects. It has been recently recorded that the pollution load of the Yamuna river near Delhi is contributed by discharge of 200 million litres of sewage daily, out of which 20 million litres are industrial effluents. The river systems in central and peninsular India are undergoing systematic pollution through the development of industries on the coastal zones. New industries are continually coming up on the river banks including paper mills on theTungabhadra, soda plants on the Godavari and caustic soda, paper and chemical plants on the Cauvery. The untreated wastes of paper pulp and steel industry are continuously discharged in the Krishna river system at Bhadrabati in Mysore. The pollutants include unrecoverable pyroligenous compounds and chlorine.

A similar situation prevails in the rivers around Bombay where the industrial complexes discharge organic products including chemicals, pesticides, fungicides and petrochemicals as major pollutants, in Tamil Nadu, nearly 50% of the 450 tanneries are located along the coast of the river Palar in north Arkot district. They allow their effluents to flow mostly into the river. Tannery wastes render the groundwater extremely saline due to the large amount of salt used in tanning.

About 90% of the drinking water in out country comes from these polluted rivers and their tributaries. It has been recorded that in India only a few cities have primary water treatment facilities while majority have secondary or partial secondary plants. Several important cities have little or no treatment facilities at all. Discharge of domestic wastes poses a serious problem. These water courses are not supposed to be normally open sewers but raw sewage is regularly discharged into them, causing serious health hazards. Several stretches of the Adyar, Cooune and Buckingham canals in Madras were examined and the flow was found to contain predominantly sewage matter. A similar situation occurs in the streams flowing through Hyderabad, Secunderabad and Vishakapatnam. It is claimed that due to the nuclear fuel complex on the outskirts of Hyderabad city, the wells contain nearly 440 ppm of nitrates against 50 ppm of permissible dose. Excessive nitrate can cause methaemoglobinaemia—a physiological disorder affecting the oxygen carrying capacity of the blood.

In India, out of potential water resources of approximately 1.9×10^{12} m^3 only 10% of the rural population can obtain safe drinking water. In urban areas more than 60% have partial recycled sewage systems where as 40% can get protected water. The principal source of water pollution is the discharge of liquid municipal wastes, which has been calculated as 33×10^6 m^3 in total volume. Several rural communities suffer from toxicity of heavy metals, such as manganese in subsoil water (ITRC memoir, 1976).

The construction of the reservoir in the Krishna river dam has been responsible for a major disturbance in the natural ecosystem causing fluorosis due to imbalance in copper and molybdenum metabolism in the body.

The cause of fluorosis in Punjab, Andhra Pradesh, Karnataka and Tamil Nadu has also been traced to such human interference with nature systems. Following the establishment of Nagarjunasagar Dam at Andhra Pradesh, there has been an increase in molybdenum concentration in the soil vis-a-vis in the cereals such as species as *Sorghum*. Copper deficiency, anaemia and ultimately fluorosis amongst the inhabitants in these areas have been attributed to consumption of such cereals (ICMR Bulletin 8, 1-4, 1978).

In view of the act of 1974 and its subsequent amendments, no industrial units are cleared without effective safeguards against environmental pollution and effluent treatment. However, the treatment is rather expensive. Inspite of such safeguards,

pollution hazards are on the increase, accelerating the magnitude of the problem. Several agencies, especially Central Public Health Engineering Research institute in Nagpur, and All India Institute of Hygiene and Public health in Calcutta, have developed a number of methods for waste treatment from dairy products, pharmaceuticals, explosives, paper, detergents, plastics, etc. Considering the state of water pollution in different parts of India, it is essential to evolve, standardise and implement methods to check pollution in freshwater.

AIR POLLUTION

For the sustenance of all activities, air is the most important natural resource. In addition to breathing, it is needed for driving automoblies, for generation of power, for agriculture, for cooking and for all processes of manufacture. The amount of air needed for respiration is in fact much less than that required for the later activities.

Air pollution is defined as the presence in the external atmosphere of one or several substances introduced by man to such as extent as to affect health and welfare of human system and the life in atmosphere. The pollutants in air may be in the form of solids, gases and liquids. The particles may range from carbonaceous soot to heavy metals and complex organic compounds as well as nuclear fallout. Several pollutants may be directly emitted by human activities whereas the others may be formed in the air with the effect of sunlight, as in photochemical smogs. They may have a periodicity which is especially manifested in the biological pollutants, including the airborne spores.

The most dangerous after effect of human activity of climate is the increase in the atmospheric carbon dioxide through combustion of fossil fuels. Carbon dioxide absorbs infrared radiation from the surface which otherwise would have escaped into space. An essential corollary is increase in atmospheric temperature. Human activities also lead to the production of chemicals like chlorofluoromethane and nitrous oxide, which have infrared absorbing capacities. The effect of temperature alone, otherwise known as thermal pollution, is too well-known to be mentioned.

SMOG

The smog observed in most cities all over the world is a combination of fog with the effluents of coal and oil combustion. The effects of such pollutants are quite severe and acute and may even be fatal for persons with respiratory trouble. Chronic bronchitis and lung cancer represent the most drastic results of such pollution. It is principally found in industrial and urban areas where coal and oil are profusely used. The action of such pollutants on metals, stones are other materials is also not negligible, the best example being provided by the damage to ancient monuments like Tajmahal.

Photochemical smogs emanate through the action of sunlight through the principal constitutents are emitted from automobiles. They cause severe irritation of the eye and often aggravate respiratory diseases. A photochemical oxidant occuring as a pollutant in the smog is the product of reactions between oxide and hydrocarbons. Important oxidants are ozone a well as peroxyacetal nitrate (PAN), both of which may cause damage to vegetation. Ozone is also responsible for lung irritations, its presence, on the other hand, in the stratosphere screens biological systems on earth from injurious effects of ultraviolet rays. It occurs in very low amounts in the atmosphere (1 part per trillion-AMBIO, 1979). The continued production of chlorofluoromethanes leads to an average ozone decrease by about 15%, resulting in a 30% increase of ultraviolet radiation on earth (WHO report, 1976).

Several particles, often emitted in the atmosphere through automobile exhaust may not necessarily cause respiratory trouble's but may participate in biochemical pathways of the body system, initiating high toxicity. The most common examples are carbon monoxide and lead which react with blood

haemoglobin, affecting its capacity as oxygen carrier. Lead, mercury, beryllium, cadmium and nickel enter into the enzyme system (Webb, M, Chemistry, *Biochemistry and Biology of cadmium*, Elsevier, 1979; Nriagu JO, *Biogeochemistry of lead the environment*, Elsevier, 1978; and *Biogeochemistry of mercury in the environment*, Elsevier, 1979), Their origin can be traced to various sources but, they induce biochemical toxicity by participating in the body metabolism.

It is often claimed that problems of pollution are not so severe in our country as compared to most other industrial cities of the world. But, it has been observed that in India, the density of automobile traffic per square kilometer with the discharge per unit area is comparable to many of the developed countries.

AIRBORNE ORGANISMS

The other category of pollutants in air includes a vast range of airborne particles as well as microbes and spores. The Science dealing with their relationship with the environment, with special reference to their infective property, is known as aerobiology. An essential aspect of aerobiology is an analysis of allergy, its manifestation and mechanism of control. At one time, allergy was through to be a disease of the fashinable and thoughtful, the price of wealth and culture and the penalty of indoor life. Fortunately there has been a considerable change in outlook in later years with the gradual realization that a vast portion of human population suffers from allergic diseases in which the airborne particles play a significant role. The biological sources include fungi, bacteria, algae, viruses, spores of gymnosperms and angiosperms of which grasses occupy a significant percentage. The occupational allergy often noted amongst wood and paper mill workers and even mushroom dealers is traceable to such biological sources.

With increase in application of Science and development of technology, land use patterns including agricultural, urban and rural planning have undergone a series of transformations. They also include creation of pastures, farmland and planting of trees, some which bear allergic pollen. This state of affairs has resulted from an erroneous approach to planning without proper regard to biological allergies and safeguarding against their deleterious effects. It is, indeed, a fallacy that in urban planning and in studies of pollution, airborne microbes and spores which seriously interfere with our living system and affect industrial development and cause infections and wounds, are not often included.

INDUSTRIAL POLLUTANTS

In general, air pollution is caused by both inorganic particles, liquids and gases of which sulphur dioxide, carbon monoxide and carbon dioxide are the most frequent (Lynn DA, *Environment*, Murdoch WM ed. 223, Sinauer Associates 1975). The particle size is one of the most important factors in air pollution as it determines the extent to which it can remain suspended in air and the capacity of its dispersal in atmosphere, its size also is related to its deposition in human lungs. The large particles are often found in the upper portion of the respiratory tract whereas the smaller ones penetrate deeply and cause severe damage.

The important cities of this country represent outstanding examples of air pollution (BARC Symposium, *Pollution and Human Environment*, 1970 and *Management of Environment*, ed. G Patel 1980). On the basis of regular fuel consumption alone, the quantity of air required in the city of Delhi is 65.5 cubic kilometer per day, for Calcutta it is 86.0 cubic kilometer per day and for Bombay it is 81.5 cubic kilometer per day. For combustion of 1 ton of mineral ore almost 12 tons of air are required. Considering the effective ceiling height as 1,000 ft., the approximate areas affected in the cities of Delhi, Calcutta and Bombay are 80, 105 and 100 square miles respectively. Climate plays,

no doubt, an important factor in controlling the pollution of air, The effects of air pollution are maximum on children where the immediate result is decline in growth rate and general health as compared to adults.

The environmental pollution in certain industrial complexes like Durgapur has assumed menacing proportions. Several diseases including bronchitis, asthma and even cancer are becoming endemic to the area, specially due to the uncontrolled dischange of effluents from the industrial complex. Houses remain covered with thick layers of dust, coal and chemicals, quite a number of which are mutagenic in nature. Acid and alkali pollutions are leading to the destruction of crops and damage to the drinking water. The gradual disapperance of the vegetation, the coating of plants with coal dust and the careless disposal of waste oil and carcinogenic lubricants destroying aquatic life are evident around such complexes.

From the different types of industries the discharges in air are different and consequently their effects on biological system vary to a great extent. With the development of new and sophisticated machines, and with very high production rate there has been a logarithmic increase of pollution. In India, the data collected by the Central Labour Research Institute so far reveal the enormity of the problem. In dichromate industry, the effect on olfactory system is quite severe and nasal perforations and mucosal ulcerations in the nasal septum are observed among more than 20% of the workers. There is also positive correlation between the length of service and infection in the nasal region. The magnitude of the problem can be judged from the fact that average dust count in chromate mines is more than 114 (in million particles per cubic feet of air) and free silica and chromate are the principal constituents of the pollutants. Similarly, in the storage battery industry, the pollution is principally due to lead. Nearly 20% of the pasters with maximum exposure show early lead poisoning. A direct relationship has been noted between the exposure rate and the presence of lead in blood and urine. The situation in the mica procession unit is even more severe. Here, the pollutants arising out of grinding greatly exceed the permissible values. Nearly 60% of the workers reveal ground glass appearence in the lungs through X-ray analysis. A high incidence of silicosis is noted amongst grinders engaged in metal grinding operations and 30% of the workers show the disease. The correlation between the incidence of silicosis and air pollution is significant. Normally, pure iron ore does not pose a very serious problem but it often remains associated with quartz containing materials which may culminate in silicosis and sidero-silicosis. Silicosis is principally the binding of silica with the membrane protein of the lung cells. With manganese, the neural disorder known as *manganism* is caused due to its effects on target cells of the brain. Similarly, heavy metals principally bind to specific proteins of the cells.

In pottery and ceramics, most of the clay contain a high percentage of silica. Cough is a common complaint and more than 25% of the workers suffer from heavy cough and nearly 15% from silicosis. A very pathetic picture is presented by the workers of ferro-manganese industries. Manganese pollution near the furnace reaches a level of almost 35% (milligram per 10 cubic meters) as against not to fumes, which are much more hazardous. Manganese poisoning symptoms are relatively irreversible. Retropulsion signs, which forms an index, shows nearly 7% complete disability. With fume poisoning it is more severe. It is, indeed, a pity that such cases, which are curable through early diagnosis, are normally not brought in for treatment at the primary stage.

Various forms of lung cancer are prevalent amongst workers in dyestuff, rubber and asbestos industries. In USSR, metal workers engaged in polishing or sharpening operations are exposed to vibration for nearly 50 to 85% of their working

hours. They often suffer from vibration diseases which are remedied by reducing the working hours by 20 to 30% and allotting to them other occupations not exposed to vibration. With the development of industries, the use of metals, solvents, dyes, alloys and other chemicals is on the increase and there is a proportionate enhancement of occupational hazards. In the large-scale industries certain standards are maintained to some extent. But in small-scale industries, with long working hours, such as in the lead smelters in most of the cities of India, no such standard is ever adopted. This is specially relevant to Indian conditions where the number of people engaged in cottage and small-scale industries is almost four times (8.4 minions) that of large scale industries. Fortunately, World Health Organisation (WHO) is assisting in the field studies on environmental and health problems of small industries in several countries of the world.

Since coal combustion is a major source of sulphur dioxide the pollution is severe in areas near combustion zones. Out of the total amount of sulphur dioxide emitted, 70% is attributed to coal combustion and 16% to petroleum products. In addition to its action on life, the damage to the monuments like Taj at Agra through such pollution is well-known. Air pollution in cement factories too occurs in a very high rate. In the vicinity of such factories particles of silica, lime, bauxite and sulphur dioxide are of frequent occurrence. They affect visibility and retard growth of plants through deposition on foliage and soil.

It is not necessary to go into the details of casualties often noted amongst the mine workers. Even a few years back, 9 cases of pneumoconeosis and 150 cases of silicosis in coal mines and 17 cases in mica mines were recorded in India. Extensive data on these aspects are available from the Central Mining Research Institute at Dhanbad. Pneumoconiosis is practically incurable and the only method of control is to control the dust. In most countries there is a prescribed limit of the airborne dust concentration. No such prescription is however available for the control of pneumo-coniosis in India in spite of the fact that India's coal reserve is very high and will be further utilized in the coming years to meet the shortage of energy.

CONTROL OF AIR POLLUTION

Realising the dangers of air pollution, several developed countries have tackled the problem on an emergency basis. Methods have been devised to find out the most adequate measures to control emission, setting out absolute emission standards, the violation of which leads to heavy punishment. Researches are encouraged on determining and monitoring air quality in order to arrive at a permissible concentration of pollutants from a particular source at specified area. As a corollary to the last process, the minimum sanitary belt needed for specific industries is also determined and standards are set.

It is, indeed, remarkable that amongst the few countries which enacted laws in relation to pollution, India is one where legislation was passed in 1905 in Calcutta, in 1912 in Bombay, in 1953 in Kanpur and later in Gujarat and Delhi. None of these acts are free from limitations and all these refer principally to industries. For example, a large number of toxic substances are discharged from the industries in the gaseous form but their limit of stack condition is not specified.

Over and above such inherent limitations, the acts are not rigidly enforced and punishment is not severe. Situations are common in which residential and industrial complexes intermingle with each other and the residents are continuously subjected to oxides of sulphur, hydrocarbons and oxidants. It is an irony that the power station at Delhi, which is supposed to be one of the most well-planned cities of the world, is discharging several tons of sulphur dioxide and of soot every day. It is located in the vicinity of World Health Organization, with Indian Standard Institution at its base, in front of the

Indian Medical Association and School of Town Planning and Architecture and in close proximity to the University Grants Commission and Indian National Science Academy, where academicians and planners set standards for pollution. Is it not a glaring example of indifference of our citizens, of our academicians and naturally of our planners as well ?

In India, several measures have been worked out to reduce dust pollution, at least in mining operations. In general, where the mines are a little moist and seams are damp, the concentration of airborne dust is minimum. In gold mines, with use of water as the wetting agent, adequate ventilation system and sharp drilling methods, the hazards are reduced to the minimum. In mica mines, almost 47% of airborne dust can be suppressed by employing 1 : 500 water as the dampening agent. In the reclamation tunnels, the heavy dust problems require to be minimized with the use of water. The dust concentration has been reduced to 1,700-7,000 ppc with water as against more than 80,000 ppc with dry ore. Proper ventilation with several hoods over each feeding point of the tunnel has been recommended. Mist spraying also reduces dust hazards to a great extent. With suitable precautionary measures and rigid control of permissible dosage, one can look forward with optimism towards reduction of dust concentration in mines for the protection of health and life of the miners. With pollutants, the permissible dosage is estimated in relation to 8 hours stay in the working conditions. It is, therefore, imperative that in the remaining 18 hours of the day the worker should remain in an atmosphere free from pollutants. This guideline should be the primary criterion in the establishment of industries and industrial townships.

The approach towards a control of air contaminants is rather difficult as it is not feasible practically to collect waste air for recycling or treatment before discharging into the atmosphere. There are three different ways through which such problems of air pollution may be tackled.

1. Emission of effluents may be reduced by controlling the combustion of industrial systems.
2. The pollutants may be allowed to disperse over a wider area in order to dilute the effects instead of being concentrated in a restricted zone. In such cases the amount of pollutants remains the same, but it is widely scattered. Such wide dispersal may however have serious effects in distant areas.
3. Additional materials may be added as scavengers so that some of the pollutants are removed before discharge.

All such alternatives need to be implemented to control air pollution under different conditions in India.

EFFECTS OF AIR POLLUTANTS ON VEGETATION

Plants have been found to be affected seriously by sulphur oxide, oxidants, ozone, peroxylacetate nitrate, nitrogen oxides, halogen derivatives, ammonia, ethylene, mercury and several heavy metals (Sharma AK and Sharma A, *Int. Rev. Cytology* 10, 1960 ; Sharma AK, The *Cell Nucleus, 2* 264, 1974). With sulphur dioxide, chronic or acute injuries may occur through accumulation of sulphites or sulphates, the former being more toxic than the latter. The trees in general in the inner fume zone normally exhibit a high rate of mortality. Most of the environmental factors which accelerate growth act also as retardants of sulphur dioxide injury. They include light, temperature, humidity and soil moisture. In efforts to prevent pollution damage, these factors along with the nature and genotype of the species need to be considered in their totality. The most susceptible stage is the period of active growth. Even very toxic concentrations of sulphur dioxide are ineffective in the absence of proper environmental conditions and susceptible growth stages. So far as anatomical

characters are concerned, closure of stomata leads to less pollution damage as in darkness.

A serious air pollutant affecting vegetation is ozone, a secondary product from automobile exhaust. The phytotoxic effects may be manifested in the form of pigmentation, chlorosis, bleaching and even necrosis. The weather flecks of tobacco or chlorotic flecks of pine needles are the other important examples of ozone damage. The pine forests which are one of the important constituents of hill vegetation are extremely susceptible to various forms of ozone damage. Another severe pollutant is peroxyacetyl nitrate (PAN), a byproduct of automobile exhaust, which even suppresses photosynthesis. The leaf cells often collapse and glazing and bronzing are common symptoms. Most of the horticultural plants like tomato, lettuce, mustard, dahlia are very sensitive to PAN damage. Begonia, chrysanthemum, corn, cotton and sorghum are relatively tolerant. The sensitivity is generally maximum during period of high light intensity.

High temperature combustion processes, combined with oxidation in air, lead to the production of several kinds of injurious oxides such as NO_2 which affect the vegetation. Low light causes increased sensitivity to NO_2 because of the comparatively inactive nitrate reduction process. Amongst the Indian plains the sensitive ones include mustard, tobacco and sunflower, whereas asparagus, beans, etc., are more resistant.

Common pollutants, noted near the superphosphate fertilizer factories and mines, are the fluorides which may be absorbed in the form of gases or particles. Chlorosis and necrosis are the common symptoms. Fluorides not only inhibit photosynthesis but also inhibit enolases needed for glycolysis. The grapes, pines etc. are extremely sensitive, while cotton, tobacco, cabbage, cauliflower and brinjal can tolerate the effect to a greater extent. Fluoride toxicosis, through the food chain, may develop in animals as well.

Chlorine injury is also not uncommon in plants located near chlorine manufacturing plants, water purification plants, plastic incinerators or similar other sites. Defoliation, deblossoming, fruit drop in walnut, apple, pear and peach are rather common, though the effect is mostly localized. On the basis of threshold dosage, chlorine is placed between fluoride and sulphur dioxide (Linzon SN 1971, *Effects of air pollutants on vegetation*, 143, ed. BM McCormere, Reidel Holland, Scientific study of atmospheric pollution).

An allied pollutant is hydrochloric acid. Its effect is often widespread near soda plants and plastic factories in which marginal and interveinal necrotic lesions are the common symptoms. Of all the hydrocarbons, ethylene is most toxic and is responsible for abscission, chlorosis and necrosis. Ammonia released through various processes also affects vegetation, mostly causing bleaching and coloured lesions. The fumes can injure wheat, sunflower and tomato whereas maple is comparatively resistant.

Amongst the heavy metals, mercury is harmless in inorganic form, but the formation of alkyl mercury compounds in the bodies of animals, birds and fishes is extremely dangerous. Mercury is liberated through the use of pesticides and fungicides, the most common compounds being phenyl-mercuric acetate and methyl mercuric dicyandi-amide. Normally plants can accumulate a large concentration of mercury but damage may be caused. Bleaching of perianth and injury to stamens are rather common phenomena.

Damage from paniculate matters includes chlorosis from cement dust, reduction of crop yield due to excessive magnesium and lime, suppression of growth through smoke soot, blocking of leaf surfaces through sulphuric acid droplets combined with moisture, and lead injury to crops by fumes emanating from automobiles and batteries. However, not being absorbable, washing may lead to removal of lead particles. Nickel too causes severe injury to plants, like necrotic lesions.

Phytotoxicants can easily be controlled, unlike the usual plant diseases since in the latter there is horizontal or vertical transmission of infection. Removal of the pollutant is the best remedy.

Another facet of the problem of pollution is evolution of resistant plant species. Such evolution may be very rapid, specially in relation to plants exposed to acute and chronic pollution hazards. This is of special ecological significance as it enlarges the tolerance range of the species enabling it to survive in a polluted situation.

The best example of the role of pollution in influencing evolution is the heavy metal tolerance shown by different species. Zinc tolerance of *Anthoxanthum odoratum,* copper tolerance of *Agrostis tenuis,* lead tolerance of *Festuca rubra,* cadmium tolerance of *Impatiens balsamina* and a number of species have been worked out by different workers (Bradshaw AD, 1976, in *Effects of air pollutants on plants:* Tyagi, YD, 1980 unpublished report-UGC project).

Such plants can be effectively used as indicators and pollutant avengers. Even water hyacinth may be used as a scavenger. In such resistant plants, inbuilt systems are developed for withstanding pollution hazards. These may involve combining with the pollutant to render it ineffective, degradation of the pollutant, development of resistant enzymes or finally excreting the pollutants by anatomical modifications. All these characters are under genetical control. These effects emanating from pollution hazards are results of natural selection, through which pollution resistant genotypes are allowed to survive. Thus, in programmes of tree planting in rural and urban areas, a knowledge of pollution resistant plants is essential.

NOISE POLLUTION

Noise has been defined as a sound having undesirable effects on the recipient. In industry, it is mostly the byproduct of energy conversion, poses peculiar problems and is principally prevalent in certain urban areas, in the terminology of noise pollution, the perceived noise level (PNL) is measured in the units of decibels (PNDB) — a quantity correlated with the response of the recipient. In absence of any preventive measures, the Indian towns are noisier than those in the West. Calcutta, Bombay and Delhi are regarded to be among the noisiest cities in the world, where the average noise level even ten years back rose to more than 90 decibels (BARC symposium 1970). The airports and railway stations are the noisiest areas. Nearly 20 to 40 decibels are estimated to be normal while 120 decibels may lead to disastrous effects. Pollution hazards include loss of hearing, emotional distress, blood pressure, sleeping sickness, increased heart beats and tension. In majority of the developed countries, noise zones are being developed in areas around the airport, demarcating areas for development and control.

The problem of noise pollution has three distinct components, i.e., source, propagation and recipient. The *source is* well-known and may be of varied nature. The automobiles and jet engines are some of the principal sources.

Several factors, such as, the atmosphere, velocity of the wind, temperature changes as well as natural obstruction affect the *propagation* of sound. There is a gradual reduction of sound level with increasing distance. The problem of propagation is often overcome with adequate insulation. As far as the *recipients* are concerned, the primary need is to minimise the period of exposure to reduce the noise hazard. Protection of hearing through use of cotton plugs and working in insulated chambers are measures often recommended. The programme for conservation of hearing is one of the most essential necessities for a tension-free life.

IONIZING RADIATION AND POLLUTION

Ionizing radiations are the potent sources of energy. Their toxicity is almost 100 million times more than that of cyanides and other reagents. The

danger of radioactive pollution principally lies in nuclear war and in testing of nuclear weapons. Both short-and long-term effects have far-reaching implications. Since 1945, with the initiation of nuclear weapon testing and the disastrous results at Hiroshima and Nagasaki there has been considerable awareness of nuclear hazards. The US nuclear power submarine, lost in the Atlantic in 1963, released a large quantity of radioactive materials in the environment. As such, even if nuclear weapons are not used during major wars, radioactive pollution of the ocean is a continuous threat to mankind. The total number of nuclear detonations up to the end of 1978 was 1,619 by the United States of America, 274 by the USSR, 29 by France, 24 by Peoples Republic of China and one by India (cf. Office of Public Affairs, USA). In the United States, it is true that even at the time of maximum testing the average fallout was 30 mrem, well below the guidelines of 170 mrem per year. But in spite of this minimal dosage the shortening of life span due to any exposure to radiation cannot be overlooked.

The nuclear tests may be underground, underwater and atmospheric, The underground test, as carried out by India, can be fully contained and generally result in cratering. The Plowshare programme of Atomic Energy Commission, USA, recorded that cratering explosions may release 10% of the radioactivity into the atmosphere. The ecological balance is usually not upset. The danger is posed by the remaining 90% which may be leached and affect the underground water. It is quite likely that underground explosions may release radioactive contaminants as often noted in the burning of radioactive natural gas in the process of stimulation of its production from the geological strata of low permeability (Cook E, *Ionizing radiation in Environment,* 297, Ed. Murdoch WM Sinauer Associates, USA 1975).

The classification of the underwater test is based on the criterion of depth under the surface of water and that of the atmospheric test on different heights from the surface of the earth up to the stratosphere. The principal threat to our ecosystem and human life lies in underwater and atmospheric tests.

Several peaceful uses of nuclear explosion have been programmed, including the acceleration of gas and oil production and formation of underground storage chamber for gas and oil. Others involve use in mining projects, refineries, excavations as well as in the construction of harbours and canals. Precautions are normally taken in such cases to contain hazards up to the level of zero discharge. Though paradoxical the techniques of radiation and radiation chemistry have themselves been applied to solve the problems of industrial pollution.

The potential for the release of radioactivity to the environment is a serious concern for the future generation. The wastes from nuclear fuel processing plants are endowed with a hazard life of 600 years. One may visualize the magnitude of the problem in that the half life of plutonium is 24,350 years and its potential for causing hazards may persist for several times this period. With even low levels of exposure, the induced mutations may wreck several generations. This long-term effect, leading to abnormally and lethality, is responsible for regarding radiation hazards as the most severe of all other hazards so far known. Somatic damage induced in irradiated embryos as noted in the uranium miners from Colorado plateau and the survivors of Hiroshima, are too well-known to be recounted. The number of deaths from leukaemia, following a continued radiation exposure even at the guideline dosage of 170 mrem per year, ranges from 160 to 32,000 per year in the United States.

In the human system, the embryo and the uterus are most sensitive to the effects of ionizing radiation. There is a decrease in the sensitivity to radiation with age, as sensitivity is a reflection of the number of cells undergoing cell division. Different parts of the body differ in response to radiation and the gonads are highly sensitive. The fact that cells in active phase are more susceptible to radiation and

also to induction of cancer is the reason why younger people are more prone to radiation induced carcinogenesis. The intensity of radiation also exerts a significant influence amongst the Hiroshima survivors; leukaemia has been more prevalent in areas near the explosion site. Extensive studies have been carried out by scientists on Hiroshima survivors, on the occurrence of lung cancer in uranium miners and the prevalence of leukaemia and other cancers in the progeny of mothers receiving radiation during pregnancy. The effects of the dosage and nature of radiation have also been analysed. The different types of radiations show specific sites of preference. For example, plutonium, radium, strontium, barium, thorium and actinium mainly concentrate in the bones. There is significant reduction in the life span of individuals receiving chronic radiation.

The use of radioactive elements and radiation has become a powerful tool in the hands of scientists in solving problems of biological research and in diagnosis of diseases. Radiation devices used in medicine, if not properly manipulated, may have drastic effects. The birth of mentally retarded children has been recorded amongst mothers receiving radiotherapy during early pregnancy. Amongst workers working with X-rays, including the physicians, a high rate of cancer has been detected.

Even the dentists sometimes develop cancer of the finger for holding X-ray films in the mouths of the patients. There has been an increase in leukaemia following X-ray treatment of spondylitis. Patients treated for tuberculosis through fluoroscopic examinations have also been reported to develop breast cancer at a very high rate.

With the development of technology, the potentiality for the application of X-rays is expanding but there is a very cogent reason to eliminate radiation exposure as far as practicable for diagnostic purpose. In the United States, where a maximum yearly dosage of 170 mrem is recommended, doctors are recommending exposure only in cases where the risk is worth undertaking (Cook E, 1975 l.c.).

With instruments bearing electronic systems dangers of radiation hazard cannot be overlooked. Any electronic tube having a potential of several thousand volts may provide a source of X-radiation. Electron microscopes, television tubes may also be sources of such hazards. It has been calculated that with an average viewing time of 1,000 hours for a television, the skin exposure has an yearly average of 40 mrem for children and 10 mrem for adults. However, following the gradual introduction of solid state devices with well-protected tubes in television sets, the harmful exposure to X-radiation is eliminated considerably.

As regards control of wastes from reactors, recent advance in technology have led to the development of methods of zero release design, viable both technically and economically. In fact, if the elements are handled with proper precaution, there should not be any radioactivity in the environment at the site of the power plant. The hazards mainly arise from fission products which may escape by diffusion or the production of radioactive substances like tritium which may mix with water. Such tritiated water, after dilution with pure water, is released into the ground at the reactor site. Tritium, having a long half life (more than 12 years), may pose a serious environmental hazard. Protective measures are being devised to avoid such a situation as in the case of radioactive iodine, of which 99% is removed from the effluent. Thanks to the advances in methodology — the reactors can be made as clean and as safe as possible though no doubt at considerable expense.

The term "safety" is however relative and cannot be absolute as, even at a very low level, continued exposure may lead to genetic damage. Most of the radiation standards are devised on the basis of harmful effects on human system. The overall environmental contamination is not ultimately taken

into account which affects the overall food chain in our ecosystem. In order to set a proper standard against radiation hazards, the entire ecosystem and the food chain in nature require to be considered. Absence of such a standard may cause irreversible genetic damage to life on earth and its environment.

POLLUTION BY CHEMICALS

Hazards including the use of Agricultural and other Chemicals

With the increased production in agriculture all over the world and especially in India, it is essential that maximum efforts should be geared to protect the health of workers engaged in this vital field of activity. Herbicides are used more or less in the same scale as pesticides and the effects of the former are comparatively less harmful than the latter.

But indiscriminate use of herbicides has serious repercussions as they often attack the nontarget plants, even killing the soil binders and accelerating soil erosion. They may cause siltation of the freshwater system and pollute freshwater lakes. Several herbicides are also health hazards. Some of them can cause genetic damage affecting the chromosomes or nontarget plants (Sikka K and Sharma AK, *Proc, Ind, natl. Sci. Acad,* 42B, 299, 1976) influencing ultimately the productivity of crops. The herbicide 2, 4, T is teratogenic and may initiate birth defects. The problem of weed control needs to be tackled with great caution as allelopathic or weed interaction forms a part of the ecosystem and is beneficial to crop production.

In tropical countries like India pest control is required on an extensive scale in view of the occurrence of a large number of pests with regular periodicity. Insecticides or pesticides, including the rodenticides and fungicides, pose serious problems of pollution in agriculture. They interfere with the reproduction of birds and disrupt the ecological balance. Some insects may become resistant through mutation to such chemicals, thereby jeopardizing agricultural production. In view of the growth of these mutant strains, extremely toxic compounds such as methyl parathion instead of DDT are often employed to kill the insects. They are disseminated in large quantities in the environment and pose hazards to the health of agricultural workers. The poisoning capacity of the residue is normally measured by its acute toxicity. The response varies in different populations, which is evidently under genetic control. A relationship between DDT and liver tumour, cirrhosis and hypertension has been recorded. Similar studies have been carried out with its metabolite DDE (dichlorodiphenyl ethane-Rudd RL in *Environment ed.* Murdoch WM Sinauer Associates USA, 7975). Several plant compounds such as rutinones, pyrethroids, nicotine, chlorinated hydrocarbons, mercurials affect the kidney, respiratory system and central nervous system. Even the endocrinal and gonadal systems are affected.

Amongst the peach and strawberry pickers, phosphate poisoning after parathion application has been reported through the conversion of parathion into paraxone, a very toxic and stable compound. The carbamates are strong cholinesterase inhibitors and may even lead to mental aberrations. Several rodenticides, including cyanide, strychnine, sodium fluoro-acetate are highly toxic and cause convulsion and respiratory failure. Pesticides remain for long periods in the environment. For DDT 39% residual after-effect has been recorded even after 17 years. Non-persistent pesticides are comparatively less toxic. In order to minimise the effects it is often recommended that spraying or dusting should be carried out following the direction of prevalent wind and a protective clothing against skin contact is required for the operator.

Food products and water are often preserved in plastic containers due to their ready availability and low cost. The possible leaching of thalates, lead salts and other plasticisers has injurious effects on health, against which proper precautions are . desirable (CR Krishnamurti, *ITRC Report* 1973).

In Sweden, the agricultural use of seed-dressing by mercury and industrial effluents led to the accumulation of high levels of mercury in fish and birds. As a result, the use of mercury was banned. Similarly, thinning of egg shells in Peregren falcons was noted as mainly due to DDE, dieldrin, PCB and mercury. A complete ban on the use of such pesticides, where toxic effects may spread through leaching and is not confined mainly to the site of application, is necessary. The use of pesticides having persistent effects for a long period is also dangerous. Chemicals with non-persistent residual effects (one to two days), such as "Tapp", are comparatively less harmful.

The aftermath of accidents in the use of pesticide was shown in a disaster in 1976 in Sevesco, near Milan. In a pesticide factory, the safety valve blew off due to high pressure, emitting a highly toxic substance. Following several deaths due to the chemical, the town was evacuated.

In the last Asian Congress on Rural Medicine, held in Japan (Usuda), several cases of poisoning amongst greenhouse cultivators have been reported. They were mainly attributed to the compounds which remained suspended in air following spraying and workers were affected through inhalation or skin absorption. Dullness, headache, excessive perspiration as well as contact dermatitis are rather'common ailments. The use of copper and arsenic and other toxic compounds has led to several accidents.

Lately, antibiotics have proved to be extremely important in the protection of crops, including fodder, and as preservatives in meat processing. Their use in treatment of several diseases in animal husbandry including mastitis in cows is responsible for the problem of residues in milk. Their application in stimulating the growth of poultry and pigs is also practised, it is claimed that the development of bacterial resistance to drugs in man is related to the presence of antibiotic on food chain in our ecosystem.

The continued use of chlorinated pesticides, which have a lasting effect on pest management in agriculture, has been responsible for the presence of the residues in grains, milk, eggs, vegetable and human tissues. Significant amounts of residues of chlorinated hydrocarbons have been recorded in human placentae, cord blood and breast milk in the tests conducted at the Industrial Toxicology Research Centre, Lucknow. The contamination of wheat flour with gammaxene has led to the development of epilepsy and other complications. Several peculiar paralytic attacks have been reported following the consumption of crabs caught from rice fields which had received massive doses of pesticides (CR Krishnamurti, ITRC workshop NCIRTC, 1979).

The heavy demand and comparatively lower production of food in terms of population has prompted adulteration of grains, pulses, and milk, which is continually on the increase. Several samples of legumes, spices and vegetables contain dyes which have an injurious effect on health. Similarly the seeds of *Argemone mexicana*, growing together with rape seed and mustard and often used as adulterants, are well-known for their carcinogenic and neurotoxic properties. The use of processed food and beverages requires a strict guideline for their production as they often contain toxic antioxidants and cyclamates.

A problem often affecting agricultural and veterinary workers is the increasing speed associated with the agricultural operations including the use of implements. The heavy load on the engine generates heat, influences the microclimate of the cabin, and emits carbon monoxide and hydrocarbons which pervade the atmosphere of the operator. The stresses of working at high speed lead to loss of hearing, cardiovascular and nervous diseases (recorded by Kiev Occupational Health Research Institute, USSR) in Japan, a survey has revealed that amongst the agricultural workers, hypertension, rheumatism, neuralgia, shoulder stiffness, lumbar pain, nocturnal polyurea, breathlessness — all

manifestations of chronic fatigue attributed to cumulative effects of stress and strain — are rather common. Chronic bronchitis is one of the prevalent diseases amongst the crop threshers.

In India, where the principal occupation is agriculture there is an immense possibility for the development of Ergonomics — a synthetic Science combining Biomedicine and Engineering. The design of tools and methods of work, commensurate with the ability of the individual, lead to reduction of unnecessary effort and fatigue. In this subcontinent, where developments in agriculture are progressing at a rapid pace, it is essential to utilise the knowledge of ergonomics for agricultural workers, to provide them with a congenial environment.

Due to shortage of vegetable oils, soap industry is often dependent on synthetic detergents. The sulphonation of hydrocarbon alcohol in ether or lauric acid, if not carried out under strictly controlled conditions, may give rise to several toxic compounds like sulfones. It is essential that the standards for non-soap detergents be set under proper quality control list. The use of mercury too in the manufacture of soap needs to be strictly avoided. For cosmetics, such as shampoos and hair dyes, rigid guidelines should be formulated to exclude chemicals like *p*-phenylene diamine, known to have a carcinogenic property. In indigenous medicines, several synthetic cortisones and analgesics have been incorporated which have a drastic effect on the body system, if not properly administered. Several such preparations, widely marketed in India, do not undergo the scrutiny of the drug controller because of the indigenous nature of the medicine.

In the present context, contemporary toxicologists may well conjure up a cause and effect grammar for several chemicals, "asbestos should stand for lung cancer, benzene for leukaemia, kepone for sterility and vinyl chloride for cancer of the liver *(Time,* Sept. 22, 1980)", of course with a slight stretch of imagination.

BIOLOGICAL PEST CONTROL

Possibly the best way through which the agricultural production can be augmented without the use of pesticides is biological control. This practice is based on the principle of introducing natural enemies to the environment without harming the crop. The progress technology in relation to biological control has been rapid and several methods are now in vogue. These are the culturing, breeding and release of already existing natural enemies in the environment, introduction of new enemies from the country of origin of the pest; the use of microbes to kill the pests and lastly sterile mating for their ultimate elimination, in cases, such enemies may require other plants for the completion of life cycle. The necessary environment needs however to be provided. For example, the leaf hopper in vines, in the United States, has been controlled by growing blackberry plants near the fields.

The history of biological control can be traced to two important events (Conway GR *Environment,* 355, 1975). At the end of 19th century citrus plants in California were attacked severely by a scaly insect *Icerya purchasi.* In order to eliminate this insect, a beetle *Rodolia cardinals* was introduced from New Zealand and Australia. Similarly, *Opuntia* developing as a pest in Australia had been eliminated through insects namely *Cactoblastis pectora* introduced from Argentina. The use of micro-organisms has resulted in the extermination of sawfly in the pine forests of Canada. It is reported that in Estonia, ant reserves are being maintained for control of insect pests.

For exotic pests, biological control is not very difficult. But for endemic ones the problem is much more complicated. In the practice of biological control extreme caution is, however, desirable as alterations in environmental chain following pest control may lead to injurious effects on wild plants and animals. The recent report of rat plaques in the central provinces of Henan and Hubli on the Yangtze

and yellow rivers at China is an example of harmful effects of disturbance in ecological balance. Due to the use of rodenticides, cats and birds, feeding on poisoned rats, have been exterminated. It has led to a tremendous increase in rat population, which has resulted in severe damages. This is an example of the adverse effects of upsetting the ecological balance and natural mechanism of biological control.

GENETICAL EFFECTS OF POLLUTANTS

Man has always been exposed to innumerable toxic agents in the environment which-influence the genetic systems and cause mutation. Such mutagenic substances which affect the *genes* and the *chromosomes* — the vehicles of the genetic material have a far-reaching influence on the progeny of the affected individuals, due to their transmission through the hereditary mechanism. With rapid urbanization and industrialization, in addition to physical agents, like UV-rays, X-rays and g-rays, such compounds are continuously on the increase in our atmosphere including soil, air and water and embrace atmospheric trace components, aerosols, food additives, pesticides, hair colourants and a large number of industrial chemicals mentioned previously (Hollstein M *et. al*., *Mutat. Res.,* 65, 133, 1979; Hollaender, A, ed. *Chemical Mutagens* 1-5, 1971-75, Plenum, New York; Ames BN *et al., PNAS,* 6, 2423, 1975). Several of these compounds are not only mutagenic, producing genic and chromosome abnormalities and genetic damages but are carcinogenic as well. Fortunately, in nature, majority of the existing mutagenic pollutants are removed from the atmosphere by various scavenging systems, such as gravitational settling, precipitation, absorption of pollutants, by plants, soil and water surfaces.

In the United States alone, about two years back, a large percentage of 70,000 commercial chemicals was listed to have mutagenic, clastogenic and even carcinogenic effects. In fact, the remarkable developments in Science and Technology have simultaneously accelerated the potential of genetic hazards to the human race as a whole. The extent to which atmospheric mutagens have initiating, additive, cumulative or synergistic effects, is however not yet clear even though the manifestations of hazards are well-recognized. In order to assess the risk of genetic hazards, several test systems are in vogue, the applicability of which, in relation to extrapolation of data to human systems is yet to be fully established. Outstanding advances in technology for detection of DNA, RNA and protein associated with alterations of the genetic material (see Caspersson T, *Cancer Research,* 39, 2341,1879 and vide Sharma AK and Sharma *A–Chromosome Techniques Theory and Practice,* Butterworths, 1930) in a multiple test system have facilitated mutation and cancer researches to a significant extent.

Along with atmospheric mutagens, several drugs which are of common use including antibiotics, such as penicillin, have been shown to have mutagenic properties at certain dosages (Hollaender, A, ed. *Chemical Mutagens,* 1-5, 1971-75). The toxic action of caffeine too has been demonstrated. After the discovery of mutagenic effect of X-ray by Miiller in 1927 and of chemicals by Auerbach in 1932, detailed researches were initiated to explore the mutagenic property of other compounds (Sharma AK and Sharma A, *International Review of Cytology,* 10, 601, 1960). In the present decade, the trend of research is oriented entirely in a reverse direction, where the main thrust is to explore the chemicals which are harmless and non-mutagenic in nature. The results are generally exposing the magnitude of the hazards to which the biological systems are exposed.

Amongst the atmospheric mutagens, the contents of the trophosphere and the stratosphere, covering a height of up to 7 and 30 miles respectively, with special emphasis on the former, are of principal concern to the human race. In the latter, ozone concentration is high, and CO_2 concentration is comparatively much reduced, along with the

pollutants. Rapid progress in space technology may change the balance to a significant extent.

Of the different environmental constituents causing mutagenesis, sulphur components form an important part. In addition to natural processes such as soil and rock erosion, degradation of biological products, natural fires and others, the man-made emission of sulphur mostly originates during power generation from coal or oil, as well as combustion of both, smelting of ores, coke processing and several other procedures including manufacture of sulphuric acid.

Bisulphite ions are known to induce mutagenic effects on viruses bacteria and plants. Such mutations have been found to affect cytosine-guanine site including reversions; *CG* to *TA* transitions, as well as conversion from cytosine to uracil. At very high concentrations, through ionic reaction, sulfonates of dihydroxy uridine and cytidine are formed followed by deamination under alkaline conditions. This property is of importance for chemical modification of transfer RNA. *In vitro* studies have shown that there is very little protection of DNA from bisulphite damage, suggesting that the genetic material is extremely sensitive to it.

Such damages are of special concern, as in addition to their occurrence as environmental pollutants, bisulphites are used as food preservatives. Sulphur dioxide, itself having mutagenic property, forms sulphuric acid along with NO_2. and nitrous acid in water, which are also very strong mutagens. Chromosomal abnormalities have been recorded in several mammalian systems with these chemicals. Foetal loss and congenital abnormality in cows in contaminated areas are often attributed to sulphur damage.

The gaseous components of nitrogen in the atmosphere arise from biological action and organic decomposition in soil and ocean in addition to emissions from industry, automobiles, fuel combustion and others. The most common pollutants are oxides of nitrogen, NO and NO_2 as well as ammonia, the principal sources of which are soil and microbial deamination. Significant amounts are emitted from aircrafts along with carbon monoxide, hydrocarbons and other particles. The oxides of nitrogen are capable of forming the carcinogen and mutagen — *N*-nitrosamine, through nitrosating secondary and tertiary amines. The mutagenic property of nitrous acid has mainly been attributed to the oxidative deamination of adenine and cytosine as well as to induction of cross linking within DNA molecule leading to deletions.

Polynuclear aromatic hydrocarbons, arising from several industrial operations including wood pyrolysis, acetylene production, coke and gas generation, oil refineries, synthetic alcohol and various other industries are sources of potentially effective mutagens. The most potent carcinogenic and mutagenic compounds are, benzopyrene, benzoanthracenes and benzofluoranthenes. Extensive data are available on the carcinogenicity and mutagenicity of these compounds (vide IARI report, 1973) including large-scale occupational hazards. The latter include the pioneering studies on cancer amongst the chimney sweeps in England and Kangri users at Kashmir in recent years.

The molecular mechanism involved in oncogenesis is reaction with DNA analogues leading to alkylation mutagenesis. This may be due to electrophilic attack on N-7 position of the base moiety of DNA molecule. Benzopyrenes however affect both euchromatic and heterochromatic loci of chromosomes. In this respect, this compound stands apart from non-reactive carcinogens. Several of the polynuclear aromatic hydrocarbons tested (Ames test: Ames BN *et al.,* PNAS, 70, 2281, 1973; Iball test: Iball *J; Amer. J. Cancer* 1939) for the correlation of mutagenicity and carcinogenicity, have been categorised as frame shift mutagens. Within dibenzanthracene and phenobarbitals a quantitative correlation between the two properties has been recorded.

Cigarette smoke too contains several polynuclear aromatic hydrocarbons including the very potent benzopyrene. There are conflicting reports of the degree of mutagenicity of benzopyrene and benzopyrene derivatives (see Banerjee A and Sharma A, Toxicol. Let. 1980). In any case, for a number of polycyclic hydrocarbons, metabolic activation is needed for mutagenicity. It has been shown (Ames BN *et al.,* 1972, *Science* 176,47) that carcinogenicity of PAH is due to the mutagenicity of epoxides as intermediates, and the molecular mechanism involved is intercalation followed by covalent reaction.

Peroxyacetyl nitrates mostly derived from atmospheric photo-oxidation of hydrocarbons in presence of nitrogen oxides, as mentioned earlier in case of *smog,* have serious effects on lachrymatory systems. Olefines are often emitted by automobiles, which through auto-oxidation and photochemical oxidation in air to hydroperoxides, epoxides and similar compounds exhibit carcinogenicity (van Duuren *et al., Ann. N. Y. Acad. Sci.,* 163, 633, 1969). The mutagenicity of a few hydroperoxides and epoxides is known. The peroxides and peroxide-like formaldehydes have severe action on mature sperms, but formaldehyde may affect even earlier stages of spermatogenesis.

Ozone is an important atmospheric mutagen which normally is present between 10 km and 80 km above sea level at different latitudes. It has both destructive and useful action. In the stratosphere, it filters the solar radiation so that ultraviolet rays below 300 nm, which often cause lethality, are prevented from entering the troposphere and causing damage to life on earth. But this ozone layer is often destroyed by supersonic air transport as well as by chlorine compounds generating nitrogen oxides through photochemical reactions. The reduction in the ozone concentration has repercussions on the biological system involving principally the incidence of skin cancer through ultraviolet injury. The National Academy of Sciences in U.S.A. recorded in 1973 that 8% depletion of ozone led to an increase in 8,000 cancer cases (Fishbein, L, In *Chemical Mutagens,* 5, Plenum, New York 1976).

However, it is noteworthy that ozone itself, originating in the stratosphere, through low level of photochemical action or generated during transport of polluted air, may, once olefine and nitrogen oxides are depleted cause adenoma, cellular hyperplasia and a series of radiomimetic and mutagenic changes. Ozone may also be generated from high voltage electrical equipments and ozonisers used in water, food and air purification. Infact, decomposition of ozone in water produces OH and HO_2 radicals, the cyto-logical and cytogenetic effects of which are well-known. Ozone induces chromosome breakage in *Vicia faba* and mammalian cell cultures including human cells (Feder WA and Sullivan F, *Science,* 165, 1374, 1969; Fetner RH, *Nature,* 794, 793, 1962). Chromatid breaks in human cell cultures are quite well-established. In bacterial systems too mutagenicity of ozone has been demonstrated (Hamelin C and Chung YS, *Mutat. Res;* 24,271,1974) as also inhibition of mitotic activity in plant systems (Feder and Sullivan *I.c.).* It is claimed that ozone possibly exerts direct lethal and mutagenic effects on cells, primarily affecting the permeability of the cell membrane.

Heavy toxicity has been recorded with several halogenated hydrocarbons having a high mutagenic potential. Starting from DOT onwards a vast array of detergents, refrigerants, propellants, cosmetics, perfumes, dry cleaning fluids, solvents and others fall in this category (Fishbein L. *I.c.,* Sikka K and Sharma AK, *Proc. Ind. Natl, Sci Acad.* 423, 299, 1976). Of the fluorocarbons, trichlorofluoromethane and dichlorodifluoromethane have a strongly toxic action. Moreover, they are photochemically stable and remain undegraded even after several weeks. The data regarding carcino-genicity and mutagenicity of fluorocarbons are rather meagre.

But mutation studies with four fluoridated hydrocarbons in *Drosophila* have indicated their high mutagenic potential (Foltz VC and Fuerst R, *Environ, Res.* 7, 275, 1974).

The wide use of vinyl chloride and its derivatives is of serious concern in view of the high carcinogenic property. In addition to plastic industries, vinyl chloride monomer is extensively consumed along with food products as cachets, packaged in polyvinyl chloride containing packets. The catalytic oxychlorination of ethylene yields ultimately vinyl chloride monomer as well. Vinyl chloride normally undergoes reaction in the atmosphere in presence of nitrogen oxide and solar rays. The human system is principally exposed to this compound through inhalation, skin contact or consumption of food and water. The mutagenic effect of vinyl chloride ties been worked out in the bacterium *Salmonella typhimurinum,* rats, mice and human system. In rats, inhalation causes zymbal gland carcinoma, nephrobiastoma and angiosarcoma of liver (Mattoni C and Lefemine G, *Environ. Res.* 7, 387, 1974). The gaseous form shows a high rate of mutation and as such the risk through inhalation is significant, its action has mostly been considered to be through frame shift mutation.

The enzyme mediated mutagenic system is also claimed to be controlled by NADPH generating mechanism (Burtsch hi *et al. Int. J. Cancer,* 15, 429, 1975). The mutagenic effect is attributed to an intermediate — chloroethylene oxide. High incidence of chromosome damage amongst workers exposed to vinyl chloride is on record (Selikoff I, *Env. Newsletter,* 13, 1974) and stillbirth and miscarriages are often attributed to such exposures.

With chloroethylenes, employed as solvents for oils, rubber, paints as well as in printing and textile industries, the action is found to be narcotic in nature. The oxides of trichloroethylene lead to the production of chloral hydrate having both mutagenic and mutachromosomic action on plants and animals (vide Sharma AK and Sharma A, 1960 *I.c.).*

Carbon tetrachloride, extensively utilized in grain fumigation, as solvent for cleaning, has also been reported to show chromosome breaking action (Barthelmess, A In *Chemical mutagenesis in mammals and man,* eds. Vogel F, and Rohrborn G-Springer, 1970) in the mammalian system.

Several *bromoalkanes* pose health problems because of their wide use as pesticides and fumigants. The hazards from their degradation products and residues are enormous, which have already been discussed. Inhalation of or oral exposure to compounds like ethylene dibromides results in carcinogenic growth. Their Capacity of inducing gene mutation and chromosome breakage has been well worked out.

An important halogen, fluorine, a byproduct in various industries and fertilizer projects, has no doubt some beneficial effect on human systems, specially in the cure of dental cavities. But its harmful effects on plants, animals and human systems through airborne, systems are also well established. Different sources of fluoride including fluorine emission involve asbestos and cigarettes as well. It is claimed that smoking of 25 cigarettes leads to the inhalation of at least 0.4 mg fluoride (Fishbein L *I.c.).*

Along with fluorosis, discussed earlier, mutagenicity of fluorides has been worked out (Jagiello G and Lin JS, *Arch. Environ. Health, 29,* 230, 1874; Carr DM, *Canad. Med. Assoc.* J., 103, 343, 1970) in various biological systems. Sodium fluoride causes chromosome aberrations during oocyte meiotic maturation and leads to triploidy, monosomy, aborted foetuses and sex-linked lethals.

A few investigations have indicated genetic damage to the circulating lymphocytes and spermatozoa of smokers induced by cigarette smoking. A significant correlation has been obtained between paternal smoking and the rate of perinatal mortality and frequency of congenital abnormalities (Bridges BA, Clemmesen J and Sugimura T, *Mutat.*

Res., 65, 71, 1979). The genetic hazards to the children of cigarette smokers have been indicated — a study of which however needs to be carried out on an intensive scale, particularly in India, where tobacco is consumed in different forms.

The environmental hazards of the use of insecticides, detergents and their residues have already been pointed out earlier in this article. The potentiality or DDT and DDE for inducing genic and chromosomal changes has been recorded in both plants and animals. The observations, though often conflicting due to the different test systems applied, yet indicate tumorogenic or mutagenic activity of DDT and DDE in general on the mammalian cell lines. Of the different pesticides, strong mutagenic activity and effect on the human system have been demonstrated for dichloro vinyl dimethyl-phosphate (DDVP). It has the property of alkylating DMA (Leforth, G *Naturwiss,* 8, 393, 1970) comparable to some extent with methyl methane sulphonate. A clear correlation has been established in *E. coli* between concentration and period of exposure to DDVP on the one hand and induction of mutation on the other (Wild D, *Mutat. Res.* 75,33,1973).

The mutagenic property of formaldehyde has been studied as it is often present in the environment, through automobile and diesel exhausts, tobacco smoke and degradative thermo-plastic substances. Its mutagenic action has been attributed to the formation of free radicals, adenine dimers or reaction with amino acids and proteins (Poverenny AM; *et al, Mutat. Res.*, 27, 123, 1975).

Ethylene oxide, commonly employed as a fumigant for sterilization and a pesticide, shows a strong mutagenic activity. Both in plant and animal systems, chromosome aberrations have been induced by this compound. Several genetic effects of ethylene oxide are on record. High degree of lymphocytosis has been noted amongst workers in ethylene oxide factories in Sweden (Ehrenberg L *et al. Mutat.* Res., 24, 83. 1974). Very high frequencies of chromosome aberrations are induced in high frequency in cultured lymphocytes.

Polychlorinated biphenyls, used in capacitors, transformers and plasticizers, can induce mutation, carcinoma and teratoma (Fishbein *I.c).* It is also obtained from DDT vapour through irradiation with ultraviolet light.

Aerosols having solid or liquid trace elements suspended in a gaseous solvent serve as a source of mutagenesis. Several metals, including zinc, lead, copper and iron, are present in different amounts in aerosols. Lead derivatives and organo-lead compounds cause chromosomal aberrations and disturbance in spindle fibre formation (see Ahlberg J *et al., Ambio,* 1, 29, 1972; Sperling, K *et al.* 1970, Arbeitsgruppe Blot; Nriagu, JO, ed *Biochemistry of lead in the environment,* Elsevier, 1978; Giri AK, Banerjee R, Talukder G and Sharma A, *Proc. Inc. Acad. Sci.* 89, 311, 1980; Pal OP and Sharma A Nucleus, 23, 1980). However, negative findings have been reported by several authors as well. In majority of cases lead exposure has been shown to induce dicentrics, rings, chromatid exchanges, gaps and fragments. It is claimed that congenital malformations may be due to such anomalies.

Of the mercury compounds, methylmercury poses maximum genetic hazards as compared to other organo-mercurials. The sources of mercury in the atmosphere, either natural or through various industrial processes including petrol plants, are well-known. Blood cultures of man have revealed serious chromosome damage by methyl mercury (Nriagu, JO, *Biogeochemistry of mercury in the environment,* Elsevier, 1979, Skerving, S, *et al. Environ. Res.* 7, 83, 1974). Aneuploidy and chromatid aberrations have even been correlated with blood level mercury. Somatic mutations too are not uncommon. The action of methyl mercurials has a wide spectrum affecting plant, animal and human genetic systems.

The tolerance and susceptibility of the living organism to physical and chemical mutagens are controlled by its inherent genetic composition and physiological state. Nutrition plays an important role in influencing the physiology of the organism. The way through which malnutrition contributes towards susceptibility to congenital anomalies is evident from the fact that average incidence of major congenital anomalies including both live and stillbirths in India is about 2%, comparable to the world figure (Talukder G and Sharma A *Proc. Ind, Nat. Sci. Acad.,* 458, 273, 1979; Verrna 1C, ed, *Medical genetics in India* 1, 5, 1978). The low industrialization but high frequency of congenital anomalies similar to that of highly industrialized countries can be attributed to poor nourishment offering lower resistance to environmental hazards. With high rate of industrialization without a concomitant check of the problem of malnutrition, the incidence of anomalies will be on the increase.

The establishment of an International Commission for Protection against Environmental Mutagens and Carcinogens, in addition to Environmental mutagen societies in different countries, is a reflection of the genuine concern of the scientists regarding environmental hazards of mutagenesis and carcinogenesis.

Its principal objective is to prevent and minimize the deleterious effects resulting from the interaction of chemicals with the genetic material of maft. It is engaged in the task of identifying scientific principles of testing, setting up guidelines and regulations for minimizing environmental hazards on the genetic system for application at national and international levels and genetic counselling on the basis of appropriate tests on the exposed populations, as already done on victims of Seveso disaster in 1976. The relationship between mutagenicity and carcinogenicity, a comparison between *in vitro* and *in vivo* tests for carcinogenicity (Clayson DB, *Mutat. Res.* 75, 205, 1980) on, a quantitative basis, if any, and the extent to which the test for the former is predictive of the latter, are being precisely ascertained. Various facets of the problem, including sensitivity of germ cell stages, the spectra of genetic changes, and the validity of the data obtained from the test systems for extrapolation in human systems, are also being analysed. The Commission encourages national and international requests for solution of certain problems as has been done recently in case of "possible mutagenic effects of saccharin" carried out at the request of the U.S. National Academy of Sciences (Sobels FH, *ICPEMC News Let.* 1979). The need for such Commissions at the national level and the continued utilization of this international Commission by the different national bodies can hardly be overemphasized.

GLOBAL AWARENESS OF THE POLLUTION PROBLEM

The universal concern against pollutants in the environment was duly expressed at the United Nations Conference on Human Environment held in 1972 at Stockholm. Various International bodies like United Nations Environmental Programme (UNEP), United Nations Organization on "Habitat", World Health Organization (WHO), International Commission for Protection against Environmental Mutagens and Carcinogens (ICPEMC), World Wildlife Organisation and a host of other bodies are dealing with the environmental problems on a global scale. The observation of the World Environment Day every year, with the emphasis it deserves, is symbolic of the people's anxiety to keep the environment free from pollution.

On May 17, 1972 eleven Mediterranean nations signed a treaty which commits them to cleanse their rivers and sewage discharges, to keep the Mediterranean ocean free from pollutants. At present, 90% of the sewage from the 120 large Mediterranean cities is discharged untreated into the sea. An effective control of their resources is

the principal objective of this treaty which will cost almost six billion pounds *(Nature,* 285, 181, 1980), The treaty is the successful outcome of one of UNEP Regional Seas Programmes.

On March 5, 1980, 200 environmentalists gathered in Washington to discuss World Conservation Strategy sponsored by IUCNN, UNEP, FAO, UNESCO and World Wildlife fund. The conference was the outcome of the conviction that integration of conservation and environmental balance in the planning for development is essential for the emergence of a dynamic world Society. It was made categorically clear that the present day World economic crisis is the outcome of negligence to environmental and conservational challenge by both the developed and developing nations of the world. The Secretary General stated that International Cooperation is not a luxury but an essential factor for preserving this global balance of nature and reducing damage to the World's ecosystem.

At the national level, environment agencies or similar bodies set up in countries like Sweden, Japan, Singapore, USA, USSR, Germany and various other states have been giving due importance to this problem with the seriousness it deserves.

In USA, the Federal Environment Protective Agency has listed 35,000 chemicals used in the market as potentially hazardous to human health. The gradual recognition of this menace has led to the promulgation of a number of State laws which makes improper waste disposal a criminal offence. Under a 1979 New Jersey statute, the offenders can be fined up to 50,000 dollars a day as long as they keep the waste unprotected and may even incur a jail sentence of up to ten years *(Times* New York Sept. 22, 1980). The result is a sharp decline in careless disposal.

In Britain, the operation for cleaning the Thames started a few years back and today Salmon has again returned to the river *(Nature,* 255, 18. 1980). In Germany, where the environmental laws are rigid, several legal measures have been taken for the protection of the environment. A change in the constitution has given the Federal government the right to legislate for atmospheric purity, noise reduction and waste disposal. Several laws have been promulgated including Emission protection law protecting human, animal and plant life from dirt and noise in the environment; Petrol lead law; Sewage levy law giving incentive for sewage treatment plants; Waste disposal law and Refuse economic programme for collection, disposal and recycling of refuse, as well as Aerial noise law for protection and measures against sonic effects.

Amongst the countries in the far East, Singapore's achievements are remarkable in converting waste into wealth and utilizing it for economic development. In addition to an independent ministry, the anti-pollution cell is extremely active and rigid in the execution of laws.

In Japan, the environmental legislation, which covers a wide range of pollutants, is rigidly enforced. For instance, the use of cadmium has been completely banned due to its insidious toxic effect on the biological systems (EEC, Health and Safety Directorate Criteria, Pergamon Press, 1978; Aylett BJ, *Topics in Environmental Health, 2,* 1, 1979).

CONDITIONS IN INDIA

Indian constitution framed as early as 1948 makes full provision in Article 48A, for the prevention of pollution. Indian Standards Institute was established in 1948 to formulate Indian Standards for all types of industries, including mines, their effluents and permissible limits. Industrialists, scientists and administrators are involved in the functioning and mechanism of its operation in the overall interest of the nation.

A series of Acts have since been passed reflecting the earnestness of the Government in the conservation and purification of the environment. The Factories Amendment Act of 1948, amended

in 1976, includes the effective disposal of wastes and control of the level of dust and fumes injurious to human health. The Insecticide Act of 1968 is supposed to regulate manufacture and distribution of insecticides in a manner to prevent risk to human health. Similarly, there are laws against water pollution (1975), and air pollution (1978) in addition to other legislations for drug control and food adulteration (1954, 1976), though their enforcement in the states is yet to be implemented.

The Wild Life Board at the State and National levels is aimed at preserving the natural ecosystem and providing a congenial environment for our flora and fauna.

Problems related to environment are dealt with extensively, along with other agencies, by National Environmental and Engineering Research Institute of Nagpur; Industrial Toxicology Research Centre; Central Drug Research Institute; National Botanical Research Institute, Lucknow and other laboratories under Council of Scientific and Industrial Research; National Remote Sensing Agency, Hyderabad; National Institute of Occupational Health, (ICMR) and the Central Board for the Prevention of Control of Water Pollution. The Central Ground Water Board is ultimately concerned with results on problems of environment including uses of water.

The most important organization involved in environmental problems is the National Committee for Environment Protection and Control (NCEPC), which was set up in 1972 primarily at the initiative of our Prime Minister after the U. N. conference on Human Environment, with the principal objective of, identifying, investigating and proposing solutions to problems of environmental degradation resulting from unplanned development and population explosion. It is a body, acting at present under the aegis of the Department of Science and Technology, and is entrusted with the job of advising the government on environmental policies. It functions through two distinct wings, the Environment Research Committee and Man and Biosphere Committee. The NCEPC has two Sub-committees manned by academics, foresters, administrators and planners, dealing with environmental problems. General projects involving effluents, metals, pesticides, air, water and noise pollution are financed by this agency along with conducting different seminars and symposia as well as curriculum development in environmental education in collaboration with appropriate agencies like UGC and NCERT.

The Committee on Man and Biosphere programme, in addition to financing different projects, has already listed a number of areas in India, which should be preserved as *biospheres* through suitable legislation. Such areas include, amongst others, Mysore Plateau; Wynad Nilgiri; Sikkim Khangchendzonga National Park; Kanha National Park, Madhya Pradesh; Sunderbans in West Bengal and Valley of Flowers in Garhwal Himalayas, all of which, if not properly protected, may lose their distinctiveness soon with the gradual extinction of their rare flora and fauna. This body has expressed its deep concern for the protection of environment related to the Silent Valley Project — a stand also taken by the Indian Science Congress Association last year. Areas of Arunachal Pradesh, as also several zones of Meghalaya and North Eastern Hill Provinces, have been demarcated as Biosphere Reserves and as areas of wild gene pool having potential genetic resources of several of the crop species.

The continuing threat to our environment due to large-scale industrialization without proper planning led to setting up of a Panel to review existing legislative measures and administrative arrangements needed against destruction and pollution of our environment. A Parliamentary Committee headed by the Deputy Chairman, Planning Commission, submitted a report and the scientific community is anxious for adequate steps to be taken for safeguarding our national heritage. The establishment of the Department of Environment

set up on their recommendations has been long overdue. This body with powers for initiating legislation would undoubtedly mitigate the problem to a great extent. The inclusion of a clause on Ecology and Environment in the framework of the Sixth Five Year Plan (1980-85 chapter H, p 29) indeed indicates a pragmatic approach to the problem and has added a new dimension to our national planning. The deep concern of our Prime Minister for the protection of environment has been repeatedly emphasised on various occasions.

Unfortunately, knowledge of environmental hygiene and awareness of pollution hazards are seriously lacking amongst even our enlightened citizens. The callousness with which the entire problem is viewed is reflected in the filing of less than forty court cases so far against industries violating the anti-pollution law. Such an attitude may be attributed to the apprehension of a general indifference of upholders of law and the difficulty of obtaining legal redress. The recent Supreme Court Judgement on the Ratlam Pollution case is indeed a remarkable example of the enlightened judiciary upholding the citizens' right even within the limitations of law. In a dispute between Ratlam municipality and its citizens who complained of unhygienic surroundings and industrial pollution, the court has strongly indicted the Municipal Authorities and the judge in his verdict has stated that "Public Nuisance, because of pollutants being discharged by these factories to the detriment of the poorer section, is a challenge to the social justice component of the rule of law".

Is it not a paradox that in India, where legislation against industrial pollution was enacted in 1905, where measures for pollution control are enshrined in the constitution formulated in 1948 and where a series of laws have been periodically passed by the Parliament, its major cities and rivers symbolize the worst pollution centres? It is indeed a fallacy but the factors responsible for such a paradoxical situation are not difficult to analyse.

1. Undoubtedly, the excessive growth of population obscures all the developmental efforts aimed at environment protection. It puts a heavy premium on all our resources — soil, water and land, ultimately leading to the gradual depletion of natural resources and destruction of the environment. A severe check on the growth of population is imperative for the enrichment of our economy and conservation of environment. Application of the techniques already available, researches on newer drugs of organic and synthetic origin and strict administrative measures require utmost priority in achieving this objective.
2. There is a serious lack of awareness of the environmental problems not only among our citizens who are illiterate but even amongst a significant section of our so-called intelligentsia. The absence of any environmental education in the curricula of schools, colleges and universities in majority of the states has contributed to such colossal ignorance of the issues related to the environment; its necessity to human life and its protection from hazards. The study of ecology is not to be treated as a luxury but necessary for our very existence on earth. The temper and culture of Science of environment should be generated at the rural and urban levels. In achieving this objective, the government agencies, the professional societies and academics may play a prominent role.
3. One of the most important factors contributing to the seriousness of pollution problem in India is the laxity in adherence to rules and regulations meant for maintaining the level of pollution to a minimum. The laws at present in vogue are fraught with limitations and need to be updated and there is no rigidity in their enforcement. Our Prime Minister has already assured us that

legislations for water and air pollution control are receiving serious consideration from the government.

The importance of such legislation in cleaning the environment from its present deplorable state can hardly be overestimated. The impact on environment must be one of the principal factors in controlling grant of licences to the industries, not on paper but in practice.

4. The industrialists in general, with a few exceptions, are the major offenders in creating the pollution hazards in this subcontinent. The motivating force being profit alone, complete disregard for environment is exhibited in their operations, which are promoted by laxity in the enforcement of environmental laws. Such an attitude is detrimental not only to the growth of the present but also to the welfare of the future generations in view of the long-term effects of environmental pollutants,

Last but not the least, it must be admitted that in spite of achieving excellence in several spheres of national endeavour in our planning and development projects, the environment has not so far been considered in its totality. The depletion of natural resources and destruction of environment, causing serious upset in ecological balance, are due in a large measure to inadequate planning in the past. Only in the framework of the Sixth Five Year Plan, Ecology has been given its due share end as such indiscriminate development, ravaging the environment, may not happen as in the past.

In brief, the serious pollution hazards in our country may be attributed to five principal factors, viz., population explosion, lack of awareness of environmental problems due principally to absence of environment education in our curriculum, outdated environmental laws and laxity in their enforcement; indifference of the industrialists towards environmental problems and inadequate planning.

RECOMMENDATIONS

For the protection and conservation of natural ecosystems ; in order to provide clean air for breathing, pure water for drinking, uncontaminated food for consumption, suitable drugs for medical cure, habitat with proper sanitation facilities — all in totality contributing to a congenial environment for growth and development, the following remedial measures may be recommended :

1. Immediate legislation and implementation of acts for :
   (a) Air pollution control.
   (b) Water pollution control.

   The standard of limit set by Indian Standards Institution and Mining Research board and similar other official agencies should be adopted, while maintaining enough flexibility for variation of the standards to be set by specific agencies at periodic intervals, whenever necessary.
2. Specific standards should be established for the use of agricultural chemicals, such as insecticides, pesticides and fertilizers. Similar standards in the use of chemicals in pharmaceutical, cosmetic, plastic, mining and other industries should be determined from time to time : legislation for adhering to the prescribed standard is essential.
3. Strict adherence to Factories Act (1976), Drug control Act (1955), Food Adulteration Act (1976) and Insecticide Act : These acts require further modification with the introduction of several new chemicals in industry. The violation of any of the set standards should be liable to heavy penalty and rigorous imprisonment.
4. Creation of a Department of Environment or an environment protection agency with power for initiating legislative measures by the Parliament. Fortunately, such a step has already been taken by our Government. Such a department, amongst its other functions,

should be entrusted with the following responsibilities :

(a) Control of the use of environment including soil, air and water, maintaining a strict vigilance system, over metropolitan areas.
(b) Regular monitoring of air and water quality with the help of a special cell meant for the purpose.
(c) Imposition of penalty on offenders not adhering to set standards.

5. Environment protection should be included in the concurrent list of the constitution.
6. Collaborative programmes and researches should be initiated for the control of air and water pollution with the other industrialized countries, and an appraisal be made of the measures adopted by them,
7. Publication of Health and Safety Directorate criteria — for different pollutants should be carried out as a routine measure as done by EEC in England. This function may also be entrusted to the Department of Environment.
8. In the sphere of education, in order to foster awareness and understanding of the impact of ecological interdependence, environment education should be made compulsory in the curricula of schools and colleges. This education, while catering to students, should also be imparted to adults and professionals whose activities are directly concerned with the preservation, improvement, and quality of the environment.
9. Scientific Societies, Associations and Academies, including the National Committees of the Indian National Science Academy as well as Professional Societies should play a vital role in creating a temper of science and generating awareness of environmental problems in the rural and urban sectors. The preparation of the State of the Art reports, arranging for seminars and symposia and undertaking coordinated research on environmental problems in specific areas should be undertaken as coordinated projects with central support.
10. Planting of trees properly suited to the climate is to be adopted as a routine measure through Forest Department and Educational Institutiions. Aerobiological data should be available specially for plants having allergic pollens. Deforestation should be legally prohibited.
11. Each State must form a functioning Wild Life Board and an Environment cell, looking after the needs of the state and collaborating with the Department of Environment at the Central level.
12. Recycling plants for municipal waste and sewage in the major cosmopolitan cities must be established with partial Central support for generation of gas, fertilizers and chemicals.
13. Major industries will have to undertake
    (a) installation of effluent recycling plants;
    (b) Even after recycling, a charge will have to be paid as Anti-Pollution Tax for discharging the effluents within the permissible limits. This is necessary as such permissible limits too have a cumulative effect, for which remedial measures are to be adopted by the government;
    (c) A fraction of R&D efforts must be directed to anti-pollution research.
14. Reclamation of land to its original state should be the responsibility of the industries involved in mining and similar operations in the area. Legislation to this effect and rigorous measures for violation are necessary.
15. Incentives are to be provided at the state level for such voluntary movements comparable to "Chipko" movement for the protection of plants.
16. In agriculture as far as practicable,
    (a) Biological control of pests should replace as far as practicable use of insecticides,

pesticides and fungicides. The data available from different agencies with regard to pesticide residues may be utilized;

(b) Biological nitrogen fixation through algae, substituting for nitrogen fertilizers, may adopted to the maximum level. Incentives should be provided for researches on transfer of nitrogen fixing property to non-legumes through genetic engineering technology;

(c) Suitable post-harvest technology should be adopted for prevention of aflatoxin production during storage of grains and

(d) Suitable strategies should be developed against shifting cultivation of crops, treating it as a socio-economic issue.

17. A large number of Biosphere Reserves containing endangered, rare or commercially important species should be established as early as possible on the basis of the Directory of flora and fauna. Adequate legislative measures are necessary for management of such reserves, mandatory on the states concerned, as constituents of such reserves are to be treated as a national heritage.
18. Gene Pool Reserves and gene sanctuaries should be demarcated and protected in their natural environment, as for example in NEFA and Arunachal Pradesh, to preserve wild germ plasm from extinction and for their conservation and utilization.
19. In the practice of conservation of flora and fauna, the list of endangered species should be continually updated in view of the dynamics of evolution. Suitable measures for protection of endangered species may be adopted through legislation. High priority should be given for the protection of ecology and conservation of resources in the Himalayas.
20. Brickfields should be prohibited by law near the agricultural lands or populated areas. They should always be established in riverine coastal belts to avoid the danger of affecting plant and animal life in the environment. The brickfield has an encroaching effect, pollutes the environment and diminishes the productivity of crops in its vicinity.
21. Aerobiological centres should be established in different parts of India including the cosmopolitan cities for monitoring and research in airborne spores.
22. Cleaning of choked lakes and rivers should be undertaken for all states.
23. To augment energy sources free from environmental hazards, in addition to solar energy,
    (a) Biomoss from algae, microbes and higher plants should be employed as a source of energy, with the byproducts serving as feed and fertilizers.
    (b) Suitable genetic engineering techniques be evolved for proper microbial strains needed for degradation of cell walls of woody plants, to be used as a source of biomass for energy production.
    (c) Energy Plantation with hydrocarbon sources should be undertaken on a massive scale on non-arable lands. Incentives for researches on these three facets should be treated on a priority basis.
    (d) In order to meet the demands of wood as direct or indirect source of energy, without endangering the forest resources, social forestry should be encouraged with incentives to farmers like cash crops.
24. A suitable agency should be established for conservation and monitoring of our marine resources and providing protection against pollution hazards. The Department of Environment may have a special cell for that purpose. The expertise of National Institute

of Oceanography may be utilized to achieve this objective.

25. For coastal factories, submarine pipelines are to be laid for discharge of effluents at a depth of 17 to 20 m from the bottom.
26. Satellite and space technology may be adopted on a wider scale for weather forecasting, agricultural practice and monitoring of airborne particles to prevent the impact of environmental changes and proper harnessing of natural resources.
27. Genetic counselling units should be established at different regions of India to monitor genetic disorders and congenital anomalies and for formulation of suitable guidelines for prevention against their spread to future generations.
28. Centres of researches on ergonomics and work physiology should be set up at different industrial zones and tribal centres.
29. Scientific, administrative and social measures should be adopted to check population explosion. Researches on antifertility drugs including tissue culture and genetic techniques for improvement and propagation of steroid yielding species should be given special mention.
30. At all levels of planning, including urban and rural planning, the involvement of ecologist is essential. Ecology is to be treated not as a luxury or option but a necessity for the very existence of life.

With the adoption of these measures and rigid enforcement of laws undeterred by any consideration, political or otherwise, one can look forward with confidence to keeping the environment free from the evils of pollution. A polluted environment is not congenial for creative ideas, innovative skills or brilliant scientific discoveries. It hampers the aesthetic sense, degrades the values of life and generates evils in our body and mind. It does not allow the pursuance of the basic philosophy of a devotee of Science — the search for truth and for harnessing Science and Technology towards the alleviation of human suffering. The outstanding potential of the development of Science and Technology can neither be realized nor enriched in an atmosphere with disturbed ecological balance and susceptible to pollution hazards. The eradication of pollution and the conservation of the natural ecosystems in all the developmental efforts are imperative not merely for the growth of our economy but for our very existence on earth. As such it demands the attention it deserves.

In the preparation of the address, free use has been made amongst others of the following reports: Reports of the Central Mining Research Station, Fertilizer Corporation of India, Industrial Toxicology Research Institute, National Environmental Engineering Research Institute, National Committee on Environmental Protection and Control, Seminar on resource, development and environment in Himalayan region, Man and Biosphere Committee, AMBIO, National Institute of Oceanography; International Commission for protection against environmental mutagens and carcinogens; Draft Sixth Five year plan, Government of India; Report on World Environment Day Programme; BARC Symposium on Pollution and Human environment, Man and Environment, BARC symposium; Mutation Research, H. Auerbach; Chemical Mutagens A. Hollaender Ed.; A perspective of environmental pollution-H. W. Moldqate and Technology, Man and Environment-D. Hamilton (Through courtesy of Mr A. K. Boss, Head, Extramural Research, C.S.I.R.); Environment-W. W. Murdoch, Ed; and Biogeochemistry of metals in environment-J. O. Nrigge, Ed.

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HEALTH BENEFITS OF BETEL LEAVES AND THE HEALTH EFFECTS OF BETEL QUID

U.B. Roy and K.K. Vijayalaxmi*

Since time immemorial the use of betel leaves has been an integral part in India and in general, a large part of Asian countries. It is well known for its extensive use in Ayurvedic medicine and also plays a vital role in various ceremonies and auspicious occasions as an indicator of goodness. Consumption of betel leaf is usually in the form of betel quid or paan which consists of areca nut, lime and some spices with or without tobacco. Long term consumption of betel quid with tobacco is known to cause adverse health effects, mainly carcinomas. In addition to oral cancer it is also known to induce chromosomal aberrations and tumours in the pharynx and oesophagus. However, consumption of betel leaf alone does not induce cancer and has invaluable health benefits due to its tremendous medicinal properties.

SYSTEMATIC POSITION

Kingdom	:	Plantae
Division	:	Angiosperma
Class	:	Magnoliidae
Order	:	Piperales
Family	:	Piperacea
Genus	:	*Piper*
Species	:	*betle* Linn.

Betel (*Piper betle*) is the leaf of a vine belonging to family Piperaceae, which also includes pepper and kava. It is a mild stimulant and has a lot of medicinal properties. Betel leaf is mostly consumed in Asia and elsewhere in the world by some Asian emigrants, as betel quid or paan, with or without tobacco, in an addictive psycho-stimulating and euphoria-inducing formulation with adverse health effects (WHO, 2006). The betel plant is an evergreen and perennial creeper, with glossy heart-shaped leaves and white catkin. The betel plant originated from South and South East Asia (India, Nepal, Bangladesh and Sri Lanka). Even though consumption of betel quid with tobacco poses serious health hazard, the leaves alone when consumed have innumerable health benefits.

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VERNACULAR NAMES

Betal leaf is called Nagavalli in Sanskrit. It is variously known in different names in different regions, Paan (in Assamese/Urdu/Hindi/Oriya/ Bengali), Vetrilai (Tamil), Tambula and Tamalapaku (Telugu), Vidyache pan (Marathi), Veeleyada yele (Kannada), Vettila (Malayalam), Plu (Mon), Malus (Tetum), Maluu (Khmer), Plu (Thai), Bulath (Sinhalese), Malu (Tokodede), Bileiy (Divehi), Bulung samat (Kapampangan), Daun sirih (Malay), Daun sirih/suruh (Bahasa Indonesia), Papulu (Chamorro), Ikmo (Philippines), Pu (Lao), and Trau (Vietnamese).

CULTIVATION

Betel leaf is cultivated in most of South and Southeast Asia. Since it is a creeper, it needs a

compatible tree or a long pole for support. Betel requires high land and especially fertile soil. Waterlogged, saline and alkaline soils are not suitable for its cultivation. In Bangladesh, farmers called Barui prepare a garden called a Barouj in which betel is grown. The Barouj is fenced with bamboo sticks and coconut leaves. The soil is plowed into furrows of 10 to 15 meters length, 75 centimetres in width and 75 centimetres depth. Oil cakes, manure and leaves are thoroughly incorporated with the topsoil of the furrows and wood ash is added on top. The creeper cuttings are planted after proper dressing in the months of May and June at the beginning of the monsoon season. The plants are neatly arranged in parallel rows about two feet apart, and the saplings are twined around upright sticks of split bamboo and reeds. Proper shade and irrigation are essential for the successful cultivation of this crop. The plants are regularly watered in the hot months. The leaves of the plant become ready for plucking after one year of growth and the production of the Barouj lasts for several years from the date of planting. Betel needs constantly moist soil, but there should not be excessive moisture. In 3 to 6 months the vines reach 150 to 180 centimeters in height and they will branch. The harvested leaves are used both for domestic consumption and for export to other parts of Asia, the Middle East, Europe, and the United States. Betel is an important part of the economy in rural Bangladesh.

CONSUMPTION

An extensive research monograph by the World Health Organization in 2004 reports that betel leaf is consumed in South East Asian community worldwide, predominantly as a betel quid or paan. The betel quid contains betel leaf, areca nut and slaked lime, and may contain tobacco. Other substances are often added to the betel quid, in particular, spices, such as cardamom, saffron, cloves, aniseed, turmeric, mustard or sweeteners according to local preferences. Numerous commercially produced mixtures containing some or all of these ingredients are also available in various parts of the world. The betel quid is thus a mixture of substances and betel leaf is not consumed alone. For a predominant majority, the paan usually contains the betel leaf with two basic ingredients, either tobacco or areca nut or both, in raw or any processed form. There is archaeological evidence that the betel leaves have been chewed along with the areca nut since very ancient times. In most countries the mixture of both has a ceremonial and highly symbolic value. In India, Burma, Nepal, Sri Lanka and other parts of South Asia and Southeast Asia, the leaves are chewed together in a wrapped package along with the areca nut which, by association, is often inaccurately called the "betel nut" and mineral slaked lime (calcium hydroxide). The lime acts to keep the active ingredient in its freebase or alkaline form, thus enabling it to enter the bloodstream via sublingual absorption. The areca nut contains the alkaloid arecoline, which promotes salivation, and is itself a stimulant. In India, the betel and areca play an important role in Indian culture, especially among Hindus. Many traditional ceremonies governing the lives of Hindus use betel and areca. The betel and areca also play an important role in Vietnamese culture. In Vietnamese there is a saying that "the betel begins the conversation", referring to the practice of people chewing betel in formal occasions or "to break the ice" in awkward situations. The betel leaves and areca nuts are used ceremonially in traditional Vietnamese weddings. In Papua, New Guinea, betel is prepared with a mustard stick dipped in lime powder and acts as a stimulant to suppress hunger, reduce stress and heighten the senses. Most families have backyard gardens and many grow betel there. The lime must be purchased and is processed from corals, especially the fast-growing stag horn corals of genus *Acropora*. Chewing betel quid to give fragrance to mouth, after washing one's teeth,

applying collyrium on one's eyelids, colouring one's lips with alacktaka, is mentioned in chapter 4 of the Kama Sutra.

COMPOSITION

The specific spicy burning taste of this leaf is derived from the presence of volatile oil consisting of phenols and terpenes etc. The presence and proportion of the varous components in the oil vary markedly among the cultivars which makes them differ in aroma and taste. It exhibits carminative, stimulant, astringent and aromatic properties. It contains Protein (3.1%), Fat (0.8%), Minerals 2.3% which includes Iron and Aluminium, Fiber 2.3%, Carbohydrates (6.1%), Calcium, Riboflavin, Carotene, Niacin, Thiamine, Vitamins B and C, Sugar, Tannins, Diastases and essential oil. The active ingredients of betel oil, which is obtained from the leaves, are primarily a class of allylbenzene. Though particular emphasis has been placed on chavibetol (betel-phenol; 3-hydroxy-4-methoxyallylbenzene), it also contains chavicol (p-allyl-phenol; 4-allyl-phenol), estragole (p-allyl-anisole; 4-methoxy-allylbenzene), eugenol (allylguaiacol; 4-hydroxy-3-methoxy-allylbenzene; 2-methoxy-4-allyl-phenol), methyl eugenol (eugenol methyl ether; 3,4-dimethoxy-allylbenzene) and hydroxycatechol (2,4-dihydroxy-allylbenzene). Several terpenes and terpenoids are present in the betel oil as well. There are two monoterpenes, p-cymene and terpinene, and two monoterpenoids, eucalyptol and carvacrol. Additionally, there are two sesquiterpenes, cadinene and caryophyllene.

HEALTH EFFECTS

The betel leaf is predominantly consumed in the world as *betel quid* or *paan*, which is a mixture of substances. The *paan* almost always contains a betel leaf with two basic ingredients, either areca nut or tobacco or both, with lime (calcium hydroxide or calcium carbonate)[4]. Both tobacco and areca nut are considered as carcinogenic. Betel quid is strongly carcinogenic[2, 11]. It is said that the percentage of oral cancer among all cancers diagnosed in hospitals in Asia has always been much higher than that usually found in western countries, where the habit of chewing betel quid, with or without tobacco, is virtually unknown. In many descriptive studies, investigators have obtained histories of chewing betel quid with tobacco from series of patients with oral cancer; and in all these studies the percentage of patients who practice betel leaf chewing was found to be extremely large. Researchers also noted that the cancer generally develops at the place where the betel quid is kept. In an earlier study in 1985 scientists linked malignant tumors to the site of skin or subcutaneous administration of aqueous extracts of betel quid in mice. In hamsters, fore stomach carcinomas occurred after painting of the cheek-pouch mucosa with aqueous extracts or implantation of a wax pellet containing powdered betel quid with tobacco into the cheek pouch. Carcinomas occurred in the cheek pouch following implantation of the wax pellets. In human populations, there are reports of elevated frequencies of micronucleated cells in buccal mucosa of people who chew betel quid in Philippines and India. Scientists also found that the proportion of micronucleated exfoliated cells is related to the site within the oral cavity where the betel quid is kept habitually and to the number of betel quids chewed per day. This proportion, they report, could be reduced by administration of vitamin A or β-carotene or a mixture of the two. In related studies, scientists have reported that oral leukoplakia shows a strong association with habits of betel-quid chewing in India. Some follow-up studies have shown malignant transformation of a proportion of leukoplakias. Oral sub mucous fibrosis and lichen planus, which are generally accepted to be precancerous conditions, appear to be related to the habit of chewing betel quid, that is paan (WHO, 2008). In a study conducted in Papua New Guinea it was found that the most common malignant tumour was oral squamous cell cancer which is

associated with betel chewing[9]. They reported that the oral cancer is concentrated at the corner of the mouth and cheek, and corresponds precisely with chewing site of betel leaf with lime in 77% of 169 cases. Powdered slaked lime applied to the chewed areca nut placed inside a betel leaf causes the mean pH to rise to 10, at which reactive oxygen species are generated from betel quid ingredients *in vitro*. They claim that Reactive oxygen species, together with sustained lime-induced cell proliferation which is a possible mechanism of carcinogenesis. Betel chewing increases the risk of cardiovascular disease and mortality[12]. In this study, they investigated the association between betel nut chewing and general obesity (BMI 25 kg/m2) and central obesity. Using multiple linear regression analyses, they claim betel consumption was statistically significantly associated with obesity. The reason for these links between obesity and betel leaf chewing, the scientists admit is unclear. In another study, they reported that the extent of cancer risks of betel quid chewing is beyond oral cancer. In addition to oral cancer, significant increases were seen among chewers for cancer of the esophagus, liver, pancreas, larynx, lung, and all cancer. Chewing and smoking, as combined by most betel chewers, interacted synergistically and was responsible for half of all cancer deaths in this group. They also said that chewing betel leaf quid and smoking shortened the life span by nearly 6 years. A Lancet Oncology publication claims that betel leaf quid or paan masala may cause tumours in different parts of the body and not just the oral cavity as previously thought. A study conducted in Sri Lanka by found that there was a high prevalence of oral potentially malignant disorders in rural Sri Lankan populations[3]. After screening for various causes he reported that betel-quid chewing is the major risk factor, with or without tobacco. In October, 2009, 30 scientists from 10 countries met at the International Agency for Research on Cancer (IARC), a World Health Organization sponsored group, to reassess the carcinogenicity of various agents including betel leaf quid with areca nut, and mechanisms of carcinogenesis. They concluded that there is sufficient evidence that betel quid without tobacco leads to tumor in oral cavity and oesophagus, and that betel quid with added tobacco is a carcinogen to oral cavity, pharynx and oesophagus[1]. The high rate of oral cancer in South Asia is thought to be due to the chewing of betel preparations; the inclusion of tobacco may worsen the risk, but there is also evidence that the areca nut, alone or as part of a betel quid, may cause cancer even without tobacco[5]. Some reports suggest that betel leaf by itself has adverse health effects. They reported chromosome damaging effects of betel leaf in human leukocyte cultures[8]. These researchers observed an increase in the frequency of chromatid aberrations when the leaf extract was added to cultures. Another scientific study from Japan finds that betel leaf may by itself cause fore stomach papilloma[6]. However, scientific studies that evaluate the health effects of betel leaves by itself are limited, in contrast to the extensive medical studies on betel quid or paan.

HEALTH BENEFITS

Betel leaf has long been recognised as one of the medicinal plants that has tremendous health benefits. The medicinal properties of betel leaf are well known since time immemorial. Betel leaf is used as a stimulant, an antiseptic and a breath-freshener. According to traditional Ayurvedic medicine, chewing betel leaf is a remedy for bad breath.

- It acts as aphrodisiac.
- It lessens thirst and strengthens teeth.
- It has cooling as well as analgesic properties.
- It is useful in providing relief for headaches.
- Leaves are useful in healing of wounds and boils.
- Beneficial in treating nervous pains, exhaustion as well as debility.

- A mixture of betel leaf juice and honey can be used as a tonic.
- Betel leaves have diuretic properties.
- Juice mixed with diluted milk is consumed for easing urination.
- The leaves are useful in pulmonary affection in old age and childhood.
- Effective in treating sore throat and to get relief from cough and difficulty in breathing.
- Helpful in treating inflammation such as orchitis and arthritis.
- Helps secretion of milk during lactation.
- Relieves one of ear aches.
- Some components prevalent in betel leaves may help in diabetes.
- Betel leaf juice is a tonic to brain, heart, liver and other internal organs.
- Effective to improve bowel action in the case of constipation.
- When applied to the temples, it is effective to provide relief from headache.
- Relieves pain of swollen glands.
- Leaf juice is effective to cure eye problems and night blindness.
- The leaf has good smell along with sharp taste and this improves taste and appetite.

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LIFE SKETCHES OF OFFICE BEARERS, SECTIONAL PRESIDENTS & RECORDERS OF THE INDIAN SCIENCE CONGRESS ASSOCIATION, 2013-2014

PROF. R. C. SOBTI

General President

R. C. Sobti is presently Vice-Chancellor, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow.

Prof. R. C. Sobti's association with academia-as a teaching assistant in 1974 to the Vice-Chancellor of one of the top ten Universities in India-spans close to four decades. His contribution as a ground-breaking biotechnologist, skilled orator, efficient administrator and futuristic Vice-Chancellor has won him accolades at both and national and the international level-a fact recognized by the Government of India while honoring him with the Padmashree in 2009. He has recently been offered the first Vice-Chancellor of DAC University, Jalandhar (Pb). The Government of India had earlier offered him Vice-Chancellorship of newly created Central University of Himachal Pradesh. It is because of his dynamism, transparency and proactiveness for societal work particularly for the marginalized groups.

Prof. Sobti began his teaching career in the Department of Zoology, Panjab University in 1976 and went on to become the founder-Chairperson of the Biotechnology Dept. as a Professor or Cell Biology. Currently he has over 246 publications and 22 books to his credit. His research work, particularly in the areas of Cancer and Environmental Biology, has more than 1200 citations with an 20 H factor and has seen him head or be a part of the editorial boards of respected national and international journals such as DNA and Cell Biology, Molecular Cell Biochemistry, Mutation Research, Oncology Research. He has also been awarded over 23 joint and independent projects by the UGC, CSIR, ICMR, DOE, DBT for policy-driven research in genetic markers and cancer-environment linkages.

From receiving the INSA Young Scientist Medal over three decades ago, Prof. Sobti has now moved on to being nominated a Fellow of this prestigious Indian National Science Academy of India along with fellowships to the National Academy of Sciences, National Academy of Medical Science, National Academy of Agricultural Sciences, Indian Society of Cytologists & Geneticists *et al*. He has recently been awarded the D.Sc. Degree as notified by Himachal Pradesh University.

Under his nine-year tenure as the Chairperson, the Biotechnology Dept. grew to be an Internationally recognized centre even at a time when the study of this discipline was in its infancy.

Besides serving as a member of various committees of the UGC, Prof. Sobti is also an Executive Committee member of NAAC and a part time Director of the National Research Development Organization, Earlier, he has officiated as the University Dean, Alumni Relations, Dean Foreign Students, Hon. Director UGC Academic Staff College, besides coordinating the University-Industry Interaction Cell and the Centre for Vocational Studies.

Experience gained during the above tenures was brought into play by Prof. Sobti during his Vice-Chancellorship of Panjab University, beginning 23rd July, 2006. The last five-odd years have seen the University progress at an accelerated pace, chalking many firsts to its credit-research grants totaling over 80 crore; central funding of over 300 crore; introduction of more than 65 industry-oriented courses; creation of the post of Dean Research; establishment of chairs to promote both contemporary and traditional thought; across-the-board introduction of the semester system and the groundwork for the choice based open-credit system in keeping with the UGC guidelines; ICT-driven administrative reforms, particularly with reference to examination, hallmarked degree and Central Information Management Modules for greater work efficiency and transparency.

Transparency, in fact had been the lodestone of Prof. Sobti's Vice-Chancellorship as all decisions are routed through duly-constituted committees and implemented after Senate/Syndicate clearances-meetings of which are held strictly as per the provisions of University Calendar.

In recognizing that a University is more than just a cluster of brick and mortar cemented with the ink of academia, Prof. Sobti focused on creating a world class academic infrastructure and a conducive work environment for research while at the same time safeguarding the principle of equity by ensuring that education remained both inclusive and affordable. Affirmative action was taken by establishing Regional Centres and Constituent Colleges in rural areas; creation of special seats for the Single Girl Child, Cancer, AIDS and Thalasemia patients, not just on campus but also in the 188 affiliated colleges; and free education for orphans, blind, BPL and special-abled students.

Special focus was laid on Distance Education, starting with changing the nomenclature of the Dept. of Correspondance Studies to the University School of Open Learning and moving on to an entire structural-functional transformation that resulted in a quantum jump in enrolments.

He also spearheaded the move to adopt 8 peripheral villages of Chandigarh in order to improve their socio-health profile through the organization of computer literacy, language proficiency, health and hygiene workshops. Jyotirgmaya 91.2 MHz, a community radio station was set up on campus to provide an empowering platform for lesser-privileged sections of society. The setting up of an Education Multi-media Research Centre is under process for the production of socio-cultural docudramas to be telecast on Gyan Darshan as also for EDUSAT-linked teaching and learning hubs. NGO collaborations have been set up for providing the services of University students to educate the under-privileged children. A Senior Citizen Home too is on the anvil.

Acutely attuned to the importance of environment because of his work in cancer biology, Prof. Sobti ensured that the 50% ratio of green cover to concrete remains undisturbed on campus. Uninhabited tracts of land were developed into gardens with budgetary provisions for water harvesting and the campus was declared a smoke-free and polythene-free zone.

Prof. Sobti has been Vice-Chancellor with a difference having excelled as a leader in academics and education. Prof. Sobti initiated a large number of new interdisciplinary courses and made campus academically vibrant. Under his leadership, university took many new initiatives for an all inclusive growth of the society namely creation of seats for single girl child and Cancer, AIDS and Thallesemia patients not only in the campus, but also in its 198 affiliated colleges; provision of free education to BPL blind, orphan and handicapped students; made the campus green by planting thousands of saplings and creating new parks as also making the campus smoke and polythene free; adopted 8 villages around Chandigarh for healthy

profile, 100% literacy and caring for the environment and he is replicating his experiences at BBA University, Lucknow with much more vigour. Taking into account his contribution to NCC and societal commitment the Government of India has given him honorary rank of Colonel.

In a nutshell he has applied innovative ideas to make education society and industry relevant, taking higher education to rural India and leading Panjab University & now Babasaheb Bhimrao Ambedkar University to the forefront of international level.

ER. NILANGSHU BHUSAN BASU
General Secretary (Membership Affairs)

Born on 14th day of July, 1956, Sri Nilangshu Bhusan Basu graduated in Civil Engineering from Bengal Engineering College in the year 1977 with distinction. He completed Master's degree in Structural Engineering from Jadavpur University in the year 1983 with distinction and successfully undergone training in River Basin Management at Thames Water Authority, U. K. in the year 1989. He has served as Chairman of Architectural Engg. Division of Institute of Engineers, West Bengal Chapter. He is also adorning the honoured post of the Vice President at the Institute of Public Health Engineers. Presently, he is working at The Kolkata Municipal Corporation in the capacity of the Principal Chief Engineer (civil). Under the supervision of his Engineering skills a good number of infrastructure projects for the city of Kolkata have been completed successfully. 40 MGD water treatment plant at Palta, 100 MGD pressure station for clear water at Palta, 100 MGD intake jetty with intake station of Palta, Networking for water mains, Booster pumping stations at Parkcircus, Bagmari, Ranikuthi, Kalighat Drainage pumping station of Southern Avenue, Automated computerized car parking system at Rowdan street (over ground) at Lindsay street (underground) etc, are only a few among the large number of successful projects that he has so far undertaken. All the JNNURM projects of KMC worth Rs. 1000 crores had also been formulated and is being executed in his leadership. These prestigious projects include 134 year old underground brick sewer rehabilitation of Kolkata also. He has also been invited to deliver lectures in many National and International seminars in India and Abroad and has a number of International publications in prestigeous engineering magazines too.

PROF. ARUN KUMAR
General Secretary (Scientific Activities)

Prof Arun Kumar has over 30 years of teaching and research experience in Department of Earth Sciences, Manipur University. He initially started his research in the field of fluvial geomorphology with application of GIS and Remote using techniques in the watersheds studies in Manipur. He has carried out the landslide hazards studies along the National Highways in Manipur, North Eastern, Jammu & Kashmir and Himachal Pradesh India.

He has established number of seismic observatories in Manipur as well as NE India to

monitor the ongoing seismological status as the region of Manipur, falls under highest Seismic Zoning map of India. He created the earthquake hazard awareness in a scientific manner in many schools in NE region where school children can witness to measure the earthquake epicentre parameters in their school earthquake laboratories. Approximately sixty observatories are operational in various higher secondary schools in the NE India.

Now, he is establishing a multi-parameter geophysical observatory at Imphal, Manipur to observe the earthquake precursory phenomenon by using the geo-electric, electro-magnetic, magneto-telluric, seismic & micro-strain through boreholes and anomalies due to the crustal deformations. He has continued the crustal deformation measurements along actives faults in (Swalbard) Arctic Region, which is quite interesting in estimating the Isostatic Rebound phenomenon for ongoing climate change. The entire research activities are financially supported by the Ministry of Earth Sciences (MoES), Science Technology, Ministry of Environment & Forest (MoEF) Government of India. He is presently the members of Programme Advisory Committee (Seismology Programme) of MoES and Expert Advisory Committee of Hydroelectric & River valley Projects of MoEF.

He has travelled various countries for attending International conferences, training programmes and research activities. More than fifty research articles in various International and national journals are published. Besides, two volumes are edited and contributed a scientific database on water balance of small watershed from Manipur. Ten students have been awarded and six are in progress for their Ph. D. degree. He has trained many of his research scholars and M. Sc. students in GIS, Remote Sensing and Seismology.

He is active member of the Indian Science Congress Association, Kolkata and enjoyed the elected post of Sectional President (ESS Section, 98 ISCA).

PROF. DHYANENDRA KUMAR
Treasurer

Professor Dhyanendra Kumar is presently Professor and Head, Department of Zoology, Veer Kunwar Singh University, Arrah, Bihar. He is Member Syndicate and Convener of the committee for Academic and Administrative reforms of Veer Kunwar Singh University, Arrah. He was Dean faculty of Science and was Coordinator College Development Council of the University. He was also Coordinator of Vidya-Sagar classes (a Video Conferencing Class-room programme) of the University. He is also a member (eastern zone-RAC) of central Board of Workers Education (CBWE) under Ministry of Labour and Employment, Government of India.

He did his M.Sc. and Ph.D. from Visva-Bharati University, Santiniketan. During his M.Sc. Classes he was selected to represent Visva-Bharati at Diamond Jubilee Session of ISCA at Chandigarh (1973) as a student delegate. He was also selected among 52 students across the country as a Post-Graduate Meritorious Student to attend Summer Institute at Porto-Novo, Annamalai University, organized by U.G.C. in 1972. He was Senior Research Fellow under Council of Scientific and Industrial Research at Visva-Bharati, Santiniketan (1976-1978) and obtained his Ph.D. degree in 1978.

Professor Kumar has more than 38 years of teaching and research experience and has successfully supervised 15 students for the award

of Ph.D. degree. He is presently working on effect of pollutants on enzyme activity and also working on endocrine disruptors and has published more than 50 papers in the journals of National and International repute.

He was the Executive Secretary of 6th International Congress of *Asia Oceania Society for Comparative Endocrinology* (An International organization of 19 countries). He has also represented ISCA and the Country at University of Kelaniya, Colombo- Sri Lanka at 65th Session of SLAAS (Sri Lanka Academy of Advances of Sciences). He was awarded 50000 Yen in 1990 to attend International Congress of Ecology at Yokohama, Japan. He is in the editorial Board and reviewer/ referee in a number of Journals of National and International repute. His research papers were accepted for presentation in several Seminars/ Symposia at Japan, USA, Thailand, Egypt, Netherland and China. He has organized and chaired various sessions of the International and National conferences on the topics like molecular signaling, endocrine disruptors, fish-toxicity, biodiversity and other environmental related issues.

Professor D. Kumar has worked as a Recorder in the Section of the Environmental Science of ISCA in 2005 at Ahmedabad. He was the Member Council from 2006 and 2011 and member of the Executive Committee from 2008 to 2011 of the Indian Science Congress Association.

PROF. SWAPAN KUMAR DATTA
President
Section of Agriculture and Forestry Sciences

Prof. Swapan Datta is the Deputy Director (Crop Science) of the ICAR (Indian Council of Agriculture Research), New Delhi since June 2009. Prior to assuming the charge as the DDG (CS), he served as the Rashbehari Ghosh Professor and Head of Botany Department at Calcutta University. Born at Sirajganj in 1953 and studied in Jnanadayini High School (now Bangladesh), obtained BSc from Presidency College, MSc and PhD from University of Calcutta., IP-Agricultural Biotechnology management course from Cornell University.

Dr Datta is a Member/Chairman of several important National Committees of Govt. of India and International scientific committees/societies. He has been elected Fellow of the National Academy of Sciences (FNASc) and National Academy of Agricultural Sciences (FNAAS). He has received several awards including Panchanan Maheshwari Medal for outstanding work on Embryology and Plant Biotechnology; ISCA Platinum Jubilee lecture 2010, Paul Johnnes Brouhl Memorial Medal 2009. Dr Datta has lectured at Various Universities all over the world and delivered contributed talks at national and international seminars as invitees and key note speaker.

Dr Datta has over 38 years of research and teaching experience in Plant Biology including developmental biology, molecular biology, and plant biotechnology towards crop improvement. During his research career, he served Ramakrishna Mission V.C. College, Rahara, Visva-Bharati University, Santiniketan and University of Calcutta in India. Dr Datta was awarded several prestigious fellowships/assignments in abroad including FMI (Friedrich Miescher Institute) Fellowship, Basel, Switzerland, ETH-Zurich, Switzerland, BBA-Gruenbach, Germany, UC-Davis, USA, IRRI (International Rice Research Institute), Los-Banos, Philippines and HarvestPlus global Rice Crop Leader.

Dr Datta made significant contributions in cereal biotechnology particularly in rice. Some of his group's pioneering research contributions include: (1) First report of genetic engineering of fertile indica rice, (2) Sheath blight resistance in rice (Nature Biotechnology, 1995, Mol. Plant Pathology, 2013, (3) Development of stem borer resistance in rice and field evaluation in China and in India (4) Function of green revolution gene in rice, Developed DH lines in rice, wheat and barley and utilized in molecular and transgenic breeding, Enhanced photosynthesis using C4 pathways, Abiotic stress tolerance in rice, Low Phytate and high bioavailable iron enriched rice, supervised 30 PhD students across the world, Bangladesh, China, India, Myanmar, Portugal, Switzerland, Vietnam etc., and has published 120+ research papers in major reputed journals with more than 2000 citations of 10 best research papers.

Dr Datta is an internationally known Plant Biotechnologist and also recognized as an acclaimed public speaker. He has published two books and also contributed articles on Agricultural Science Policy particularly in Crop Biotechnology.

PROF. PREMENDU PRAKASH MATHUR

President

Section of Animal, Veterinary and Fishery Sciences

Prof. Premendu Prakash Mathur, is the Vice-Chancellor, KIIT University, Bhubaneswar, India. Previously he served as Dean, School of Life Sciences and Professor of Biochemistry & Molecular Biology and Head, Center of Excellence in Bioinformatics, Pondicherry University, Pondicherry. He received M.Sc.and Ph.D. degrees from Banaras Hindu University, Varanasi. He has contributed significantly in the field of male reproduction, reproductive toxicology and bioinformatics and has guided several Ph.D., M. Phil. and M.Sc. dissertations. He has more than 32 years of teaching and research experience. He has published around 140 scientific papers/ reviews in various high impact journals and books and participated in more than 100 national and international scientific conferences. His publications has h index of 22 (Scopus). He is on the Editorial Boards of several International & National. He is Reviewer for more than sixty five national and international journals. He is recipient of many prestigious awards such as Young Scientists' Award (ISCA), Rockefeller Foundation Special Postdoctoral Fellowship Award, Rockefeller Foundation Biotechnology Career Award, INSA-German Academy (DFG) Exchange Programme, Dr. P.N. Shah Memorial US Vitamin (India) Oration Award, ICMR International Fellowship Award for Senior Indian Biomedical Scientist, Subhash Mukherjee Memorial Infar India Oration Award and Dr. K.K. Iya Memorial Oration (NDRI). He has travelled widely within India and abroad. He is on the Committee on Reproduction and the Environment of the Society for the Study of Reproduction, U.S.A. and was Vice-Chairman of Scientific Committee of Third Asia-Pacific Forum on Andrology, China.

Prof. Mathur has been Visiting Professor/ Scientist at The Population Council, Rockefeller University, New York, Cleveland Clinic, USA and Westfalische-Wilhelms Universitat, Muenster, Germany. He has been Chairman/ Member for many national and International Committees. He has been member/ member coordinator of NAAC

peer teams to more than 50 institutions and has been Chairman/ Member of many academic/ scientific committees. He was member of Executive Committee of Indian Science Congress Association (ISCA), (2008-09 and 2009-10) and Founder Convener of Pondicherry Chapter of ISCA. He served on National Task Force on Bioinformatics and Infrastructure Facilities of the Department of Biotechnology (DBT) and Department of Information Technology, Government of India. He is on the National Task Force on Fertility Regulation & Expanding Contraceptive Choices of Indian Council of Medical Research. He has made many innovations in teaching and research including launching of Study in India Programme at Pondicherry University. He received huge funding support from various national and international funding agencies. He developed a Bioinformatics Centre at Pondicherry University, which has become a Centre for Excellence for teaching and research. He is a Fellow of National Academy of Medical Sciences (India).

DR. R. L. BHARADWAJ

President

Section of Anthropological and Behavioural Sciences (including Archaeology, Psychology, Educational Sciences and Military Sciences)

Born on Feb. 3, 1950 at Agra. Rtn. Dr. Rajeev Lochan Bharadwaj formerly Associate Professor pursued his academic at interests, Agra College, Agra and earned the Degree of Doctor of Philosophy in Psychology in 1978 from Agra University, Agra. He joined D.S. College, Aligarh as Lecturer on Jan. 1983 and nourished the research oriented academics as Associate Professor, in the Department of Psychology.

During his educational involvements 45 research articles, 3 Book Reviews, 3 Conference Reports and 3 Creative writings stand on his name as contributions, which have found place in various Scientific Journals and Newspapers of great repute.

Dr. Bharadwaj also constructed and standardized 12 Psychological measures (Published), a few of which are Socio-economic Status Scale, Comprehensive Scale of Tension, Emotional Competencies Scale, Parenting Scale (Perceived), Value-conflict Scale, Prejudice Scale and Aggression Scale. Amongst these scales, a few have been translated in different languages of Indian Territories and in Arabic language in Kuwait. Recently he is constructing and standardizing a battery (almost ready) to study Reading Disorders namely Dyslexia, Dysgraphia and Dyscalculia for the Students of 8th & 9th standards.

Seventeen students in all have been awarded so far the Degree of Doctor of Philosophy in Psychology on various subjects namely Creativity, Personality, Social Tensions, Emotional Competencies, Parenting, Value-conflicts, Conduct Disorder, Aggressive Behaviour and Traumatic Disability by taking samples of Early Adolescents, Handicapped Children specially Spastics and Congenitally Blind, Child Labour and Different Religious and Cast Groups.

He has also involved with various organizations of Psychological and Educational importance. He is the founder Secretary of Society of Behavioural Scientists established in 1997. He has served various

organizations as member of I.P.A. Election Committee 1994, 1995, Executive Member, U.P.P.A., since, 1994, Praachi Psycho-cultural Association in 1995-1997, I.P.A (Central Zone) 1995-1998, Member of Sectional Committee of Psychology & Educational Sciences (ISCA) for 1997-1998, Treasurer- I.P.A. 1997-1998, Organizing Secretary of 1st and 2nd Conference of Society of Behavioural Scientists, at Central JALMA Institute, Agra and St. John's College, Agra and National Conference 2013 held at St. John's College, Agra and coordinated more than thirty conferences.

He has also good fortune to have attended more than 50 National and International Conferences, where he presented more than 30 research articles. In addition to it, he has been given the opportunity, to act as a Resources person, Key Note Speaker, Valedictory Addresser, Committee member to screen articles for presentation in I.S.C.A.-1995, Adjudicated member of the poster presentation in the Section of Anthropological and Behavioural Sciences (ISCA-2009, 2013) and also delivered special invited lectures in different workshops and symposia throughout the country. He had also served Indian Science Congress 2006-08 as Sectional Recorder in the section of Anthropological and Behavioural Sciences. He is also associated as Joint Editor with Indian Psychological Review since 1997 and the founder Editor of Behavioural Scientist, since 2000, (Peer reviewed/referred).

Dr. Bharadwaj has been the recipient of 9th Professor Uma Nag Lecture Award of Excellence 2003, 2nd O.P. Tripathi Professional Award 2005, IPERA-Dr. Mahesh Bhargava Best Psychometrician Award 2009 and IAIP, Indore-Scholar of Wisdom Award 2009. IAIP. He has been also felicitated by different organizations at different places and also recipient of Har Prasad Bhargava Memorial Vyavhar Vigyani Tatha Shikha Manishi Honour in 2012.

PROF. (DR.) RAJNEESH DUTT KAUSHIK

President

Section of Chemical Sciences

Professor Rajneesh Dutt Kaushik, born on December 2, 1956 at Muzaffarnagar (U.P.), obtained his master's and doctorate degrees respectively, in 1976 and 1981. Currently he is the senior most professor (by selection) in the Department of Chemistry of Gurukul Kangri University, Haridwar, besides holding additional responsibility of the Dean of Faculty of Ayurved & Medical Sciences as well as the Dean of Faculty of Engineering & Technology in the same university. With over thirty six years experience of teaching and research, he has served in different capacities including Dean, Head of department, liaison officer, Registrar etc. He is credited for establishment of P.G. and research Department of Chemistry (Girl's wing) at Gurukul Kangri University, Haridwar. Prof. Kaushik also established the Department of Pharmaceutical Sciences and Faculty of Ayurved & Medical Sciences in the same University.

So far, thirty five students have obtained their Ph.D. under the supervision of Prof. Kaushik. He is the author/ co-author of more than eighty research publications in International journals, three chapters in reference books and many articles of general importance. He has attended over forty one national conferences and twelve International conferences

in various capacities. Prof. Kaushik has delivered many invited talks, key note address and plenary lectures at various conferences and institutes both in India and abroad.

He has completed seven projects funded by UGC and CSIR till now. His field of research work is Physico-organic and Physico-analytical chemistry. He has also worked in the field of natural products, environmental chemistry and archaeo-chemistry. His team has successfully developed newer and cost effective methods for estimation of metals, carcinogenic substances, dust and NOx besides using stopped flow technique for evaluation of important features of short lived intermediates in oxidation processes of physiological importance. In collaboration with Spanish scientists, he has worked on the doped materials for solar cells. He is on the editorial board of many research journals. Also he is a referee in many International SCI journals and fellow/ member of many academic/ professional societies/ bodies. He has acted as member of board of studies and research degree committees of many universities besides being a resource person for INSPIRE programme of DST and refresher courses for university teachers. Prof. Kaushik had been invited as UGC visiting fellow in some of the universities.

Prof. Kaushik was instrumental in getting MOU signed between his university and Institute of Chemical Engineering, Bulgarian Academy of Sciences, Sofia for research collaboration. Under his leadership, IBM declared his University as Centre of excellence. He was invited as scientist under Brain pool programme of Republic of Korea and worked at Korea Institute of Energy Research for a year during 2007-08. Besides this, he has visited and worked in many countries for research collaboration. These include Canada, South Korea, France, Bulgaria and Spain.

PROF. AMARENDRA KUMAR SINHA

President
Section of Earth System Sciences

Professor Amarendra Kumar Sinha was born on 15th January 1953 at Forbesganj in Bihar. He completed his schooling in 1967 from NNHE School located at a village Niranjanpur under Arwal district of Bihar. He graduated from Science college Patna and completed his postgraduation in Geology and M.Phil course in Environmental science from Department of Geology, Patna University, Patna and from Jawaharlal Nehru University New Delhi respectively. He received his PhD degree from Patna University.

He also received professional training in Computer Application in Data base Management; Remote Sensing; Watershed Management, Wetland Management, Groundwater Modeling, Disaster Management at national and International Institute of repute under UNESCO, Netherland Govt, UK govt, SIDA and Govt of India fellowship and partnership program.

He served university of Rajasthan from 1976 to January 2013 in capacity of Assistant Professor, Associate Professor and Professor in Geology. He has been founder Head of the Department of Geology and founder Director of Centre for Water Management & Research, University of Rajasthan Jaipur besides being a member of Senate, Academic Council and Convener Board of studies in Geology.

He is credited to have played key role in creation of PG department in Geology, Indira Gandhi Centre for Human Ecology , Environmental Science and Population Studies (IGC HEEPS) and Centre for Water Management & Research (CWMR) at University of Rajasthan campus. He convened and coordinated a good number of national and International scientific events and training programs which further strengthened capacity and research in Earth science and fostered research collaboration. He also founded two professional society namely ENVIRON at School of Environmental Science, Jawaharlal Nehru University, New Delhi and "Association Of Geo-environmentalists" (AGE) university of Rajasthan to promote linkage between science and society.

The main domain of Professor Sinha's research activities has been hydrogeology including Environmental Geology. Twenty two scholars have been awarded PhD degree under his supervision and a good number of postgraduate students from IGCHEEPS, CWMR and Department of Geology have completed their Dissertation work under his supervision. Professor Sinha has published 82 Research papers in peered Indian and international journals and proceedings of repute and has been invited by 28 countries of the world to present his research papers. He successfully accomplished various R&D projects awarded to him by various national and international agencies including Department of Science & technology; Ministry of Water Resources, University grants Commission, UNESCO etc. and edited and coedited seven books on environmental and Groundwater issues. He has been nominated as Expert member on various state, national and International committees including IAH commission on Groundwater & Climate Change; IGU Commission on Water & Sustainability; Indian National Committee on Geoscience program; Indian National Committee on Groundwater as well as a member on subcommittee constituted for prioritize research in Water sector within Public Private partnership framework under the PM's council on Trade and industry and state Commission for Urban Development. He is Life member and fellow of various national and International professional scientific bodies.

DR. MOHAN KHEDKAR

President

Section of Engineering Sciences

Presently, he is Vice-Chancellor, Sant Gadge Baba Amravati University, Amravati.(M.S.). He has been Conferred Honorary Colonel by N.C.C. Directorate Maharashtra, Mumbai and Honorary Fellowship by Indian Society for Technical Education (I.S.T.E.) for the year 2011. He served as Professor & Head, Electrical Engineering Department, Visvesvaraya National Institute of Technology (V.N.I.T.), Nagpur. He is Certified Energy Auditor by Bureau of Energy Efficiency, Ministry of Power,G.o.I.; Ex- Vice-President I.S.T.E. New Delhi; Ex-Dean (Academic) and Ex-Dean (Administration), V.N.I.T., Nagpur. Nominated as 'Eminent Engineer' by Institution of Engineers (India), Amravati Local Centre. Conferred Maharashtra State Best Engineering Teacher Award for the year 2006 and Chartered Engineer- The Institution of Engineers (India). He was Chairman Board of studies in Electrical Engineering, V.N.I.T. Nagpur. Professor In-Charge of Training & Placement V.N.I.T. Nagpur.

He did his B.E. (Electrical Engg.), M.Tech. (Power Systems) & Ph.D. in Power System Stability from Nagpur University, Nagpur & Diploma in Industrial Management. He has Published more than 125 Papers at various National/International Level Journals / Conferences. Five fellows have completed Ph.D. under his guidance. He has Filed Two Patents. He has Guided 18 M.Tech. Projects and nominated as Referee for papers to be published in an International Journal. He visited Japan, U.S.A, Canada, Singapore, Malaysia, Nepal, Dubai (U.A.E.), U.K., Spain & China for paper presentation & interaction. He is the Fellow of Institution of Engineers (India), Life Member of ISTE, Life Fellow of Society of Energy Auditors & Energy Managers (S.E.E.M.) & Honorary Fellow of Institution of Electronics & Telecommunication Engineers (I.E.T.E.), Life Member of Indian Science Congress Association.

He has been awarded Union Ministry of Energy - Department of Power Prize. He received Certificate of Merit from Institution of Engineers (I) for the paper published in journal during 2004-05 & Best Paper Awards for the papers presented at National Conference SEEM'04 held at N.I.T. Trichy and The Institution of Engineers (I), Nagpur local centre. He was Chairman I.S.T.E. Maharashtra-Goa Section for the term 2001-2002. He Chaired Technical Sessions at different conventions/conferences. He has worked as Member of Advisory Committee for number of conventions/conferences. He was Principal Investigator for Rs. 107 lakh project received under FIST by Electrical Engg. Deptt., V.N.I.T. He was Co-opted as Member on "Board of Studies' in Electrical Engg. of Nagpur university, College of Engineering, Aurangabad, Shivaji University, Kolhapur, Amravati University, Dr. Babasaheb Ambedkar Technology University-Lonere-Raigad. He was Four times Co-ordinator of ISTE/AICTE S.T.T.P. held at VRCE/ VNIT, Nagpur. He was Presiding Officer for GATE 2003 & 2004 exam.

He has Authored a book and acted as a Member AICTE / U.G.C. Expert Committees including N.B.A. Delivered Guest Lectures on Micro processor/Distribution Automation/Renewable Energy Sources etc. Passed 'Hindi Pragya Pariksha', Conducted by Department of Official Languages, G.o.I. Passed 'Praveshika Pratham' exam. in merit in 'Singing'.

DR. PITAMBER PRASAD DHYANI
President
Section of Environmental Sciences

Dr. Pitamber Prasad Dhyani, born in village Rampur, Devprayag (district – Tehri Garhwal), Uttarakhand on 3rd September 1958, obtained Masters and Doctoral degree in Botany from HNB Garhwal University, Srinagar, Uttarakhand. He served the University as a Research Officer (1986-1988), Lecturer (1988-1992) and Member of the Executive Council (1995-1998, 1999-2002). Dr. Dhyani joined G.B. Pant Institute of Himalayan Environment and Development (an autonomous Institute of Ministry of Environment and Forests, Govt. of India), Kosi-Katarmal, Almora, Uttarakhand in January 1993 as a Scientist-D and presently he is the Scientist-G and Head of the Socio Economic Development (SED) & Environment Assessment

and Management (SED) Group at this Institute. As a Group Head, he is responsible for conceptualizing and supervising Institute's research programmes, related to the thematic areas of socio economic development and environmental assessment and management, in the Indian Himalayan region.

Dr. Dhyani's scientific expertise includes biophysical plant physiology and ecology, restoration ecology, conservation biology and Himalayan ecology. He, by virtue of hard work and foresight, has established himself as a renowned biophysical plant ecologist as well as restoration ecologist in the Country. His pioneering work on leaf energy exchange characteristics of mountain plants in relation to the adaptability and survival potential, modification of existing leaf energy balance equation, development of a mechanistic thermal diffusion model for understanding adaptability potential of plants with increasing elevation, and classification of Indian mountain plants into two categories, namely over-temperature and under-temperature, has significantly added new knowledge to the discipline of biophysical plant physiology and ecology. His work on scientific selection of broad-leaved plants for degraded land rehabilitation and afforestation has opened new avenues for Research and Development activities in the areas of eco-physiology and restoration ecology. Dr. Dhyani's path-breaking work on the revival of Badrivan (*the ancient sacred forest of Badrinath shrine*) at Badrinath and establishment of Kalikavan (*a sacred community forest*) at Koli Dhek has clearly showed that how science and religion can work together for the benefit of environment and preservation of cultural and spiritual values; these programmes have been acclaimed widely and cited internationally as unique models for afforestation of religious places all over the world. Dr. Dhyani's contribution on promotion of Science and Technology activities in the Indian Himalayan region, through the implementation and management of 284 IERP projects, has also played a significant role in developing scientific capabilities and strengthening infrastructure for environmental research in the India Himalayan region. His work on collection, collation and dissemination of information on the aspects of Himalayan ecology, through ENVIS Centre, as a Coordinator at the GHPIHED, has proved crucial in spreading environmental awareness among the masses and helping Research and Development (R&D) in the areas related to Himalayan ecology.

Dr. Dhyani has 32 years research experience; his research findings have found place in reputed national and international journals. He has 124 research publications, including 4 books and 1 monograph, to his credit; he has also edited and published, as an Executive Editor, 15 ENVIS Bulletins and 9 ENVIS Newsletters on the aspects of Himalayan ecology. Dr. Dhyani has participated in 218 national and international conferences/ symposia/workshops and chaired various technical sessions and delivered many invited talks. he has traveled worldwide for the purpose of scientific presentations/discussions. Dr. Dhyani has successfully completed 16 major R&D projects. He has supervised/evaluated doctoral work of 23 Ph.D. scholars.

Dr. Dhyani has served as members of many national and international committees; he was identified as a Member of the Mountain Protected Area (MtPA) Network of the World Conservation Union (IUCN), USA in 1995; Member of the Sub-Committee 'Energy including Non-conventional Energy, Science and Technology' of the Planning Commission, Govt. of India, New Delhi, in 1997; Member of the Uttaranchal Forest Research

Advisory Committee of the Govt. of Uttaranchal, Dehradun, in 2003; Member of the Governing Council of Central Himalayan Environment Association, Nainital, in 2006/2009; Member of the Research Advisory Group (RAG) of the Himalayan Forest Research Institute, Shimla, in 2007; and, Member of the Research Advisory Group of the Forest Research Institute, Dehradun, in 2007/ 2009. In 2010, Dr. Dhyani acted as a Member of the Working Group for Preparing Roadmap for the Forestry Research, Education and Extension Sector in India of the Ministry of Environment and Forests GOI.

Based on Dr. Dhyani's outstanding contribution in the arena of scientific research, he, in 2009, was named as one of the 'Leading Scientists of the World' and 'Top 100 Scientists of the World' by the International Biographical Centre (IBC), Cambridge, UK. In 2009, he was honored by the 'Bharat Excellence Award' by the Friendship Forum of India, New Delhi. In 2010, he was awarded by the 'Gold Medal' by the Indian Academy of Environmental Sciences, Haridwar, Uttarakhand. In 2012, Dr. Dhyani was conferred by the 'Gold Medal for India' and 'Award of Excellence' by the American Biographical Institute, North Carolina, USA.

Recognizing Dr. Dhyani's contribution to science and society, he has been listed in various global documents including 24 national and international biographical directories; he is the Life Member of 25 national and international scientific societies and based on his outstanding contribution in the field of ecology and environmental science, he has been elected as a Fellow of the National Institute of Ecology (FNIE), Indian Academy of Environmental Sciences (FIAES) and Indian Botanical Society (FBS). Dr. Dhyani and his wife Mrs. Renu have two sons, Mr. Praveen and Mr. Piyush.

DR. SUBHASH CHANDRA YADAV

President

Section of Information and Communication Science & Technology (including Computer Sciences)

Dr. Subhash Chandra Yadav, Associate Professor and Head in the Department of Computer Applications has obtained five master's degrees, i.e., M.Sc., MCA, MPhil (CS), MTech(IT), MBA (IT & HR) . He has completed his Ph. D. on the topic "Role of Computer Animation in Development of Tutoring System for Chemical Reactions", an interdisciplinary topic exploring computer applications in chemical sciences.

With more than 15 years of experience in postgraduate teaching, Dr. Yadav has also worked as Acting Director of Rajarshi School of Management & Technology, Varanasi, running UG and PG courses, for more than two years. He has conducted, many times, State Entrance Examination in the capacity of Nodal Director/ Nodal Director (confidential) and also handled the online counseling process for admissions to courses of U. P. Technical University / Gautam Buddh Technical University. He is also a member of Board of Studies (BoS) for Computer Science & Engineering / Information Technology / MCA courses in Gautam Buddh Technical University, Lucknow.

Dr. Yadav is the Founder Chairman of Varanasi Chapter of CSI established in the year 2010. He

has received twice, National Significant Contribution Award by CSI at IIM, Ahmedabad and at Science City, Kolkata. Apart from this he is also the recipient of "Purvanchal Samman - 2012", for his significant contribution in education in eastern U P. He was a sectional member and recorder for the section of "Information and Communication Science & Technology (including Computer Sciences) of Indian Science Congress Association. He has received best poster presentation award during 95th ISCC at Vizag in the year 2008.

Dr. Yadav has published one book with more than 21 research papers in national and international journals of repute and presented more that 25 papers in various conferences/seminars. He is associate editor of reputed journal "Atambodh". He has successfully completed two DST projects and organized more than six national seminars and workshops.

PROF. LALIT MOHAN MANOCHA

President

Section of Materials Science

Dr. Lalit Mohan Manocha, F.N.A.Sc., FGSA, Academician, World Academy of Ceramics (Italy), is Professor at the Department of Materials Science at Sardar Patel University, Gujarat.

Professor Manocha has made outstanding contributions to the field of Carbon fibers, composites and engineering ceramics. His scientific and technical achievements have expanded the knowledge base and industrial potential of a number of advanced ceramics and composites. Additionally, he has been a strong advocate of engineering ceramics and composites, and a credible technical and professional research leader in these areas internationally.

He has made significant contributions to the development and understanding of processing and manufacturing technologies for advanced reinforcing fibers, including high-strength carbon fibers and high-temperature composites, oxidation resistant ceramic coatings for fibers and composites, nanotube growth on ceramic fibers as 3D hybrid reinforcements, and ceramic-matrix composites via electrophoretic deposition and sol-gel processing for tribological and other applications. He has made outstanding research contributions to porous ceramics and porous carbon, nanomaterials such as nanotubes, hydroxyapatite, nanoclays and graphene, and their composites for thermal management. He has received research funding from the U.S. National Science Foundation, Honeywell Corporation, and other organizations and companies internationally and within India, and had a number of collaborative research partnerships with universities and institutes in the United States, Japan, Czech Republic, France and Russia.

For his research and leadership in ceramics, Professor Manocha has received a number of awards and honors such as NPL prize, Alexander von Humboldt award from Germany, JSPS Award from Japan, Homi Bhabha Award for Applied Sciences, Sarabhai Award for R&D, KK-IIM Award of Indian Institute of Metals, Bengur Lifetime Achievement Award of Indian Carbon Society, three best paper awards, MRSI Medal of the Materials Research Society of India, and CSIR Technology Prize from Council of Scientific & Industrial Research, Annual Superconductivity and Materials Science Annual Prize (2011) of MRSI and Bridge Building Award (2011) of ECD, American Ceramics Society.

He was a Visiting Professor at Tokyo Institute of Technology, UNIDO consultant to Chungnam National University, Korea, and is an Elected Fellow of National Academy of Science of India, Gujarat Science Academy, and an elected member of Asia Pacific Academy of Materials. He is the Co-Editor-in-Chief of the International journal "Carbon Science" and on the editorial boards of several respected journals. He is also Vice-President and founding member of Indian Carbon society, and a member of the American Ceramic Society and its Executive Committee for Engineering Ceramics Division, German Ceramic Society and Carbon Society of Japan.

He has organized, chaired, and served on Advisory Boards of a large number International conferences, workshops and forums around the world. He was the general chair of HTCMC-6 (2007), International Symposium on High Temperature materials (2009), Indo-Japan Workshop on CMCs, Annual General Meeting of MRSI (2010), and several others. He has been invited to deliver many keynote and invited lectures at a number of international conferences.

Dr. Manocha has authored more than one hundred and twenty publications in refereed journals, coauthored a book on reinforcements and carbon-carbon composites, and edited five books/ proceedings. He also holds four patents on ceramic and carbon fibers and carbon-ceramic composites. His has supervised 20 Ph.D. students and more than 100 masters students in the area of carbon and ceramic composite materials.

Dr. Manocha has served on a number of International R&D Review Committees for universities and institutions, National Universities Grants Commission committees on advanced material, DST TSG committee on Ceramic Technology and Products, as advisor to Government agencies such as DRDO and IPR, and as a consultant/advisor to industries involved in development of carbon and ceramic materials for spacecrafts and other advanced systems. Dr. Manocha also served on a highly influential five-member Task Force under the chairmanship of the former Indian President, Dr. A. P. J. Abdul Kalam, to develop advanced composite nose tips for India's ICBM, Agni Missile and other components for Light Combat Aircraft program.

PROF. D. S. HOODA

President

Section of Mathematical Sciences (including Statistics)

Prof D. S. Hooda (born November 05, 1942) is a Mathematician and educator. He is known for his contributions in the field of Information Theory and its Applications and his research interests are information measures, source coding, entropy optimization principles and their applications in statistics, finance mathematics, survival analysis, and bounds on probabilities of error, pattern recognition, fuzzy sets and fuzzy information. He has become one of the leading Mathematicians in the country.

Prof D.S Hooda was born in 1942 in Rurki district Rohtak Haryana (India) He completed post graduation in Mathematics from Delhi University in 1969 and M.Phil. from Meerut University, Meerut, in 1976. In 1981 he got Ph.D. degree in Mathematics from K.U. Kurukshetra

Prof D.S Hooda started his career as a school teacher at the Directorate of Education, New Delhi in 1964 and served for five years. In 1970 he joined at CCS H.A.U., Hisar as a lecturer and remained up to 1985 as Associate Professor. He served as a Principal in C.R.M. Postgraduate College, Hisar from Dec. 1985 to August 1987 Thereafter he joined back to CCS H.A.U Hisar, as a Associate Professor and continued there till November 2002 as Professor and Head of Mathematics department, In November 2002 he was appointed Pro-Vice Chancellor Kurukshetra University, Kurukshetra for a short span of time, He has been working a as Professor & Dean Research in Jaypee University of Engineering & Technology Guna since August 2003 till date.

As a Educationist Professor D.S Hooda has published about 100 papers in various journals of National and International repute. He has attended 57 National and International conferences and has visited twenty foreign countries He has authored 26 popular articles written 8 books and two manuals and one book on "Aryabhatta : life and contributions". He has guided eight Ph.D., Six in mathematics and Two in Statistics. Presently, 2 scholars are perusing under his guidance for Ph. D.

He is an elected member of International Statistical Institute and an executive council member of International Society of Business and Industrial society (ISBIS). He is country coordinator from India in the advisory committee of International Statistical Literary Project (ISLP). He participated in International Congress on Mathematics Education (ICME)- 12 held at Seoul, South Korea 2012 as a member of Indian delegation constituted by National Board of Higher Education, Department of Atomic Energy, Government of India. In addition to the above mentioned he is a member of many other academic and professional National and Internationals societies. He is member of Governing Council of the Institute of Excellence of Higher Education, Bhopal.

He is member of Governing Council of the Institute of Excellence of Higher Education, Bhopal. American Biographical Institute, USA, chose him in 2004 to confer with honorary appointment for his outstanding research to Research Board of Advisors of the institute. Indian Society of Information Theory bestowed him with a prestigious award on him in 2005 for his outstanding contributions and research in information theory. He was awarded with the International Plato Award for Educational Achievement in 2010. He was also bestowed with Distinguished Service Award by Vijnana Parishad of India.

DR. SURYA KANT TRIPATHI

President

Section of Medical Science (including Physiology)

Dr. Surya Kant has been working as Professor and Head, Department of Pulmonary Medicine, in King George's Medical University, Lucknow. He has been elected Vice President of Indian Chest Society. He passed his MBBS in 1988 and MD in 1992 and was awarded Prof. R. N. Tandon Gold Medal for the best MD student. He has also done Medical Teacher's Training from Maulana Azad Medical College, Delhi, Diploma in Health Education and Nutrition U.P. Tajarshi Purshottam

Das Tandon Open University, Allahabad, Diploma in Yoga & Naturopathy, from Lucknow University, Certificate course in Evidence-based Management of Diabetes Mellitus form Public Health Foundation of India. He has been felicitated and honored with various distinction and swards by Govt. and number of National and International bodies for his contribution in Respiratory Medicine. He has been conferred Charu Chandra Das Memorial Award of TB Association, LS Lowesche Award by Association of Physiologists and Pharmacologists, Dhanwanti Ratan Award for Outstanding charitable work. Vigyan Ratna Award by Department of Science and Technology of Uttar Pradesh Government, to name a few. He has written 4 Books, 15-chapters in book/updates on medical topics and published more than 340 Papers in renowned International and National scientific journals. His article "Multi-drug resistant tuberculosis: An iatrogenic problem", published in Bioscience Trends has been adjudged as no.1 among top ten in the domain of Tuberculosis.

PROF. PARIMAL C. SEN

President

Section of New Biology (including Biochemistry, Biophysics & Molecular Biology and Biotechnology)

Professor Parimal C. Sen, received his M.Sc. degree in Organic Chemistry (1973) and Ph.D. in Analytical Chemistry (1977) from Calcutta University; Post Doctoral training in Enzymology at State University of New York and University of Minnesota, USA (1978-1983). He joined Bose Institute in the Department of Chemistry in December 1983 and served as Chairman in the Department of Chemistry for five years. Visiting Professor at Cornell University during 1989-1991. At present he is Senior Professor and Head of the Division of Molecular Medicine and Dean of Studies, Bose Institute, Kolkata, India. He is a Fellow of the National Academy of Sciences (F.N.A.Sc.), India and a Fellow of the West Bengal Academy of Science and Technology (WBAST). He is Recipients of Prof. P. B. Sen Oration Award from the Physiological Society of India, Prof. P. A. Kurup Endowment Award from the Society of Biological Chemists (India) and Prof. R. C. Shah Memorial Award from Indian Science Congress Association. Dr Sen has published almost one hundred papers in international high impact journals.

Prof Sen has been working with ion transporting enzymes (Na^+, K^+ -ATPase, Ca^{2+}- and Ca^{2+}, Mg^{2+} -ATPases etc.) and their regulation by drugs, endogenous modulator proteins and protein kinase(s) for more than thirty years. He has made significant contribution in the above mentioned area which has been recognized by the International Scientific community working in the related areas. During the investigation, a novel Mg^{2+}-independent Ca^{2+}-ATPase has been identified in rat and goat testes that has been purified and characterized and is found to take part in Ca^{2+}-transport and Ca^{2+}-pump regulation thus possibly is involved in fertility regulation. This Ca^{2+}-ATPase has a lot of similarities with the well known Ca^{2+}, Mg^{2+}-ATPase. From immunocrossreactivity study, it is found that both belong to SERCA (sarcoplasmic-endoplasmic reticulum Ca^{2+}-ATPase) family. The ATPase activities are found to be regulated by endogenous modulator proteins of varying masses. One, molecular mass of 13 kDa from rat brain cytosol was found to inhibit Na^+, K^+-ATPase, another, a 12 kDa protein from the same source, regulate Ca^{2+}- and Ca^{2+}, Mg^{2+}-ATPases by inhibiting former and stimulating the latter.Therefore, the 12 kDa

modulator is considered to be a specific tool in distinguishing the properties of Ca^{2+}- and Ca^{2+}, Mg^{2+}-ATPase, reported first time from laboratory. They also inhibit protein phosphorylation by a novel protein kinase (PKx) which is activated by arachidonic acid and has been purified and characterized in our laboratory from goat testis. So these modulator proteins are believed to be involved in various cellular function (through protein phosphorylation) including the regulation of ATPase activities. The phosphorylation and dephosphorylation steps of Ca^{2+}-ATPase is comparable to Ca^{2+}, Mg^{2+}-ATPase except that in the former case it is controlled by high and low concentration of calcium ion thus further strengthened the support of its involvement in Ca-transport in sperm cells thus fertility regulation like Ca^{2+}, Mg^{2+}-AT Pase. The 12 kDa modulator protein is found to be effective as female anti-fertility agent as evident from experiments with rat and rabbit. An Indian patent has been awarded on this work. Recently a group of analogs of calcium blockers have been synthesized and their effects on Ca-ATPase are being investigated. At least one compound, have been named if as "nifetepimine", an analog of nifedipine is found to be quite effective not only as an inhibitor of SERCA but it found to induce apoptosis in breast cancer cells at a significant level.

DR. SANJEEV RAMACHANDRA INAMDAR

President

Section of Physical Sciences

Dr. Sanjeev R. Inamdar, born on 18th October 1960 in Belgaum (Karnataka), had his education up to B.Sc. degree (with Physics as Major subject) at Belgaum city. He completed his M.Sc. degree in Physics in 1983 from Karnatak University, Dharwad with Solid State Physics as special subject. To work on Energy Transfer Dyes Lasers (ETDLs) pumped by nitrogen leser. During the course of his Ph.D. degree, he investigated various energy transfer parameters, generalized the ideal combination of dyes for efficient energy transfer dye lasers to cover wide tuning range, high power, low concentration – and pump – threshold using 400 kW nitrogen leser as pump source. For the first time, he introduced the experimental concept of 'penetration depth' which is a key parameter in determining the efficiency of dye lesers. He was awarded Ph.D degree by the Karnatak University in 1990.

Dr. Inamdar became first scientist to be appointed under the Leaser Spectroscopy Programme established at Karnatak University by DRDO, New Delhi. Dr. Inamdar initiated ultrafast spectroscopy research work with pulsed Nd:YAG leaser (35 ps pulses) using a novel optical set up with a fast photodetector (Pump-probe experiment) and measured ground state repopulation times of leser dyes with a resolution of ~50 ps. Using this technique and polarized light pump and probe pulses, determined the molecular orientational relaxation times of dyes in solvents of varying viscosity, in order to probe the nature of solute-solvent interactions. The advantage of pump-probe technique is that the time resolution is determined by the pulse width of the excitation source and not the response time of the detection system. Dr. Inamdar also set-up a novel experiment employing ps laser based frequency up-conversion technique, based on three wave mixing phenomena. This technique is unique, in that, one can time resolve

the fluorescence (and also laser) emission and reduce background noise drastically. This was the first report of its kind in India employed to study finer details of salvation dynamics of a laser dye in variety of solvents. Dr. Inamdar has also carried out interdisciplinary research exploring applications of lasers in chemistry, sericulture, botany and biochemistry. Laser irradiation of silkworm eggs has been carried out and several morphological changes have been noted in the off springs. He has also studied Non-linear optical properties of polymer films, organic crystals using picoseconds laser. He has, over the years, brought recognition to the Laser Spectroscopy programme at both national and international levels. He has rich experience in experimental research on lasers and fluorescence spectroscopy.

During 1997-98, Dr. Inamdar successfully carried out international collaborative research work with French Space Agency (CNES) and ISRO, India viz., Indian Ocean Experiment (INDOEX). The work was carried out in the Indin Ocean region for studying the role of aerosols, clouds and tropospheric chemistry on climate, during the 1999 intensive final phase (IFP-99). The ground based observation centre with Sun Photometer, aethelometer, laser particle counter, aerosol filter sampliong lines, etc. was setup in Dharwad for this purpose in 1999. The analysis of the date collected at the Dharwad and Goa Ground based observation centres was taken up jointly with the French scientists at University of Paris – 12, Paris (France). Dr. Inamdar was appointed as Reader in Physics in 1997 and has been teaching M.Sc., M.Phil. and Ph.D. students. Dr. Inamdar was appointed as Professor of Physics in 2005. He has published 50 research papers in International and National journals of repute and has contributed a chapter on rotational diffusion to a book on Hydrodynamics.

Prof. Inamdar has visited Germany, Netherlands, France and Italy on scientific Assignments and conferences. He has established collaboration with University of Paris, France, BARC., TIFR, Mumbai, National Centre for Ultrafast Processes, Chennai and Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore. He has been INSA Visiting Fellow to the Tata Institute of Fundamental Research, Bombay in 2000.

Prof. Inamdar has rich administrative experience as Chairman of Physics & Electronics Departments, Coordinator of Laser Spectroscopy Programme, Member of several committees in the university, Member, Academic Council of Autonomous College, etc. He has been the Coordinator of UGC SAP programmes (DSA Phase-II & III) in the Department of Physics for 10 years and has been supporting the activities under thrust areas of Laser Physics and Condensed Matter Physics. The remarkable achievements of SAP programme has resulted in the award of Centre of Advanced Study to the Physics Dept by the UGC in 2009. He has been on the Selection Committees (For appointment/ promotion under CAS) several university. He has brought research grants from various funding agencies. He is currently the Coordinator of the UGC-Centre with Potential for Excellence in Particular Area (CPEPA) Dr. Inamdar's current research interests are : developing chemical and bio-sensors using semiconductor nanoparticles (quantum dots) and time resolved spectroscopy using lasers.

In recognition of his contribution to Physical Sciences, the Govt. of Karnatraka has awarded him with Sir C.V. Raman Young Scientist award in 2006. The Karnatak University has given Certificate of Excellence to him in recognition of his research credentials.

PROF. SURINDER PAL KHULLAR
President
Section of Plant Sciences

Prof. Surinder Pal Khullar (b 23 May 1941), Professor of Botany, Panjab University, Chandigarh was Chairman of the Department from 2000–2003. He obtained the M Sc (Hons School) and Ph D degree from Panjab University. Prof. Khullar is the first person from India to be elected as Councilor of International Association of Pteridologists. He is an Elected Fellow of The National Academy of Sciences, India (Allahabad) (FNA Sc); Indian Botanical Society (FBS); Indian Fern Society (F.I.F.S). The Birbal Savtri Sahni Foundation, Lucknow awarded him the Birbal Centenary Award. For his researches on Pteridophytes, The Indian Fern Society conferred upon Prof Khullar the first Gold Medal in Pteridology (1987) and 'The Life Time Acheivement Award' (2010). The Indian Botanical Society presented the "G. Panigrahi Comm. Lecture" at the 23 Annual Conference of the Indian Botanical Society 2000, Meerut. For the Indian Science Congress, Prof Khullar was elected as Recorder (Section Plant Sciences) for the years 2004-2005; 2005-2006; and Sectional Committee Member (Section Plant Sciences), 1998-99; and 2002-2003. He is member of many Scientific Societies.

His field of Research Specialization is Taxonomy, Cytology, Floristics and Morphology of Pteridophytes and Angiosperms. In recognition of his contributions to the taxonomy of ferns four fern species have been named after him. He has had the privilege of working with the Nobel Laureate (1950) Prof. T. Reicheistein (Basel, Switzerland), who also named a fern, *Asplenium khullarii* Rasbach & Reichstein *ex* Fraser-Jenkins after Prof Khullar. Other ferns named after him are (i) *Dryopteris khullarii* by C. R. Fraser-Jenkins; (ii) *Lepisorus khullarii* by Shing & Pande and (iii) *Pteris* x *khullarii* Pangtey, Samant & Verma. Several rare ferns have been re-collected from the West Himalaya by him and he has described fourteen new fern taxa.

Prof. Khullar's *magnum opus*, "*An Illustrated Fern Flora of the West Himalaya*" in two volumes, has been reviewed in most leading Journals on Pteridophytes. It was considered as the latest taxonomic account and contribution of its kind and the most valuable in the understanding and conservation of Plant Diversity and Evolution.

Prof. Khullar has contributed immensely towards correcting the nomenclature of several West Himalayan Ferns. He is tirelessly and diligently working on various aspects of ferns and fern allies and is thoroughly conversant with the Pteridophytic flora of India, having collected pteridophytes from various regions of the country. Due to his vast experience and knowledge of fern taxonomy and Nomenclature, most Indian fern workers consult him to get their collections identified.

Prof Khullar has also authored four more books and has over 125 widely quoted and referred publications. Prof Khullar has vast experience of teaching and research having guided several students for the PhD and M Phil degrees. He has participated and delivered lectures in several Symposia/Seminars (nationally and internationally).

Prof Khullar is currently the Secretary-Treasurer, Indian Fern Society and the Coeditor Indian Fern Journal.

DR. KRISHNENDU DAS

Recorder

Section of Agriculture and Forestry Sciences

Dr. Krishnendu Das joined the Agricultural Research Service of the Indian Council of Agricultural Research in 1986 in the discipline of Soil Science (Pedology) and was posted in the National Bureau of Soil Survey and Land Use Planning,Nagpur.He received his Ph. D. degree in Soil Science from Bidhan Chandra Krishi Viswa Vidyalaya, Mohanpur in 2000. He is presently posted at Regional Centre, Kolkata as Principal Scientist. Dr. Das has over twenty five years research experience in National Agricultural Research System with respect to formulation, monitoring and accomplishment of various projects viz. Institutional, Inter institutional, NATP, NAIP, Sponsored/ consultancy projects (DST, World Bank and several State Governments) as Principal Investigator/ Co-Principal investigator / Associate. He has handled about 20 research projects so far comprising the themes of soil resource inventorisation and monitoring at various levels viz. state, district, watershed, village etc., application of remote sensing towards natural resource inventorisation, preparation of soil and soil related maps, soil correlation, classification, assessment of land degradation, soil based data management by GIS for land evaluation towards land use planning for the states of Jharkhand,Orissa,West Bengal, Gujarat, Rajasthan and Uttar Pradesh.

Dr. Das is actively involved as a faculty member for Post Graduate Education in the discipline of Agricultural Chemistry and Soil Science in co-operation with Department of Soil Science, BCKV, Mohanpur, Nadia, West Bengal with special reference to Land Resource Management. He was appointed External Examiner for M.Sc. and Ph.D. students in Palli Shiksha Bhavan,Viswa Bharati,BCKV Mohanpur and CAU, Imphal Universities. He was elected as Councillor (2008-2010) of the Indian Society of Coastal Research, West Bengal and served as Sectional Committee Member of the Agriculture and Forestry Sciences Section of Indian Science Congress during 2003-04 and 2009-2010. He is also the Secretary, Indian Society of Soil Science, Kolkata Chapter and Convenor, National Environmental Science Academy, West Bengal Chapter. Dr. Das has published more than 27 research papers in refereed Journals, 19 popular articles and 15 Technical Bulletin/Reports and attended more than 37 Seminar/Symposium papers.

DR. B. S. CHANDEL

Recorder

Section of Animal, Veterinary and Fishery Sciences

Dr. Babu Singh Chandel was born on 10th August 1955 at District Kanpur, U.P. , Dr. Chandel started his research –cum –teaching career as the assistant Professor of Zoology at D.B.S. College, C.S.J.M. University, Kanpur (U.P.) since 1988 till present as Associate Professor of Zoology at D.B.S. College.

He has completed Ph. D. and D.Sc. degree in Zoology (Entomology) in the year 1984 and 1988, respectively.

Dr. Chandel held different posts in organizations like member of Advisory Board of Indian Society of Life Sciences, Society of Life Sciences and Editorial Secretary of Indian Academy of Environmental Sciences and also became a member of Research Board of Advisor by American Biographical Institute, North Carolina, U.S.A., Dr. Chandel was elected as member of sectional committee of Animal, Veterinary and Fishery Sciences section of ISCA, 2004-2005.

Dr. Chandel had been conferred with several academic honours. These include, Fellowship of Society of Life Science, Indian Academy of Environmental Sciences, Zoological Society of India, Society of Environmental Sciences, Entomological Society of India.

Dr. Chandel has been conferred with several awards for outstanding contribution for advancement of sciences. In this connection Zoological Society of India Awarded of Congress of Zoology Medal in 2006, Indian Academy of Environmental Sciences awarded Gold Medal of the Society, The American Biographical Institute, NC, USA awarded him with the Man of The Year 2008, India.

In various national and international conferences /seminars of Scientific Societies of Zoology and Environmental Sciences, Dr. Chandel delivered lectures in more than 20 occasions. He has research experience of 32 years and teaching experience of 27 years. Twenty two students have received Ph. D. Degree in Zoology under his guidance. He has published 43 research papers in national and international journals of repute. Dr. Chandel has delivered invited Talks, Plenary Lecture, Keynote Address and Chaired Technical Sessions at various conferences, Seminars, Symposium and Workshops in India.

DR. MANOJ KUMAR SINGH

Recorder

Section of Anthropological and Behavioural Sciences (including Archaeology Psychology Educational Science and Military Sciences)

Manoj Kumar Singh was born in Ranchi, Bihar and completed all his education from Ranchi. He has done graduation in Anthropology from Gossner College, where he topped in the University. He completed his Master Degree in Anthropology in Ranchi and joined Department of Anthropology as a Ph.D. student and successfully completed his Doctorate Degree in 2002. His specialization is Archaeological Anthropology. He won three consecutive times "Best Poster Presentation Award" in Anthropology and Archaeology Section during the Indian Science Congress (1999, 2000 and 2001) and finally got "Young Scientist Award" in 2002. He was also elected "Sectional Committee Member" in Anthropology and Archaeology Section in 2001.

He joined Department of Anthropology, University of Delhi in 2002 as Lecturer. He teaches Archaeological Anthropology and Palaeoanthropology. He has visited several countries to attend the Conferences and presented papers. He was awarded Erasmus Mundus Post Doctoral Fellowship in 2005 for 2 years.

Now he is excavating a Lower Palaeolithic Site Kondapeta in Prakasam District of Andhra Pradesh. He has published 26 research paper and 1 Book. There are 4 Ph. D. Students working under his supervision.

He is one the Council Members of World Archaeological Congress, Australia and also Junior Representative of Southern Asia. He is also a member of International Union of Prehistoric and Protohistoric Sciences, France.

DR. ARVIND DIXIT
Recorder
Section of Chemical Sciences

Dr. Arvind Dixit (February 20, 1962) Associate Professor (Dept. of Chemistry,VSSD College, Kanpur since 1988) and Director Pt. Madan Mohan Malaviya Ethical Education Centre got his higher education in Chemical Sciences and later obtained his Ph.D. in 1989 from Kanpur University, Kanpur. He has supervised several Master's and doctoral students for their dissertations and Ph.D. He has published about 20 research papers in scientific journals and presented Papers in International and National Conferences. He is Ex-Member of Implementation committee Commemoration of the 50th anniversary of Indian Republic, U.P. Constituted by Department of Culture, Government of India. During 2003-2008 Dr. Dixit served as Member of U.P. Secondary Education Service Selection Board, Allahabad. He has also served as Expert Member, U. P. Public Service Commission, M. P. Public Service Commission, Subject Expert for DRDO, Member, Syllabus preparation committee of C.S.J.M. University, Kanpur, Resource Person in Academic Staff Colleges of different universities, Keynote Speaker in various National and International Seminars. He has been resource person/panelist in group discussion by Gyan-Vani, news channels & All India Radio, Kanpur.

Dr. Dixit was Director, College Development Cell, Formerly Director and Advisor of I.C.T. Lab. Advisor, Equal Opportunity Centre, Co-ordinator, Career Oriented Certificate Course Sponsored by University Grants Commission, New Delhi. Member, Anti Ragging Committee of Kanpur District. Apart from his active academic and administrative career, he has been associated with a several professional and scientific organizations as Fellow or Life Member.

He has visited various countries like Thailand, Bangladesh, Nepal, Malaysia and Singapore.

DR. DEVESH WALIA
Recorder
Section of Earth System Sciences

Dr. Devesh Walia (DoB- August 17, 1965) Professor, Department of Environmental Studies, North-Eastern Hill University (NEHU), Shillong, India completed his University education B. Sc. (1985) and M. Tech. Applied Geology (1988) from Dr Hari Singh Gour Vishwavidyalaya, Sagar and Ph. D. (1997) from Gauhati University, Guwahati. Subsequently, he joined NEHU as a faculty in 1990 and is actively engaged in teaching, research and consultancy with more than 24 years of experience. He has been the Associate NCC Officer, 20 Mizoram Independent Coy, NCC and as Lieutenant served the PUC- NCC unit (1999-2004).

Dr Walia is a recipient of NCC Scholarship (1985-86); has passed NCC 'A'. 'B' and 'C'

certificates and University (UGC) Fellowship (1997-88).

Dr Walia has successfully completed and ongoing a number of research projects funded by various agencies such as North-Eastern Council, Department of Science and Technology, Ministry of Earth Sciences, Government of India, New Delhi, BARC-BRNS, Mumbai. He has guided research leading to the award of Ph. D. degree including Geophysical Studies of the Deep Crusta! Structure of North Eastern Indian region using Magnetotelluric Techniques; Hydrogeochemical Study of Hot Springs of the North East India. He has many research papers in reputed National and International Journals to his credit. He has participated and presented his research findings in various National and International conferences/seminars held in India and abroad. And has attended the Industry - Academia workshops on Upstream Petroleum Technology- Geology and Geophysics at Kaziranga, Gandhinagar and Duliajan. He has been invited to deliver keynote address, state of art lecture and to chair the session in different National and International conferences/seminars. He has been collaborating with recognised scientists from national and international institutes of repute.

Some of the areas of interest of Dr Walia include magnetotellurics; radon emanation studies; micro-seismology; global positioning system, seismic disaster management and mitigation; Earthquake forecasting; Remote Sensing and CIS and Structure and tectonics of NE India. Dr Walia is faculty for the training imparted to the Legislators, Architects, Engineers, Contractors and different level of Officers of Meghalaya on the seismic disaster mitigation, DM Act 2005 and building codes for the disaster resilient structural and non-structural elements.

Dr Walia is life fellow of Geological Society of India, Indian Geophysical Union and Indian Society of Remote sensing and life member of a number of academic and professional bodies and Member of the Sectional Committee (ESS) for 2009-2010 (97th Indian Science Congress) and for 2010-2011 (98th Indian Science Congress). He has also worked as referee of scientific journals, expert in the area of disaster management and mitigation advisor/ consultant and Member of the Shillong Disaster Management Plan Technical Committee. He has been member of the Term Review Committee of GSI-NER and attended CGPB Group VIII meeting. 37.

MR. ISMAIL HUSSAIN

Recorder

Section of Engineering Sciences

Mr Ismail Hussain born in a Transport business family handled the entire repairs and Maintainance of entire fleet. He passed Dip in Automobile engineering on the year 1992 and later on passed Marketing of Services in the year 2000 from ASCI Hyderabad. He also passed P G Dip Risk and Insurance Management from MIT Pune and is also Valuer for Plant and Machinary. He underwent Technical Programmes by SIAM at New Delhi by TELCO at Pune from Automobile International USA. He did Masters from Rochvelli University, USA. He is member on advisory council of Ministry of New & Renewable Energy, GOI. Having command in rectifying defects in automotive related designs his suggested modifications were accepted by M&M for auto electrical system as well as Telco for uneven tyre wear in utility segment vehicles. He is presently Director of Universal Academy of Tech Education which conducts various computer based courses in Automotive as well as Solar Power Technology related courses.

PROF. DHARMENDRA PRASAD

Recorder

Section of Environmental Sciences

Prof. Dharmendra Prasad, was born on 12th August 1955 at a village called Bodhaul of Nalanda district in Bihar. He did his graduation (B.Sc. (Hons) and Post graduation (M.Sc.) in chemistry from Patna University and Ph.D. from S.K.M. University, Dumka, Jharkhand. He is working as Head, PG Department of Chemistry at Deoghar College, Deoghar, which is a constituent unit of S.K.M. University, Dumka. He has teaching and research experience of 32 years. His field of specialization is Organic and Environmental Sciences. He has published many research papers in journal of national and international repute. He is also life member of different scientific organizations.

DR. (KU.) NEERU ADLAKHA

Recorder

Section of Information and Communication Science & Technology (including Computer Sciences)

Dr. Neeru Adlakha is presently working as Associate Professor of Mathematics on Deputation at MANIT, Bhopal since 4th July 2012. Earlier she was working as Associate Professor in Mathematics at SVNIT, Surat during 11th June 2009 to 3rd July 2012. She has also worked as Faculty Position in Mathematics at Jaypee Institute of Engineering and Technology, Guna, Sant Hirdaram Girls College, Bhopal, Dr. H. S. Gaur University, Sagar and RKDF Institute of Science and Technology, Bhopal.

She has done her Ph.D. degree in Mathematics in the area of Mathematical and Computational Biology from Jiwaji University, Gwalior in 1994. She has won seven National awards for her research papers. She has forty publications in Journals of International repute. She is Secretary, special Interest Group on Bioinformatics of CSI, member of work group on Bioinformatics under TC 5 of IFIP. She has visited Ialy, USA and Singapore. She has organised first IFIP International Conference on Bioinformatics and several training programs on bioinformatics. She has supervised one Ph.D., Her current interests are Biomathematics/Biocomputing/ Bioinformatics, Dta Mining.

PROF. AMREESH CHANDRA

Recorder

Section of Materials Science

Dr. Amreesh Chandra is currently an Assistant Professor in the Indian Institute of Technology at

Kharagpur, India in the Department of Physics. Dr. Chandra did his Ph.D. in 2004 from School of Materials Science and Technology, Indian Institute of Technology, B.H.U., Varanasi, India in the broad area of multiferroic ceramics. In 2005, he moved to the Max Planck Institute for Polymer Research in Mainz, Germany as a post-doctoral fellow where he worked in the area of preparation and characterization of polymer composites with tailor viable thermal expansion. In early 2007, he moved to University of Surrey, U.K. where he was involved in the designing, fabrication and characterization of supercapacitors and microbial fuel cells with special emphasis on materials. Ever since joining I.I.T. Kharagpur in 2009, Dr. Chandra heads the multifunctional and energy materials laboratory. The team mostly focuses on synthesis, characterization and applications of oxide ceramics and nanoparticles in power harvesters, supercapacitors and microbial fuel cells. Dr. Chandra has more than 30 research publications in international journals of high repute. Dr. Chandra has strong collaborative program with University of Surrey (UK), University of Malaya (Malaysia), Max Planck Institute for Polymer Research (Germany), TU-Darmstadt, CNRS-Paris (France), Deakins University (Australia), Delhi University (India), BARC (India), ARDE DRDO Lab (India), Dr. Chandra has more than 3 Young Scientists Awards to his credit, delivered more than 10 Invited Talks in the last two years and chaired sessions in 3 national and international conferences. Dr. Chandra was also a Guest Editor of the recently (2012) published special issue on Energy systems for the Journal (PNAS-Phys. Sci., India Publishers: Springer). This Journal is brought out by the National Academy of Sciences, India.

PROF MEENAKSHI PRALHADRAO WASADIKAR

Recorder

Section of Mathematical Sciences (including Statistics)

She passed B. Sc. (Honors) with First class and Distinction in 1977, obtained M. Sc. in 1979 and Ph.D. (Mathematics) in 1985from the thenMarathwada University, Aurangabad. She was awarded Giridharrao Deshmukh Gold Medal and C. V. Limaye Prize for securing First Rank at M. Sc. (Mathematics) Examination. She was a CSIR Junior and Senior Research Fellow from 1980 to 1985.

She worked as a lecturer in Govt. College of Arts and Science, Aurangabad, Institute of Science, Aurangabad, Elphinston College, Mumbai during 1986 to 1997. She joined as a Reader in Dept. of Mathematics, Dr. BabasahebAmbedkar University, Aurangabad in 1997 and now working as a Professor. She has 27 years teaching experence which includes 22 years P. G. teaching experence.

She worked as the Head, Dept. of Mathematics, Member of Research and Recognition Committee in Mathematics, and member of Board of Studies (Mathematics), Dr. BabasahebAmbedkar University, Aurangabad, from 2001 -2003. She was a Member of the Book Writing committee of Govt. of Maharashtra for writing a text book for S. S. C. students (2010). She was a Member of the Sectional Committee (Mathematical Sciences including Statistics) of Indian Science Congress Association for the years 2008 - 2009 and 2009 - 2010.

She is a Reviewer for Mathematical Reviews published by American Mathematical Society. She has worked as a referee for various Journals. She has 20 publications in National/International Journals and Conference Proceedings. The number of citations of her papers is 28 (9 in books and 19 in papers). She participated in five International Conferences (1 Invited talk and 3 paper presentations) and 25 National conferences (with 10 invited talks). She guided one student for Ph. D., two for M. Phil and three students are working for M. Phil. She is a member of the Indian Mathematical Society, Indian Science Congress Association, Jammu Mathematical Society. She has delivered lectures in various refresher courses, workshops, NET / SET training programs.

DR. DEBASISH BANDYOPADHYAY

Recorder

Section of Medical Science (including Physiology)

Dr. Debasish Bandyopadhyay obtained his M. Sc. Degree in Physiology from University of Calcutta in 1986. He has obtained his Ph. D. degree in Physiology from University of Calcutta. He has visited University of Texas Medical Branch at Galveston, Texas, USA for his post-doctoral research works. He joined as Reader and founder Head of the Department of Biotechnology, Assam (Central) University, Silchar in 2004. Later on he Joined as a Reader and became Head of the Centre for Biotechnology, School of Life Sciences, Visva-Bharati, Santiniketan (A Central University) in 2005. Dr. Bandyopadhyay has joined University of Calcutta as a Reader in Physiology in September, 2006 and later became Head of the Department for a period of two years, and, presently serving as Associate Professor at the same department.

Dr. Bandyopadhyay's current research interests are in the areas of myocardial ischemia, stress and drug-induced gastric ulceration, heavy metal-induced oxidative stress, development of effective antioxidants from natural sources and flavin metabolism. Dr. Bandyopadhyay has national and international collaborations as well as inter and intra-departmental collaborations within the university. Received funding for research from UGC and is a participating scientist at the Centre with Potential for Excellence in Particular Area (CPEPA) awarded to University of Calcutta from UGC, Govt. of India. He has 50 research papers to his credit in various national and international peer reviewed journals with high impact factors. Dr. Bandyopadhyay is a member of the Editorial Board of the Journal of Herbal Medicine and is also a reviewer of a number of high impact international journals. Besides, he is the Joint Editor of Indian Journal of Physiology and Allied Sciences. Dr. Bandyopadhyay is a life member Society for Biological Chemists of India and Physiological Society of India.

DR. BADRI NARAIN PANDEY

Recorder

Section of New Biology (including Biochemistry, Biophysics & Molecular Biology and Biotechnology)

Dr. Badri Narain Pandey joined Radiation Biology and Health Sciences Division, BARC, Mumbai in 1995 after Graduation from 38th Batch of Biology-Radiobiology Orientation Course (1994-95), BARC Training School, Mumbai. He received his Ph.D. in Life Sciences from Mumbai University in 2003. His research activities involve studying mechanism of bystander effect in normal and cancer cells irradiated with low/high LET radiation. Moreover, his research interest also includes studying role of cellular oxidative damage in the mechanism of apoptosis induced by ionizing radiation relevant to radioprotection and cancer therapy. His current research activities also involve development of nanoparticles based novel strategies for cancer therapy and developing suitable strategies for amelioration of heavy metal radio-nuclide toxicity. Under a collaborative project with Tata Memorial Hospital, Mumbai, Dr. Pandey studied correlation between magnitude of apoptosis and clinical response in Non-Hodgkin's Lymphoma patients undergone to Low Dose Total Body Irradiation, which can be further developed as prognostic assay. Dr. Pandey and his research team showed oxidative mechanism of toxicity induced in different target organs by thorium and uranium at acute and sub-chronic doses, which could be prevented by chelating agent like DTPA during his post doctoral fellowship New Jersey Medical School, New York, USA (2004-05), Dr. Pandey studied role of oxidative damage in radiation induced bystander effect and modification in mitochondrial protein import in γ-irradiated cells. Dr. Pandey investigated role of translationally controlled tumor protein in mechanism of DNA damage repair in human cells exposed to low dose of radiation.

Dr. Pandey received Best Oral Presentation Award at International Conference on Free Radicals in Health & Disease, Lucknow, 2003. He has been awarded Fellowship from Department of Energy, USA to attend Gordon Research Conf. on Radiation Oncology, California. In recognition of his contribution in radiation biology, Dr. Pandey received M.R. Raju Award, AARR Young Scientist Award and International Cancer Technology Transfer Fellowship by International Union Against Cancer Control (UICC), Switzerland to conduct bystander experiment using proton microbeam irradiation facility at NIRS, Japan. He is a Member of Podcast Committee, Radiation Research Society, USA and Treasurer, Indian Society for Radiation Biology. Dr. Pandey is a Fellow of Association of UICC Fellows, Switzerland. Dr. Pandey has published more than 50 research papers in refereed Journals, 4 book chapters and 4 scientific articles. Dr. Pandey is serving as Editor, 'Radiation Research Today', an eNewsletter published by Indian Society for Radiation Biology.

DR. I. HUBERT JOE

Recorder
Section of Physical Sciences

Dr.I.Hubert Joe, born in Thazhakkan Vilai, Kanyakumari District of Tamil Nadu, received his B.Sc. from Nesamony Memorial Christian College Marthandam, M.Sc. and M.Phil. from Bharathidasan University Trichy and Ph.D. degrees from, University of Kerala, Trivandrum . Joined as a lecturer, Mar Ivanios College in 1995, became reader in 2004 and is now serving as Associate Professor in the same college. He has presented research papers at the XIII International Conference on Raman Spectroscopy Sep, 1992 at Wurzburg, Germany, XIX International Conference on Raman Spectroscopy Aug, 2004 at Queensland, Australia and XXII International

Conference on Raman Spectroscopy Aug, 2010 at Boston, Massachusetts, USA. He has Organized the II International Conference on Perspectives in Vibrational Spectroscopy February, 2008, Trivandrum. His research interests at the moment include design and development of non linear optical crystals, Quantum chemical computations using *ab initio* and Density Functional Theoretical methods for geometry Optimization and vibrational spectral prediction of Bio molecules , natural products with medicinal properties and anticancer drug molecules. He has published 101 research papers in various international journals and more than 170 papers in the conference proceedings. He has guided eight research scholars in earning Ph.D. degrees and six research scholars are currently working with him. He has successfully completed one minor and one major project sponsored by UGC and two respond projects sponsored by ISRO, Govt. of India. Now serving as a Member, Board of Studies in Physics (PG), Manonmaniam Sundaranar University, Tirunelveli. He is a regular reviewer of a number of International journals. He has received the Best poster presentation award in the section of Physical science at the 97th Indian Science Congress Association January, 2010.

PROF. ARUN KUMAR PANDEY

Recorder

Section of Plant Sciences

Professor Arun Kumar Pandey (born 1953), received his school to University education at Lucknow. He obtained M.Sc. Degree from University of Lucknow (1973) and worked for Ph.D. degree at National Botanical Research Institute, Lucknow (degree awarded by Kanpur University in 1978). He joined the Department of Botany, TM Bhagalpur University, Bhagalpur in 1983 and rose to the position of Professor in 1994. He has taught taxonomy, reproductive biology, plant resources and genetics and supervised doctoral work of 18 scholars. He was selected as Professor of Botany at the University of Delhi in August 2008. Thus he has more than three decades of research and teaching experience.

Prof. Pandey was Post-doctoral Fellow in the Ohio State University, USA during 1987-88. In 1994, he visited Herbarium, Royal Botanic Gardens, Kew, England. In 2002 and 2004, twice he was awarded Bass Fellowship of the Field Museum Chicago,USA where he worked on molecular taxonomy of the ginseng family. He was Visiting Professor at the University of Vienna, Austria (2006) and INSA visiting Fellow at the Korea Research Institute of Bioscience & Biotechnology (2008). In 2010, he was invited by the Chinese Academy of Sciences to participate in an International Workshop on "Flora of Pan-Himalayas" held in Beijing. In 2012, he visited University of Munich, Germany under Indian National Science Academy Bilateral Exchange Programme. He has delivered invited lectures at the University of Munich (Germany) and Vienna (Austria).

Prof. Pandey has carried out extensive research on the systematics and reproductive biology of families such as Asteraceae, Cucurbitaceae, Fabaceae and Araliaceae. He has done taxonomic revision of *Tricholepis* (Compositeae), *Trichsanthes* (Cucurbitaceae) and *Aralia* and *Panax* (Araliaceae) of India. He has also published papers on molecular phylogeny of *Aralia-Panax* complex and Indian Cucurbitaceae. His current interests include systematics and biogeography of Compositae genus *Inula* and legume genus *Crotalaria* and *Indigofera*.

Ethnobotanical studies done by him has helped to record numerous important and useful traditional knowledge from among different tribal groups in Santhal Paragana (Jharkhand) and Similipal (Orissa) and Chothe tribe (Manipur).

Prof. Pandey is recipient of YS Murty medal of the Indian Botanical Society and VV Sivarajan medal of the Indian Association for Angiosperm Taxonomy. He has delivered G. Panigrahi Memorial lecture (2009) at University of Kuvempu (Karnataka) and Parukutty Barua Memorial Lecture (Gauhati) in 2006. Dr. Pandey is president of East-Himalayan Society for Spermatophyte Taxonomy (EHSST) and Past President of the Indian Association for Angiosperm Taxonomy (IAAT).

He has published over 120 research papers and has authored 14 books. Professor Pandey is member/ office bearer of 16 national and international societies. He has completed 16 major research projects and has organized International symposia, Taxonomy training and Orientation programmes, Workshops on Ethnobotany and Molecular systematics. He was twice Organizing Secretary of the Indian Association for Angiosperm Taxonomy and was Executive Editor of Rheedea (official journal of IAAT) during 1999-2000. He is Professor-incharge of the Delhi University Herbarium (DUH) and the Botanical Garden of the Department of Botany.

KNOW THY INSTITUTIONS

INSTITUTE OF ADVANCED STUDY IN SCIENCE AND TECHNOLOGY, GUWAHATI

The Institute of Advanced Study in Science & Technology (IASST) located at Pachim Boragaon, Garchuk, Guwahati, Assam was set up in the year 1979 by the Assam Science Society as a premier research establishment in the North-East India. The institute was inaugurated by the Nobel Laureate Prof. Dorothy Hodgkin on 3rd November, 1979. The IASST was registered as a separate entity in 1991 under the Societies Registration Act XXI of 1860 under Regd. No. 4219 of 1990-91. Subsequently, the Department of Science and Technology (DST), Govt. of India provided the necessary funds to build the infrastructure thereon. On 9th March, 2009, the institute was taken over by DST as an autonomous multidisciplinary research organisation. It is an autonomous and multidisciplinary research institute actively involved in carrying out advanced study and research activities in frontier areas of science and technology.

The main objectives of the Institute are to build up a research centre with facilities for fundamental and advanced studies in different fields, to promote original, applied and interdisciplinary, investigations in the areas concerning the development and utilization of resources of the North Eastern Region in India. The aim of the research programmes is to obtain highly significant scientific results. The Institute has been conducting research in three main areas viz. Material Sciences, Life Sciences and Computational & Numerical studies.

In Material Sciences, Plasma physics section has been involved in fundamental as well as applied research like non liner phenomena, waves and instabilities and plasma processing. Flow improvers,

polymer foams and liquid crystalline polymers are the main field of research in the Polymer section. Life sciences, Biological and Chemical sciences section have been involved in research in the areas of bio-fertilizer, medicinal plants, biodiversity, bioprospecting studies, herbal drugs and seribiotechnology (Eri, Muga Silk worm genetics study, biochemical basis of fibre production etc.). Environmental pollution, exploration on flora and fauna of N. E. Region in India and eco-biological study of threatened organisims are the main field of research in the Resource management and Environment section. In the Centre of Computational & numerical studies research in applied stochastic process, distribution theory, functional analysis, sequence spaces and machine learning is being carried out.

The Institute has good number of sophisticated instruments and other infrastructural facilitites.

Contact :

Director, Institute of Advanced Study in Science & Technology
Pachim Boragaon
Garchuk, Guwahati–781 035
Assam, India.

Nominations for "Asutosh Mookerjee Fellowships of ISCA" 2014-2015

The Indian Science Congress Association has instituted 10 senior Fellowships in the name of ***"Asutosh Mookerjee Fellowships"*** in the Centenary year to utilize the services of the *Life Members* of the Association who are active in high quality research in their specialized disciplines but have superannuated from their service. The objective is to utilize the expertise of ISCA Members after superannuation primarily for research work in some R&D center/university / colleges / institute in India.

Eligibility : (i) The fellowship is open to ISCA Life Members who have superannuated and are between the age of 65 to 70 years, (ii) The applicant should posses Ph.D. in science/Engineering or MD in medicine (iii) The fellowship is meant for those who have a proven track record as evident from their Research publications and recognition.

Tenure : The term of Fellowships will be tenable initially for a period of three years, extendable for another two years after a review of the achievement of three year's works. The total number of Fellowships at a time should not be more than 10.

Emoluments : (a) The fellowship carries an honorarium of ₹ 30,000/- p.m. such that ₹ 30,000/- + pension does not exceed the gross salary drawn at the time of retirement. The honorarium of ₹ 30,000/- will be reduced wherever. The honorarium will be Taxable at source. (b) Contigency grant will be ₹ 1,00,000/- which includes the expenditure of chemicals glasswares, stationary, part time services of a scientific assistant/secretary for typing and travel within country only.

Nominations duly completed in all respects, signed, and routed through the Head of the Institution, where a scientist intends to work, should be sent to the General Secretary (Membership Affairs), ISCA, 14 Biresh Guha Street, Kolkata 700 017 so as to reach **latest by 30th December 2013.**

Details in Website : http://www.sciencecongress.nic.in/html/pdf/asutosh_fellowship.pdf.

Conferences / Meetings / Symposia / Seminars

National School on Sustainable Polymers and First Symposium on Advances in Sustainable Polymers, January 6-11, 2014, Guwahati, Assam.

- Biodegradable Polymer Synthesis
- Polymer Processing
- Polymer Modeling and Simulation
- Sustainable Packaging
- Eco-friendly Coatings/Adhesives
- Sustainable Foams
- Functional and Smart Biomaterials
- Polymer Rheology
- Polymers for Biomedical Applications
- Advances in Polymer Characterization
- Polymer Structure-Property Relationships
- Nanocomposites/Nanobiocomposites
- Sustainable Polymer based Technology
- High Performance Polymers

Contact : Dr. Vimal Katiyar, Convener ASP-14, Department of Chemical Engineering, Indian Institute of Technology Guwahati, Guwahati, Assam-781 039, Phone +91 361 258 2278 (O), +91 789 612 3664 (M); Fax : + 91 361 258 2291, Web : www.iitg.ac.in/suspol, Email : suspol@iitg.ernet.in

Fifth International Conference on Plants & Environmental Pollution (ICPEP - 5), 3-6 December 2014, Lucknow.

- Bio-indication & Bioremediations
- Environmental Microbiology and Biotechnology
- Environmental Impact Assessment, Eco-auditing & Environmental Education
- Environment & Biodiversity
- Plant Responses to Environmental Pollution
- Climate Change
- Contemporary Environmental Issues :

  (a) Paleo-environment (b) Environmental impact of cultural heritage (c) Environmental systems and disaster management (d) Hospital wastes management (e) Indoor pollutants, bio-pollutants (f) Bio-energy/Biofuel (g) Sustainable agriculture & food Security (h) Alien Plant Invasion (i) Bio-prospecting (j) Noise pollution (k) Urban pollution & green belt designing (l) Role of botanic gardens in biodiversity conservation & climate change research

Contact : Organizing Secretaries (ICPEP -5), International Society of Environmental Botanists, CSIR-National Botanical Research Institute Campus, Lucknow - 226001 Tel : 0522-2297821,2205831-35, Fax : 2205836, Website : http://isebindia.com, E-mail : isebnbrilko@sify.com / isebmail@gmail.com

S & T ACROSS THE WORLD

"PRISTINE" GAS FROM BIRTH OF UNIVERSE DETECTED

Astronomers say they have detected streams of "pristine" hydrogen gas left over directly from the birth of the universe. The cold gas is flowing, they said, into a galaxy that is now seen as it looked about 11 billion years ago, due to the time its light takes to get here.

Profuse gas flows like this are thought to be key to explaining that early era, when galaxies were copiously forming stars from the gas. A similar flow could have contributed to the creation of our own galaxy. The astronomers - led by Neil Crighton of Swinburne University in the U.K. -published the findings in *Astrophysical Journal Letters* Oct. 2, 2013. The distant hydrogen usually can't be detected. But in this case it was, thanks to a coincidental lighting arrangement provided by a distant, extremely bright object known as a quasar, according to Crighton's group. The findings came from a systematic survey using the Large Binocular Telescope on Mount Graham, Arizona and an instrument called a spectrograph on the Keck I telescope on the summit of Mauna Kea, Hawaii.

Cosmologists believe early galaxies received their material from a vast reservoir of pristine hydrogen floating between galaxies. About 10 billion years ago when the universe was one-fifth its current age, studies have found, fledgling galaxies were forming new stars at nearly 100 times their current rate. This activity would require some fuel in the form of gas, since that is what makes up stars. In the past decade, supercomputer simulations of galaxy formation have predicted that this gas funnels into galaxies along thin "cold streams" which, like streams of snow melt feeding a mountain lake, channel cool gas from the surrounding area onto galaxies.

Testing these predictions isn't easy, as such gas at the edges of galaxies is very dark. Instead, the team of astronomers searched for places where quasars could provide helpful light. Quasars are galaxies that briefly shine as the brightest objects in the universe as their central object, a black hole, sucks up material in a violent process. If a cloud of gas is floating somewhere between that quasar and our telescopes, the gas is seen to absorb the quasar's light at very specific frequencies, or "colors." The light reaches us with those frequencies blacked out. The pattern of missing frequencies reveals the makeup, thickness and temperature of the gas.

Crighton and colleagues used this method to make their determinations about the galaxy, denoted Q1442-MD50. Key to their finding was that the missing frequencies revealed the presence of deuterium, a special variant, or isotope, of hydrogen. Calculations indicate that deuterium was created just minutes after the "Big Bang," an explosion-like event thought to have given birth to the universe. Deuterium is destroyed over time as the gas cycles in and out of stars, so the presence of deuterium signals "pristine" gas never before used to form stars, the astronomers said. "This is not the first time astronomers have found a galaxy with nearby gas, revealed by a quasar. But it is the first time that everything fits together," Crighton said. "The galaxy is vigorously forming stars, and the gas properties clearly show that this is pristine material, left over from the early universe shortly after the Big Bang." The astronomers want to find about 10 more examples of similar gas flows in order to compare them against simulations of galaxy formation and test them for accuracy. The work so far suggest the flows are quite common, they added. "We only had to search 12 quasar-galaxy pairs to discover this example. This rate is in rough agreement with the predictions of supercomputer simulations," said Joseph Hennawi, leader of a research group called ENIGMA at the Max Planck Institute for Astronomy in Germany.

(*Courtesy : W. M. Keck Observatory and World Science*)