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WORLD ENVIRONMENT DAY CELEBRATED AT IITR

The World Environment Day was celebrated at Indian Institute of Toxicology Research (IITR) Lucknow on June 5, 2009. Dr KC Gupta, Director, IITR welcomed the guests Prof. Javed Iqbal, Director, Institute of Life Sciences, Hyderabad and Prof. CL Khetrpal, Director, Centre of Biomedical Magnetic Resonance, Lucknow. Dr Gupta emphasized the importance of the day and said that this day is celebrated throughout the world with great zeal to remember the Stockholm Conference of 1972. The theme of this year world environment day is "Unite to combat climate change" and in India climate change is a matter of great concern, it has its impact of environment as well as agricultural yield.



World Environment Day function (L-R) Dr Mukul Das, Prof. CL Khetrpal, Prof. Javed Iqbal, Dr KC Gupta and Er. AH Khan

The report entitled the "Assessment of Environmental Status of Lucknow City" (Pre-monsoon, 2009) was released. Er. AH Khan Scientist, Environmental Monitoring Division, IITR presented the summary of the report.

Lucknow is a fast growing city. It has a total population of 22.45 lakhs. It is projected to be doubled, about 45 lakh by 2021. The vehicular population of Lucknow till March, 2009 was more than 10.5 lakh, which was found to be increased by 8.34% since last year. The increase in population, transportation, construction and other activities result in increased air pollution. Since 1997, institute has been carrying studies to assess the air quality of Lucknow city, twice a year i.e. during pre and post monsoon seasons. This year's pre-monsoon study during March-April, 2009 was completed at 10 locations (4 in residential, 5 in commercial and 1 in industrial area) for air pollutants i.e. SPM, RSPM, SO₂, NO_x as well as day & night time noise levels.

The average SPM in residential areas ranged between 280 to 380 µg/m³ and commercial areas ranged between 355-421 µg/m³. These values were more than the National

Ambient Air Quality Standards (NAAQS) of 200 µg/m³. Similarly average RSPM in residential areas ranged between 133 to 194 µg/m³ and commercial areas ranged between 161-235 µg/m³. These values were found to be more than the National Ambient Air Quality Standards (NAAQS) of 100 µg/m³. The data when compared with the last year pre-monsoon period showed slight decrease in SPM and RSPM, however only Gomtinagar and Alambagh areas showed increased values, which may be due to enhanced construction and traffic activities, respectively.

The concentration of SO₂ and NO_x was slightly lower than previous year in all the residential and commercial areas except Gomtinagar. Nonetheless, these values were within the prescribed limit of 80 µg/m³ for residential and commercial areas. The noise survey revealed higher noise pollution during day and night time in residential and commercial areas, which were above the permissible limits of 55 & 65 dB (A) for day time and 45 and 55 dB (A) in night time respectively.

It is suggested that more use of CNG vehicles and putting grass on roadside would curtail the SPM and RSPM levels. Horns in the vehicles permitted by transport department should only be used to avoid noise pollution. Also the movement of heavy vehicles during night hours may be regulated properly to tone down noise levels.

Professor Javed Iqbal delivered 13th Dr C.R. Krishna Murti Memorial Oration. In his oration he explained that Metabolic syndrome is characterized by a cluster of metabolic disorders such as reduced glucose tolerance, hyperinsulinemia, hypertension, visceral obesity and lipid disorders. The oration provided insights on the role of AMPK as a probable target for treatment of metabolic syndromes.

Prof. Khetrpal in his presidential address said that society has to pay some price for all the scientific inventions.



Group photograph of the winners of the painting competition with Director and guests

He gave the example of atomic energy and agricultural production. To increase the yield fertilizers and pesticides are used, and this production cost is paid in terms of environmental pollution.

Earlier on June 3, 2009 a painting competition was organized at IITR, the theme of the competition was "Unite to combat climate change" children from the age group 5-15 participated in the event. The children were divided in two groups: junior and senior.

The winners of the competition were:

Junior group

Shreya Srivastava, Ist; Sumedha Mahajan, IInd; Tarun Pandey IIIrd and Sabrina Manickam, consolation prize.

Senior group

Swati Chandra, Ist; Rachit Pandey, IInd; Smriti Chandra, IIIrd and Namita Chandra, consolation prize

Judges special prize was given to Manas Mishra

At the end of the function Dr Mukul Das, Scientist G, IITR proposed the vote of thanks.



XIII DR CR KRISHNA MURTI MEMORIAL ORATION

Dr C.R. Krishna Murti Memorial Oration is organized every year at Indian Institute of Toxicology Research Lucknow, in memory of Dr C.R. Krishna Murti, a well known biochemist and environmental scientist of India and Director of IITR from 1978-83. It has been delivered earlier by eminent personalities like Prof. Harsh Gupta (2008), Prof. AK Tyagi (2007), Prof. NK Ganguly (2006), Prof. Mohan K Raizada (2005), Dr Dinakar M Salunke (2004), Prof. Samir K Brahmachari (2003), Dr Kanury VS Rao (2002), Prof. Rajendra Prasad (2001), Dr Maharaj K Sahib (2000), Prof. RK Maheshwari (1999), Prof. Asis K Datta (1998) and Prof. SS Agarwal (1997). On June 5, 2008 Professor Javed Iqbal, Director, Institute of Life Sciences, Hyderabad delivered the



Prof. Javed Iqbal delivering the oration

CR Krishnamurthi oration the title of his oration was "AMP activated protein kinase: A next generation target for total metabolic control".

Prof. Javed Iqbal explained that Metabolic syndrome is characterized by a cluster of metabolic disorders such



A view of the audience

as reduced glucose tolerance, hyperinsulinemia, hypertension, visceral obesity and lipid disorders. The benefit of exercise in maintaining total metabolic control is well known and recent research indicates that AMP-activated protein kinase (AMPK) may play an important role in exercise-related effects. AMPK is considered as a master switch in regulating glucose and lipid metabolism. AMPK is an enzyme that works as a fuel gauge, being activated in conditions of high phosphate depletion. In the liver, activation of AMPK results in decreased production of plasma glucose, cholesterol, triglyceride and enhanced fatty acid oxidation.

In adipose tissue, activated AMPK inhibits deposition of fat, but enhances breakdown and burning of stored fat, resulting in reduction of body weight. The data suggest that AMPK may be a key player in the development of new treatments for obesity, type 2 diabetes and the metabolic syndrome. This oration provided insights on the role of AMPK as a probable target for treatment of metabolic syndromes.



CSIR PROGRAMME ON YOUTH FOR LEADERSHIP IN SCIENCE HELD AT IITR

Indian Institute of Toxicology Research (IITR) organized a two-day (June 9-10, 2009) CSIR Programme on Youth for Leadership in Science (CPYLS) in which students selected from the merit list of UP Board, CBSE and ICSE participated. The following students participated in the programme: Satyam Singh and Saurabh Shakya from BNSD Shiksha Niketan Inter College, Kanpur; Ishika Mohan from Jagat Taran Golden Jubilee School, Allahabad; Sagar Arora and Sumant Arora from St. Pauls Church College, Agra; Surabhi Trehan from La Martiniere Girls' College, Lucknow; and Vidushi Sharma from Lucknow Public College, Lucknow. Out of the seven students six belonged to the mathematics stream.



Director with the participants

The programme commenced in the morning of June 9 with screening of the film "Battling the toxicants" which is a window to IITR's research programmes. While welcoming the students and their parents, Dr KC Gupta, Director, IITR emphasized the importance of scientific



Participants interacting with the scientist

knowledge for the growth of the country. He also apprised the students on the various areas in which the institute is working.

He further said that the students have a focused thinking as six of them have opted for mathematical sciences except one who shall be opting for biological science. There are many challenging problems in mathematical or engineering and the students should look for an opportunity of doing R&D in engineering sciences. He urged the students to contribute towards society in advancing knowledge. Dr SK Goel, Member, Human Resource Development Committee (HRDC), IITR gave an overview of the genesis of the programme while Mr BD Bhattacharji, Convener, HRDC proposed the vote of thanks.

Later the students were shown various laboratories and facilities in order to acquaint them with modern approaches to toxicology research and also the impact that toxicants and pollutants have on human health at molecular and genetic levels. Techniques for detecting and quantifying chemicals and toxicants and environmental pollutants were shown in the Dyes and Food Adulterants laboratory and Environmental Monitoring Division. They were also demonstrated various techniques used in Petroleum Toxicology, Analytical Toxicology, Proteomics and Toxicogenomics laboratories. A lecture was arranged for the students entitled "The world of microbes", the speaker was Mr N Manickam, Scientist, IITR



Group photograph of participants along with the Director and staff of IITR

On the second day the students were taken around the Herbal Research, In-vitro Toxicology and Embryotoxicology laboratories. Dr Nasreen Ghazi Ansari, Scientist, IITR gave a lecture on "How to analyze pollutants". In the afternoon the students visited the Digital Library of

IITR and participated in the Science Olympiad.

A valedictory function was held later in the evening where the students expressed their views on the experience of the two days' programme. While airing their opinions, generally the students expressed their satisfaction and gratitude towards the CPYLS programme. One of the students was of the opinion that this small initiative by CSIR and IITR in honing the scientific temperament and building

leadership amongst the youth of the country, will, without an iota of doubt, go a long way in overall scientific development in Indian society.

Director, IITR presented mementoes and certificates to the participants and concluded the event with an open invitation to the students to visit IITR anytime they wished, interact with scientists here, and also participate in any activity organized by this institute.



IITR RESEARCH HIGHLIGHTS

1. **Effect of caffeine on the expression of cytochrome P450 1A2, adenosine A(2A) receptor and dopamine transporter in control and 1-methyl 4-phenyl 1, 2, 3, 6-tetrahydropyridine treated mouse striatum**

[Singh S, Singh K, Gupta SP, Patel DK, Singh VK, Singh RK, Singh MP. Brain Res. 2009 Jun 9. (Epub ahead of print)]

Parkinson's disease (PD) is a progressive neurodegenerative disorder, characterized by the selective loss of dopaminergic neurons of the nigrostriatal pathway. Epidemiological studies have shown an inverse relationship between coffee consumption and susceptibility to PD. Cytochrome P450 1A2 (CYP1A2) is involved in caffeine metabolism and its clearance. Caffeine, on the other hand, antagonizes adenosine A(2A) receptor and regulates dopamine signaling through dopamine transporter (DAT). The present study was undertaken to investigate the expression of CYP1A2, adenosine A(2A) receptor and DAT in mouse striatum and to assess their levels in 1-methyl 4-phenyl 1, 2, 3, 6-tetrahydropyridine (MPTP) treated mouse striatum with and without caffeine treatment. The animals were treated intraperitoneally daily with caffeine (20 mg/kg) for 8 weeks, followed by MPTP (20 mg/kg)+caffeine (20 mg/kg) for 4 weeks or vice versa, along with respective controls. Tyrosine hydroxylase immunoreactivity, levels of dopamine and 1-methyl 4-phenylpyridinium ion (MPP(+)), expressions of CYP1A2, adenosine A(2A) receptor and DAT and CYP1A2 catalytic activity were measured in control and treated mouse brain. Caffeine partially protected MPTP-induced neurodegenerative changes and modulated MPTP-mediated alterations in the expression and catalytic activity of CYP1A2, expression of adenosine A(2A) receptor and DAT. The results demonstrate that caffeine alters the striatal CYP1A2, adenosine A(2A) receptor and DAT expressions in mice exposed to MPTP.

2. **Tea polyphenols inhibit cyclooxygenase-2 expression and block activation of nuclear**

factor-kappa B and Akt in diethylnitrosoamine induced lung tumors in Swiss mice

[Roy P, Nigam N, Singh M, George J, Srivastava S, Naqvi H, Shukla Y. Invest New Drugs. 2009 Jun 11. (Epub ahead of print)]

Background Due to lack of validated screening methods and hence poor prognosis, treatment of lung cancer has not still improved up to the expectations. Therefore, risk of lung cancer needs to be minimized by efficient preventive measures. Tea (*Camellia sinensis*) and its bioactive polyphenols have been associated with prevention of human cancer for several organs. Thus, intake of tea polyphenols seems to be a viable mean to control lung cancer burden. In the present study, we studied the chemopreventive effects of green tea polyphenols (GTP) and black tea polyphenols (BTP) against diethylnitrosoamine (DEN) induced lung tumors in Swiss albino mice. Chemopreventive potential of tea polyphenols, was recorded as evident by, low incidence of alveologenic tumors in lungs of animals at tested doses (0.1% and 0.2% of both GTP and BTP) when compared with DEN (20 mg/kg b wt) treated animals. As a mechanism of cancer chemoprevention cellular signaling pathways were also targeted. GTP and BTP treatment inhibited the expression of Akt, cyclooxygenase-2 and inactivated nuclear factor-kappa B via blocking phosphorylation and subsequent degradation of I κ B α . Thus, the study suggests that polyphenolic constituents of both cultivars of tea, i.e. green and black, have chemopreventive effects in DEN induced lung tumorigenesis in Swiss albino mice.

Probing novel allergenic proteins of commonly consumed legumes

[Misra A, Prasad R, Das M, Dwivedi PD. Immunopharmacol Immunotoxicol. 2009;31(2):186-94].

Leguminous crops are the main source of protein in Asian subcontinent including India and their proteins may induce allergic reactions in sensitized

individuals. Pepsin resistance of proteins is a characteristic feature of most of the allergens. Simulated gastric fluid (SGF) assay as validated by digestion of purified known allergenic and non-allergenic proteins was the basis of this study. Purified allergenic proteins were stable to SGF digestion contrary to rapidly digested non-allergenic proteins. Crude proteins extracts (CPE) of soybean, peanut, chickpea, black gram, kidney bean and Bengal gram were digested *in vitro* to detect their non-digestible proteins. Six proteins from soybean and seven from peanut remained undigested after SGF digestion. Likewise, seven proteins from chickpea (70, 64, 55, 45, 35, 20 and 18 kDa), ten from black gram (47, 30, 29, 28, 26, 24, 22, 16, 14 and 12 kDa), five from kidney bean (45, 29, 24, 20 and 6.5 kDa) and one from Bengal gram (20 kDa) remained undigested in SGF. Most of the proteins stable in SGF for more than 2 min showed similarity with characterized allergens on the basis of their molecular weights as in case of soybean, peanut, chickpea and black gram. Also, soybean and chickpea stable proteins showed IgE binding property with respective allergic patient's sera. The non-digestible proteins from the chickpea, black gram, kidney bean and Bengal gram are being reported for the first time by our group. IgE binding of SGF resistant soybean and chickpea proteins is being reported first time as well.

3. [6]-Gingerol induces reactive oxygen species regulated mitochondrial cell death pathway in human epidermoid carcinoma A431 cells

[Nigam N, Bhui K, Prasad S, George J, Shukla Y. Chem Biol Interact. 2009 May 27. (Epub ahead of print)]

Since skin cancer incidence and prevalence is constantly rising up the charts despite all efforts, search for newer, better agents for protection and treatment is required. Ginger (*Zingiber officinale* Roscoe), a monocotyledonous herb, is widely used as a herbal medicine, given the presence of homologous phenolic ketones, of which [6]-gingerol is the major one. The quantity of [6]-gingerol in the fresh ginger rhizome was found to be 104-965µg/g in common varieties of ginger available in Indian market. Herein, [6]-gingerol was assessed for its anti-apoptotic effects in human epidermoid carcinoma A431 cells. [6]-Gingerol treatment exhibited considerable cytotoxicity as indicated by growth inhibition of A431 cells mediated via generation of reactive oxygen species (ROS). Increase in ROS led to decrease in mitochondrial membrane potential (MMP) and subsequent induction of apoptosis. Results revealed that perturbations in mitochondrial membrane are associated with deregulation of Bax/Bcl-2 ratio at gene transcriptional level as well as

protein level, where treatment with [6]-gingerol leads to up-regulation of Cytochrome-c and Apaf-1 subsequently culminating in triggering of Caspase cascade. These firmly suggest that [6]-gingerol can be effectively used for the treatment of skin cancer.

4. Distribution, sources and characterization of polycyclic aromatic hydrocarbons in the sediment of the river Gomti, Lucknow, India

[Tripathi R, Kumar R, Mudiam MK, Patel DK, Behari JR. Bull Environ Contam Toxicol. 2009 Sep;83(3):449-54].

Sediment samples were collected for PAHs analysis (upstream, midstream and downstream) from the bank of the river Gomti in Lucknow city, India during 2005-2007. Total concentration of the PAHs ranged from 0.068 to 3.153 µg/g dry weight. A correlation existed between the sediment organic carbon content (f(OC)) and the total PAHs concentration with a correlation coefficient (r²) of 0.788, suggesting that sediment organic carbon content played an important role in controlling the PAHs levels in the sediments. According to observed molecular indices, PAHs contamination in the river Gomti seems to be originated both from the high temperature pyrolytic process as well as from the petrogenic source, indicating a mixed PAH input pattern.

5. Polymorphism in cytochrome P450 2A6 and glutathione S-transferase P1 modifies head and neck cancer risk and treatment outcome

[Ruwali M, Pant MC, Shah PP, Mishra BN, Parmar D. Mutat Res. 2009 May 3. (Epub ahead of print)]

A case control study was carried out to investigate the association of functionally important polymorphism in cytochrome P450 2A6 (CYP2A6) and glutathione S-transferase P1 (GSTP1) genes with head and neck squamous cell carcinoma (HNSCC) and treatment response in cases receiving a combination of chemo-radiotherapy. The study group consisted of 350 males suffering from HNSCC and an equal number of male controls. Multivariate logistic regression analysis revealed statistically significant decrease in risk to HNSCC in cases with variant genotypes (CYP2A6*1B and CYP2A6*4C) of CYP2A6 (OR: 0.78; 95% CI: 0.43-1.22; P=0.04) or GSTP1 (OR: 0.71; 95% CI: 0.51-1.00; P=0.05). The risk associated with these variant genotypes was found to be further decreased in cases carrying a combination of variant genotypes of CYP2A6 and GSTP1 (OR: 0.40; 95% CI: 0.25-0.65; P=0.00). A similar decrease in risk was observed in cases with variant genotypes of CYP2A6 (OR: 0.59; 95% CI: 0.40-0.86; P=0.00) or GSTP1 (OR: 0.62; 95% CI: 0.42-0.91; P=0.01) and who were regular tobacco users (cigarette smokers or tobacco chewers).

Interestingly, only 27% of the cases carrying the variant forms of CYP2A6 (*1A/*4C+*1B/*4C+*4C/*4C) responded to the treatment for HNSCC when compared to those with wild-type genotype (69%). However with GSTP1, cases with homozygous mutant genotype (Val/Val) showed a superior treatment response (75%) when compared to cases with wild-type genotype (25%). Further, cases carrying a combination of variant genotype of CYP2A6 and wild-type genotype of GSTP1 exhibited a very poor treatment response demonstrating that polymorphisms in CYP2A6 and GSTP1 not only modified the risk to HNSCC but also played a major role in determining the chemotherapeutic response.

6. Resveratrol enhances ultraviolet B-induced cell death through nuclear factor-kappaB pathway in human epidermoid carcinoma A431 cells

[Roy P, Kalra N, Nigam N, George J, Ray RS, Hans RK, Prasad S, Shukla Y. Biochem Biophys Res Commun. 2009 Jun 26;384(2):215-20].

Resveratrol has been reported to suppress cancer progression in several *in vivo* and *in vitro* models, whereas ultraviolet B (UVB), a major risk for skin cancer, is known to induce cell death in cancerous cells. Here, it was investigated whether resveratrol can sensitize A431 human epidermoid carcinoma cells to UVB-induced cell death. The combined effect of UVB (30 mJ/cm²) and resveratrol (60 microM) on A431 cells was examined. Exposure of A431 carcinoma cells to UVB radiation or resveratrol can inhibit cell proliferation and induce apoptosis. However, the combination of resveratrol and UVB exposure was associated with increased proliferation inhibition of A431 cells compared with either agent alone. Furthermore, results showed that resveratrol and UVB treatment of A431 cells disrupted the nuclear factor-kappaB (NF-kappaB) pathway by blocking phosphorylation of serine 536 and inactivating NF-kappaB and subsequent degradation of I-kappaB α , which regulates the expression of survivin. Resveratrol and UVB treatment also decreased the phosphorylation of tyrosine 701 of the important transcription factor signal transducer

activator of transcription (STAT1), which in turn inhibited translocation of phospho-STAT1 to the nucleus. Moreover, resveratrol/UVB also inhibited the metastatic protein LIMK1, which reduced the motility of A431 cells. In conclusion, our study demonstrates that the combination of resveratrol and UVB act synergistically against skin cancer cells. Thus, resveratrol is a potential chemotherapeutic agent against skin carcinogenesis.

7. Antihyperglycemic and antioxidant effect of *Berberis aristata* root extract and its role in regulating carbohydrate metabolism in diabetic rats

[Jyotsna Singh, Poonam Kakkar. Journal of Ethnopharmacology 123 (2009) 22–26]

Berberis aristata DC root is used in traditional medicine for a number of ailments including metabolic disorders. The aim of the present study was to explore the antihyperglycemic and antioxidant potential of 50% aqueous ethanolic root extract of *Berberis aristata* (BA) in alloxan induced diabetic rats.

BA root extract (250 mg/kg) was administered to diabetic rats and standard drug glybenclamide (0.6 mg/kg) to group serving as positive control. Effect of extract on antioxidant and carbohydrate metabolism regulating enzymes of liver was studied in diabetic rats along with its safety parameters.

The main constituents of root were identified as berberine, berbamine and palmatine through HPTLC. The extract besides being safe, lowered the blood glucose significantly without any hypoglycemic effect on their control counterparts. It increased CAT, SOD, GPx, GR activity significantly and reduced lipid peroxidation (41.6%) and protein carbonylation (30.15%). It also increased the glucokinase and glucose-6-phosphate dehydrogenase activities and decreased glucose-6-phosphatase activity in diabetic rats which play a critical role in glucose homeostasis. Thus, the extract of *Berberis aristata* (root) has strong potential to regulate glucose homeostasis through decreased gluconeogenesis and oxidative stress.



ASSIGNMENTS ABROAD

Dr. Kr. P. Singh, Scientist visited Kathmandu, Nepal for attending a training the trainers course on measurement uncertainty during April 26 to May 1, 2009.

Dr. D. Kar Chowdhuri, Scientist deputed to U.K. under UK-IERI Major Research Award Project from June 27 to July 7, 2009.

Dr. Alok Dhawan deputed to U.K. under the DST-UKIERI project from April 23 to May 7, 2009.

Dr. D.K. Agarwal, Scientist deputed to Columbia in connection with GLP workshop and toxicology study audit from May 4-12, 2009.

MAPPING OF TOXICOLOGY RESEARCH IN INDIA

Anvita Shaw, FN Jaffery and Poonam Kakkar

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INTRODUCTION

Toxicology is the study of the effects of chemicals on biological systems. In ancient times it was basically the study of poisons. Early civilizations were very much aware of poisonous effects of various plants and animal derived substances. They used these poisons as weapons to kill the enemy. The Ebers papyrus (circa 1500 BC) contains information pertaining to many well known poisons like hemlock, aconite, opium, and metals such as lead, copper and antimony (1). In the sixteenth century Paracelsus recognized that chemicals have both properties i.e. therapeutic as well as toxic and recognized that these may be indistinguishable except by dose (2). Paracelsus is considered as "Father of Toxicology".

Toxicology is a multidisciplinary science including chemical science as well as biological science. The chemicals include inorganic chemicals, organic chemicals, metals, pesticides, food additives etc. Toxicology addresses a variety of questions. For example, in agriculture, toxicology determines the possible health effects from exposure to pesticides or herbicides, or the effect of animal feed additives, such as growth factors, on people. Toxicology is also used in laboratory experiments on animals to establish dose-response relationships. Toxicology also deals with the way chemicals and waste products affect the health of an individual (5).

The field of toxicology can be further divided into the following sub-disciplines:

- Environmental Toxicology is concerned with the study of chemicals that contaminate food, water, soil, or the atmosphere.
- Occupational (Industrial) Toxicology is concerned with health effects from exposure to chemicals in the workplace.
- Regulatory Toxicology gathers and evaluates existing toxicological information to establish concentration-based standards of "safe" exposure.
- Food Toxicology is involved in delivering a safe and edible supply of food to the consumer.
- Descriptive Toxicology is concerned with gathering toxicological information from animal experimentation.

- Analytical toxicology identifies the toxicant through analysis of body fluids, stomach content, excrement, or skin.
- Mechanistic Toxicology makes observations on how toxic substances cause their effects.

The interest and scope in toxicology continue to grow rapidly since the subject is of immense importance to human and animal health. The increasing number of xenobiotics to which humans and other organisms are exposed, underlie this growth. These include pesticides, environmental pollutants, industrial chemicals, food additives, and drugs of which we need to know much more, particularly about their safety.

Over the years, from essentially being a data generating process on the gross effects (mainly for regulatory purposes), toxicology research now is firmly rooted in mechanistic studies focused on the understanding of toxicological endpoints. This involves the 'omics' approach towards development of biomarkers consequently allowing greater confidence in the subsequent risk assessments. In assessing research performance, emphasis is not only laid on social impact but on the quality of research and its impact on advancement of knowledge which is traditionally evaluated on the basis of the number of peer reviewed publications in impact factor (IF) journals. In India, bibliometric studies have already been carried out of several areas viz. medical research, fisheries, and agricultural research; however toxicology research remained to be analyzed (3). An attempt has therefore been made here to analyze India's work in terms of publications available on ISI's Web of Science (4). This report attempts to analyze quantitatively the growth and development of toxicology research in India in terms of publication output of Indian scientists.

The Web of Science database is available from 1987 onwards and it covers Impact factor journals only hence this analysis spans twenty years of publications (1987 – 2007), during which 21706 papers were published. The web of Science database was searched using more than 100 search terms:

(Pollution or "waste management" or toxicity or "hazardous waste" or pesticide or carcinogenic or "metal toxicity" or "pesticide toxicity" or mycotoxin or neurotoxic or neurotoxicity or pyrethroids or carcinogenicity or mutagenic or "environmental pollution" or "food additives" or

"occupational exposure" or cytotoxic or toxin or "safety assessment" or "cosmetics toxicity" or "risk assessment" or detoxification or "developmental toxicity" or ecotoxicology or ecotoxicity or embryotoxicity or "environmental impact assessment" or "environmental monitoring" or "exposure assessment" or fetotoxicity or genotoxicity or "hazard assessment" or "health hazard" or immunotoxic or nephrotoxic or "passive smoking" or "pesticide residue" or phototoxicity or pneumoconiosis or asbestosis or byssinosis or silicosis or "reproductive toxicology" or fluorosis or arsenicosis or teratogenicity or teratogenic or toxicogenomics or toxicology or toxic or bioaccumulate or biotransformation or carcinogen or carcinogenic or mutagen or pollutant or teratogen or toxicant or toxicosis or toxigenic or toxoid or xenobiotic or aflatoxin or "acceptable daily intake" or "accidental exposure" or "acute toxicity" or adenocarcinoma or bagassosis or bioaccumulation or "chemical safety" or "chemical warfare" or "chronic toxicity" or cocarcinogen or hepatotoxic or nanotoxicology or "persistent organic pollutant" or "risk assessment" or toxicokinetics or pyrethrin or "molecular toxicology" or biomarker or mutagenicity or carcinoma or detoxification or contaminant or apoptosis or xenobiotics or "industrial solid waste" or "municipal sludge" or "municipal waste" or phototoxic or toxicant or genotoxic or "environmental chemicals" or "gm food" or "genetically modified" or "genetically engineered" or argemone or "polycyclic aromatic hydrocarbon" or "persistent organic chemicals" or enterotoxicogenic or sludge or "lead toxicity" or "arsenic toxicity" or "mercury toxicity" or "cadmium toxicity" or "nickel toxicity" or "inhalation toxicology" or "fibre toxicity" or "environmental degradation") and (India)

DOCUMENT TYPE- WISE ANALYSIS

Out of 21706 papers 19321 were articles, 1015 were reviews, 516 were notes, 422 were meeting abstracts, 307 were letters, 105 were editorial material and rest were news items. (table 1)

Table 1. Document Type

| Document Type | Record Count | % of 21706 |
|------------------|--------------|------------|
| ARTICLE | 19321 | 89.0123 % |
| REVIEW | 1015 | 4.6761 % |
| NOTE | 516 | 2.3772 % |
| MEETING ABSTRACT | 422 | 1.9442 % |
| LETTER | 307 | 1.4144 % |

YEAR WISE ANALYSIS

Year wise analysis of publications (table 2) reveals that 2006 was the most productive year accounted for 10.53% of total publications followed by 2007 and 2005 which showed 9.96% and 8.345 publications respectively.

Table 2. Year wise analysis of publication

| Publication Year | Record Count | % of 21706 |
|------------------|--------------|------------|
| 2006 | 2286 | 10.5317 % |
| 2007 | 2164 | 9.9696 % |
| 2005 | 1811 | 8.3433 % |
| 2004 | 1635 | 7.5325 % |
| 2003 | 1469 | 6.7677 % |
| 2002 | 1247 | 5.7450 % |
| 2001 | 1169 | 5.3856 % |
| 1999 | 1001 | 4.6116 % |
| 2000 | 976 | 4.4965 % |
| 1998 | 919 | 4.2339 % |
| 1997 | 856 | 3.9436 % |
| 1994 | 799 | 3.6810 % |
| 1996 | 797 | 3.6718 % |
| 1995 | 749 | 3.4507 % |
| 1992 | 738 | 3.4000 % |
| 1991 | 735 | 3.3862 % |
| 1993 | 733 | 3.3769 % |
| 1988 | 431 | 1.9856 % |
| 1990 | 403 | 1.8566 % |
| 1989 | 400 | 1.8428 % |
| 1987 | 335 | 1.5434 % |

INSTITUTION WISE ANALYSIS

Publications of a total number of 414 research centres were identified for analysis with at least 10 publications in the last two decades. Industrial toxicology Research Centre (now renamed as Indian Institute of Toxicology Research) Lucknow topped the list with 1529 publications followed by Indian Institute of Technology (880), All India Institute of Medical Science (681), Banaras Hindu University (543) and University of Madras with 507 publications.(table 3)

Table 3. Institution wise Distribution

| Institution Name | Record Count | % of 21706 |
|-------------------------------------|--------------|------------|
| IND TOXICOL RES CTR | 1529 | 7.0441 % |
| INDIAN INST TECHNOL | 880 | 4.0542 % |
| ALL INDIA INST MED SCI | 681 | 3.1374 % |
| BANARAS HINDU UNIV | 543 | 2.5016 % |
| UNIV MADRAS | 507 | 2.3358 % |
| POSTGRAD INST MED EDUC & RES | 488 | 2.2482 % |
| TATA MEM HOSP | 423 | 1.9488 % |
| UNIV DELHI | 401 | 1.8474 % |
| BHABHA ATOM RES CTR | 386 | 1.7783 % |
| JAWAHARLAL NEHRU UNIV | 313 | 1.4420 % |
| INDIAN INST SCI | 307 | 1.4144 % |
| INDIAN INST CHEM BIOL | 294 | 1.3545 % |
| UNIV CALCUTTA | 276 | 1.2715 % |
| ANNAMALAI UNIV | 265 | 1.2209 % |
| CENT DRUG RES INST | 259 | 1.1932 % |
| DEF RES & DEV ESTAB | 258 | 1.1886 % |
| ALIGARH MUSLIM UNIV | 248 | 1.1425 % |
| INDIAN VET RES INST | 247 | 1.1379 % |
| JADAVPUR UNIV | 237 | 1.0919 % |
| INDIAN INST CHEM TECHNOL | 232 | 1.0688 % |
| SANJAY GANDHI POSTGRAD INST MED SCI | 226 | 1.0412 % |
| CENT FOOD TECHNOL RES INST | 221 | 1.0182 % |
| INDIAN AGR RES INST | 215 | 0.9905 % |
| NATL ENVIRONM ENGN RES INST | 202 | 0.9306 % |
| OSMANIA UNIV | 201 | 0.9260 % |

SUBJECT WISE ANALYSIS

Out of a total of 139 subject areas environmental science appeared to be the most popular subject area of

research work and publication followed by toxicology, biochemistry and molecular biology. (table 4)

Table 4. Subject Area Wise distributio

| Subject Area | Record Count | % of 21706 |
|---|--------------|------------|
| ENVIRONMENTAL SCIENCES | 3362 | 15.4888 % |
| TOXICOLOGY | 2784 | 12.8259 % |
| BIOCHEMISTRY & MOLECULAR BIOLOGY | 2088 | 9.6195 % |
| PHARMACOLOGY & PHARMACY | 1778 | 8.1913 % |
| ONCOLOGY | 1651 | 7.6062 % |
| BIOTECHNOLOGY & APPLIED MICROBIOLOGY | 1186 | 5.4639 % |
| MULTIDISCIPLINARY SCIENCES | 901 | 4.1509 % |
| CELL BIOLOGY | 873 | 4.0219 % |
| IMMUNOLOGY | 795 | 3.6626 % |
| PLANT SCIENCES | 748 | 3.4461 % |
| CHEMISTRY, MEDICINAL | 713 | 3.2848 % |
| CHEMISTRY, MULTIDISCIPLINARY | 653 | 3.0084 % |
| MICROBIOLOGY | 650 | 2.9946 % |
| PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH | 615 | 2.8333 % |
| MEDICINE, RESEARCH & EXPERIMENTAL | 610 | 2.8103 % |
| FOOD SCIENCE & TECHNOLOGY | 596 | 2.7458 % |
| ENGINEERING, ENVIRONMENTAL | 547 | 2.5200 % |
| VETERINARY SCIENCES | 538 | 2.4786 % |
| GENETICS & HEREDITY | 530 | 2.4417 % |
| BIOPHYSICS | 517 | 2.3818 % |

JOURNAL WISE ANALYSIS

During the study period out of 482 journals maximum number of papers were published in "Journal of

Environmental Biology" followed by "Current Science" and "Bulletin of Environmental Contamination and Toxicology".(table 5)

Table 5. Source Wise Distribution

| Source Title | Record Count | % of 21706 |
|--|--------------|------------|
| JOURNAL OF ENVIRONMENTAL BIOLOGY | 568 | 2.6168 % |
| CURRENT SCIENCE | 470 | 2.1653 % |
| BULLETIN OF ENVIRONMENTAL CONTAMINATION AND TOXICOLOGY | 375 | 1.7276 % |
| INDIAN VETERINARY JOURNAL | 316 | 1.4558 % |
| INDIAN JOURNAL OF ANIMAL SCIENCES | 310 | 1.4282 % |
| INDIAN JOURNAL OF MEDICAL RESEARCH | 218 | 1.0043 % |
| ENVIRONMENTAL MONITORING AND ASSESSMENT | 216 | 0.9951 % |
| CANCER LETTERS | 208 | 0.9583 % |
| JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH | 179 | 0.8247 % |

| | | |
|---|-----|----------|
| MOLECULAR AND CELLULAR BIOCHEMISTRY | 176 | 0.8108 % |
| CHEMOSPHERE | 170 | 0.7832 % |
| FOOD AND CHEMICAL TOXICOLOGY | 148 | 0.6818 % |
| TOXICOLOGY LETTERS | 148 | 0.6818 % |
| JOURNAL OF ETHNOPHARMACOLOGY | 141 | 0.6496 % |
| BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS | 140 | 0.6450 % |
| NATIONAL ACADEMY SCIENCE LETTERS -INDIA | 140 | 0.6450 % |
| BIORESOURCE TECHNOLOGY | 134 | 0.6173 % |
| ASIAN JOURNAL OF CHEMISTRY | 131 | 0.6035 % |
| INDIAN JOURNAL OF AGRICULTURAL SCIENCES | 131 | 0.6035 % |
| INDIAN JOURNAL OF EXPERIMENTAL BIOLOGY | 128 | 0.5897 % |
| ECOTOXICOLOGY AND ENVIRONMENTAL SAFETY | 126 | 0.5805 % |
| PHYTOTHERAPY RESEARCH | 125 | 0.5759 % |
| TOXICOLOGY | 120 | 0.5528 % |
| ACTA CYTOLOGICA | 116 | 0.5344 % |
| JOURNAL OF HAZARDOUS MATERIALS | 116 | 0.5344 % |
| HUMAN & EXPERIMENTAL TOXICOLOGY | 115 | 0.5298 % |
| INDIAN JOURNAL OF CHEMISTRY SECTION B -ORGANIC CHEMISTRY INCLUDING MEDICINAL CHEMISTRY | 109 | 0.5022 % |

This study is an appraisal of toxicological research in India and is indicative of research trends during the last two decades. This study further needs to be more critically performed so as to include citation as well as impact factors of the journals. Publication in high impact factor journals are limited in the area of toxicology & environmental sciences however, with expanding ambit of these multidisciplinary areas the number of publications in high impact factor journal is sure to increase.

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RESEARCH DIGEST

Thin the Air, Save the Biosphere?

ScienceNOW Daily News, 1 June 2009

Sometime between 100 million and 1 billion years from now, Earth will have lost so much carbon dioxide from its atmosphere that plants and trees will literally begin suffocating, eventually taking all life with them. In a new study, researchers propose one way to delay this Armageddon: reduce the pressure of the atmosphere, effectively creating conditions where we all feel like we're living at high altitudes.

Over the geologic history of Earth, CO₂ levels in the atmosphere have been dropping. Today, concentrations are only a small fraction of what they were several billion years ago. Plants, algae, and other photosynthesizers consume CO₂, but much of it is eventually returned to the atmosphere when the organisms die. So some other process must be socking away CO₂ permanently. The available chemical evidence points to the action of silicates in rocks: The compounds somehow turn carbon into bicarbonate and pull it out of the biosphere. If the trend continues, researchers have found, Earth would not be able to sustain photosynthesis for more than about a billion years. A team from the California Institute of Technology in Pasadena led by physicist King-Fai Li wondered if there was any way to stop this potential catastrophe. The researchers created models of Earth's atmosphere over the next several billion years. When they factored in a constant level of CO₂, they discovered a surprising development: The change required a lower overall atmospheric pressure—about one-sixth today's pressure at sea level. With that change, Earth's biosphere could persist for an extra 1.3 billion years, the team reports online in the *Proceedings of the National Academy of Sciences*. The reduction in atmospheric pressure would counteract the complex interaction of the CO₂ and the nitrogen in the atmosphere with seawater and the rocks on the ocean bottom; the net effect would be less permanent sequestering of carbon and a longer lifetime for photosynthesis, the team reports. "This is the first study that makes use of the idea that atmospheric pressure could have varied over Earth's history," Li says. "And it shows how that variation could continue to affect the atmosphere."

The trick to achieving this reduction of pressure, the researchers say, would be to develop a technology that sucks nitrogen from the air, which at 78% constitutes the bulk of Earth's atmosphere. The downside would be thinner air,

though because of other factors oxygen would be enriched. This would require our distant descendants to develop the same physiology as the Sherpa people of Nepal, who can live comfortably at elevations that make most other people either ill or in danger of dying. Still, the conditions could give our distant descendants some extra breathing room, Armageddon-wise. Global ecologist Kenneth Caldeira of the Carnegie Institution in Stanford, California, who has studied the implications of low carbon concentrations in the atmosphere, says the researchers have made "a persuasive case" that pressure can play an important role in the planet's long-term atmospheric composition. But Caldeira says he doubts that anyone knows what will happen to total atmospheric pressure in the distant future.

An Unexpected Deep-Sea Diver

Environmental Health Perspectives Volume 117, Number 6, June 2009

Domoic acid (DA), a potent neurotoxin produced primarily by the diatom genus *Pseudo-nitzschia*, is generated during harmful algal blooms—rapid surges in toxic algae populations that result from increases in nutrient availability, temperature, and sunlight, among other environmental changes. Previously, scientists assumed that once the blooms dissipated, DA was released into and diluted within the upper ocean layer. But a study published in the April 2009 issue of *Nature Geoscience* shows that DA can be trapped inside the silica shells of *Pseudo-nitzschia* and carried to the ocean floor. Concentrations of DA in particles collected in deep oceans were several times higher than the regulatory limit set by the U.S. Environmental Protection Agency (EPA) to prevent human poisoning.

DA can cause a condition called amnesic shellfish poisoning in people who eat contaminated crabs, oysters, clams, mussels, scallops, anchovies, and sardines—all of which feed on *Pseudo-nitzschia*. Symptoms include gastrointestinal upset, headache, dizziness, cardiac arrhythmia, coma, potential loss of short-term memory, and possibly death. Water-soluble DA concentrates in the stomachs of shellfish and tiny fish. To ingest DA, people must eat the whole organism, including the stomach, says Stephen Bates, phytoplankton scientist emeritus with Fisheries and Oceans Canada.

Although elderly people are considered the most vulnerable to the effects of DA, early-life exposures also

may be problematic. Recent rodent studies by biologists at the University of Prince Edward Island, published in the 23 March and 16 April 2009 issues of *Physiology & Behavior*, found that neonatal exposure to low doses of DA was associated with lasting cognitive deficits and behavioral problems in adult animals. Moreover, findings reported in the December 2008 issue of *Marine Drugs* suggest DA may be immunotoxic in mice.

For the current study, researchers set up sediment traps off the coast of Southern California, where *Pseudo-nitzschia* blooms and DA poisoning are prevalent. The traps floated above the sea floor at depths of 540, 550, and 800 m. Sediment collected in traps set at 550 m contained up to 50 ig DA/g dry sediment, and traps set at 800 m contained up to 163 ig DA/g of dry sediment. Measurements showed that DA sank rapidly, settling to 800 m in about three days. Bates says shellfish and sediment levels are not directly comparable because the former reflects wet weight, whereas the latter reflects dry weight, but that a rough comparison can be made for the purpose of assessing relative amounts.

The findings suggest that marine creatures living in deeper waters may be contaminated with DA, yet health officials currently monitor only shellfish that live close to the surface. The U.S. EPA and the Canadian Food Inspection Agency regularly check commercial shellfish beds, with increased testing during algal blooms, closing the beds when levels reach 20 µg DA/g tissue. However, says study leader Claudia Benitez-Nelson, a geochemist at the University of South Carolina, "We no longer can use algal blooms as an indicator of [potential] DA poisoning."

The fact that DA sinks to deeper waters may, in fact, help explain past mysterious outbreaks of shellfish poisoning. For instance, in 1995 lucrative deep-sea scallop beds were closed to harvesting off the coast of Nova Scotia in the Gulf of Maine. The scallops contained up to 3,400 ig DA/g tissue. "We didn't know where the DA came from," Bates says. "But the new data suggest that the cause could have been DA sinking down from surface blooms of *Pseudo-nitzschia*."

The key to curbing DA poisoning is to understand why and when *Pseudo-nitzschia* blooms occur. Although harmful algal blooms are mainly viewed as natural phenomena, the magnitude and occurrence of some toxic species can be exacerbated by nutrient inputs from human sewage and fertilizer and possibly other forms of coastal pollution. "People are working hard to reduce runoff from crops and lawns, but it takes time," says Benitez-Nelson.

Meanwhile, she adds, "Once [*Pseudo-nitzschia*] bloom, it's very difficult to control the toxins they produce."

Body Is a Wonderland ... of Bacteria

<http://sciencenow.sciencemag.org/cgi/content/full/2009/528/1>

Where can you find your skin's most diverse community of bacteria? Not in a sweaty armpit or linty belly button. According to a new survey of the bacterial ecosystem that covers us, the diversity hot spot of the body's exterior is the forearm. And the surprises don't end there.

Microbes that live in and on our bodies outnumber our own cells 10 to one, but researchers have only recently begun to catalog the residents on our skin. Traditionally, scientists identified human skin bacteria by swabbing volunteers and culturing the samples, but those results skewed toward microbes that grow well in the lab. Thanks to ever-evolving gene-sequencing technology, scientists can now use microbial RNA to identify organisms. With these techniques, researchers have found an unexpectedly wide variety of bacteria on human skin (*Science*, 23 May 2008, p. 1001). But no one had ever systematically compared bacterial colonies from different areas on the human body.

To do so, scientists from the National Human Genome Research Institute in Bethesda, Maryland, recruited 10 volunteers and asked them to wash with mild soap for 1 week. Then, after 24 hours without bathing, the volunteers arrived at the lab, where researchers swabbed and scraped their skin in 20 places—everywhere from the nostril to the navel to that bane of low-rise jeans aficionados, the gluteal crease. The team analyzed ribosomal RNA from the samples and classified the microbes based on their genomes.

The researchers found about 1000 species total, which were fairly consistent from person to person; it turns out we all have similar tenants in our noses and on our backs. The number suggests that our skin is as variegated as our guts, which house anywhere from 500 to 1000 bacterial species. The team also found vast differences across the skin, according to the study published in *Science*. Contrary to what acne-prone teenagers might expect, oily areas such as the forehead and scalp are actually less diverse than dry areas such as the forearm (though one is enough for grief: *Propionibacterium acnes* thrives in oily spots). The most barren region was behind the ear, with a median diversity of 15 species. In comparison, the forearm teemed with a median 44 species. A follow-up with five of the volunteers months later found that bacterial

makeup changed little over time.

Why some neighborhoods are more varied than others is unknown. It could be because of skin properties such as hair or oil, exposure to bacteria, or some combination. As for the forearm, geneticist and co-author Julia Segre speculates that exposed arms make a good landing pad for bacteria. Contrasted with how we clean our hands, we rarely lather up our forearms. Whatever the reason, the research shows that location matters. "This paper really highlights that the skin is an ecosystem and that the bacteria that live on our skin are not homogenous,".

The research "could contribute to explaining why certain skin diseases appear at certain sites of the body and not others," says dermatologist Richard Gallo of the University of California, San Diego. "It's a straightforward description of something that needed to be described." The next step, Segre says, is to investigate the relationship between microbial ecosystems and diseases such as eczema and psoriasis.

Keep Biofuels Out of the Gas Tank

ScienceNOW Daily News, 8 May 2009

Biofuels work better if you don't put them directly into your car. That's the conclusion of a new study that shows that ethanol derived from corn and switchgrass allows cars to drive farther and emit less greenhouse gases if these crops are converted to electricity for powering electric vehicles rather than pouring the ethanol into the gas tank.

Biofuels are widely considered a better environmental alternative than fossil fuels. Even though they release carbon dioxide (CO₂) when burned, the same amount of CO₂ is reabsorbed as the next crop of plants grows. What hasn't been well-understood is whether it's better to convert crops to ethanol that can be burned in conventional internal combustion engines or to burn the crops to generate electricity that can power electric vehicles.

To find out, Elliott Campbell, an environmental engineer at the University of California, Merced, and his colleagues carried out a life-cycle analysis of bioethanol and bioelectric technologies. The analysis took into account not only the energy produced by each technology but also the energy consumed in producing the vehicles and fuels.

Bioelectricity was the clear winner. Cars would travel 81% farther on the energy in biofuels if it were first converted to electricity, the team reported in *Science*. Powering an electric vehicle using crops would also prevent the release of up to 10 tons of CO₂ per acre compared with a similar

sized gasoline-powered car. That "offset" of unreleased CO₂ is roughly double that of bioethanol-powered cars. According to Campbell, the primary reason bioelectricity came out looking so much better is that electric engines are far more efficient than are internal combustion engines. "Even the best ethanol-producing technologies with hybrid engines aren't enough to overcome this," he says.

"It really is an important paper," says Jason Hill, a bioenergy economist at the University of Minnesota, Twin Cities. But Hill cautions that the new analysis doesn't take all of the issues into account. Still missing from consideration are the cost differences between electric vehicles and those with internal combustion engines, as well as other possible environmental effects of biofuel technology such as increased air pollution and water use.

Toxicant Is Accelerating Demise of Fossil Fish

ScienceNOW Daily News, 27 May 2009

A chemical applied to ship hulls is robbing Chinese sturgeon of their eyes and causing other deformities, according to a new study. The toxicant may deal a death blow to the already-endangered fish, a living fossil that the Chinese government considers a "national treasure."

The Chinese sturgeon (*Acipenser sinensis*) has lived in the Yangtze River for 140 million years, making it one of the world's oldest fish. Although the 450-kilogram sturgeon once thrived in these waters, overfishing and the loss of spawning areas to dams has cut its numbers by roughly 85% over the past 30 years. As of 2007, there were only about 500 spawning sturgeon left in the Yangtze.

Now Chinese scientists have identified a new threat: triphenyltin (TPT), a biocide applied to ship hulls and fishing nets that prevents the buildup of algae and other aquatic hitchhikers. The compound has slowly washed from ships and accumulated in Yangtze sediments. In this week's issue of the *Proceedings of the National Academy of Sciences*, Hu Jianying, a professor at the College of Urban and Environmental Sciences at Peking University in Beijing, and colleagues report a direct correlation between TPT levels in water and sturgeon deformities. The team captured more than 1000 Chinese sturgeon larvae from the Yangtze and recorded the incidence of mutations: 6.3% exhibited morphological deformities such as gnarled spinal cords, and 1.2% had only one eye or no eyes at all. In addition, four adult sturgeon were captured for artificial propagation in a TPT-free environment. Their offspring maintained a high concentration of TPT and showed comparable rates of deformities to sturgeon in the wild, suggesting that the

chemical accumulates in the fish and is passed to its eggs.

Hu's group also exposed a close relative of the Chinese species, the Siberian sturgeon (*Acipenser baeri*), to TPT and found similar rates of deformities in a dose-dependent relationship. When raised in a TPT-free environment in land-based breeding facilities, these sturgeon showed only a 0.66% rate of morphological deformities and no ocular deformities. Other biocides that are present in the Yangtze and similar to TPT—dibutyltin, monobutyltin, and tributyltin—resulted in fewer deformities and did not show a dose-dependent response.

TPT appears to harm reproduction as well. In a separate study conducted by Zhang Zhaobin of the College of Urban and Environmental Sciences at Peking University, exposure to TPT reduced the ability of the Japanese Medaka fish (*Oryzias latipes*) to produce viable offspring by as much as 75% in a controlled facility. Because both the Chinese sturgeon and the Medaka showed similar deformities when exposed to the same levels of TPT, Hu's team believes that TPT is likely reducing the sturgeon's fertility in the wild.

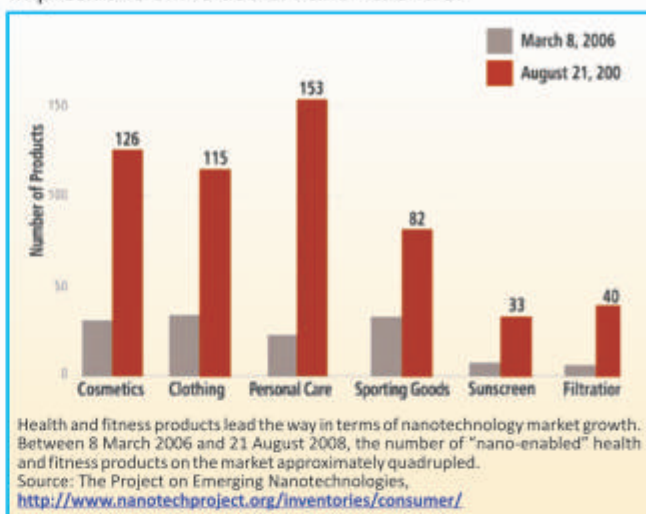
The findings may have come too late. Hu argues that although the sturgeon's population can be sustained by captive breeding and restocking the Yangtze, banning TPT at this stage would do little to undo the damage in the wild. TPT is a "legacy contaminant," says Hu, meaning that it has a very slow rate of breakdown. Even if a ban on the chemical were introduced, TPT already present in sediment could continue to cause damage for years to come. Those sturgeon still plying the Yangtze today might end up being the last of their kind: "the living dead," says aquatic ecologist David Dudgeon of the University of Hong Kong.

What Lies Ahead for Nanotechnology?

Environmental Health Perspectives Volume 117, Number 4, April 2009

Nanotechnology, the engineering of functional materials at an atomic or molecular scale, has been among the fastest growing fields of science and technology. Worldwide sales of products incorporating nanotechnology are projected to total \$2.6 trillion by 2014, according to a 2004 report from Lux Research titled *Sizing Nanotechnology's Value Chain*. But with the increasing use of nanomaterials in many consumer products has come growing concern about potential environmental, health, occupational, and general safety hazards. At the 2009 annual meeting of the American Association for the Advancement of Science, scientists held a seminar titled "Driving Beyond Our Nano-Headlights?" to discuss recent nanotoxicologic

research as well as health and environmental policy implications of the use of nanomaterials.



Speaker Agnes Kane, a medical professor at Brown University, revisited the analogy between chrysotile asbestos fibers and carbon nanotubes (CNTs), a concept first introduced in 1998. In collaboration with fellow Brown University researcher Robert Hurt, Kane has compared the two materials and found similarities in surface area, physical properties, and geometry, raising the possibility that CNTs may show asbestos-like behavior in the human body. Also, using a newly designed cell culture model, Vanesa Sanchez, a graduate student in Kane's laboratory, found that very low doses of CNTs (1 µg/mL) appeared to cause lesions known as granulomas similar to what occurs with asbestos fibers. Moreover, the CNTs formed a cage-like structure that Kane suspects might promote granuloma formation.

Kane also cited research by Ken Donaldson and colleagues of the University of Edinburgh in which the mesothelial lining of the mouse body cavity was exposed to CNTs. (In humans, asbestos is known to cause mesothelioma, a rare form of cancer of this lining.) As Donaldson's group reported in the July 2008 issue of *Nature Nanotechnology*, this exposure resulted in asbestos-like pathogenic effects that included inflammation and granuloma formation.

Sanchez's new cell culture model is one of the few that can screen for potential adverse health effects of nanomaterials. Along these lines, the various challenges of conducting nanotoxicologic research are a central focus for Sally Tinkle, senior science advisor in the Office of the NIEHS Director. Tinkle said the shape and manufacture of a nanoparticle will have a profound impact on the particle's reactivity, as well as how it interacts in the body.

"Nanomaterials hold incredible promise to solve significant world problems, like the need for energy and clean water, but these new materials have novel physical and chemical properties, and we don't know yet what their interactions with biological systems will be," she said.

Tinkle noted various problems with the interpretation of toxicologic data for nanomaterials. Citing correspondence published in the February 2007 issue of *EHP* by Günter Oberdörster and colleagues at the University of Rochester, she pointed out that toxicologic data could be interpreted differently depending on whether you looked at the nanomaterial's mass or surface area. Moreover, in six common toxicology assays on the same nanomaterial sample conducted by Nancy Monteiro-Riviere and colleagues at North Carolina State University, Tinkle noted that some assays showed a significant effect of exposure whereas others showed none. CNTs were also found to compromise the accuracy of the assays, but nanotoxicologists have yet to identify adequate positive and negative controls that would better reveal the presence and effects of such interference.

Norris Alderson, associate commissioner for science at the U.S. Food and Drug Administration (FDA), raised a related issue in the manufacturing domain—that of guaranteeing consistency (primarily in terms of size, shape, and purity of composition) from batch to batch of nanomaterial to ensure safety and efficacy. "Let's say you've

got a nanoscale material for which the majority of particles is 50 nm," said Alderson. "But if there's variation on both sides of that, how much can you vary that distribution and still procure a material with the same characteristics or safety and efficacy?"

Establishing appropriate standards for nanomaterial production is a salient concern for Travis Earles, National Science and Technology Council representative on the nanotechnology portfolio in the White House Office of Science and Technology Policy. Earles stated that such standards were still a work in progress, both nationally and internationally. "It's a little bit of the Wild West in the standards development side of things," he said. "The standardization effort is quite crucial because it ultimately will be the context through which we can successfully or unsuccessfully innovate nanotechnology into commercial use."

Despite these and other challenges, Earles was able to sound a note of optimism for scientists who are looking toward whatever might lie beyond the nano-headlights: Federal funding allocated specifically for environmental, health, and safety research in nanotechnology has grown from \$34.8 million in 2005 to \$58.6 million in 2008. The multiagency National Nanotechnology Initiative anticipates that funding for the current year will increase to \$76.4 million, well above the amount of direct investment made by any other country.



पर्यावरण संरक्षण के सन्दर्भ में प्लास्टिक अपशिष्ट प्रबंधन की भूमिका

उत्तम कुमार शुक्ल एवं डॉ. वी.पी. शर्मा

भारतीय विष विज्ञान अनुसंधान संस्थान

80, महात्मा गांधी मार्ग, लखनऊ

*पृथ्वी संगंधा: सरसास्तथापः
स्पर्शी च वायुर्ज्वलनम् च तेजः।
नभः सशब्दं महता सहैव
कुर्वन्तु सर्वे ममसुप्रभातम्॥*

अर्थात् गंध के गुण से युक्त पृथ्वी, रसयुक्त जल, स्पर्शयुक्त वायु, तेजयुक्त प्रकाश तथा शब्द के गुण से युक्त विस्तृत आकाश हमारे प्रभात (सुबह) को शुभ करो।

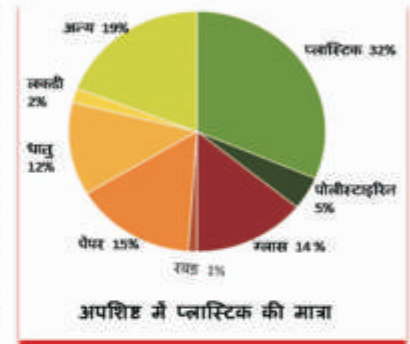
वर्तमान युग औद्योगिक विकास का युग है। संसार के सभी विकासशील देशों में हजारों लाखों फैक्टरियाँ दिन रात चलती रहती हैं। इन सब के प्रभाव से हमारा वातावरण दूषित हो गया है। जो वायु हमें सांस लेने के लिए चाहिए, वह शुद्ध नहीं रही। जल और भूमि भी प्रदूषित हो गए हैं। वायु, भूमि और जल का प्रदूषण एक बहुत बड़ी समस्या बनी हुई है। प्रदूषण की प्रतिदिन बढ़ रही समस्या के लिए प्लास्टिक का कचरा, मुख्य रूप से पॉलीथीन जिम्मेदार है। आज हर जगह प्लास्टिक की थैलियों का ही इस्तेमाल हो रहा है। अब विवाह व अन्य समारोहों में भी प्लास्टिक के गिलास व थालियों का प्रयोग होने लगा है। प्लास्टिक अपनी रासायनिक निष्क्रियता हल्केपन और सस्ता होने के कारण विभिन्न प्रयोगों में काम आता है। प्लास्टिक कई रूप में काम आता है तथा इसका विकल्प ढूँढा जाना आवश्यक है। इस्तेमाल करने के बाद फेंकी हुई थैलियाँ कचरा बन पानी में बहकर सीवेज के गटर में चली जाती है, जिसके कारण सीवेज अवरोधित हो जाते हैं। प्लास्टिक कचरा न गलने के कारण जहाँ भी रुकता है वहाँ सीवेज अवरोधित होना आम बात है। गलियों में प्रयोग के बाद फेंके गए प्लास्टिक सीवेज जाम का कारण बनते हैं। एतद्द्वारा सीवेज का गंदा पानी लोगों के घरों में या फिर सड़कों व गलियों में जमा होकर बीमारियों का कारण बनता है।



अपशिष्ट में प्लास्टिक का योगदान

प्लास्टिक जनित समस्याएँ

निस्तारण : प्लास्टिक जैव विघटन रहित होने के कारण निस्तारित करना कठिन होता है। यह वर्षों तक जमीन में पड़ा रहता है। इससे पर्यावरण प्रदूषित होता है। प्लास्टिक दो प्रकार के होते हैं, थर्मोप्लास्टिक और थर्मोसेट प्लास्टिक। पोली ओलीफिन से बने थर्मोप्लास्टिक जो जैव विघटन रहित होते हैं, को प्रकाश विघटन और रासायनिक विघटन द्वारा निस्तारित किया जा सकता है। थर्मोसेट प्लास्टिक जैसे एलिफैटिक पोलीएक्टर और पोलीएस्टर पोली उरेथेन एस्टर बांड के हाइड्रो लिटिक क्लीवेज की वजह से माइक्रोऑर्गेनिज्म द्वारा विघटित हो जाते हैं।



ड्रेनेज व सीवेज में अवरोध की समस्या : निर्धारित मापदंड के प्लास्टिक का उपयोग नहीं होने का असर ड्रेनेज सिस्टम व सीवेज पर पड़ता है।

प्लास्टिक जैव विघटन रहित होने की वजह से वर्षों तक भूमि और जल निकायों यथा नदी, नालों, तालाबों में पड़े रहते हैं और जल को प्रदूषित करने के साथ ही जल निकासी में बाधा उत्पन्न करते हैं। नालियों में बहने वाला प्लास्टिक अपशिष्ट ड्रेनेज को प्रभावित करता है।



सौंदर्यकरण में बाधक : प्लास्टिक के थैले आदि हल्के होने के कारण उड़ कर आसपास के इलाकों में बिखर जाता है जिसके कारण शहर की स्वच्छता एवं सौंदर्य प्रभावित होता है।

पर्यावरण समस्या : प्लास्टिक कचरे से छुटकारा पाने के लिए आमतौर पर कचरे को इकट्ठा करके जला दिया जाता है, लेकिन उससे उठने वाले जहरीले धुएं से वातावरण प्रदूषित होता है। प्लास्टिक कचरे से उठने वाले धुएं में कई प्रकार की जहरीली गैस जैसे डाईआक्सीजन, कार्बन मोनो आक्साइड और कार्बन डाई आक्साइड होती हैं, जो वातावरण और स्वास्थ्य के लिए हानिकारक होती है। दूसरा हानिकारक पहलू यह है कि यह थैली जहाँ कहीं भी जमीन में पड़ी रहती है और वहाँ की भूमि को बंजर कर देती है, जिसकी वजह से वहाँ पौधा नहीं उग पाता और जब कोई पौधा नहीं उगेगा तो वातावरण में जहरीली गैसों को बढ़ावा मिलेगा।



प्लास्टिक अपशिष्ट का प्रबंधन

प्लास्टिक का प्रयोग सर्वथा गलत नहीं है, लेकिन जरूरी है कि इसका प्रयोग सही ढंग से हो। प्लास्टिक कचरे को अलग करने और उसके प्रबंधन की समुचित प्रक्रिया का अभाव काफी हद तक एक बड़ी समस्या बन चुकी है। प्लास्टिक कचरा अपने आप में कोई कचरा नहीं है और इसे मूल्य संवर्धित उत्पादों में बदलकर संपत्ति के रूप में परिशोधित किया जा सकता है। जैव अपघटन रहित अपशिष्ट के बेहतर प्रबंधन के लिए पुनः चक्रीकरण, पुनःप्रयोग और न्यूनीकरण की नीति को प्रोत्साहित करने की आवश्यकता है। प्लास्टिक का पुनःचक्रण ब्यूरो ऑफ़ इंडियन स्टैंडर्ड की गाइडलाइन IS 14534 : 1998 के अनुसार होनी चाहिए। पुनःचक्रित प्लास्टिक से बने कैंरी बैग और कंटेनर जिन्हें खाद्य पदार्थ के उपयोग से इतर प्रयोग के लिए निर्मित किया गया है, को पुनःचक्रित करते समय IS 9833:1981 के अनुसार रंजको

का प्रयोग करना चाहिए। प्लास्टिक हमारी सुविधा के लिए है, लेकिन इसका अनियंत्रित उपयोग और अनियोजित निस्तारण गंभीर समस्या का कारण बन रहा है। मानकों के अनुसार बनी एवं जांच की गयी प्लास्टिक का उपयोग करना उचित होता है। प्लास्टिक की खाली बोतलों और कंटेनरों को दैनिक आवश्यकता की वस्तुओं को संग्रहित करने के लिए प्रयोग किया जा सकता है। पुनः चक्रित प्लास्टिक से बने थैली और डिब्बे, खाद्य पदार्थ के भण्डारण, प्रदाय और पैकेजिंग के लिए प्रयोग में लाना स्वास्थ्य के लिए सुरक्षित नहीं होता है। प्लास्टिक की जगह जूट और कपड़े के बैग का इस्तेमाल किया जा सकता है। समाज के शिक्षित वर्ग को इस विषय पर सचेत होने की आवश्यकता है।

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