Annual Report

2020-21

CSIR-INDIAN INSTITUTE OF TOXICOLOGY RESEARCH

Image on the cover : Confocal micrograph showing tubular heart and surrounding myofibers in *Drosophila melanogaster*. F-Actin (red) is visualized with phalloidin and Z-lines (green) of myofibers are labelled with Cypher-GFP.

Cover image courtesy : Mrs. Snigdha Gupta, DST Inspire-SRF, Embryotoxicology Laboratory, CSIR-Indian Institute of Toxicology Research, Lucknow

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CSIR-Indian Institute of Toxicology Research, Lucknow
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From the Director's Desk

We are celebrating the 56th anniversary of CSIR-Indian Institute of Toxicology Research (CSIR-IITR) this year. It is an opportune time to reflect on the progress made by us and move forward with a renewed vigour. We are immensely proud of the notable contributions made by our institute over the past five and a half decades in different disciplines of toxicology. The institute has contributed significantly towards the country's efforts in formalizing and implementing a systematic policy framework in the realms of industrial toxicology, regulatory toxicology and food toxicology while ensuring sustainable environmental safety. In addition, CSIR-IITR strongly believes in the adage that "today's basic science is tomorrow translational research" and has continued to make robust progress in basic science research thus laying a strong foundation for product development and technology transfer. Given the prevailing conditions caused by the global pandemic, CSIR-IITR made remarkable progress in basic science research, technology and product development, outreach and human resource development in the year 2020-21.

Environmental factors including chemicals and xenobiotics have detrimental influences on various life forms. The challenge in the area of environmental toxicology is to create a sustainable clean environment by monitoring and abating pollution in different matrices. Significant contributions made by our Environmental Toxicology group in this year include reporting of an increasing trend in the occurrence of multidrug resistance in bacteria isolated from river Ganga near domestic wastewater effluent discharge sites. The group evaluated the adverse effect of Cadmium on germline stem cells homeostasis, which is crucial for successful reproductive life, by using Drosophila as an *in vivo* model. The biofilm formed by bacteria isolated from tannery sludge was characterized. Development of decolourisation process and assessment of textile dye using laccase without redox mediator were achieved. Dye degradation was affirmed by UV–visible spectroscopy and FTIR analysis, and laccase treated degradation bioproducts were relatively less phyto- and cytotoxic. Further, in line with the government's programmes of Swachh Bharat and Swasth Bharat, technologies for the treatment of industrial effluents have also been developed for cleaning of environment. The institute is a vital cog in the wheel of Environmental Intervention Hub supported by DSIR-Common Research and Technology Development Hubs (CRTDHs) that was established in 2019. The CRTDH caters to the needs of MSMEs for technology-related issues on environment and health. Under CSIR-IITR-CRTDH, an agreement has been signed with M/s Yash Pakka Ltd, Ayodhya for real-time optimization of CSIR-IITR developed Bioreactor for treatment of effluent from the paper mill. The bioreactor has been installed at the premises of Yash Pakka Ltd., Ayodhya.

The GLP Certified Testing Facility of the institute fulfils international regulatory requirements while conducting safety evaluation studies, developing, validating and establishing new methodologies for toxicant identification and characterization. CSIR-IITR has taken the initiative to review existing protocols and innovate for better scientific estimates of risk from the joint exposure of widely used pesticides and metals. Detection method of bisphenols in infant formula products from India using UPLC-MS/MS was established. Further, enzyme hydrolysis methods have shown up to ~40 times under estimation of bisphenol A (BPA) levels thus compromising risk assessments. To overcome this limitation, a simplified non-enzymatic hydrolysis based method was developed for bisphenol S (BPS) and its metabolites quantification. Synthesis of an alginate-based magnetite−manganese oxide xerogel which can eliminate Chromium and Cadmium from aqueous solution was demonstrated. CSIR-IITR has contributed to the formulation of *Guidelines of CPCSEA for Reuse/Rehabilitation of Large Animals post*

experimentation, which was released in October, 2020. Mechanistic studies are being carried out to elucidate the key processes of disease initiation and promotion, for a thorough understanding to develop key endpoints to identify multiple xenobiotics exposure mediated adverse effects. It is elucidated that pesticide cypermethrin impairs neurogenesis and cognitive functions in the rat brain, decreases Neural Stem Cell (NSC) proliferation and the formation of new neurons in the brain. It enhances neurodegeneration and alters mitochondrial biogenesis and mitochondrial dynamics. Neuroprotective effects of *Withania somnifera* on 4-hydroxynonenal induced cell death in human neuroblastoma cells and the role of Resveratrol, an antioxidant, in restoring the antioxidant defence system through the activation of Nrf2 in pesticides-induced Parkinsonism were reported. Our scientific team has delineated the mechanistic events in environmentally induced α-synuclein aggregation that are involved in Parkinson's disease. Computational approaches were utilized for studying the skin sensitizing potential of chloro and fluropyrroles and an integrated QSAR and adverse outcome pathway analysis for the risk assessment of filaments used in additive manufacturing (3D printing) was developed. The group has been working to provide services in computational predictive toxicology to the industries thus fostering translational research and technology development to support entrepreneurship, start-ups and industries.

Recognizing the fact that food safety is at the very core of existence, the CSIR Mission Mode Programmes on Food and Consumer Safety Solutions (FOCUS) and Advancing Technological Leads for Assuring Safety of Food (ATLAS) are being spearheaded by CSIR-IITR. Scientists working in this research group recently detected the occurrence of mycotoxins such as Alternariol (AOH) and Alternariol monomethyl ether (AME) in edible oils using the HPLC-FLD method. Moreover, these mycotoxins retained greater than 80% stability even after deep frying for 25 minutes, which is an important factor concerning Indian cooking practices. Androgen mimicking potential of some environmental chemicals and their interaction with androgen receptor and epigenetic regulators to regulate the proliferation of androgen-sensitive prostate cancer cells were reported. A study demonstrated that Emodin and anthraquinone compounds found in *Cassia occidentalis* (CO) seeds inhibit the enzymatic activity and induce cytotoxicity in rat primary hepatocytes. During this year, CSIR-IITR developed a Food-Additive-Consumption-Safety Database that enables data-driven risk assessment and hazard characterization of the food additives. The development of food safety database is an initiative of the CSIR Mission Mode Programme - Food and Consumer Safety Solutions (FOCUS). This digital risk assessment platform plays a decisive role in food safety, and supports regulatory authorities such as Food Safety and Standards Authority of India (FSSAI) and industries in the sector. Recognizing the vast contribution of CSIR-IITR in the area of food safety, FSSAI has designated the institute as a Referral Laboratory and a National Food Reference Laboratory.

I would like to place on record the contribution made by the institute in the war against COVID-19. A state-of-the-art RT–PCR based COVID-19 Testing facility was established in the initial days of the pandemic. The untiring efforts of our scientists, technical and project staff associated with the testing facility resulted in testing more than 2.50 lakh samples (as of March 31, 2021). More than 4500 litre of hand sanitiser was prepared and distributed to personnel involved in essential services of Uttar Pradesh. During the first-wave of COVID-19, CSIR-IITR participated in the longitudinal observational cohort sero survey study in which a total of 160 samples were tested, of which 53 (33.16%) were seropositive.

During 2020-2021, CSIR-IITR implemented 33 externally funded projects, published 99 research papers in SCI journals with an average impact factor of 5.48 per paper, and ten students were awarded Ph.D degrees by the Academy of Scientific and Innovative Research (AcSIR). During the year under report, our scientists filed 11 patents in India, and one patent abroad. Institute is also participating in various CSIR programmes such as CSIR Aroma Mission Phase-II, Human Health & Wellness Mission, Ecology, Environment, Earth, Ocean & Water (E3OW) theme and Health Care Theme – projects. Two international collaborative projects-"A multidisciplinary approach to assess the environmental impact of landfill sites" supported by Indo-UK-Global Challenges Research Fund and "Novel efflux pump inhibitors for restoring *E coli* sensitivity for antibiotics (NEPIRESA)" supported by Indo-German Cooperation in Health Research, ICMR, New Delhi and BMBF, Germany were initiated during the year under report.

Based on the prominent guidance of the Research Council and as per the vision of Dr Shekhar C. Mande, DG, CSIR, the major research areas of the institute are (i) Environmental Toxicology (ii) Food, Drug & Chemical Toxicology (iii) Nanomaterial Toxicology (iv) Regulatory Toxicology (v) Systems Toxicology & Health Risk Assessment. The technological innovations in the institute are driven through the Centre for Innovation and Translational Research (CITAR). In sync with the motto of the institute, the BioNEST incubation facility was set up at the institute, with the support of BIRAC, the Department of Biotechnology, Government of India. This facility is nurtured under the CITAR of the institute and provides incubation support to young innovators and entrepreneurial start-ups with industrially viable ideas. Approximately 20,000 sq. feet of built-up incubation space is available at the BioNEST Facility making it the largest such facility in the state of Uttar Pradesh. In addition, the DSIR supported Common Research and Technology Development Hub (DSIR-CRTDH) also focuses on serving the needs of industrial establishments working in the areas of water treatment and monitoring, effluent treatment and air pollution.

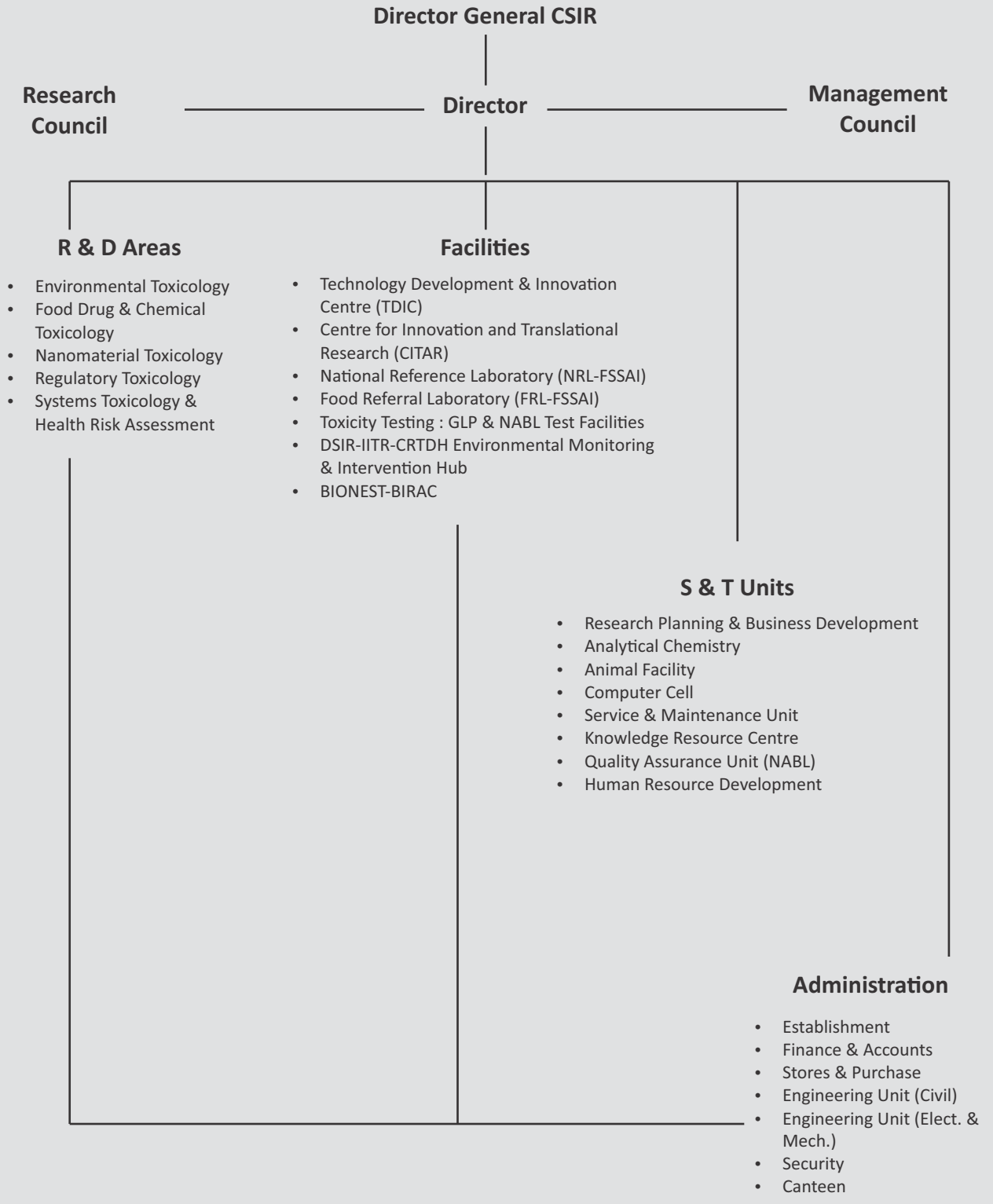
I feel happy to mention the contributions made by the institute towards the Skill India programme of Government of India. Despite the restrictions due to the lockdowns enforced from time to time, CSIR-IITR has successfully organized three hands-on training programmes and 2 programmes in the online/hybrid mode. With its NABL and GLP Certified facilities, a hands-on training programme on “Fundamentals of Care, Management and Handling of Small Laboratory Animals used in Biomedical Research” was conducted. Other offline programmes were on Quality Control / Quality Assurance and computational tools for identification and assessment of Pollution. Online programmes organized included “Pesticides Analysis in Environmental Parameters” and “Characterization of Nanomaterials”. While the skill development programmes have been one facet of the institute's service to society, the CSIR Jigyasa programme conducted by CSIR – IITR fulfils the institute's commitment towards fostering a scientific temperament in the next generation of science learners. Several student activities and interactions were held on various important occasions like National Science Day, Technology Day, World Environment Day etc.

It is my privilege to present before you the Annual Report of CSIR-IITR for the year April 2020-March 2021. I take this opportunity to congratulate each one of my scientific, technical and administrative staff, and students for their excellent accomplishments as reflected in the report. I am confident that with greater synergy and enthusiasm, we strive to dedicate more quality time towards research and bring in greater innovation in our scientific endeavours to fulfil the aspirations of our great nation.

I would like to express my sincere gratitude to Dr Shekhar C. Mande, the Director-General of Council of Scientific and Industrial Research and Secretary, DSIR for his continued support, encouragement and guidance in maintaining the high standard of S&T in CSIR-IITR. I especially thank him for taking a keen interest in our work and visiting our Institute in the year gone by. During his visit, he actively interacted with our scientists, students and staff, and motivated us through his valuable advice and words of wisdom. I wish to thank Dr C. M. Gupta, Chairman, Research Council and all the members of the council for guiding and shaping our R&D programmes. I thankfully acknowledge the members of the Management Council for their valuable inputs in the management of CSIR – IITR. I thank our industry partners, funding agencies and well-wishers for their continued support and guidance. I look forward to receiving greater cooperation than ever from all our stakeholders in our future endeavours.

(Saroj K Barik)

CSIR-IITR Organizational Chart



Environmental Toxicology

A significant challenge in the area of environmental toxicology is to create efficient ways to predict toxicity potential and exposure levels for chemicals that lack toxicological and exposure data in environmental settings. Current demand is to assess large numbers of chemicals for hazard identification in a cost- and time-efficient manner. The need for high-throughput toxicity assays coupled with ethical concerns over animal testing necessitated the pursuit of better tools for ecotoxicological studies. Hence, the development, validation and application of high throughput alternate models as well as alternative to animal models for ecotoxicity studies are of high priority in ecotoxicology. The information on usage, exposure and effects obtained from quantitative structure–activity relationships, read-across methods, thresholds of toxicological concern and *in vitro* tests prior to *in vivo* testing are ideal routes for more rapid, efficient and cost effective risk assessment of chemicals. A major challenge is the development of diagnostic capabilities to precisely determine the cause–effect relationships within impaired ecosystems. This will help in determining the extent to which existing remediation strategies/technologies are effective and the refinements needed for risk management. In this context, a major programme has been initiated to clean a large section of a pesticide contaminated site, where other institutes/ organizations are also involved. Further, technologies for the treatment of industrial effluents have also been developed towards cleanup of environment. Both these programmes are part of the Environmental Intervention Hub supported by DSIR-Common Research and Technology Development Hubs (CRTDHs) established in 2019. The hub will cater to the need of MSMEs for technology related challenges pertaining to environment and health. In view of the above, the environmental toxicology group at CSIR-IITR aims to generate knowledge/tools useful for the protection as well as management of ecosystem integrity. The group also strives to advance the understanding of ecotoxicological problems across different ecological strata at cellular, genetic and organismal levels in order to assess ecological risk assessment and to mitigate environmental pollution.

The objectives addressed by the group are:

- To elucidate the mechanism of toxicity of environmental pollutants
- Remediation of hazardous and persistent chemical substances from soil, water and industrial wastes
- To assess ecotoxicity and undertake environmental monitoring

Area Coordinator - Dr N Manickam

Participating Scientists - Er AH Khan, Dr A Raj, Dr A Satish, Dr B Sreekanth, Dr DK Chowdhuri (till May 30, 2020), Dr GC Kisku, Dr M Kumar, Dr P Chaturvedi, Dr R Parthasarathi, Dr K Ravi Ram, Dr S Anbumani, Dr SC Barman (till June 30, 2020)

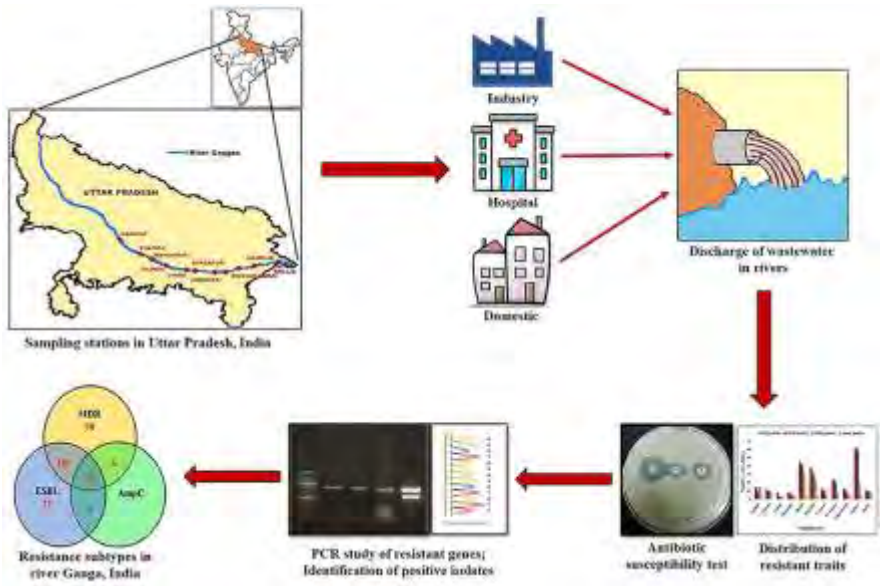
Co-occurrence of multidrug resistance, β-lactamase and plasmid mediated AmpC genes in bacteria isolated from river Ganga, northern India

Wastewater effluents released into surface water provide a suitable nutrient rich environment for the growth and proliferation of antibiotic resistant bacteria (ARB) and genes (ARG). Consequently, bacterial resistance has evolved highly over the recent years and diversified such that each antibiotic class is inhibited by a distinct mechanism. In the present study, the prevalence of Multidrug resistant (MDR), extended spectrum β-lactamases (ESBL) and plasmid mediated Amp-C producing strains was analyzed in 28 surface water samples collected near domestic effluent discharge sites in river Ganga located across 11 different geographical indices of Uttar Pradesh, India. A total of 243 bacterial strains with different phenotypes were isolated. Among 243 isolates, 206 (84.77%) exhibited MDR trait displaying maximum resistance towards β-lactams (P = 78.19%; AMX = 72.84%), glycopeptides (VAN = 32.92%; TEI = 79.42%), cephalosporins (CF = 67.90%; CFX = 38.27%), and lincosamides (CD = 78.18%) followed by sulfonamide, macrolide and tetracycline. ESBL production was confirmed in 126 (51.85%) isolates that harbored the genes: *bla*TEM (95.24%), *bla*SHV (22.22%), *bla*OXA (11.90%) and *bla*CTX-M group (14.28%). The presence of plasmid mediated AmpC was detected only in 6.17% of isolates. The existence of such pathogenic strains in the environment creates an urgent need for incorporating stringent measures to reduce the antibiotic consumption and by extension its release.

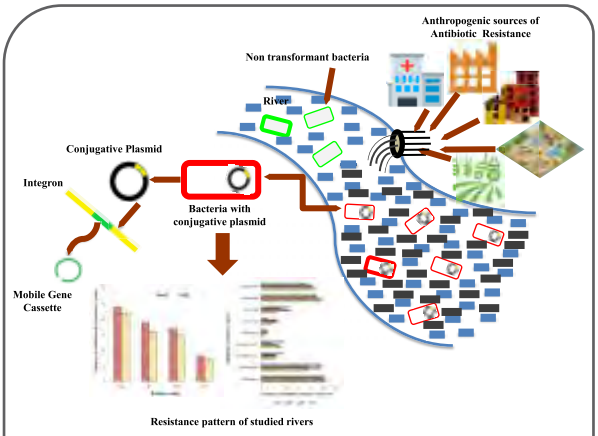
Chaturvedi P, Chaurasia D, Pandey A, Gupta P. Environmental Pollution, 2021, 267:115502.

Occurrence of emerging sulfonamide resistance (sul1 and *sul2*) associated with mobile integrons -integrase (*intI1* and *intI2*) in riverine systems

Global use of antibiotics in agricultural, veterinary and prophylactic human use has increased in recent days. Hence, these antibiotics can easily be found in the environment. This study reveals the occurrence of emerging MDR and ESBL producing strains, pollution profile, and integrons (*intI1* and *intI2*). Environmental associated factors, in the riverine systems under different ecological and geo-climatic zones were investigated. Samples were collected based on anthropogenic interventions such as discharge of domestic wastes, industrial wastes, hospital, and municipal wastes. Among 160 bacterial morphotypes, 121 (75.62%) exhibited MDR trait with maximum



Schematic study of antimicrobial resistance and factors responsible at selected sites in river Ganga in Uttar Pradesh, India



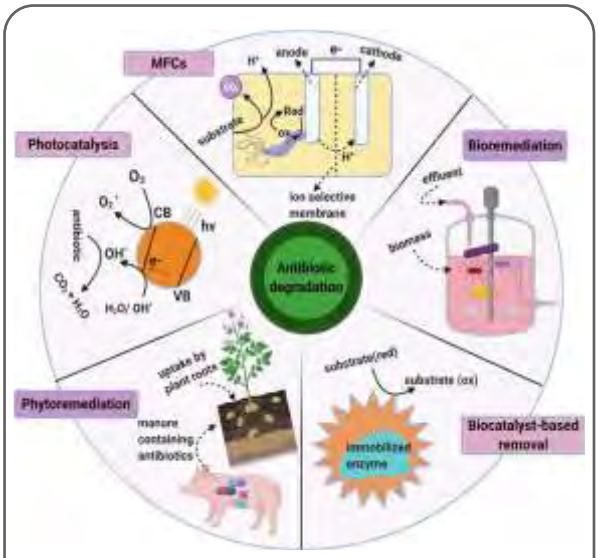
Distribution of antibiotic resistant classes and factors responsible in riverine systems

resistance towards lincosamide (CD = 71.3%), beta-lactams (P = 70.6%; AMX = 66.3%), cephalosporins (CZ = 60.6%; CXM = 34.4%), sulfonamides (COT = 50.6%; TR = 43.8%) followed by macrolides (E = 29.4%), tetracycline (TET = 18.8%), aminoglycosides (S = 18.8%; GEN = 6.3%), fluoroquinolones (NX = 18.1%; OF = 4.4%) and carbapenem (IPM = 5.0%). *IntI1* gene was detected in 73 (60.3%) isolates, whereas *intI*2 was found in 11 (9.09%) isolates. Eight (6.61%) isolates carried both integron genes (*intI1* and *intI2*). *sul1* and *dfrA1* genes were detected in 53 (72.6%) and 63 (86.3%) isolates, respectively. A total of 103 isolates (85.1%) were found ESBL positive with the presence of ESBL genes in 100 (97.08%) isolates. In the riverine systems, the most prevalent ESBL gene *bla*TEM (93.0%) was detected alone as well as in combination with bla genes. The data can be utilized for public awareness and regulation of guidelines by local governing bodies.

Chaturvedi P, Singh A, Chowdhary P, Pandey A, Gupta P. Science of The Total Environment, 2021, 751:142217.

Recent advancement in remediation of synthetic organic antibiotics from environmental matrices: Challenges and perspectives

Continuous discharge and persistence of antibiotics in aquatic ecosystems is identified as an emerging environment health hazard. Partial degradation and inappropriate disposal, induces appearance of diverse antibiotic resistant genes (ARGs) and bacteria. Conventional methods including waste water treatment



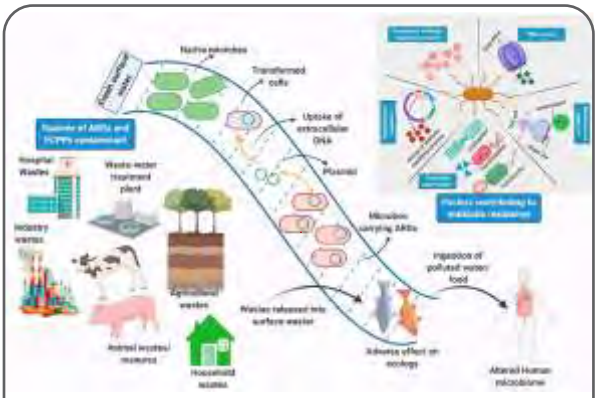
Different methods involved in antibiotic degradation

plants (WWTPs) are found ineffective for the removal of recalcitrant antibiotics. Therefore, constructive removal of antibiotics from environmental matrices and other alternatives have been discussed. This review summarizes the present scenario and different method for the removal of micro-pollutants and antibiotics from environment. Various strategies including physicochemical, bioremediation, use of bioreactor, and biocatalysts are recognized as potent antibiotic removal strategies. Microbial Fuel Cells (MFCs) and biochars have emerged as promising biodegradation processes due to low cost, high energy efficiency and environmental benignity. With higher removal rate (20–50%) combined/ hybrid processes seems to be more efficient in permanent and sustainable elimination of recalcitrant antibiotics.

Chaturvedi P, Giri BS, Shukla P, Gupta P. Bioresource Technology, 2021, 319:124161.

Prevalence and hazardous impact of pharmaceutical and personal care products and antibiotics in environment: A review on emerging contaminants

Antibiotic resistance is a global health emergency linked to unrestrained use of pharmaceutical and personal care products (PPCPs) as prophylactic agents and for therapeutic purposes across the globe. Occurrence of pharmaceuticals in ground water, surface water, soils, and wastewater treatment plants (WWTPs) in ng/l to µg/l



Factors contributing to antibiotic resistance

concentration range is well established. The prevalence of organic compounds including antimicrobial agents, hormones, antibiotics, preservatives, disinfectants, synthetic musks etc. in environment have posed serious health concerns. The aim of this review is to elucidate the major sources accountable for emergence of antibiotic resistance. Therefore, a variety of introductory sources and fate of PPCPs in aquatic environment including human and veterinary wastes, aquaculture and agriculture related wastes, and other anthropogenic activities have been discussed. Furthermore, genetic and enzymatic factors responsible for transfer and appearance of antibiotic resistance genes are presented. Ecotoxicity of PPCPs in the environment has been studied in order to present the risk posed to human and ecological health. As per the literature, the removal of antibiotics and related traces being difficult, increases the possibility of emergence of antibiotic resistance and hence sustainability in global water resources.

Chaturvedi P, Giri BS, Shukla P, Chowdhary P, Chandra R, Gupta P, Pandey A. Environmental Research, 2021, 194:110664.

Heavy metal associated health hazards: An interplay of oxidative stress and signal transduction

Heavy metal-induced cellular and organismal toxicity have become a major health concern in biomedical science. Indiscriminate use of heavy metals in different sectors, such as, industrial-, agricultural-, healthcare-, cosmetics-, and domestic-sectors has contaminated environment matrices, thus posing a severe health concern. Xenobiotics mediated effect is a ubiquitous cellular response. Oxidative stress is one such prime cellular response, which is the result of an imbalance in the redox system. Further, oxidative stress is associated with macromolecular damages and activation of several cell survival and cell death pathways. Epidemiological as well as laboratory data suggest that oxidative stress-induced cellular response following heavy metal exposure was linked to an increased risk of neoplasm, neurological disorders, diabetes, infertility, developmental disorders, renal failure, and cardiovascular disease. During the recent past, a relation among heavy metal exposure, oxidative stress, and signaling pathways has been explored to understand the heavy metal-induced toxicity. Heavy metal-induced oxidative stress and its connection with different signaling pathways were complicated; therefore, the systemic summary was essential. Herein, an effort had been made to decipher the interplay among heavy metals/metalloids (Arsenic, Chromium, Cadmium, and Lead) exposures, oxidative stress, and signal transduction, which were essential to mount the cellular and organismal response.

Paithankar JG , Saini S , Dwivedi S, Sharma A, Chowdhuri DK. Chemosphere, 2021, 262: 128350.

Cadmium mediated redox modulation in germline stem cells homeostasis affects reproductive health of Drosophila males.

Maintenance of male germline stem cells (GSCs) homeostasis is crucial for successful reproductive life of adults. New insights gained into dysfunction in stem cell maintenance could be the basis of stem cell dependent ailment during adulthood. Cadmium (Cd), a reported male reproductive toxicant, has been explored inadequately for its impact on male GSCs maintenance. The study, therefore, aimed to evaluate the adverse effect of Cd on the homeostasis of GSCs by using Drosophila testis as an *in vivo* model. Following developmental exposure of Drosophila to environmentally relevant concentrations of Cd (5.0, 10.0 and 20.0 µg/mL), a significantly increased level of reactive oxygen species was observed (ROS) at 20.0 µg/mL of Cd. This resulted in alteration of GSCs number accompanied by inappropriate differentiation leading to reduced sperm number and eventually poor reproductive performance in exposed organism. Rescuing effect was evident by

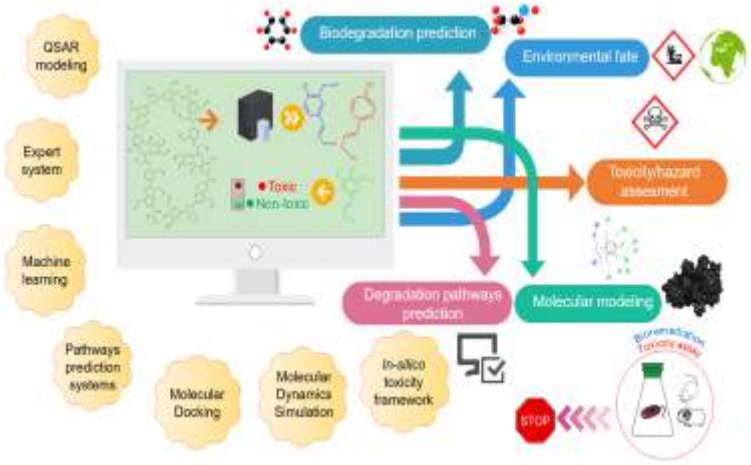
overexpressing *sod* in the early germ cell stage. The study suggests that an alteration in GSCs homeostasis due to redox imbalance plays a pivotal role in Cd induced failure in male fertility. The study further advocates the use of Drosophila as an alternative animal model for *in vivo* evaluation of male GSCs toxicity with minimal ethical concern.

Nandi A, Chowdhuri DK. Journal of Hazardous Materials, 2021, 402: 123737.

Trends in predictive biodegradation for sustainable mitigation of environmental pollutants: Recent progress and future outlook

The feasibility of *in-silico* techniques, together with the computational framework, has been applied to predictive bioremediation aiming to clean-up contaminants, toxicity evaluation, and possibilities for the degradation of complex recalcitrant compounds. Emerging contaminants from different industries have posed a significant hazard to the environment and public health. Given current bioremediation strategies, it is often a failure or inadequate for sustainable mitigation of hazardous pollutants. However, clear-cut vital information about biodegradation is quite incomplete from a conventional remediation techniques perspective. Lacking complete information on bio-transformed compounds leads to seeking alternative methods. Only scarce information about the transformed products and toxicity profile is available in the published literature. To fulfill this literature gap, various computational or *in-silico* technologies have emerged as alternating techniques, which are being recognized as *in-silico* approaches for bioremediation. Molecular docking, molecular dynamics simulation, and biodegradation pathways predictions are the vital part of predictive biodegradation, including the Quantitative Structure-Activity Relationship (QSAR), Quantitative structure-biodegradation relationship (QSBR) model system. Furthermore, machine learning (ML), artificial neural network (ANN), genetic algorithm (GA) based programs offer simultaneous biodegradation prediction along with toxicity and environmental fate prediction. Herein, we spotlight the feasibility of *in-silico* remediation approaches for various persistent, recalcitrant contaminants while traditional bioremediation fails to mitigate such pollutants. Such could be addressed by exploiting described model systems and algorithm-based programs. Furthermore, recent advances in QSAR modeling, algorithm, and dedicated biodegradation prediction system have been summarized with unique attributes.

Singh AK, Bilal M, Iqbal HM, Raj A. Science of the Total Environment, 2021, 777:144561.



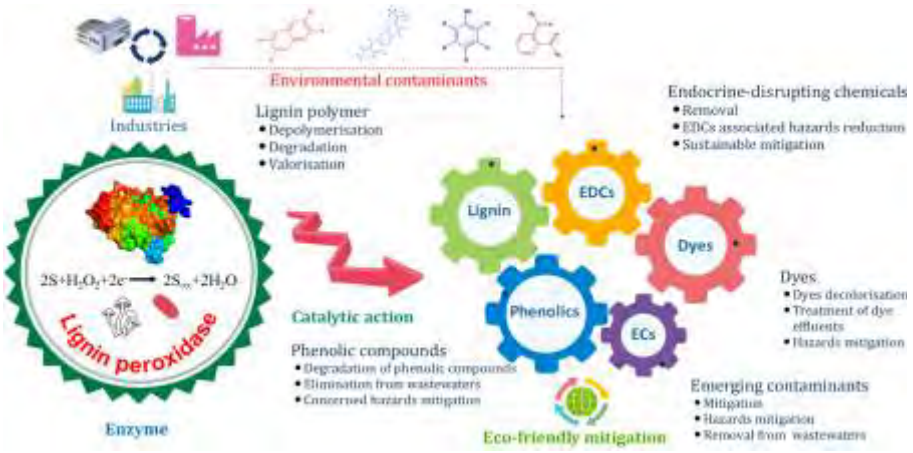
An overview in predictive biodegradation of environmental pollutants

Research Highlights

Lignin peroxidase in focus for catalytic elimination of contaminants — A critical review on recent progress and perspectives

Lignin peroxidase (LiP) seems to be a catalyst for cleaving high-redox potential non-phenolic compounds with an oxidative cleavage of C-C and C-O-C bonds. LiP has been picked to seek a practical and cost-effective alternative to the sustainable mitigation of diverse environmental contaminants. LiP has been an outstanding tool for catalytic cleaning and efficient mitigation of environmental pollutants, including lignin, lignin derivatives, dyes, endocrine-disrupting compounds (EDCs), and persistent organic pollutants (POPs) for the past couple of decades. The extended deployment of LiP has proved to be a promising method for catalyzing these environmentally related hazardous pollutants of supreme interest. The advantageous potential and capabilities to act at different pH and thermostability offer its working tendencies in extended environmental engineering applications. Such advantages led to the emerging demand for LiP and increasing requirements in industrial and biotechnological sectors. The multitude of the ability attributed to LiP is triggered by its stability in xenobiotic and non-phenolic compound degradation. However, over the decades, the catalytic activity of LiP has been continuing in focus enormously towards catalytic functionalities over the available physiochemical, conventional, catalyst mediated technology for catalyzing such molecules. To cover this literature gap, this became much more evident to consider the catalytic attributes of LiP. In this review, the existing capabilities of LiP and other competencies have been described with recent updates. Furthermore, numerous recently emerged applications, such as textile effluent treatment, dye decolorization, catalytic elimination of pharmaceutical and EDCs compounds, have been discussed with suitable examples.

Singh AK, Bilal M, Iqbal HM, Raj A. International Journal of Biological Macromolecules, 2021, 177: 58-82.

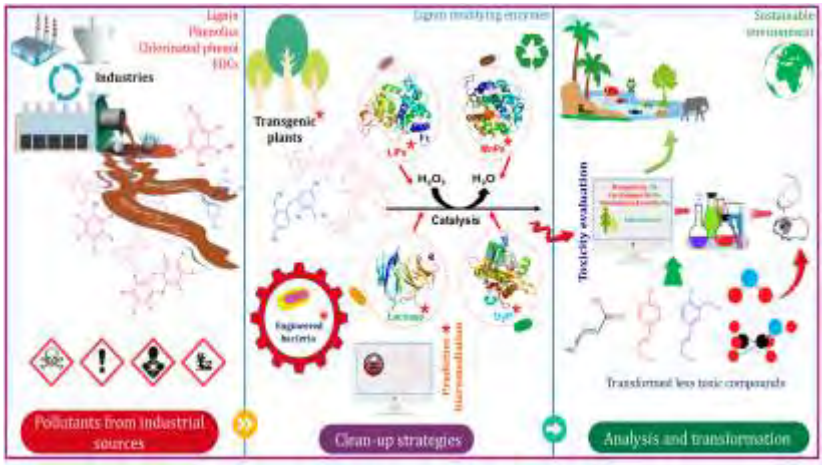


Lignin peroxidase and its catalytic action for removal of pollutants

Bioremediation of lignin derivatives and phenolics in wastewater with lignin modifying enzymes: Status, opportunities and challenges

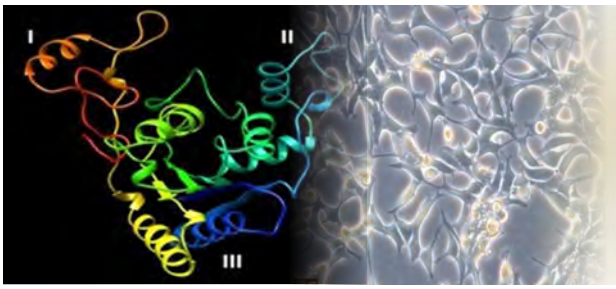
Lignin modifying enzymes from fungi and bacteria are potential biocatalysts for sustainable mitigation of different potentially toxic pollutants in wastewater. Notably, the paper and pulp industry generates enormous amounts of wastewater containing high amounts of complex lignin-derived chlorinated phenolics and sulfonated pollutants. The presence of these compounds in wastewater is a critical issue from environmental and toxicological perspectives. Some chloro-phenols are harmful to the environment and human health, as they exert carcinogenic, mutagenic, cytotoxic, and endocrine-disrupting effects. In order to address these most urgent concerns, the use of oxidative lignin modifying enzymes for bioremediation has come into focus. These enzymes catalyze modification of phenolic and non-phenolic lignin-derived substances, and include laccase and a range of peroxidases, specifically lignin peroxidase (LiP), manganese peroxidase (MnP), versatile peroxidase (VP), and dye-decolorizing peroxidase (DyP). In this review, we explore the key pollutant-generating steps in paper and pulp processing, summarize the most recently reported toxicological effects of industrial lignin-derived phenolic compounds, especially chlorinated phenolic pollutants, and outline bioremediation approaches for pollutant mitigation in wastewater from this industry, emphasizing the oxidative catalytic potential of oxidative lignin modifying enzymes in this regard. We highlight other emerging biotechnical approaches, including phytobioremediation, bioaugmentation, Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)-based technology, protein engineering, and degradation pathways prediction, that are currently gathering momentum for the mitigation of wastewater pollutants. Finally, we address current research needs and options for maximizing sustainable biobased and biocatalytic degradation of toxic industrial wastewater pollutants.

Singh AK, Bilal M, Iqbal HM, Meyer AS, Raj A. Science of the Total Environment, 2021, 777:145988



Lignin derivatives and phenolics in wastewater and their bioremediation strategies

Research Highlights



Food, Drug and Chemical Toxicology

Food is as basic to life as air. Food provides nutrients which are essential for energy, growth, activity and all vital physiological functions like breathing, metabolism, thermoregulation, keeping the immune system healthy, etc. To ensure a regular supply of adequate quantity and quality of food, it is imperative to develop methods to process and preserve the food. This need has led to the use of various preservatives and food additives and the accompanying concern with respect to contamination or adulteration. Deliberate mixing of inferior grade food components to increase quantity and to earn undue profits is an ever-increasing problem. Added to this is the un-intentional contamination that may occur during field production, processing or storage.

A recent development towards ensuring food security globally is the development of Genetically Modified (GM) foods. While recombinant DNA technology holds immense promise for production of GM food, ensuring safety of such technologically derived food/feed products is of paramount concern. India's vast knowledge base of traditional foods / herbal ingredients is increasingly being employed to handle the ever-burgeoning problems of contaminated food induced toxicity. Consequently, generating safety data on GM foods and components of traditional food items is the next logical action point. Recognizing the vast contribution of CSIR–IITR in the area of food safety, the Food Safety and Standards Authority of India (FSSAI) designated the institute as a Referral Laboratory and a National Food Reference Laboratory since 2019 as a part of CSIR safe food initiative for a new India. The scientists in the Food, Drug and Chemical Toxicology group have successfully completed the mission mode programme on Food and Consumer safety solution (FOCUS) during 2018-20. Subsequently, the scientists of the group have ventured into the followup project on advanced technological leads for assuring safety of Food (ATLAS).

With these key functional areas, the group functions with the following objectives:

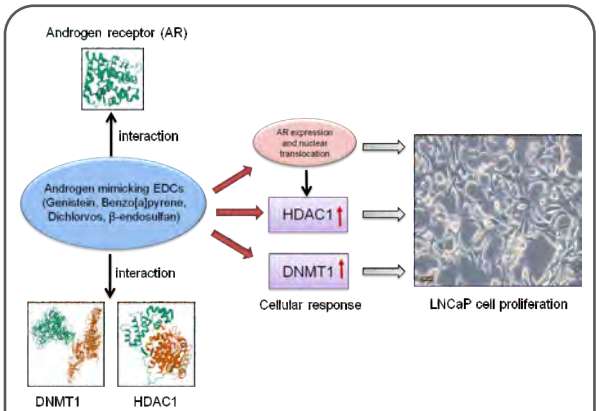
- Development and/or establishment of methodologies to quantify the potential toxic agent in different food matrices
- Identification of phytochemicals/ herbal preparations which can mitigate the toxicity of above chemical moieties
- To understand the mechanism of toxicity of new chemical entities
- Detection of GM food/crop and their safety/allergenicity assessment
- Establishment of guidelines for food and chemical safety for regulatory agencies

Area Coordinator - Dr D Parmar

Participating Scientists - Dr A Dwivedi, Dr A Tripathi, Dr D Ghosh, Dr KM Ansari, Dr PK Sharma, Dr P Tripathi, Dr R Parthasarathi, Dr SK Sharma, Dr SP Singh, Dr Y Shukla

Exposure to androgen mimicking environmental chemicals enhances proliferation of prostate cancer (LNCaP) cells by inducing AR expression and epigenetic modifications

Exposure to environmental endocrine disrupting chemicals (EDCs) is often suspected in prostate carcinogenesis. Though, estrogenicity is the most studied behavior of EDCs, the androgenic potential of most of the EDCs remains elusive. This study investigates the androgen mimicking potential of some common EDCs and their effect on androgen-dependent prostate cancer (LNCaP) cells. Based on the *in silico* interaction study, all the 8 EDCs tested were found to interact with androgen receptors with different binding energies. Further, luciferase reporter activity confirmed the androgen mimicking potential of 4 EDCs namely benzo[a]pyrene, dichlorvos, genistein and β-endosulfan, while aldrin, malathion, tebuconazole and DDT were reported as antiandrogenic in the luciferase reporter activity assay. Further, nanomolar concentration of androgen mimicking EDCs (benzo[a]pyrene, dichlorvos, genistein and β-endosulfan) significantly enhanced the expression of AR protein and subsequent nuclear translocation in LNCaP cells. Our *in silico* studies further demonstrated that androgenic EDCs also bind with epigenetic regulatory enzymes namely DNMT1 and HDAC1. Moreover, exposure to these EDCs enhanced the protein expression of DNMT1 and HDAC1 in LNCaP cells. These observations suggest that EDCs may regulate proliferation in androgen sensitive LNCaP cells by acting as androgen mimicking ligands for AR signaling as well as by regulating epigenetic machinery. Both androgenic potential and epigenetic modulatory effects of EDCs may underlie the development and growth of prostate cancer.



Schematic diagram showing androgen mimicking potential of on few environmental chemicals and their interaction with androgen receptor and epigenetic regulators to regulate proliferation of androgen-sensitive prostate cancer cells

Singh VK, Pal R, Srivastav P, Mishra M, Shukla Y, Sharma PK. Environmental Pollution, 2021, 272: 116397.

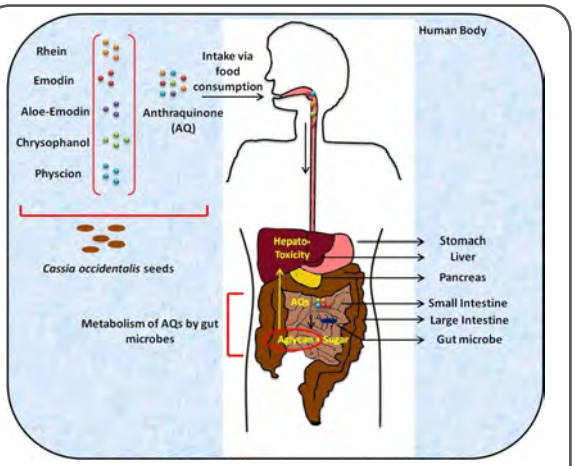
Occurrence of alternariol and alternariol monomethyl ether in edible oils: their thermal stability and intake assessment in state of Uttar Pradesh, India

Alternariol (AOH) and Alternariol monomethyl ether (AME) mycotoxins are found to be naturally present in various food commodities, such as barley, oats, pepper, rye, sorghum, sunflower seeds, tomatoes, and wheat. A few epidemiological studies have correlated the consumption of *Alternaria*-contaminated cereal grains with an higher occurrence of esophageal cancer in Chinese populations. In addition, several studies have reported the toxicological properties of *Alternaria* mycotoxins. However, surveillance data on AOH and AME occurrence are still limited. Therefore, the goal of this study was to determine the presence of AOH and AME in various commonly consumed, edible oils using the HPLC-FLD method. Thirty four percent of samples were found positive for AOH and 35% for AME. Moreover, AOH retained 80% stability, while AME retained 84% stability, after deep frying for 25 min, which is an important factor with respect to Indian cooking practices. To the best of our knowledge, this is the first report on the presence of *Alternaria* mycotoxins in edible oils and their probable dietary intake in Indian population. This surveillance study may help in formulating guidelines for *Alternaria* mycotoxin levels in India, which are not yet implemented by Food Safety and Standards Authority of India.

Bansal M, Saifi IJ, Dev I, Sonkar AK, Dixit S, Singh SP, Ansari KM. Journal of Food Science, 2021, 86:1124-1131.

Role of anthraquinones in *Cassia occidentalis* induced hepato-myo-encephalopathy

Different plant parts of *Cassia occidentalis* Linn, (CO) such as root, leaves, seeds and pods have traditionally



Metabolic fate of anthraquinone glycon in human: Anthraquinone glycon is digested by gut microbes into aglycon form, absorbed through small intestine and finally transported into liver. Free aglycon form shows toxicity by entering into the systemic circulation

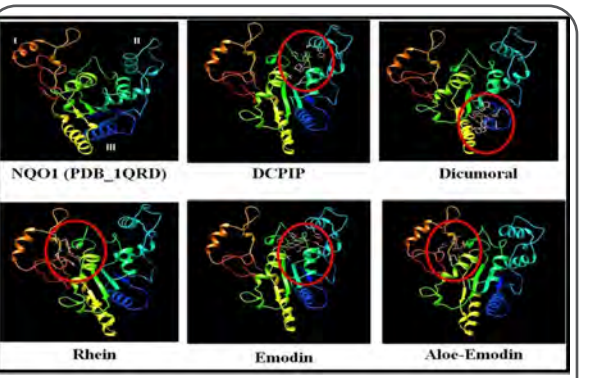
been used in multifarious medicines for the treatment of dysentery, diarrhea, constipation, fever, eczema, cancer and venereal diseases. A systematic literature search was carried out using various published material and scientific databases like Science Direct, Pubmed, Google Scholar and Scopus etc. The data set collected was compiled and analyzed to review the information regarding the phytochemistry, toxicology and mechanism of toxicity of CO. Unintentional exposure to CO causes a serious pathological condition in children, known as hepato-myo-encephalopathy (HME). The toxicity after CO consumption is associated with the presence of anthraquinones (AQs), a class of secondary plant metabolites. These AQs at high concentrations are known to cause detrimental effects on essential vital organs such as liver, kidney, spleen, brain, muscle and reproductive organs. Animal studies in rodent models as well as clinical investigations have clearly revealed that CO toxicity is associated with enhanced hepatotoxicity serum markers (ALT, AST, and LDH) and presence of necrotic lesions in liver. Furthermore, CO also causes vacuolization in muscle tissue and increases the level of CPK which is a prominent muscle damage marker. Apart from these target organs, CO consumption also causes neuronal damage by disturbing the levels of different proteins such as (GFAP and β-tubulin III). Mechanistic studies show that AQs present in CO have the potential to disturb the cellular homeostasis by binding to DNA, thus increasing the production ROS and showing inhibitory effects on essential enzymes. Therefore, AQs have been observed to be the primary culprit agents contributing to the toxicity of CO in children and animals. Multiple mechanisms are involved in the CO induced HME in patients. Lack of appropriate diagnostic measures and a poor understanding of the CO toxicity mechanism in humans and animals complicate the clinical management of CO poisoning.

Shukla V, Asthana S, Singh S, Tripathi A. Journal of Ethnopharmacology, 2021, 267:113431.

Emodin inhibited NADPH-quinone reductase competitively and induced cytotoxicity in rat primary hepatocytes

Consumption of *Cassia occidentalis* (CO) seeds, a ubiquitously distributed weed plant, is responsible for a pathological condition known as hepato-myo-encephalopathy (HME). The toxicity of CO seeds is largely attributed to the presence of anthraquinones (AQs). Here, we report that Emodin, a CO anthraquinone, inhibits the enzymatic activity of NADPH-Quinone reductase, which is an intracellular enzyme fundamentally involved in the detoxification of quinone containing compounds. Emodin binds to the active site of the enzyme and acts as a competitive inhibitor with respect to 2, 6-Dichloro-phenolindophenol, a known substrate of NADPH-Quinone reductase. Moreover, our *in-vitro* study further revealed that Emodin was cytotoxic to primary rat hepatocytes.

Shukla V, Asthana S, Yadav S, Rajput VS, Tripathi A. Toxicon, 2020, 188: 117-121.



Structure of NADPH-Quinone reductase

Research Highlights

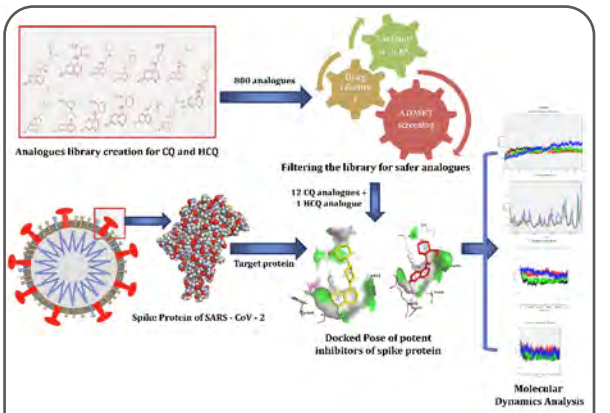
Environmental survival of SARS-CoV-2 – A solid waste perspective

The advent of COVID-19 has kept the whole world on their toes. Countries are maximizing their efforts to combat the virus and to minimize the infection. Since infectious microorganisms may be transmitted by variety of routes, respiratory and facial protection is required for those that are usually transmitted via droplets/aerosols. Therefore, this pandemic has caused a sudden increase in the demand for personal protective equipment (PPE) such as gloves, masks, and many other important items since, the evidence of individual-to-individual transmission (through respiratory droplets/coughing) and secondary infection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). But the disposal of these personal protective measures remains a huge question mark towards the environmental impact. Huge waste generation demands proper segregation according to waste types, collection, and recycling to minimize the risk of infection spread through aerosols and attempts to implement measures to monitor infections. Hence, this review focuses on the impact of environment due to improper disposal of these personal protective measures and to investigate the safe disposal methods for these protective measures by using the safe, secure and innovative biological methods such as the use of Artificial Intelligence (AI) and Ultraviolet (UV) lights for killing such deadly viruses.

Iyer M, Tiwari S, Renu K, Pasha MY, Pandit S, Singh B, Raj N, Krothapalli S, Kwak HJ, Balasubramanian V, Jang SB, Kumar DG, Uttpal A, Naranayasamy A, Kinoshita M, Subramaniam MD, Nachimuthu SK, Roy A, Gopalakrishnan AV, Ramakrishnan P, Cho SG, Vellingiri B. Environmental Research, 2021, 26:111015.

Analogue discovery of safer alternatives to HCQ and CQ drugs for SAR-CoV-2 by computational design

COVID-19 outbreak poses a severe health emergency to the global community. Due to availability of limited data, the selection of an effective treatment is a challenge. Hydroxychloroquine (HCQ), a chloroquine (CQ) derivative administered for malaria and autoimmune diseases, has been shown to be effective against both Severe Acute Respiratory Syndrome (SARS-CoV-1) and SARS-CoV-2. Apart from the known adverse effects of these drugs, recently the use of CQ and HCQ as a potential treatment for COVID-19 is under flux globally. In this study, we focused on identifying a more potent analogue of HCQ and CQ against the spike protein of SAR-CoV-2 that can act as an effective antiviral agent for COVID-19 treatment. Systematic pharmacokinetics, drug-likeness, basicity predictions, virtual screening and molecular dynamics analysis (200 ns) were carried out to predict the inhibition potential of the analogous compounds on the spike protein. This work identifies the six potential analogues, out of which two compounds, namely 1-[1-(6-Chloroquinolin-4-yl) piperidin-4-yl]piperidin-3-ol and (1R,2R)-2-N-(7-Chloroquinolin-4-yl)cyclohexane-1,2-diamine interact with the active site of the spike protein similar to HCQ and CQ respectively with augmented safety profile.

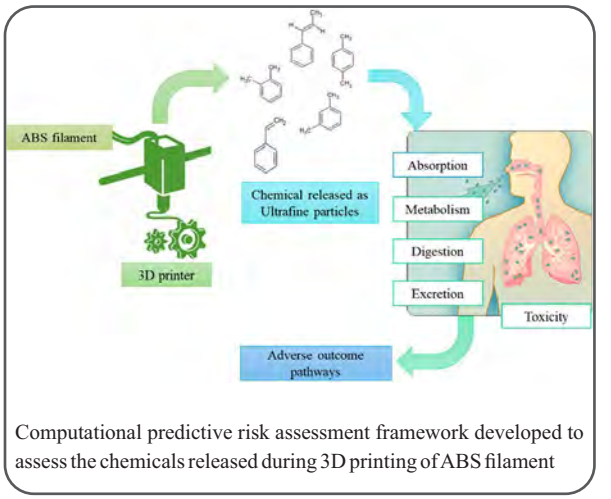


Identification of potent therapeutic analogues against spike protein of SARS-CoV-2 through computational designs

Sinha M, Gupta A, Gupta S, Singh P, Pandit S, Chauhan SS, Parthasarathi R. Computers in biology and medicine, 2021, 130:104222.

Integrated QSAR and Adverse Outcome Pathway Analysis of Chemicals Released on 3D Printing Using Acrylonitrile Butadiene Styrene

Additive manufacturing commonly known as 3D printing has numerous applications in several domains including material and biomedical technologies and has emerged as a tool of capabilities by providing fast, highly customized, and cost-effective solutions. However, the impact of the printing materials and chemicals present in the printing fumes has raised concerns about their adverse potential affecting humans



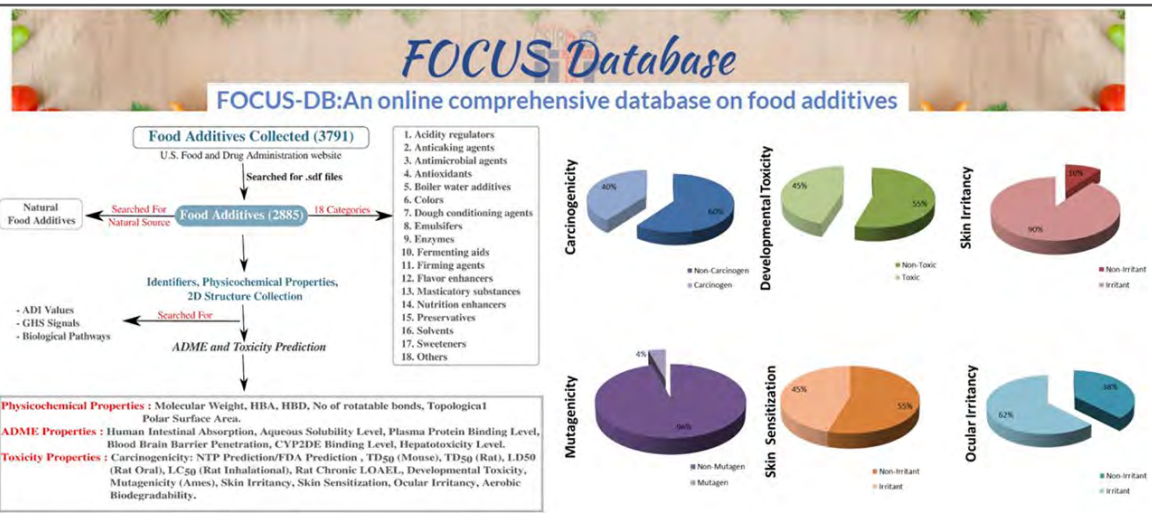
Computational predictive risk assessment framework developed to assess the chemicals released during 3D printing of ABS filament

and the environment. Thus, it is necessary to understand the properties of the chemicals emitted during additive manufacturing for developing safe and biocompatible fibers having controlled emission of fumes including its sustainable usage. Therefore, in this study, a computational predictive risk-assessment framework on the comprehensive list of chemicals released during 3D printing using the acrylonitrile butadiene styrene (ABS) filament was developed. Results showed the data that the chemicals present in the fumes of the ABS-based fiber used in additive manufacturing have the potential to lead to various toxicity end points such as inhalation toxicity, oral toxicity, carcinogenicity, hepatotoxicity, and teratogenicity. Moreover, because of their absorption, distribution in the body, metabolism, and excretion properties, most of the chemicals exhibited a high absorption level in the intestine and the potential to cross the blood-brain barrier. Furthermore, pathway analysis revealed that signaling like alpha-adrenergic receptor signaling, heterotrimeric G-protein signaling, and Alzheimer's disease-amyloid secretase pathway are significantly overrepresented given the identified target proteins of these chemicals. These findings signify the adversities associated with 3D printing fumes and the necessity for the development of biodegradable and considerably safer fibers for 3D printing technology.

Pandit S, Singh P, Sinha M, Parthasarathi R. Chemical Research in Toxicology, 2021, 34:355-64.

FOCUS-DB: An Online Comprehensive Database on Food Additive Safety

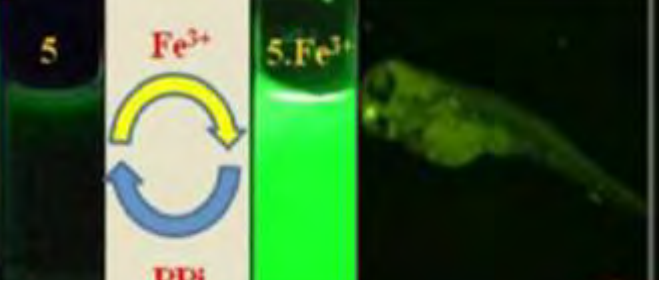
Processing and packaging food has greatly exaggerated the use of food additives in different types of food products. Safety assessment to determine the pharmacokinetic and toxicological properties of food additives is imperative and experimentally challenging. Several resources of food additives properties have been collated; however, information remains partial, scattered, and not readily accessible, particularly for food safety. To address the concern related to the potential health hazard of food additives, we have developed the Food-Additive-Consumption-Safety Database (FOCUS-DB). Presently, the database



Food-Additive-Consumption-Safety Database (FOCUS-DB) resource enables a risk assessment of food additives

comprises 2885 food additives, distributed into 18 categories with 40,800 collected data points, 89,435 predicted data points, and 14,425 external links. The dynamic web interface of the FOCUS-DB resource enables a risk assessment of additives, their approval status in various regulatory authorities, physicochemical properties, acceptable daily intake, GHS signals, biological pathways, predicted pharmacokinetic parameters, and various toxicity endpoint values. FOCUS-DB supports the exploration of food additives; it is beneficial for both the regulatory authorities and industries to optimize the usage limits of the additives and formulations. This database is a promising tool that helps understand the relationship between food additives and toxicity, which could be used to develop a future food safety framework.

Chauhan SS, Sachan DK, Parthasarathi R. Journal of Chemical Information and Modeling, 2021, 61:202-10.



Nanomaterial Toxicology

With a critical mass of its scientific manpower contributing to this emerging area of toxicology and expertise of more than a decade, the institute has created a niche in the area of nanotoxicology. CSIR-IITR spearheaded two major network projects of Council of Scientific & Industrial Research (CSIR) on nanotechnology and was a partner in many international flagship projects. The institute has been a flagbearer in the synthesis and characterization of engineered nanomaterials (ENMs), development of methodologies/assays/techniques for toxicity assessment, alternate models, and mechanisms of action and interaction of ENMs with biological systems.

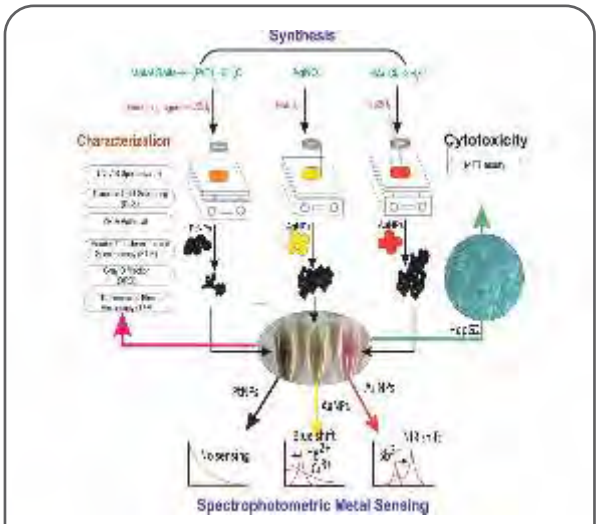
CSIR-IITR has played a major role in formulation of several National guidelines for nanosafety in the area of pharmacology and agriculture as well as BIS standards in the area of eco-nanotoxicology. A strong working web has been created in the area of nanotechnology collaborating with several IITs, universities, IISc, research institutes and industries. To assess the safety/toxicity of nanomaterials, the most critical issues that need to be addressed include: i) effect of shape and size; ii) dosimetry; iii) route of delivery and tracking; iv) development and validation of test models; v) *in vitro* vs. *in vivo* extrapolation; vi) ecotoxicity; vii) computational nanotoxicity and viii) life cycle analysis. The scientists of the nanomaterial toxicology group aim to investigate the health and environmental effects of nanomaterials, to delineate their toxicity and assure safe usage in consumer, healthcare and agri-nutri products and medical devices. The overall objectives of the group are:

- Synthesis, characterization and testing of simple and composite nanoparticles for therapeutic, imaging and consumer use
- Develop methods for toxicity, life cycle analysis and risk assessment
- Frame guidelines for safe handling of nanomaterials in laboratory/occupational settings
- Dissemination of outcomes to the society

Area Coordinator - Dr DK Chowdhuri (till May 30, 2020), Dr AK Pandey (w.e.f. June 01, 2020)
Participating Scientists - Dr A Dhawan, Dr A Satish, Dr A Tripathi, Dr D Ghosh, Dr KM Ansari, Dr R Parthasarathi, Dr R Rajagopal, Dr RS Ray, Dr S Patnaik, Dr SP Singh, Dr V Srivastava, Dr Y Shukla

Bare plasmonic metal nanoparticles: Synthesis, characterisation and *in vitro* toxicity assessment on a liver carcinoma cell line

Metal nanoparticles have generated great interest due to their excellent optical and chemical properties. The widely used chemical method for synthesising nanoparticles involves capping agents for colloidal stability. At present there are scarce reports on the application of metal nanoparticles synthesised without using capping agents. A need was felt to develop pristine nanoparticles devoid of capping that can be used for translational research. With this background, a facile and rapid method was developed for synthesising bare metal nanoparticles (platinum/silver/gold) that are chemically reactive and stable for a month upon storage. Bare metal nanoparticles of sub-15 nm were synthesized and characterisedusing standard techniques (UV-VIS-NIR/DLS/zeta//TEM/XRD). The safety of the synthesised nanoparticles was assessed on the liver carcinoma cell line (HepG2). Bare gold and platinum nanoparticles were non-toxic in comparison to bare silver nanoparticles. Bare metal nanoparticles were also checked for metal detection wherein antimony, mercury and chromium were detected using bare gold and silver nanoparticles. The spectroscopic shifts of the nanoparticles when bound to metals resulted in blue and red shifting of the plasmon band, indicating the sensing of metals. These results show that bare metal nanoparticles have the potential to emerge as a promising candidate for biomedical and sensing applications.

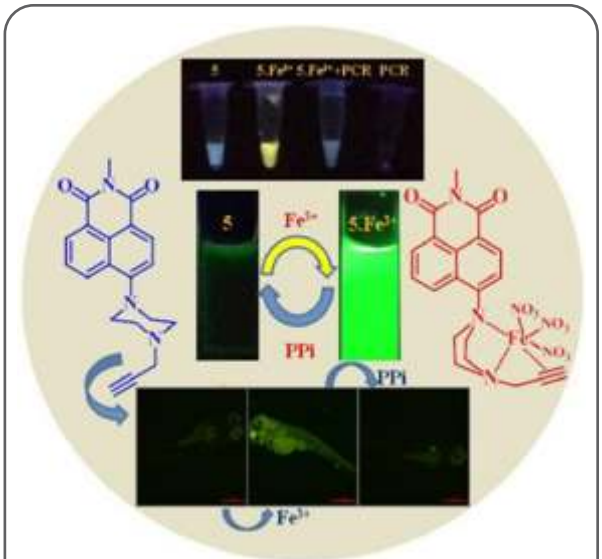


Synthesis of bare metal nanoparticles of gold, silver and platinum. Bare metal nanoparticles were characterized and used for toxicity and sensing applications

Das N, Kumar A, Roy SK, Satija NK, Gopal RR. IET Nanobiotechnology, 2021, 14: 851-857.

A simple naphthalimide based PET probe for $Fe3^{+}$ and selective detection of pyrophosphate through displacement approach: Cell imaging studies and logic interpretation

The present work describes design, synthesis and photophysical behavior of a new molecular fluorescent probe 5. The probe 5, upon interaction with different metal ions in phosphate buffer (THF:H_2O; 1:99, v/v; pH 7.2) exhibited enhanced emission (*turn-On*) with Fe^{3+} (LOD=1.05×10^{-9} M) selectively due to the formation of an ensemble, $5.Fe^{3+}$. On the other hand, the interaction of ensemble $5.Fe^{3+}$ with different class of anionic species caused selective fluorescence quenching (*turn-Off*) with pyrophosphate ions (PPi) (LOD=4.2×10^{-7} M) due to the formation of ferricpyrophosphate in the medium. The *Off-On-Off* emission behaviour exhibited by the probe in the presence of Fe^{3+} and PPi is attributed to PET-*Off-On* mechanism, respectively. The live cell imaging and *in vivo* studies in zebra fish suggested a potential biological application of the probe to detect both the ions. The ensemble, $5.Fe^{3+}$ has also been tested to detect PPi in



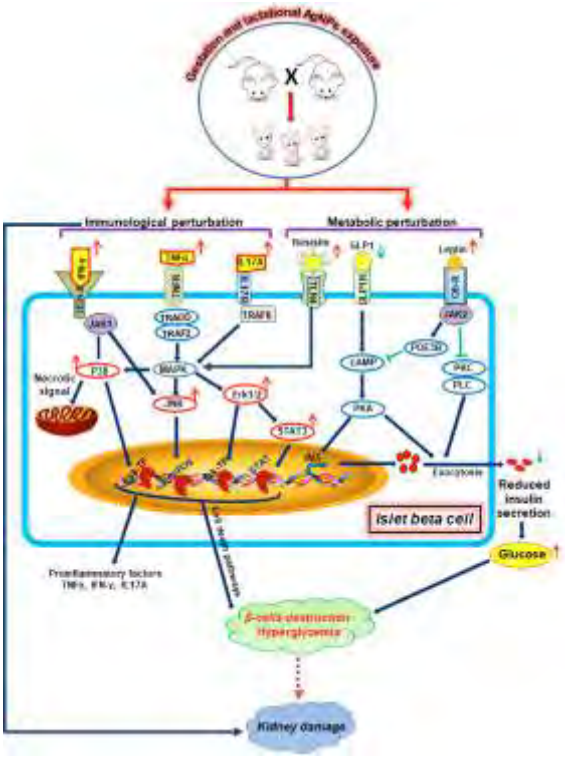
A simple PET-on-off based molecular probe for detection of $Fe3^{+}$ and pyrophosphate in cells

DNA polymerase chain reaction (PCR) product. Additionally, the probe upon providing Fe^{3+} and PPi ions as chemical inputs sequentially mimic "write-read-erase-read" functions through the formation of an INHIBIT gate.

Dwivedi SK, Ali R, Singh M, Gupta T, Kar AK, Prakash V, Anbumani S, Patnaik S, Misra A. Journal of Photochemistry and Photobiology, 2021, 403: 112854.

Perinatal exposure to silver nanoparticles reprograms immunometabolism leading to pancreatic beta-cell death and kidney damage

Silver nanoparticles (AgNPs) are extensively utilized in food, cosmetics and healthcare products. Though effects of AgNPs exposure on adults are well documented, the long-term effects of gestational/perinatal exposure upon the health of offspring have not been addressed. In the present work, it has been found that even perinatal exposure to AgNPs could lead to chronic inflammation in offspring which persists throughout life. Spleenocytes from AgNPs exposed offspring show increased secretion of proinflammatory mediators like TNF-α, IFN-γ, IL1-α and Il-1β upon re-stimulation, suggesting alterations in immune conditioning. This further promotes adverse metabolic changes (resistin, GLP1, leptin, insulin) leading to death of pancreatic cells, reduced insulin production and increased blood glucose levels. The combined effect of these changes further leads to renal damage particularly to tubular and glomerular regions. The study thus shows how even perinatal exposure to AgNPs could affect foetal immune conditioning leading to heightened inflammation, altered metabolism and organ damage later in life.



A possible role of various immune and metabolic regulators in pancreatic beta-cell damage resulting from perinatal AgNPs exposure. The immunometabolic perturbations result in beta cell destruction and reduced insulin secretion leading to low levels of serum-insulin and high blood glucose levels. Chronic inflammation and high glucose levels further damage the kidneys of offspring later in life. Arrows indicate upregulated and downregulated mediators.

Tiwari R, Singh RD, Binwal M, SrivastavAK, Singh N, Khan H, Gangopadhyay S, Argaria N, Saxena PN, Roy SK, Kumar M, Sharma V, Srivastava V. Nanotoxicology, 2021, 15: 636-660.

Regulatory Toxicology

The need to understand human and ecological risks of exposure to emerging chemicals and toxicants has been the driving force behind the ever-expanding and diversifying realm of regulatory toxicology. Over the last few decades, several novel synthetic chemicals/drug molecules/agrochemicals, etc., have found their way into the lives of mankind and other life forms. While these new entrants have definitely helped in tackling contemporary problems, they come with their own baggage of unexpected and unexplained toxicities. In addition, little is known about whether or not these chemicals remain and accumulate in the ecosystem over time. On one hand, the use of antibiotics in aquaculture has helped in increasing profits by reducing losses due to infection outbreaks, while on the other, indiscriminate use of the same has resulted in bioaccumulation of such pharmaceuticals in the ecosystem. Similarly, while triazine derivatives have replaced the more toxic brominated fire retardants, little is known about its ecological impact. Recent times have also seen a greater focus on work environments, both outdoors and indoors, the latter being more pronounced due to increasing work-from-home situations. Setting the limits for occupational exposure to a chemical is one of the first steps in regulating its use to ensure safety. Having identified key areas of concern in the toxicology ecosystem unfolding around us, our group strives to develop and establish new methodologies for toxicant identification, analyze its characteristics through toxicokinetic profiling, develop and validate methods to mitigate its toxicity while ensuring a robust GLP certified testing facility that meets international regulatory requirements.

Biomonitoring studies from several developed and developing countries have demonstrated that we all may carry several chemicals in our bodies. Therefore, it is crucial to understand the risk of these chemical mixtures on human health so that proper risk assessment and management strategies can be devised. The current regulatory framework does not take into consideration the combined effect of chemical mixtures to set the safety limits. Further, risk assessment is one of the most critical components of regulatory action. Toxicokinetics has been well-recognized as a potentially valuable tool in human health risk assessment. Through the integration of toxicokinetic, physiological, biochemical and physicochemical data, physiologically based toxicokinetic (PBTK) models can scientifically support risk assessment by facilitating extrapolation between species (animal to human), exposure routes, and levels of exposures (high to low doses). Systemic exposure provides valuable insights into the interpretation of toxicity studies and aids in adequate risk characterization in humans. CSIR-IITR has taken an initiative to review existing protocols and innovate for better scientific estimates of risk from the joint exposure to widely used pesticides and metals. Mechanistic studies are being carried out to elucidate the key processes of disease initiation and promotion, for a mechanistic understanding and to develop key endpoints to identify multiple xenobiotics exposure mediated adverse effects. The generated information will be used for taking the decisions that affect public health including risk assessment, risk management and regulatory requirements as well.

CSIR-IITR is a GLP-certified laboratory with a proven track record of several decades of conducting pre-clinical safety studies for global regulatory submissions. CSIR-IITR has capabilities for the full range of safety assessment (toxicology) studies required for drugs/ chemicals, products from AYUSH, medical devices, phytotherapeutics, agrochemicals, dyes, and other materials. We are also involved in the generation, analysis and curating the data for pre-clinical safety, and analytical studies of industrial chemicals, agrochemicals, pharmaceuticals, cosmetic products, food/feed additives, etc., as per the regulatory requirements. The institute also has NABL accreditation for biological and chemical testing since 2000. The scope of regulatory studies under NABL cover the water, waster water, soil, air and environmental health associated parameters. The Scientists of the Regulatory Toxicology Research Group also provide the intellectual inputs and expertise to the regulatory agencies for taking the Go/ No Go decisions for new chemicals and products.

The activities of the group are being pursued with following objectives:

- To identify the levels of antimicrobial residues and mycotoxins in various biological matrices, and predict the human health risk using toxicokinetic modeling approaches
- To develop newer and more sensitive analytical methods for characterization and quantification of chemicals in various matrices
- To identify the ecological impact of novel products and mitigation potential of identified natural products against xenobiotics mediated ecotoxicology
- To conduct the pre-clinical toxicology/ safety evaluation of chemicals and products under the regulatory framework
- To develop and establish experimental models under the scope of expansion of GLP based pre-clinical safety/ toxicity studies
- Management and supply of healthy laboratory animals for R&D programs

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Area Coordinator - Dr A Dwarakanath

Participating Scientists - Dr A Ayanur, Dr A Sadasivam, Dr AB Pant, Dr AK Pandey, Dr AK Yadav, Dr B Vamadevan, Dr D Singh, Dr D Ghosh, Dr DK Patel, Dr J Singh, Dr KC Khulbe, Dr M Kumar, Dr NG Ansari, Dr NK Satija, Mr N Garg, Dr SK Roy, Dr VP Sharma, Dr Y Shukla, Dr YK Satija

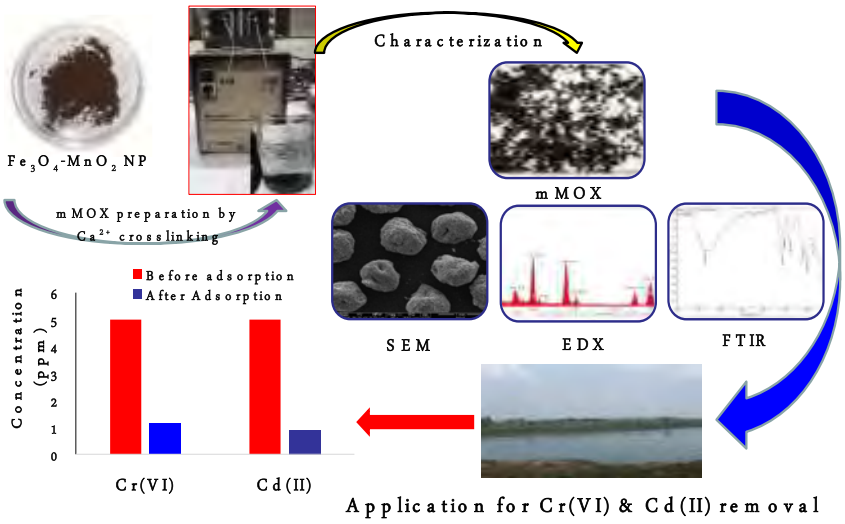
Synthesis of an alginate-based Fe_3O_4–MnO_2 xerogel and its application for the concurrent elimination of Cr(VI) and Cd(II) from aqueous solution

In this study, magnetite−manganese oxide (Fe_3O_4−MnO_2) nanoparticles were synthesized and immobilized on alginate, producing a magnetite−manganese oxide xerogel (mMOX). This eco-friendly xerogel was used as an adsorbent of Cr(VI) and Cd(II). It was mesoporous and thermally stable, as determined by Brunauer−Emmett−Teller and thermogravimetric analysis. A scanning electron microscope coupled with an energy dispersive X-ray system, Zetasizer, and an attenuated total reflectance−Fourier transform infrared system were used for characterization of adsorbents. The performance of the mMOX,for the simultaneous adsorption of Cr(VI) and Cd(II) was investigated at different temperatures, pH values, contact times, initial concentrations of the adsorbate, and adsorbent doses. The developed xerogel (mMOX) showed high adsorption capacities of 3.86 mg/g for Cr(VI) and 3.95 mg/g for Cd(II) at 120 min of contact time with 5 ppm Cr(VI) and Cd(II) solution. The kinetic data fitted well with the pseudo-second order, while the Freundlich isotherm model was found to be a good fit for adsorption data. Thermodynamic study revealed the adsorption to be spontaneous and exothermic. The adsorbent showed useful application for real water samples by more than 75% uptake of Cr and Cd with low adsorption of Na, K, and Mg. The regeneration study indicated that the mMOX could be reused up to six cycles with more than 50% removal of Cr(VI) and Cd(II) ions from aqueous solution with minimal leaching of metal ions (Fe, Ca, Na, K, and Mn) into the solution.

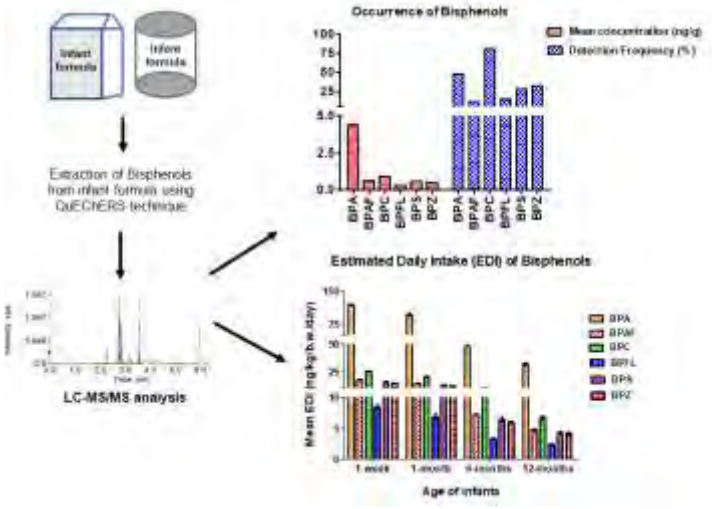
Kumar A, Prasad S, Saxena PN, Ansari NG and Patel DK. ACS Omega, 2021, 6: 3931−3945.

Determination of bisphenol analogues in infant formula products from India and evaluating the health risk in infants associated with their exposure

Bisphenol A (BPA) is a well-recognized endocrine disruptor, and considering its adverse effects, its use in infant bottles has been banned in many countries. Growing concern on the use of BPA has led to its replacement with its analogues in numerous applications. The present report is the first to determine the occurrence of seven bisphenols (BPs: BPA, BPAF, BPC, BPE, BPFL, BPS, and BPZ) in Indian infant formula. A reliable and efficient UPLC-MS/MS method for their simultaneous determination was developed and validated in powdered infant formula (n = 68). The limit of quantification of the method was 0.19 ng/g for BPA, BPAF, BPE, BPS and BPZ and 0.78 ng/g for BPC and BPFL. The highest concentration was detected for BPA (mean = 5.46 ng/g) followed by BPZ and BPS. BPAF, BPFL, BPC and BPE were detected in none of the



Development of ecofriendly nanocomposite for concurrent removal of heavy metals from water



Determination of bisphenol analogues in infant formula products from india and evaluating the associated health risk in infants

samples. The estimated daily intake (EDI) of total BPs in infants (0-12 months old infants) was determined to be 54.33-213.36 ng/kg b.w./day. BPA mainly contributed to the total intake (EDI = 92.76 ng/kg b.w./day). The dietary exposure to total BPs evaluated in the present study was approximately 1 order of magnitude lower than the reference value of BPA set by EFSA (4 µg/kg b.w./day) and, thus, may not pose considerable risks to infants.

Karsauliya K, Bhateria M, Sonker AK, and Singh SP. Journal of Agriculture and Food Chemistry, 2021, 69: 393-3941.

The implementation of the three Rs in regulatory toxicity and biosafety assessment: the Indian perspective

Animal models have long served as the basis for scientific experimentation, biomedical research, drug development and testing, disease modelling and toxicity studies. These models are widely thought to provide meaningful, human-relevant predictions. However, many of these systems are resource intensive and time-consuming, have low predictive value and are associated with great social and ethical dilemmas. Often drugs appear to be effective and safe in these classical animal models, but later prove to be ineffective and/or unsafe in clinical trials. These issues have paved the way for a paradigm shift from the use of *in vivo* approaches, towards 'science of alternatives'. This has fueled several research and regulatory initiatives, including the ban on the testing of cosmetics on animals. The new paradigm has shifted towards increasing the relevance of the models for human predictivity and translational efficacy. This has also resulted in the recent development of many new methodologies, from 3-D bio-organoids to bioengineered 'human-on-a-chip' models. These improvements have the potential to significantly advance medical research globally. This paper offers a stance on the existing strategies and practices that utilize alternatives to animals, and outlines progress in the incorporation of these models into basic and applied research and education, specifically in India. It also seeks to provide a strategic roadmap to streamline the future directions of the country's policy changes and investments. This strategic roadmap could be a useful resource to guide research institutions, industries, regulatory agencies, contract research organizations and other stakeholders in transitioning towards modern approaches to safety and risk assessment that could replace or reduce the use of animals without compromising the safety of humans or the environment.

Pant AB, ATLA, 2021, 48: 234-251.

Systems Toxicology and Health Risk Assessment

All living organisms are constantly subjected to repeated threats in the form of exposure to numerous chemicals and other environmental stress factors. In order to analyse the damage done by these xenobiotics and to be able to predict probable future detrimental effects, understanding the mechanisms by which they act is paramount. This is the primary focus of Systems and Health Risk Assessment Group, with an aim to apply systems biology approach to evaluate and predict the effects of chemicals on different biological systems. Other key focus areas of the group are to study the disturbance caused in the biological system by chemicals and stressors; monitor changes in molecular expression and conventional toxicological parameters, followed by an integration of the data generated to achieve a mechanistic understanding of the specific toxicity. The understanding thus obtained is eventually used to develop and validate biomarkers for predicting toxicological responses.

Several high throughput genomic screens developed in recent times have resulted in a greater understanding of the effect of xenobiotics on biological system. In addition, there has been a constant interest in the possibility of using the output of these genomic assays as a tool to recognize and predict toxicological hazards. An integral component of the overall attempt to understand the adverse effects of chemicals on human health and the environment is the development of an integrated framework through the identification of toxicological pathways and data analysis tools. Particular focus has been on the development, assessment and application of methods to assess the adverse effects of environmental chemicals and nanomaterials. The group endeavours to use these integrated testing strategies to describe all the toxicological interactions occurring within a living system.

With these strategies in place, the group functions with the following objectives:

- To study the perturbation of organ systems by chemicals and stressors
- To monitor changes in molecular expression and conventional toxicological parameters and integrating data to achieve a mechanistic understanding of the specific toxicity and
- To develop and validate biomarkers for predicting the toxicological responses

Area Coordinator - Dr D Parmar

Participating Scientists - Dr AB Pant, Dr C Singh, Dr CSN Kesavchandran, Dr MP Singh, Dr NK Satija, Dr RK Chaturvedi, Dr RS Ray, Dr R Parthasarathi, Dr S Bandyopadhyay, Dr S Priya, Dr VK Khanna, Dr V Srivastava

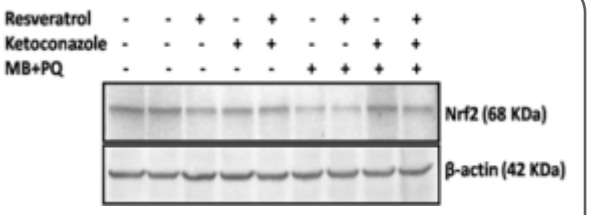
Neuroprotective effects of *Withania somnifera* on 4-hydroxynonenal induced cell death in human neuroblastoma SH-SY5Y cells through ROS inhibition and apoptotic mitochondrial pathway

The antioxidant, anti-inflammatory, and anticancer activities of *Withania somnifera* (WS) are known since a long time. The aim of this study was to examine whether WS also diminishes 4-hydroxy-trans-2-nonenal (HNE)-induced neurotoxicity in human neuroblastoma (SH-SY5Y) cell line. The cytotoxic response to HNE (0.1-50 µM) and WS (6.25-200 µg/ml) was measured by MTT assay after exposing SH-SY5Y cells for 24 h. Thereafter, the neuroprotective potential was assessed by exposing the cells to biologically safe concentrations of WS (12.5, 25, and 50 µg/ml) followed by HNE (50 µM). Results showed a concentration-dependent protective effect of WS at 12.5, 25, and 50 µg/ml against HNE (50 µM) induced cytotoxicity and cell inhibition. Pre-exposure to WS resulted in a stronger inhibition of 24, 55 and 83% in malondialdehyde (MDA) level; 5, 27 and 60% in glutathione (GSH) level; 12, 36 and 68% in catalase activity; 11, 33 and 67% in LDH leakage; and 40, 80 and 120% in cellular LDH activity at 12.5, 25, and 50 µg/ml, respectively, induced by 50 µM HNE in SH-SY5Y cells. The HNE-mediated cellular changes (cell shrinkage, rounded bodies, and inhibition of outgrowth) and increased caspase-3 activity were also prevented by WS. The HNE-induced upregulation of proapoptotic markers (p53, caspase-3, and -9, and Bax) and down regulation of antiapoptotic marker Bcl-2 genes were also blocked by pre-treatment with WS. Altogether, our findings indicate that WS possesses a protective potential against HNE-induced neurotoxicity.

Siddiqui MA, Farshori NN, Al-Oqail MM, Pant AB, Al-Khedhairy AA. Neurochemical Research, 2021, 46:171-182.

Resveratrol regulates Nrf2-mediated expression of antioxidant and xenobiotic metabolizing enzymes in pesticides-induced Parkinsonism

Combined maneb (MB) and paraquat (PQ), two widely used pesticides, increases oxidative stress leading to Parkinsonism. Xenobiotic metabolizing enzymes, cytochrome P450 (CYP) 2D6 and its mouse ortholog



Western blot showing cytosolic Nrf2 and loading control, β-actin, in the nigrostriatal tissue, suggestions the effect of resveratrol, ketoconazole and MB + PQ

Cyp2d22 protect against Parkinsonism. Resveratrol, an antioxidant, restores antioxidant defense system through the activation of nuclear factor erythroid 2- related factor 2 (Nrf2). However, a probable crosstalk between Cyp2d22/CYP2D6-mediated protection and resveratrol-induced Nrf2 activation leading to neuroprotection is not yet elucidated. The study aimed to decipher the effect of resveratrol on Nrf2 activation and expression of its downstream mediators, nicotinamide adenine dinucleotide phosphate quinone oxidoreductase 1 (NQO1) and thioredoxin 1 (Trx1) along with Cyp2d22/CYP2D6 activity in combined MB and PQ mouse model of Parkinsonism and differentiated neuroblastoma cells. MB and PQ reduced the dopamine content (mouse) and Cyp2d22/CYP2D6 activity (mouse/neuroblastoma cells), increased the nuclear translocation of Nrf2 and expression of both NQO1 and Trx1. Resveratrol ameliorated pesticides-induced changes in dopamine content and Cyp2d22/CYP2D6 activity. It was found to promote nuclear translocation of Nrf2 and expression of NQO1 and Trx1 proteins. Since, Cyp2d22/CYP2D6 inhibitor (ketoconazole/quinidine) per se reduced Cyp2d22/CYP2D6 activity and dopamine content, it was found to substantially increase the pesticides-induced reduction in Cyp2d22/CYP2D6 activity and dopamine content. Inhibitors normalized the pesticides induced changes in Nrf2 translocation and NQO1 and Trx1 levels in pesticides treated groups. The results suggest that resveratrol promotes the catalytic activity of xenobiotic metabolizing enzyme, Cyp2d22/CYP2D6, which partially contributes to Nrf2 activation in pesticides- induced Parkinsonism.

Rasheed MSU, Tripathi MK, Patel DK, Singh MP. Protein & Peptide Letters, 2021, 27:1038-1045.

Cypermethrin impairs hippocampal neurogenesis and cognitive functions by altering neural fate decisions in the rat brain

Neurogenesis is a developmental process that involves fine-tuned coordination between self-renewal, proliferation, and differentiation of neural stem cells (NSCs) into neurons. However, early-life assault with environmental toxicants interferes with the regular function of genes, proteins, and other molecules that build brain architecture resulting in attenuated neurogenesis. Cypermethrin is a class II synthetic pyrethroid pesticide extensively used in agriculture, veterinary, and residential applications due to its low mammalian toxicity, high bio-efficacy, and enhanced stability. Despite reports on cypermethrin-mediated behavioral and biochemical alterations, no study clarifies whether cypermethrin exposure has any effect on neurogenesis, or not. Therefore, the present study was undertaken to comprehend the effects of cypermethrin treatment on embryonic and adult neurogenesis. We found that cypermethrin exposure led to a considerable decrease in the BrdU/Sox-2^+, BrdU/Dcx$^+$, and BrdU/NeuN$^+$ co-labeled cells indicating that cypermethrin treatment decreases NSC proliferation and generation of mature and functional neurons. On the contrary, the generation of BrdU/S100β^+ glial cells increased, resulting in neurogliogenesis imbalance in the hippocampus. Further, cypermethrin treatment also led to an increased number of BrdU/cleaved caspase-3^+ and Fluoro-Jade B$^+$ cells suggesting an induction of apoptosis in NSCs and increased degeneration of neurons in the hippocampus. Overall, these results explicate that cypermethrin exposure not only reduces the NSC pool but also disturbs the neuron-astrocyte ratio and potentiates neurodegeneration in the hippocampus leading to cognitive dysfunctions in rats.

Yadav A, Tandon A, Seth B, Goyal S, Singh SJ, Tiwari SK, Agarwal S, Nair S, Chaturvedi RK. Molecular Neurobiology, 2021, 58: 263-280.

Hypothyroidism induces interleukin-1 dependent autophagy mechanism as a key mediator of hippocampal neuronal apoptosis and cognitive decline in postnatal rats

Thyroid hormone deficiency induces hippocampal neuronal loss and cognitive dysfunction, however, the participating mechanisms remain less-explored. Hippocampal dysfunction in a rat model of hypothyroidism, generated through methimazole exposure from gestation until young adulthood, was assessed hypothesizing the involvement of impaired autophagy that relates with neuronal damage. Methimazole-mediated increased autophagy proteins, LC3-II, Beclin-1, ATG-7 and ATG-5/12 conjugate; modulation of p-mTOR/mTOR and p-ULK/ULK autophagy regulators and an induction of autophagosomes in the hippocampus of infantile and young adult rats were detected. The methimazole-induced hippocampal autophagy could be inhibited by thyroxine treatment. Probing up-stream mediators of autophagy revealed hippocampal inflammation, marked by increased interleukin (IL)-1alpha and beta and activated microglial marker, Iba-1, causing enhanced neuronal IL-1receptor-1 (IL.1R1) expression in the hypothyroid rats. Moreover, hippocampal infusion of IL-1R-antagonist (IL-1Ra) that reduced neuronal IL-1R1, also suppressed the methimazole-induced neuronal autophagy in the hypothyroid rats. These events were linked with hypothyroidism-induced hippocampal neuronal loss, apoptosis and learning-memory dysfunction. We observed that the autophagy inhibitor, 3-methyladenine, and IL-1Ra, like thyroxine, reduced methimazole-induced cleaved-caspase-3 expression and TUNEL staining in hippocampal neurons and restored the Nissl-stained surviving neuronal density. Corroborating the molecular results, IL-1Ra and 3-methyladenine inhibited the methimazole-induced loss in saving memory (%) and transfer latency time and increase in error (%) in the Y-Maze and passive avoidance test for learning-memory. Taken together, the study indicts inflammation-dependent autophagy as a key pathway for hypothyroidism-induced hippocampal neuronal dysfunction in infants and young adults. This could be blocked by thyroxine or by inhibiting the autophagy and neuroinflammation processes.

Mishra J, Vishwakarma J, Malik R, Gupta K, Pandey R, Maurya SK, Garg A, Shukla M, Chattopadhyay N, Bandyopadhyay S. Molecular Neurobiology, 2021, 58:1196-1211.

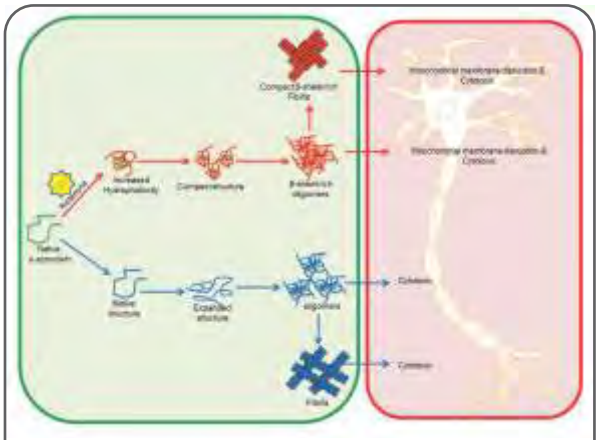
Fast kinetics of environmentally induced α-synuclein aggregation

Aggregation of α-synuclein (α-syn) is associated with the manifestation of various pathogenic synucleinopathies, including Parkinson's Disease. The disease pathogenesis is attributed to both genetic and environmental stress factors, however, the initial events triggering α-syn aggregation and disease initiation due to environmental stress factors are largely unknown. Here, to understand the mechanism of misfolding and aggregation initiation, α-syn aggregation was induced with rotenone, an established pesticide and chemical inducer of PD-like symptoms. The study found that rotenone accelerates the formation of structurally distinct oligomers and fibrils that act as templates, and increase the formation of conformers capable of spreading to the neighbouring neuronal cells. Molecular dynamics simulations and NMR studies revealed the involvement of the NAC region and formation of helical conformations, resulting in structural variations in oligomers and fibrils. These structural variations affect the cytotoxic potential of oligomers and fibrils, where, the beta sheet rich oligomers and fibrils alter the membrane potential of neuronal cells and lead to early apoptosis. The results of this study describe the initial mechanistic events unfolding in pathogenic protein aggregation, where initial structural alterations in response to external stress factors dictate the toxicity of resulting conformers. This information is useful to provide insights in understanding the role of environmental risk factors in protein aggregation, disease progression and pathogenesis.

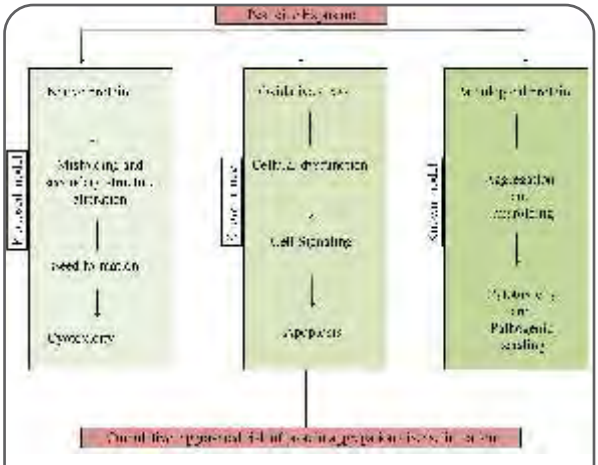
Srivastava T, Raj R, Dubey A, Kumar D, Chaturvedi RK, Sharma SK and Priya S. Scientific Reports, 2021, 10: 18412.

Pesticide-protein interactions induce alterations in the secondary structure of protein

Environmental exposure to pesticides increases the risk of neurotoxicity and neurodegenerative diseases. The mechanism of pesticide-induced toxicity is attributed to the increased reactive oxygen species, mitochondrial dysfunction, inhibition of key cellular enzymes and accelerated pathogenic protein aggregation. The structural basis of pesticide-protein interaction is limited to pathogenic proteins such as α-synuclein, Tau and amyloid-beta. However, the effect of pesticides on metabolic proteins is still unexplored. Here, we used rotenone and chlorpyrifos to understand the interaction of these pesticides with a metabolic protein, malate dehydrogenase (MDH) and the consequent pesticide-induced cytotoxicity. The study found that rotenone and chlorpyrifos strongly bind to MDH, interfere with protein folding and trigger an alteration in its secondary structure. Both pesticides showed high binding affinities for MDH as observed by NMR and LC-MS. Rotenone and chlorpyrifos induced structural alterations during



Schematic representation of rotenone induced α-syn aggregation and cytotoxicity mechanism. Rotenone-induced pathway represented as red arrows in comparison to normal α-syn aggregation (blue arrows)



Pesticide induced cellular toxicity; (A) oxidative stress-mediated pathway (B) aggregation of pathogenic protein (C) misfolding of metabolic proteins and their cytotoxicity.

MDH refolding resulting in the formation of cytotoxic conformers that caused oxidative stress and reduced cell viability. These findings suggest that pesticides, in general, interact with proteins resulting in the formation of cytotoxic conformers that may have implications in neurotoxicity and neurodegenerative diseases.

Devi S, Aggrawal K, Srivastava T, Raj R, Kumar D, Priya S. Chemosphere, 2021, 263:128074.

Research Publications

Total publications	**99**
Average Impact Factor (IF)	**5.48**
IF NA	**6**
IF<3	**11**
IF 3-5	**28**
IF 5-7	**22**
IF 7-12	**30**
IF > 12	**2**

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Patents Filed in India

Sl. No	Title	Inventors	Filing Date	Application No.
1	A ready to use test strip for the rapid detection of polyphenols and use thereof	Pawankumar Rai Srishti Mehrotra Sandeep Kumar Sharma	09-Jun-20	202011024280
2	A test strip for the rapid detection of nitrate and nitrite in aqueous medium and use thereof	Pawankumar Rai Srishti Mehrotra Sandeep Kumar Sharma	29-Jun-20	202011027503
3	A ready to use test strip for the rapid visual detection of cyanide	Pawankumar Rai Srishti Mehrotra Sandeep Kumar Sharma	11-Aug-20	202011034411
4	An apparatus for staining and immunolabeling of biomolecules on gels, membranes, slides or similar surface in cool mist phase	Sanjay Yadav Sana Sarkar Nishant Singh Abhishek Mishra	22-Aug-20	201911033775
5	A process for detection of ammonia and ammonium compounds in aqueous sample and product thereof	Pawankumar Rai Srishti Mehrotra Sandeep Kumar Sharma	24-Aug-20	202011036322
6	A ready to use test strip for rapid and simultaneous detection of urea, boric acid and detergent and use thereof	Srishti Mehrotra Gayatri Bagree Pawankumar Rai Sandeep Kumar Sharma Alok Dhawan	02-Sep-20	202011037839
7	A rapid and economical process and product for the detection of argemone in edible oils and fats	Pawankumar Rai Srishti Mehrotra Sandeep Kumar Sharma	03-Sep-20	202011037979
8	A novel process and product thereof for the detection of Karanja oil in edible oils	Sandeep Kumar Sharma Pawankumar Rai Srishti Mehrotra	08-Sep-20	202011038720
9	Primer for detection of circular RNA and its method thereof	Sanjay Yadav Anuj Pandey Nishant Singh Devendra Parmar	27-Oct-20	202011046807
10	A process and product for detection of butter yellow in edible oils and fats	Sandeep Kumar Sharma Pawankumar Rai Srishti Mehrotra	29-Oct-20	202011047675
11	Processing and instrumentation for Solid Phase Extraction (SPE)	Pawan Kumar Rai Srishti Mehrotra Sandeep Kumar Sharma	31-Mar-21	202111015501

Patents Filed in Foreign Country

Sl. No	Title	Inventors	Filing date	Application number	Country
1	An apparatus for staining and immunolabeling of biomolecules on gels, membranes, slides or similar surface in cool mist phase	Sanjay Yadav Sana Sarkar Nishant Singh Abhishek Mishra	22-Aug-20	PCT/IN2020/050730	WO

Patents Granted in India

Sl. No	Title	Inventors	Grant Date	Patent number
1	A green process for the biological synthesis of arsenic nanoparticles	Kumar Manoj Chauhan Lalit Kumar Singh Saxena Prem Narain Shankar Jai Arjaria Nidhi Das Mukul Singh Dinesh Kumar	18-Jan-21	356044

Agreements & Memorandum of Understanding

1. A Memorandum of Understanding (MoU) was signed between CSIR-IITR, Lucknow and Lifecare Innovations Pvt. Ltd, New Delhi and SGPGIMS, Lucknow on May 11, 2020 for submitting a joint proposal to BIRAC for funding.

2. A collaboration agreement was signed between CSIR-IITR, Lucknow; CSIR-IIP, Dehradun; University of Glasgow, Glasgow and Gram Utthan, Bhubaneswar on May 04, 2020 to perform the project titled "Feasibility and impacts of Bio-energy Trigeneration systems (Bio Trig) in disadvantaged rural areas in India" under the Global Challenges Research Fund, which has been approved by the Scottish Funding Council.

3. A non-disclosure agreement was signed between M/s Yash Pakka Limited, Ayodhya and CSIR-IITR, Lucknow on June 30, 2020 for real time optimization of newly developed bioreactor by CSIR-IITR at the premises of M/s Yash Pakka Limited, Ayodhya.

4. A MoU was signed between CSIR-IITR, Lucknow and KIET Group of Institutions, Ghaziabad on August 05, 2020 for long term collaboration in the areas of mutual interest.

5. A MoU was signed between CSIR-IITR, Lucknow and Hindu College, University of Delhi, Delhi on August 26, 2020 to mutually share the existing facilities and available expertise at both the institutions.

6. A MoU was signed between CSIR-IITR, Lucknow and Integral University, Lucknow on September 18, 2020 for long term collaboration in the areas of mutual interest.

7. A MoU was signed between CSIR-IITR, Lucknow and National Institute of Pharmaceutical Education and Research, Hyderabad on September 24, 2020 for long term collaboration in the areas of mutual interest.

8. CSIR-Indian Institute of Toxicology Research signed a MoU with LV Prasad Eye Institute (LVPEI), Hyderabad on December 30, 2020.

9. CSIR-Indian Institute of Toxicology Research signed a Memorandum of Understanding (MoU) with Babu Banarasi Das University, Lucknow on December 31, 2020.

10. CSIR-Indian Institute of Toxicology Research signed a MoU with Atal Incubation Center-Gujarat Technological University (AIC-GTU), Ahmedabad on December 31, 2020.

11. A non-disclosure agreement is signed between CSIR-Indian Institute of Toxicology Research and Arceli Agribiz Pvt. Ltd. (AAPL), Mumbai regarding the toxicity testing of the ayurvedic formulations developed by AAPL on February 08, 2021.

12. A Memorandum of Cooperation (MoC) was signed between CSIR-IITR, Lucknow and CSIR-NBRI, Lucknow on February 11, 2021 for joint R&D activities in the OLP project of CSIR-NBRI (OLP-106).

Externally Funded Research Projects

Title	Sponsor	Principal Investigator	Start Date	Total Value (INR)
Bhujal sansadhan ki gunvatta ke anushrawan evam mapping ki vishleshanatmak report hetu bhujal namoono ka vishleshan kiya jana	UP Ground Water Department Lucknow	Dr P Chaturvedi, CO-PI Dr K.C. Khulbe	05-Jun-20	16000000.00
Feasibility and Impact of Bioenergy Trigenerations systems-(Biotrig)in disadvantaged rural areas in India	University of Glasgow	Dr P Chaturvedi	15-Jun-20	643500.00
Analysis of metals and physicochemical parameters in LWTP sludge samples(4 nos.)	National Thermal Power Corporation, Vindya Nagar, Singrauli(M.P.)	Dr B. Sreekanth	30-Jun-20	132000.00
Collection and analysis of inlet and treated effluent of STP, Ayodhya, Gorakhpur and Sultanpur Districts	Toshiba Water Solutions Pvt. Ltd., 3/1194 Vashundhra, Ghaziabad, UP	Dr P Chaturvedi	15-Jul-20	1642560.00
Anti-gerogenic therapy in augment lifespan and health span by bioactive peptides from rasayana herbs: generation of PoC for the first in class Ayurveda based peptide therapeutics	SERB, New Delhi	Dr S Bandyopadhyay	19-Aug-20	1593000.00
Analysis of ground water samples and soil samples.	Bharat Oil and Waste Management Limited, Kanpur.	Dr S Patnaik	15-Sep-20	127440.00
Toxicity study of SCS-10k (Chloride dioxide powder) as a disinfectant of water	Jalgal Vibhag, Nagar Nigam, Lucknow	Dr AB Pant	06-Oct-20	197060.00
Stack emission monitoring and analysis of PM, SO2, Nox, CO and preparation, submission of technical report	Continental Carbon India Limited, Ghaziabad	Dr B Sreekanth	15-Oct-20	295000.00
Inspection of Gross Polluted Industries (GPIs) by third party agency	CPCB, New Delhi	Dr P Chaturvedi	17-Oct-20	1805400.00

Safety assessment of biostimulant formation	Director, CSIR-NBRI, Lucknow	Dr AB Pant	23-Oct-20	1947000.00
Analysis of pesticides in water and soil samples.	India Pesticide Limited, Chinhat, Lucknow	Dr AK Yadav	18-Nov-20	276250.00
Analysis of Barium and Aluminum in PM 2.5 digested samples	UP Pollution Control Board, Gomti Nagar, Lucknow	Dr NG Ansari	18-Nov-20	318600.00
Third party testing & monitoring of stack emission, ambient air monitoring and water effluent, drinking water testing, noise with preparation of environmental audit statement and testing of coal bottom ash, fly ash and dried sludge.	Anpara Thermal Power Station, Anpara	Er. AH Khan Dr DK Patel	24-Nov-20	1720700.00
Analysis of Single Super Phosphate	Nirma Limited, Ahmedabad	Dr AB Pant	07-Dec-20	535720.00
Analysis of metals in rat brain and Abhrak bhasin samples	UP University of Medical Sciences, Saifai, Etawah	Dr RS Ray	18-Dec-20	182900.00
Discovery of potent natural analogues to overcome off-target toxicity of RNA: An integrated machine learning and chemoinformatics approach	SERB, New Delhi	Dr R Parthasarathi	28-Dec-20	1454039.00
Effect of non-steroidal anti-inflammatory drugs on the gut microbiome and host immune responses	SERB, New Delhi	Dr P Tripathi	30-Dec-20	1675000.00
Monitoring of pollution parameters by third party recognised by UPPCB	NTPC, Rihand	Dr GC Kisku	01-Jan-21	3962520.00
Safety/ toxicity evaluation of a new plant product	DS Innovative Products LLP, Delhi	Dr AB Pant	04-Jan-21	2006000.00
Online training programme on analysis of pesticide and other organic chemicals in environmental samples	CPCB, New Delhi	Dr NG Ansari	05-Jan-21	158700.00

Toxicity assessment of biocontrol agent and their formulations	CSIR-NBRI, Lucknow	Dr AB Pant	12-Jan-21	5723000.00
Analysis of metals, pesticides and antibiotics in water sample	NBFGR, Lucknow	Dr RS Ray	15-Jan-21	278480.00
Investigating the role of zearalenone, a mycoestrogen in the promotion of endometrial cancer	ICMR, New Delhi	Dr KM Ansari	01-Feb-21	550410.00
Work of measurement of Nox emission from the boiler of 5x200MW units of BTPS, Obra, Sonebhadra	Obra Thermal Power Station, Obra	Dr B Sreekanth	01-Feb-21	112100.00
Analysis of water and soil samples for physiochemical, metals and bacteriological parameters	NCL, Khadia	Dr S Patnaik	22-Feb-21	132160.00
Predicting the developmental toxicity of fungicides by physiologically based toxicokinetic modeling facilitated reverse dosimetry using Zebra fish embryo model as an alternative to animal-free risk assessment approach	SERB, New Delhi	Dr SP Singh	23-Feb-21	4698259.00
Understanding the association between xenobiotic exposure and obesity using caenorhabditis elegans as a model	ICMR, New Delhi	Dr A Satish	15-Mar-21	1413160.00
Predicting the risk of azole fungicides to human health using physiologically based toxicokinetic modeling and their intake assessment in Indian Population	ICMR, New Delhi	Dr SP Singh	15-Mar-21	1207160.00
Hippocampal E2, neuronal dysfunctions and sexual dimorphism in adult rats: effects of chronic arsenic exposure	SERB, New Delhi	Dr S Bandyopadhyay	15-Mar-21	4708240.00
Analysis of metals, flouride in soil samples from contaminated sites of UP	UPPCB, Lucknow	Dr RS Ray	15-Mar-21	541620.00

Testing parameters and collection of their samples from different places of power house of OTPS, Obra	Obra Thermal Power Station, Obra	Dr B Sreekanth	23-Mar-21	1965000.00
Fibre count in 10 slides of North East Roofing Private Limited, Assam	North East Roofing Private Limited, Guwahati, Assam	Er AH Khan	26-Mar-21	118000.00
Fibre count in 10 slides of Assam roofing Limited, Assam	Assam Roofing Limited, Guwahati, Assam	Er. AH Khan	26-Mar-21	118000.00

Ph.D. Awarded-AcSIR

Fellow	Thesis Title	Stream	Supervisor	Year
Manish Kumar Tripathi 	A study on the molecular mechanism of Silymarin-mediated protection against MPTP- induced Parkinsonism: Role of autophagy.	Biological Sciences	Dr Mahendra Pratap Singh	2020
Mohd Sami Ur Rasheed 	A study on the role of Nrf2 in Cyp2d22-mediated neuroprotection against maneb- and paraquat- induced Parkinsonism.	Biological Sciences	Dr Mahendra Pratap Singh	2020
Ankur Srivastava 	Studies on Zinc Oxide (ZnO) nanoparticles induced alteration in adult and developing brain.	Biological Sciences	Dr Devendra Parmar Co-supervisor: Dr Sanjay Yadav	2020
Ankita Srivastava 	Effect of prenatal exposure of lindane during postnatal brain development in rat offspring and understanding their response when rechallenged at adulthood.	Biological Sciences	Dr Devendra Parmar Co-supervisor: Dr Vinay Kumar Khanna	2020
Sugandh 	Studies on role of mitophagy in hyperglycemia induced nephrotoxicity.	Biological Sciences	Dr Poonam Kakkar	2020
Anuradha Yadav 	Cellular and molecular mechanism(s) of cypermethrin mediated effects on neurogenesis in the rat brain.	Biological Sciences	Dr Rajnish Kumar Chaturvedi	2020
Lavi Rani 	Development of a *Drosophila* based model for studying diabetes mediated renal tubular dysfunction.	Biological Sciences	Dr D Kar Chowdhuri Co-supervisor: Dr Naveen Kumar Gautam	2021

Abik Nandi 	Studies on cadmium mediated adversities on male germline stem cells homeostasis using *Drosophila melanogaster* as an in vivo model.	Biological Sciences	Dr D Kar Chowdhuri	2021
Sumit Kumar Anand 	Studies on redox mediated cellular signaling of Bisphenol-A induced hepatotoxicity.	Biological Sciences	Dr Poonam Kakkar	2021
Neha Singh 	Studies on adverse effects of mycotoxin patulin on intestinal cells.	Biological Sciences	Dr Kausar Mahmood Ansari	2021

Recognitions, Honours and Awards

Dr Ashok Pandey
Distinguished Scientist

2020

- Top 21 Scientist No. 1 in Biotechnology field in India
- Fellow, Indian Chemical Society
- Distinguished Scientist, 7th International Scientist Awards on Engineering, Science and Medicine. Coimbatore, India

Dr Vinod P. Sharma
Chief Scientist

2021

- Technical Advisory Group Member of Scientific Panel on Packaging [SP-20] of Food Safety Standards Authority of India [FSSAI] for 2020-2022
- Plastics Packaging Sectional Committee PCD12 and PCD 21 – National expert member of Bureau of Indian Standards [BIS], New Delhi

Dr Vinay K. Khanna
Senior Principal Scientist

2020

- Appointed as Adjunct Professor (Honorary), NIPER-Hyderabad, Hyderabad

Dr Aditya B. Pant
Senior Principal Scientist

2020

- Member, Microphysiology System (MPS) Summit Scientific Advisory Committee

Dr Dhirendra Singh
Principal Scientist

2020

- Received Ram Singh Memorial National Animal Welfare Award- 2020. A Lifetime Achievement Award by *Pashudhan Prahree*

Dr R Parthasarathi
Principal Scientist

2021

- Elected as Fellow of Royal Society of Chemistry (FRSC), UK

Dr Ashish Dwivedi
Scientist

2021

- Full member, The Society of Toxicology (SOT), USA

Dr Yatendra K. Satija
Scientist

2020

- Represented CSIR-IITR, Lucknow at International Workshop on Technopreneurship for Developing Countries, Malaysia organized by Centre for Science & Technology of the Non Aligned and Other Developing Countries (November 24-25, 2020), Online

2021

- Represented CSIR-IITR, Lucknow at Global Young Scientist Summit 2021 held at Singapore (January 12-15, 2021), Online

Shweta Singh Chauhan
Research Fellow

Sushmita Tiwari
Research Fellow

2021

- Selected as finalist of Grundfos Challenge at the global Next generation water action program on technology development and received a full scholarship sponsored by the Poul Due Jensen Foundation to participate in World Water Week 2021

Dr R. Parthasarathi
Principal Scientist

COVID-19 Testing Facility

Severe Acute Respiratory Syndrome Novel Corona virus (SARS-CoV2) infection had been declared a pandemic (COVID-19) by World Health Organization in March 2020. In modern history, this COVID-19 outbreak created havoc and inflicted despair across the globe, and India is not an exception. Since things have been happening at such a rapid pace, we haven't had time to respond with adequate preparedness. Even though extensive vaccination is being done across the country, COVID appropriate behaviour is the only efficient means to control the community spread of the infection. The Real Time-PCR-based assay using nasal and pharyngeal swab specimens has proved to be the gold standard for diagnosing COVID-19. At the beginning of the pandemic itself, CSIR-IITR, Lucknow, established a state-of-the-art RT-PCR-based COVID-19 testing facility within the campus. The facility is equipped to ensure BSL2+ level safety, quality control and quality assurance, efficacy, and real-time data reporting. The facility has so far reported over 2.50 lacs test results till March 31, 2021. Apart from the diagnostic services, this facility is also working as a resource center to impart hands-on training in the methods of corona testing and biosafety measures to be taken, to the personnel from other institutes for their capacity building for corona testing. The COVID-19 testing facility is also being used

for molecular surveillance of SARS-CoV2 by genome sequencing and variant analysis in COVID-19 positive samples tested at CSIR-IITR, Lucknow. The next-generation sequencing (NGS) for molecular surveillance of SARS-CoV-2 is being done as part of the pan-CSIR consortium using MinION Nanopore Sequencer from Oxford Nanopore Technologies (UK). The aim is to trace patients digitally and establish the chain of virus transmission and mitigate the transmission. These studies will help sequence-based identification of the virus strains, understanding the molecular epidemiology in the virus infecting the human population in the different regions of Uttar Pradesh and the country.

Establishing BioNEST at CSIR-IITR

The BioNEST incubation facility was established in March 2020 at CSIR-IITR with the support of BIRAC, Dept. of Biotechnology, Government of India. This bio-incubation and translational research programme is nurtured under Centre for Innovation and Translation Research (CITAR) hub of the institute and will provide incubation support to young innovators and start-ups with industrially viable ideas to support and translate them into market-reaching products. The incubation and mentoring support was provided to the incubatees to make them globally competitive with their innovation and technology through academy-industry interactions. This is a unique bio-incubation ecosystem with the advanced instrumentation, scientific and technical expertise housed at CSIR-IITR. Approximately 20,000 sq. ft. of built-up area of incubation space is available under BioNEST incubation facility.

This ecosystem is established with a vision to provide researchers, innovators, and entrepreneurs from academia and industry to access state-of-the-art platform technologies and mentorship in a multidisciplinary collaborative environment. This inturn will enable them to

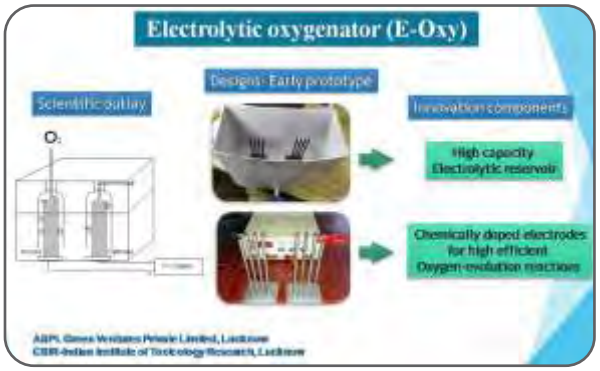
innovate, develop, probe, and address the most important technological challenges in the health and environment sectors. Based on the ever enhancing global demand to develop smart products and effective process interventions in scientific sectors of biotechnology, biomedical engineering, environmental science and toxicology, the BioNEST incubation facility will cater to the requirements and demands of researchers, innovators, startups, industries, and MSMEs.

CITAR-BIRAC-BioNEST is housed at the Technology Development and Innovation Centre (TDIC) building. Exclusive features of this innovation and incubation ecosystem are:

- First BioNEST facility awarded and established within CSIR organization.
- Largest BioNEST incubation facility in the state of Uttar Pradesh
- The only BioNEST incubator with scientific strength highlighted on toxicology aspects

Mentorship for innovation and incubation support provided at BioNEST

M/s ASPL Green Ventures (P) Ltd, the BioNEST resident incubatee of CSIR-IITR was supported and engaged to pitch in for Nidhi4Covid 2.0 funding drive of DST and NSTEDB that supports indigenous solutions and innovative products to fight against COVID-19 pandemic.



This innovation idea has passed the preliminary screening and pitched in for the second round of Nidhi4Covid 2.0 innovation program during the second week of July 2021.

Outreach events & activities of CITAR-BIRAC-BioNEST

As a part of CSIR-IITR's 55th Annual Day celebrations, 6th International Toxicology Conclave (ITC-2020) was organized on November 5th, 2020 with a focus on Artificial Intelligence for Health Research and Environmental Safety Decisions (ARISE). An exclusive session to showcase the activities and interests of CSIR-IITR-BioNEST was organized during this event involving Start-up interaction, Young Scientist forums, and Industry involvement was made by Dr Priyanka Banerjee, University of Berlin; Dr Sunil Kumar, SAI Life; Mr Ajit Deshpande, Rise Analytics and Dr. Rukmini Kumar, Vantage Research. The research scholars' community was represented by Ms. Himakshi Sharma of CSIR-North East Institute of Science and Technology, Jorhat, and Ms Shweta Singh, CSIR-Indian Institute of Toxicology Research with their lectures on Informatics and Modelling on Covid-19 Drug Development and Computational Toxicology for Food Safety respectively.

A virtual road-show was organized by BioNEST of CSIR-IITR on 24th of February 2021 in support of the Global Bio-India Summit-2021. During the event, activities of various CSIR labs and centers in promotion of Innovation and bio-entrepreneurship were showcased. Dr Devendra Parmar, Chief Scientist, CSIR-IITR welcomed the online gathering followed by several insightful presentations made by scientists of various CSIR institutions such as Dr Madhuudana Rao (Atal

Incubation Centre, Hyderabad), Mr Ankush Varma (CSIR-IIIM, Jammu), Dr. Mahesh Gupta (CSIR-IHBT, Palampur), Dr Ramjee Pallelle (CSIR-CCMB, Hyderabad) and Dr R. Parthasarathi (CSIR-IITR, Lucknow). The scope and aim of Global Bio India event was presented in detail by Dr Bhuvnesh (BIRAC). This session was followed by discussion with three successful entrepreneurs Dr Pawan (Aarna Biomedical Products), Dr Atul (Alfa Corpuscles) and Dr Rachna (MicroGO).

Being invited as the BioNEST network member of BIRAC, CSIR-IITR has participated and showcased its research interests and innovation capabilities during the

Interactions during the sessions

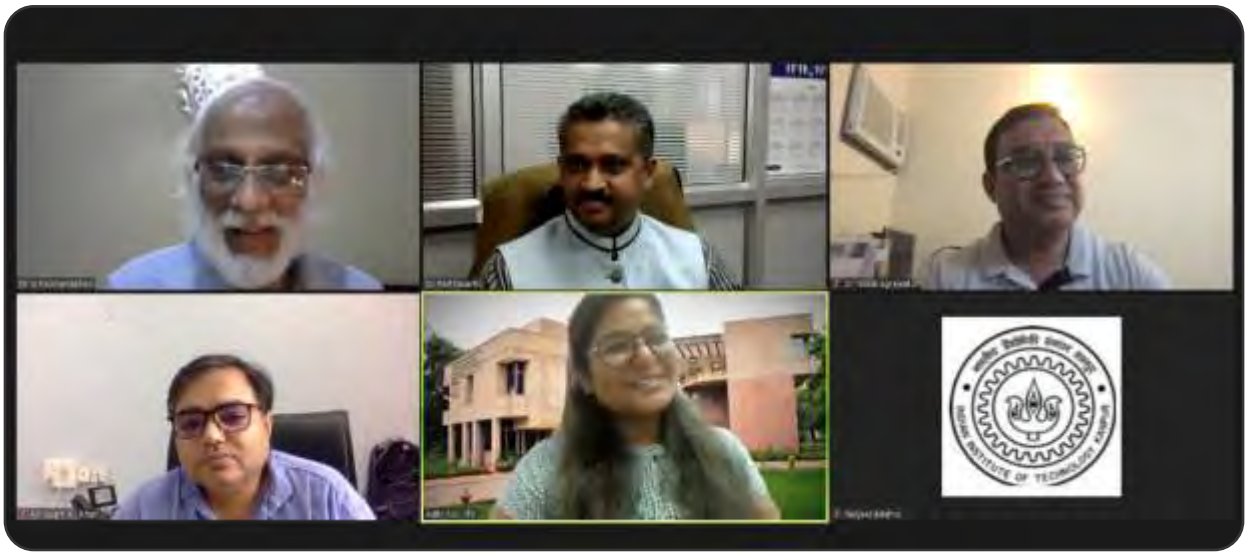
second edition of Global Bio India 2021 international congregation conducted via virtual mode during 1st to 3rd March 2021.

Virtual pavilion of CSIR- IITR BioNEST at GBI exhibition 2021

Better with Biotechnology (BioNEST) of CSIR-IITR

BioNEST of CSIR-IITR in association with SIIC-IIT Kanpur, TIDES-IIT Roorkee along with BIRAC, co-organized a 3-days event to celebrate and acknowledge the contribution of Biotechnology to India's economy specially highlighting the role of Bio-entrepreneurs as Azadi Ka Amrut Mahotsav. The event was inaugurated by Dr Padmanabhan. Exciting keynote sessions and panel discussions were held on the emerging trends in biotechnology. Insights on the innovation ecosystem at SIIC-IIT-Kanpur, TIDES-IIT-Roorkee, and CSIR-IITR were also discussed during engagement sessions.

Regular monthly orientation events for entrepreneurship promotion



Interactions during the sessions

Monthly orientation events were organized on every third saturday for the benefit of graduate scholars, incubatees and associated researchers connected through BioNEST facility of CSIR-IITR. These events are aimed to promote entrepreneurship among young researchers and to ignite their academia to industry transition potential through deep interactions and trainings *via* direct connectivity and mentorship with subject experts of Biotech, Agritech, Medtech and Healthcare domains.

DSIR-Common Research and Technology Development Hub

DSIR-IITR-CRTDH Environmental Monitoring and Intervention Hub (established in January 2019) is primarily working on three areas, such as (i) Water treatment and monitoring (ii) Effluent treatment, and (iii) Air pollution abatement to serve the industries and public. Technologies in these areas developed by the hub are enhanced from lab level research to field/commercial level on supporting MSEs and industries.

Director General, Council of Scientific & Industrial Research (CSIR) & Secretary, DSIR Dr. Mande inaugurated the "Environmental Monitoring & Intervention Hub" supported by DSIR-Common Research & Technology Development Hubs (CRTDH) which helps in serving MSME's in the clean air/water and effluent management sector to develop indigenous & effective solutions for environmental monitoring, water treatment, and effluent management. Dr Mande, DG, CSIR released the brochure and website of Environmental Monitoring Hub. Renovation works are in progress on the dedicated space identified for DSIR-CRTDH-IITR "Environmental Monitoring and Intervention Hub". Currently, two facilities such as instrumentation laboratory and analytical facility are established for the use of testing services and training programmes. Prototyping of water treatment, effluent treatment and air quality were also initiated.

Major achievements of DSIR-IITR-CRTDH

- **Water Treatment Sector:** Commercial models of water disinfectant technology developed by the institute are available for non-exclusive licensing.
- **Effluent Treatment Sector:** Pilot Scale 2000L Bioreactor plant has been deployed at M/s Yash Pakka Limited, Ayodhya for pulp and paper mill effluent treatment. A non-disclosure agreement was signed between M/s Yash Pakka Limited, Ayodhya and CSIR-IITR, Lucknow on 30th June 2020.
- The Lignin-based bioadsorbent gel has been developed for water treatment from industry waste under DSIR-IITR-CRTDH. This technology has been selected as a finalist in "Next Generation Water Action the future of water by young academics and entrepreneurs" 2021 hosted by Technical University of Denmark–DTU, Denmark in collaboration with NITI Aayog, India.
- Biochar from sewage and paper mill sludge waste and treatment of textile effluent has been at the lab scale.
- Waste water treatment process for textile industry in Unnao has been established at lab level.
- **Air Pollution Abatement:** 25 Industries/Startups/ MSMEs have been served through various services and technology support.
- A patent (App. No – 0065NF2020) has been filed for a device and technique for air quality monitoring & management.

Recognition:

1. Finalist of Grundfos Challenge at the global Next Generation Water Action program on technology development and received a full scholarship sponsored by the Poul Due Jensen Foundation to participate in World Water Week 2021.

Technological Solutions & Support for Industries at DSIR-IITR-CRTDH

Lab scale and Pilot-scale (2000 L) Bioreactor - The paper mill effluent treatment studies using consortium of five ligninolytic bacteria was carried out on a laboratory scale bioreactor with minimum inputs (0.25% yeast extract).The bioreactor plant was operated at 3.3 L/h flow rate of effluent in reaction tank so as to obtain 12 h HRT, whereas re-circulation of active biomass from settling to reaction tank was maintained 6.6 L/h in order to maintain active biomass in reaction tank. The reduction of colour, lignin and phenolics by activated sludge treatment was 28%, 35% and 48% respectively after 12 HRT. When treated with activated sludge + ligninolytic bacterial consortium, increased reduction in colour (52%), lignin (58%) and phenolics (85%) was observed.

- In the field of bioremediation, to treat the effluent coming from paper mill, the technology is being

carried out in collaboration with M/s Yash Pakka Ltd., Ayodhya. The MoU has been signed between CSIR-IITR and M/s Yash Pakka Ltd., Ayodhya.

Biochar – The biochar prepared from sewage and paper mill sludge were used for treatment of textile effluent. Different concentrations (1-10%) of biochar were reacted with effluent under shaking conditions and reduction in effluent colour was measured at 465 nm after for 3 hr. Significant colour reduction in textile effluent was observed with all tested concentrations (1-10%). The colour reduction was almost the same by both sewage and paper mill sludge biochar. The effluent added with 8% biochar exhibits a maximum (>90%) colour reduction after 3h interaction. Significant amounts of colour reduction (70-80%) were also observed with 1% biochar.

Lignin based hydrogel - Value addition of paper and pulp industry waste, lignin into adsorbent polymer by utilizing Polyvinyl alcohol and Polyacrylic acid as comonomers. These absorbents are biodegradable and will be useful in textile effluent treatment and water conservation and agro-chemical carrier.

- R&D work on immobilized bacterial consortia for the remediation of waste water (textile and paper industry) is progressing.
- For waste water treatment application, the institute will work in partnership with stakeholders including investors, suppliers, consumers, industries governments and regulators and other businesses.
- Outreach program to disseminate product information and solution to the consumers (farmers).
- **Device for air quality monitoring & management-** Air monitoring and controlling technology developed at the institute is also converted to a prototype for further testing and validation in indoor and outdoor settings (Patent applied, App. No– 0065NF2020).

Knowledge Resource Centre

Knowledge Resource Centre (KRC, Library & Information Division) provides critical information and knowledge support to the Scientific & Technical staff, Research Fellows, Project Assistants and users from other organizations. CSIR-IITR KRC is a central location for accessing current toxicological literature and serves the need of the scientific fraternity.

Information Resources: Presently, CSIR-IITR KRC has following collections

1. Books (includes PR Collection): 9019
2. Hindi Books: 970
3. Bound Volumes of Journals: 14,440
4. During the year (20-21), the Centre purchased 52 Hindi books.

Subscriptions: Our S & T team has access to many common resources as CSIR-IITR KRC is a member of National Knowledge Resource Consortium (NKRC).

The following e-journal platforms are subscribed by the Centre and NKRC:

- Science Direct/Elsevier:
- Cell,
- Free Radical Biology & Medicine,
- Toxicology,
- Toxicology Letters.
- Wiley Online : 252
- Springer Online (Biomedical and Life Science; Medicine): 400
- Nature Online
- Oxford University Press Online:
- Carcinogenesis,
- Journal of Analytical Toxicology and
- Toxicological Sciences
- ACS: 59
- RSC: 46

- T&F: 2700
- Science Online
- Annual Reviews in Neurosciences,
- Annual review in Pharmacology & Toxicology.

Services: The services provided by the Centre are as under:

- **Toxicology Updates:** Articles from Nature & Science as well as news about the subject are distributed to the scientific staff on regular basis through email.
- **Online Document Search:** This service is provided through LIBSYS (Library Management Software) in which KRC staff does literature search for the scientists, research fellows & other users on the subjects of their interest. Our institutional staff can also avail this service and can search our collection using OPAC (Online Public Access Catalogue) over Intranet.
- **Reprography Service:** Photocopy of the articles, Project Reports and other scientific documents are provided to the users of the Institute.
- **Newspaper Clippings:** On a daily basis, essential information is given to the responsible authority after browsing 02 national newspapers for newspaper clipping service.
- **Plagiarism Detection Service (PDS):** The Centre provides plagiarism detection service using Ithenticate plagiarism tool.
- **Document Delivery Service (DDS):** The facility collects articles from other laboratories and Institution and distribute them to Scientists and Research Scholars as well as delivering them to other Labs and Institutes.
- **Publication Information Service (PIS):** The centre compiles publication information on calendar year basis.
- **OPACs:** 02 OPACs (Online Public Access Catalogues) are active on the Intranet.

1) KOHA OPAC is available for browsing our Collection on the Internet.
2) LibSys OPAC is active on the Intranet.

Research Planning and Business Development Division

Research Planning and Business Development Division (RPBD) is the focal point to govern and project the overall activities of the institute by planning, monitoring and evaluating the in-house, networked and externally funded project activities. The division also explores the possibilities of business development by liaisoning with industries, private and public sector undertakings, government organizations, research institutions and universities. Other important activities of the division include:

- Interaction with International Scientific and Technology Affairs Directorate (ISTAD) of CSIR and other international and national agencies to organize visits of scientists under various bilateral exchange programmes.
- Preparation of annual future plan, policy & road maps, strategic business plan, etc. of the institute.
- Ensuring proper management of intellectual property in coordination with the scientists for identification of patentable content of the material and coordinating with Innovation Protection Unit (IPU) of CSIR.
- Sending replies to Parliament questions and preparation of audit replies
- Rendering help for Research Council (RC) meeting, Management Council (MC) meeting and other activities related to extramural human resource development.
- Signing of MOUs/ Agreements between the institute and outside parties.
- With respect to image management of institute, interaction with the media and issuing press notes during various institutional activities for effective science outreach.

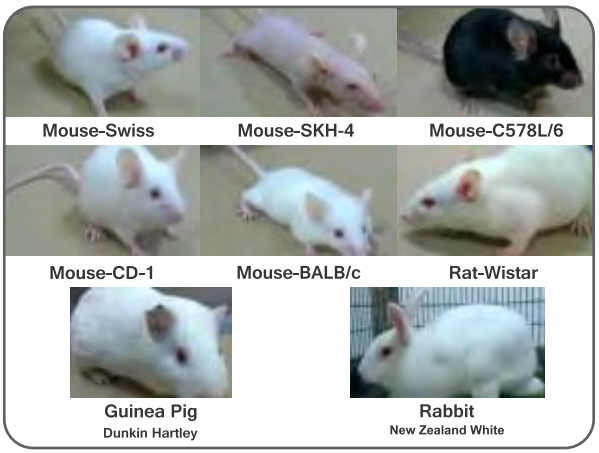
Computer Centre

Computer Centre caters to the computational and ICT needs of the staff and students of the institute engaged in R&D and S&T activities. Major services provided by this centre include, web-based software development; maintenance and troubleshoot of ICT infrastructures, such as Proxy, Gateway, SMTP, Antivirus, Active directory Servers and Unified Threat Management device. Both campuses of the institute have campus-wide Local Area Network consisting of more than 400 nodes. The network infrastructure is built from the combination of optical fiber, UTP cables and switches. The internet access is provided through a gateway using 100 Mbps NKN and 20 Mbps (1:1) OFC links at the M.G. Marg Campus, and 20 Mbps (1:1) OFC link at the Gheru Campus. Multilayered firewall, anti-spam, intrusion prevention system and antivirus solutions have been implemented for network security. Domain controller server is configured and implemented for policy-based central management of computers within the institutional network.

Institutional bilingual web site, Intranet site, websites and web-based applications for all the major conferences and Skill India initiative programmes organized by the Institute were developed by the Centre staff. The Institute has its presence on the major social media platforms like Facebook, Twitter, Linkedin, WhatsApp and YouTube where current information on R&D activities, events and developments are posted on a regular basis. Live streaming of important events in realtime is also ensured.

The staff of this centre continues to participate in the project "Toxicity testing: GLP test facility" and shares responsibilities related to Electronic Data Processing unit. The tasks performed by the division include document control and maintenance of hardware, software & network infrastructure available in GLP certified divisions. The staff of the computer centre also runs the Institute's Video conferencing and multimedia facilities. Computer Center provides training to the staff according to their computational needs. Also, training programs and workshops on the use of bilingual text input methods are organized on a regular basis.

Animal Facility



State of the art Animal facility for breeding, research, educational training and trade is maintained at Gheru Campus of the institute.

Services of the facility are available to the institute and also to other Central / State Government establishments and private organizations. The services offered are broadly classified in the following categories:

- Professional veterinary services provided to all animal users as and when required before, during and after the experimentation.
- Supply of animals for different R&D projects and sponsored regulatory studies.
- Supply of surplus stock of animals to other institutions as per the guidelines framed by CPCSEA (Department of Animal Husbandry and Dairying (DAHD), Ministry of Fisheries), Government of India.
- Maintenance of breeding colony of five strains of Mice (Swiss, BALB/c, CD-1, C57BL / 6 and SKH-1), Wistar Rat, Dunkin Hartley Guinea Pig, Zebra Fish and facility for the maintenance of Rabbit, birds, honey bee etc.
- Hematology, biochemistry and histopathology services for all in-house R&D, regulatory toxicology, collaborative and sponsored projects.
- GLP and other toxicology / safety evaluation studies for variety of products for their regulatory requirements.

AcSIR Ph.D. Programme

Under the aegis of the Academy of Scientific & Innovative Research (AcSIR), the Ph.D. programme at CSIR-Indian Institute of Toxicology Research (CSIR-IITR) is aimed to create highest quality researchers with multidisciplinary knowledge in the field of toxicology and associated areas of science and technology. AcSIR-Ph.D. programme in Biological Sciences and Chemical Sciences at CSIR-IITR provides state-of-the-art research facilities and a unique platform for research and innovation in toxicological sciences. The programme aims to strengthen the required skills and capabilities among research professionals under the mentorship of leaders in the field of toxicology. In addition to developing discipline-specific research skills, AcSIR-IITR Ph.D. programme is structured to train and support the development of personal and professional competencies. This programme offers exciting opportunities to the candidates holding Master's degree with a valid fellowship (such as UGC/CSIR-NET/DBT/ICMR/DST-INSPIRE or any other equivalent fellowship), having a keen aptitude and scientific inquisitiveness for pursuing advanced scientific research of global standards.

The AcSIR Ph.D. programme in CSIR-IITR started in January 2011 and since then, 248 students have been enrolled till January 2021. Total 88 students (75 in biological and 13 in chemical sciences) have completed Ph.D. degree successfully. Every year, several hundred young enthusiastic candidates apply for few available seats and undergo rigorous screening and interview process. As per new course structure AcSIR-IITR Ph.D. students are expected to acquire a total of 18 credits (14 credits from the course work, 4 credits from CSIR-800 societal programme related project work) prior to submission of their thesis.

In August 2020 and January 2021 sessions of AcSIR-IITR Ph.D. programme, the courses offered in Biological & Chemical Sciences cover various facets of toxicology with the emphasis on both translational and fundamental research. Experienced faculty of CSIR-IITR teach the courses with great enthusiasm every year and have been recognised as faculty of AcSIR-IITR

During 2020-2021, 15 students completed their course work and many students finished their comprehensive examinations as well. Further, 09 students submitted their thesis after acquiring the necessary credits. Furthermore, 10 students successfully defended their theses in viva-voce examination and were awarded their provisional/final doctoral degrees. Several IITR graduates have successfully scored reputed post-doctoral fellowships in US and European Universities, jobs in Government institutions and leading private companies.

In order to promote research in science and technology that has a bearing on social, economic, cultural and intellectual welfare of the people, AcSIR has mandated that the students aspiring to obtain a Ph.D. degree from the academy undertake a 6-8 weeks project concerned with societal / rural issues under the 'CSIR-800 societal programme'. The premise of this course is the aspiration of inclusive growth and improved quality of lives of the fellow underprivileged Indians through S&T interventions that are socially and economically relevant.

Coordinator - Dr MP Singh
Co-coordinators - Dr S Patnaik, Dr S Priya
Assistant Manager - Mrs S Shrivastava

CSIR-IITR, a NABL (National Accreditation Board for testing and calibration Laboratory) accredited laboratory in the field of chemical and biological testing and GLP (Good Laboratory Practices) compliance for toxicity and mutagenicity studies has been in the forefront in imparting training and generating skilled manpower. Provisional affiliation of CSIR-IITR with two sector skill councils namely, Life Sciences Sector Skill Development Council (LSSSDC) and Agricultural Skill Council of India (ASCI), under National Skill Development Corporation (NSDC), reflects the commitment and alignment of the Institute to the Skill India mission of Government of India. As part of this Integrated skill development, CSIR-IITR has conducted multiple training programs in the areas of environmental health & safety and xenobiotic residue analysis.

Hands-on training program on "Fundamentals of care, management and handling of small Laboratory animals used in biomedical research"

A five-day hands-on training program on "Fundamentals of care, management and handling of small laboratory animals used in biomedical research" was conducted at the institute from February 15-19, 2021. This was a part of the series of workshops organized by the institute every year for research scholars. Drs. A.B. Pant and Dhirendra Singh were the course coordinators and several CSIR-IITR faculty imparted the training. The training program was conducted as per CPCSEA regulations and in accordance with CSIR-IITR's

Participants and faculty interacting during the program

personnel training and qualification policy that mandates training for all animal users prior to first experimental use. The course primarily focused on the basics of laboratory animal husbandry, experimental procedures, and quality control measures. The participants gained an understanding of the fundamental requirements of laboratory animal care, management, and experimentation in a GLP compliant laboratory. The course offered greater insight, competency, and responsibility towards the use of animals for research in new researchers. The exposure to GLP principles reiterated the importance of proper planning, controlled performance of techniques, correct recording of all observations and appropriate monitoring of activities. The importance of complete archiving of all raw data obtained so as to ensure global acceptance of the data generated from the experiments was emphasized.

One day skill development program on quality control and quality assurance

One day program on quality control and quality assurance was organized under CSIR-Integrated Skill Initiative on February 22, 2021 at CSIR-IITR, Lucknow. The program was organized in hybrid mode for increasing awareness among students / academicians about the relevance of quality in day to day laboratory activities. Professor S.K. Barik, Director, CSIR-IITR emphasized on the importance of program and

Coordinator - Dr D Parmar
Convener - Dr R Kristipati
Course Coordinators - Dr AB Pant, Er. AH Khan, Dr AK Pandey, Dr DK Patel, Dr D Singh, Dr GC Kisku, Dr NG Ansari, Dr R Parthasarathi, Dr S Patnaik, Dr B Sreekanth, Dr VP Sharma

Participants and faculty at the training programme

motivated the students for attaining state of art knowledge on salient regulatory guidelines which are directly connected for quality life and monitoring of toxicants using modern equipments which are appropriately maintained in compliance to ISO/IEC 17025:2017. Dr V.P. Sharma course co-ordinator gave the genesis of the programme and delivered the lecture on ISO/IEC 17025:2017 and inter-relationship with ISO 9001, ISO 22000, and OECD. Dr Rakesh Kumar delivered lecture on Importance of QA and QC in analytical Chemistry. Prof. Seema Joshi, Head of Department of Chemistry, IT College, Lucknow expressed her views on QC/QA in academic institutions. She encouraged the students for active participation and exploring career opportunities as Quality Assurance Personnel in corporate houses. Dr S.P. Singh referred to quality aspects with special relevance to monitoring of pesticides in water and other matrices. Dr G.C. Kisku, spoke on quality control for physico-chemical testing of water. Data reporting and management were explained by Dr R. Parthasarthi. Dr N.G. Ansari elaborated on standard methods for assurance of heavy metals. Ms Deepshi and Dr Preeti Chaturvedi expressed views on safety measures in microbial testing of water. During the program, experts highlighted the role of quality control and assurance as per ISO 17025:2017. Critical aspects of sampling, analysis of representative samples, standardization/ validation using certified reference materials and risk management were explained. Role of proficiency training and interlaboratory checks following BIS guidelines as per FSSAI requirements in framing specifications for water/ polymers biodegradability test methods were discussed. In addition to salient topics of analytical aspects, the guidance was imparted on report writing, compilation of data, interpretations, preparation of powerpoint slides for presentation, communication skills. The sessions were interactive and 56 candidates from different institutions participated with enthusiasm. Participants enquired about the different activities of National Skill Development in niche areas and procedures for enrolment. The program ended with special words of appreciation by Dr V.P. Sharma to all participants, faculty, team of CSIR-IITR family.

Workshop on computational tools for assessment, identification, and apportionment of pollution sources

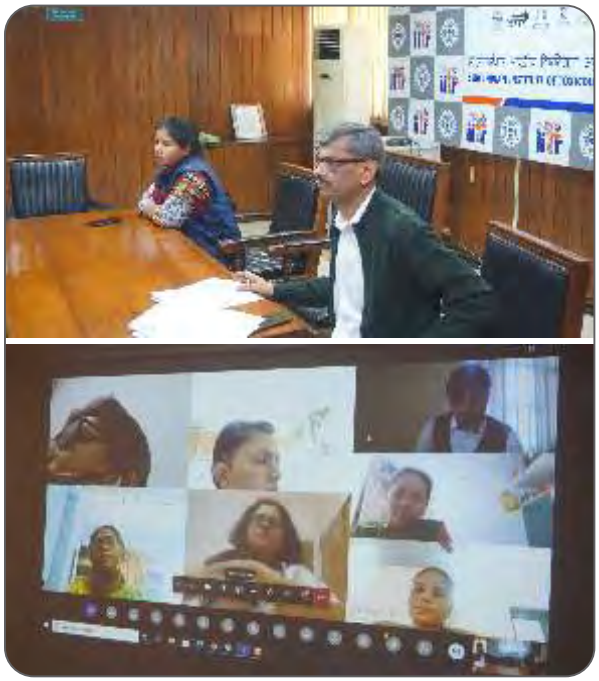
A workshop on "computational tools for assessment, identification, and apportionment of pollution sources" under skill integrated initiative was held through hybrid mode (online/offline mode) on March 19, 2021, at the institute. The objective of the workshop was to enhance and upgrade the skills in the usage of various software models and computational tools for air and water pollution assessment. Fifteen participants attended the workshop and all actively interacted throughout the programme. Participants were engineers, scientists or students from Amity University, Tufan Ganj college, Vimta Labs Ltd., Sunglobz Pvt. Ltd., other environmental consultancies and CSIR-IITR. Dr D. Parmar, Coordinator, Skill Development Programme at CSIR-IITR, welcomed all the participants to the workshop and gave a glimpse of various integrated skill initiatives at CSIR-IITR. Dr N.

L-R: Dr B. Sreekanth, Dr D. Parmar, Dr N. Manickam and G.C. Kisku

Manickam, the Area Coordinator, Environmental Toxicology Group at CSIR-IITR briefed about environmental toxicology studies and diverse contributions of CSIR-IITR. Dr G.C. Kisku, Head, Environmental Monitoring Division (EMD), provided a detailed overview of the various research activities and regular industrial services provided by the division and presented the genesis of the workshop. Subsequently, Dr B. Sreekanth, Scientist, CSIR-IITR and coordinator of the workshop, delivered the talk on air quality data, modeling, and application of AERMOD software for estimation of impact. Dr G.C. Kisku, during his presentation, highlighted various technologies and tools that are available for air and water pollution assessment. Dr Dhirendra Singh, CEO and founder of Airshed Planning Professionals, IIT Kanpur demonstrated the methodology for source apportionment and CMB model usage for identification repetition. Ms Deepshi Chaurasia, CSIR-IITR, delivered a talk on fundamental statistics for water quality analysis and interpretation of the water quality index. Dr Harshit Mishra, Director EHM Consultancy Pvt. Ltd., Kanpur, presented the spreadsheet models and advanced computation tools for analysis of leachates, fate, and transport of water pollutants. Finally, Mr. Thirumalesh Konathala, Director, Data Science & Analytical Services at Cardlytics, demonstrated SPSS software applications for different statistical analyses of air and water quality data. Towards the end were the questions and answer session involving faculty and participants. Er A.H. Khan, Senior Principal Scientist, CSIR-IITR and Co-coordinator of the workshop, proposed the vote of thanks. Overall, the workshop trained the participants for the usage of various technologies/tools/methods/ models that are available for air and water quality analysis and apportionment of pollution sources.

Online training programme on "analysis of pesticides and other organic chemicals in environmental samples"

An online training programme on "Analysis of pesticides and other organic chemicals in environmental samples" was organized by CSIR-IITR during March 3-5, 2021 for employees of Central Pollution Control Board. This training programme was sponsored by Central Pollution Control Board, New Delhi. The programme was inaugurated by the Director, CSIR-IITR and coordinated by Dr Nasreen G. Ansari as the Coordinator. Training programme consisted of five modules, namely, sample collection, sample storage, standard preparation and sample extraction, principle and application of analytical instruments, quality assurance and quality control, calibration, data acquisition and interpretation and online demonstration through videos. 28 participants from Central Pollution Boards of different states including Assam, Meghalaya,



Participants and faculty interacting during the training program

Sikkim, West Bengal, Orissa, Himachal Pradesh, Kerala, Maharashtra, Gujarat, Goa, Uttar Pradesh, Madhya Pradesh and Telangana were trained during the three day programme.

National workshop on characterization of nanomaterials

Under the aegis of the CSIR Integrated Skill India Initiative, CSIR-IITR organized a National workshop on the Characterization of Nanomaterials on March 23, 2021. The objective of the workshop was to provide basic experience on some of the most relevant methods for the characterization of nanomaterials using state-of-art techniques and instrumentation and to establish a platform for the participants from different institutes to learn the techniques to characterize some of the most commonly used nanoparticles. Twenty-one participants from various academic and research institutions across India participated in the workshop organized in offline and online mode. The workshop started with the remarks from Professor S.K. Barik, Director, CSIR-IITR. Dr Alok K Pandey, Principal Scientist, CSIR-IITR, gave a lecture on 'Nanomaterials and Characterization' and then Mr. Amit Bhatia and Mr. Kuldeep Kumar from Malvern Panalytical, gave a brief about ZetaSizer and NanoSight respectively. Lecture on NP characterization through FTIR was given by Mr. Amit Joshi from Thermo Fisher. Dr P.N. Saxena, Principal Technical Officer gave a lecture on Electron microscopy. In the afternoon session, participants were demonstrated sample preparation for ZetaSizer and NanoSight. Wet-lab on Nanomaterials characterization using ZetaSizer and NanoSight was conducted by Dr Alok K. Pandey and his team. Wet-lab on Nanomaterials characterization using FTIR was conducted by Dr Satyakam Patnaik and his team. Dr P. N. Saxena and Mr. Jai Shanker demonstrated the sample preparation and image analysis through TEM and SEM. The workshop concluded with the feedback from the participants regarding their experience of the workshop and their expectations.

Participants and faculty interacting during the program

National Skills Qualifications framework (NSQF) compliant courses at CSIR-IITR

- EHS manager-Life Sciences (LFS/Q0214)
- Soil and Water Testing Lab Assistant (AGR/Q8102)
- Soil and Water Testing Lab Analyst (AGR/Q8103)
- Pollution monitors (Air and water)

Other skill development courses offered at CSIR-IITR in offline or online mode

- Advance instrumentation for monitoring and analysis of environmental pollutants
- Computational predictive biology and bioinformatics
- Regulatory-preclinical toxicology
- Basic and advanced tools in Microbiology and Molecular biology
- Add-on course on Analytical Toxicology

Short-term courses

- Training of trainers
- Ambient air and stack monitoring techniques-Hands on training for CPCB personnel
- Advanced analytical instrumentation techniques and their application in environmental field-Hands on training for Maharashtra Pollution control board personnel
- Hands-on training program on "Fundamentals of care, management and handling of small laboratory animals used in biomedical research

Workshops

- Skill development in Genetic Toxicology
- Characterization of nanomaterials
- Flow Cytometry
- Computational tools for assessment, identification, and apportionment of pollution sources

Jigyasa Activities

In order to enrich scientific temperament among the school children, CSIR-IITR has been conducting Jigyasa programme regularly to inculcate scientific spirit among the school children. Due to the COVID-19 conditions, CSIR-IITR organized online events for school students during National Science Day, Technology Day, Acharya Prafulla Chandra Ray Vigyan Yatra, Outreach Activities-IISF 2020, and National Scientific Seminar on Drinking Water: Problems and Redressal 2021. The zeal was high among the students

and they showed a lot of interest to participate in the online scientific and technical events organized by the institute. In addition, CSIR-IITR has also received approval for creating virtual lab content and researchers are working on developing the scientific knowledge base resources on environmental health and safety.

Coordinator : Dr R Parthasarathi
Co-PI Mr N Garg, Dr YK Satija

Webinar on "Environmental Management: Challenges and Road Ahead: EMCR-2020"

CSIR-Indian Institute of Toxicology Research organized a Webinar on "Environmental Management: Challenges and Road Ahead" on June 29, 2020. The purpose of the webinar is to expand the scope of environmental research at the Institute and to initiate a dialogue in this important area during the current COVID-19 pandemic. This will create awareness towards environmental quality in the citizenry at large.

Environment management solutions require a perfect blend of what is technologically practical and ecologically essential. New initiatives need to complement traditional regulatory processes. Existing regulations, such as Environmental Protection Act, Air Act and Water Act are important safety nets in India for protecting human health and the environment. However, emerging challenges such as urban sprawls, climate change and resource depletion require renewed approaches towards integrated problem-solving. Discussions are also required to understand the implications on environmental, social and economic sustainability. EMCR-2020 addressed the drivers for change, the implications of inaction, and key factors to achieve industrial development coupled with environmental and social sustainability. The first lecture of the webinar by Professor VirendraSethi, IIT Bombay, Mumbai addressed region specific emission factors of coal based cook stoves. This was followed by a talk on industrial business and biodiversity by Mr Peter Dsouza, DGM Environment, TATA Motors, Lucknow. Lectures were also delivered on the environmental status and air quality of Lucknow city during the lockdown periods since March 25, 2020.

Commemoration of 150th Birth Anniversary of Mahatma Gandhi Ji

To commemorate the 150th Birth Anniversary of the Father of Our Nation, Mahatma Gandhi, CSIR-Indian Institute of Toxicology Research (CSIR-IITR) organized several activities during the concluding week of the celebrations i.e. September 28 – October 02, 2020. Various activities conducted include invited lectures, essay competitions, quiz competitions etc.

Among the invited lectures, Professor Vibhuti Patel, Former Professor, The Advanced Centre for Women's Studies, Tata Institute of Social Sciences (TISS), Mumbai delivered a talk entitled "Mahatma Gandhi and Empowerment of Women" on September 29, 2020, which was arranged in the virtual mode. Mahatma Gandhi strongly believed that there is no occasion for women to consider themselves subordinate to men. In fact, if strength means moral power, then woman is immeasurably man's superior, he said. He always saw women as equal partners in the freedom struggle. Professor Vibhuti Patel reiterated Gandhi Ji's profound belief that a woman is an embodiment of sacrifice and Ahimsa.

Professor Rakesh Chandra, Department of Philosophy, University of Lucknow, Lucknow, delivered a talk entitled "Gandhi's Eutopia and Some Reflections" on September 30, 2020. Professor Chandra enlightened the audiences with Mahatma Gandhi's life style, his works

towards non-violence, Gram Swarajya, feminism etc. and also asked the participants to introspect whether we have been successful in following the ideology of Mahatma Gandhi.

On October 01, 2020 first lecture was delivered by Ms Mirai Chatterjee, Director of the Social Security Team at Self-Employed Women's Association (SEWA), Ahmedabad. In her talk on "Remembering Gandhiji Today", she spoke at length about Gandhiji's practice of simple living. Gandhiji was deeply convinced with the idea of "Anuband" and Ms Chatterjee opined that the current Covid-19 pandemic once again reminds us about the importance of maintaining an inter-connect with nature.

The second lecture on October 01, 2020 was delivered by Professor Anil K Gupta, Visiting Faculty, Indian Institute of Management, Ahmadabad and Founder, Honey Bee Network, SRISTI, GIAN and National Innovation Foundation. His lecture introduced the concept of "Gandhian Legacy of Inclusive Innovations and Social Development". He said that Gandhiji's famous talisman of thinking about the most marginalized person in society when faced with a decision making situation is as relevant today as it was a century ago.

Mahatma Gandhi believed that every individual is empowered to make a change and it is up to us to believe in ourselves and make whatever possible small change towards meeting the sustainable development goals. Sharing these thoughts, Professor Ricky Kej, National Institute of Advanced Studies, Bangalore and Grammy Award Winner, delivered his lecture on "Gandhian Way of Self-sustainable Living" as a part of the celebrations to commemorate the 150th Birth Anniversary of Mahatma Gandhi.

Gandhiji was way ahead of his time when he made a clarion call to his countrymen to suggest methods to improve the Charkha, which was most dear to him. This is surely among the first instances of "crowd sourcing" to drive "innovation", both of which are buzzwords today. This was the thought echoed by Mr Ravi Pandit, Chairman and Co-founder, KPIT Technologies Ltd., Pune in his talk titled "Gandhian Innovation and its Relevance in Today's World". On October 2, 2020, Mr Pandit said that, though Gandhiji looked towards scientific methods to tackle situations, he insisted that Science should always go in hand with Humanity.

Workshop on Risk Assessment and Approval of Novel Foods and Ingredients

CSIR-Indian Institute of Toxicology Research, Lucknow in association with Food Safety and Standards Authority of India (FSSAI) and Capability Harnessing Initiative on Food Safety Sciences (CHIFSS) organized a one-day workshop on Risk Assessment and Approval of Novel Foods and Ingredients in the online mode on October 28, 2020. Professor Alok Dhawan, Director, CSIR-IITR in his opening remarks highlighted the need for increasing the awareness of professionals from various segments of the food industry and regulators regarding risk assessment framework which in turn would enable a scientific evaluation of known or potential adverse health effects resulting from human exposure to novel foods and ingredients. Dr N Bhaskar, Advisor FSSAI, appreciated the efforts of CSIR-IITR and CHIFSS in helping regulators as well as industries in ensuring availability of safe food to the consumers. Dr DBA Narayana, Expert Member, FSSAI shared the overall regulatory approval process in India for novel foods and ingredients. Dr D Kanungo, former Additional Director General, Ministry of Health and Family Welfare participated in the event through the virtual medium and highlighted the overall approval process of a novel food in the European Union. Dr Sheelendra Pratap Singh, Senior Scientist, CSIR-IITR, presented an overview regarding safety and risk assessment of the novel foods and ingredients with case studies. Over 100 participants from different industries, regulators, and academia attended this workshop. CSIR-IITR has been at the forefront in laying down policy guidelines for national regulatory standards and will continue such efforts for ensuring food safety to protect public health.

Workshop on Risk Assessments of Novel Foods: Scientific and Regulatory Framework

A one-day workshop on "Risk Assessments of Novel Foods: Scientific and Regulatory Framework" was conducted in the online Mode at CSIR-Indian Institute of Toxicology Research, Lucknow in association with Food Safety and Standards Authority of India (FSSAI) and Capability Harnessing Initiative on Food Safety Sciences (CHIFSS) for food processing industries, scientists and research professionals, academia-students & faculties and regulatory agencies on February 24, 2021. Professor S K Barik, Director, CSIR-IITR and CSIR-NBRI, Lucknow in his opening remarks highlighted the need of increasing awareness among professionals from various segments of food industries and regulators regarding the risk assessment, regulatory and scientific framework. This would enable scientific evaluation of known or potential adverse health effects resulting from human exposure to novel foods and ingredients. Dr Rubeena Shaheen, Director-Science & Standard, FSSAI, New Delhi gave an overview of the workshop and highlighted significant contributions made by CSIR-IITR in formulating the guidance document for risk assessment of novel foods and food additives. Dr Sheelendra Pratap Singh, Senior Scientist, CSIR-IITR, Lucknow discussed the concepts and principles being followed for risk assessment for novel foods. Dr K. Madhavan Nair, Member Expert Scientific Panel, FSSAI highlighted the key requirements for formulating the novel foods application for the regulatory approval process in India. Dr Rafael Perez Berbejal, European Commission, DG ANTE, presented an overview of the regulatory approval process in the European Union.

6th India International Science Festival IISF-2020 Curtain Raiser Ceremony

L-R: Professor S.K. Barik, Dr S.C. Mande, Smt Neelima Katiyar, Smt Sanyukta Bhatia, Shri Shreyansh Mandloi

CSIR-Indian Institute of Toxicology Research in association with Vigyan Bharti organized a Curtain Raiser Program for the India International Science Festival – 2020 (IISF-2020) at its campus on November 28, 2020. Students from schools and universities were engaged through the virtual mode. India International Science Festival (IISF-2020) is a unique combination of seminars, workshops, exhibitions, discussions, and debates with several interactive forms of engagements including hands-on demonstrations, dialogues with

experts, and scientific theatre, music, and poetry. The festival began on December 22, 2020, and culminated on December 25, 2020, the birthdays of world-renowned Indian Mathematician Srinivas Ramanujan and former Prime Minister of the country Sri Atal Bihari Vajpayee, respectively. Both these stalwarts were deeply committed to the belief that Science and Technology will always be at the core of the nation's progress.

Delivering the keynote address at the curtain raiser function of IISF-2020, Dr Shekhar C Mande, Secretary, Department of Scientific and Industrial Research, Director General, CSIR, India and Chairman, Steering Committee, IISF-2020 said that this is a much awaited annual event and inspite of the restrictions imposed by the COVID-19 global pandemic the event being organized itself signifies the indomitable spirit of nurturing and celebrating scientific temperament among all the stake holders. The theme of IISF 2020: "Science for Self Reliant India and Global Welfare" was to deliberate on the role of Science, Technology, and Innovation to build an Atmanirbhar Bharat and also provide solutions to global problems. Smt. Neelima Katiyar, Honourable Minister of State for Higher Education and Science & Technology, Government of Uttar Pradesh was the Chief Guest of the function, and Smt. Sanyukta Bhatia, Mayor of Lucknow graced the event as the Guest of Honour.

Earlier welcoming the participants, Professor SK Barik, Director, CSIR-IITR and CSIR-NBRI said that the festival is an opportunity for young scientists to interact,

Dr Shekar C. Mande inaugurating the event with lighting a lamp

Dr Shekhar C. Mande addressing the gathering

Smt Sanyukta Bhatia addressing the gathering

Smt Neelima Katiyar addressing the gathering

share ideas, and collaborate for greater global benefits. Sri Jayant Sahasrabudhe, National Organizing Secretary and Sri Shreyansh Mandloi, Organizing Secretary, The Avadh Prant, Vijnana Bharti also interacted with the participants through the online mode and urged the schools and colleges to participate in large numbers and use the IISF platform to understand the intrinsic role of science and technology in our daily lives.

Acharya Prafulla Chandra Ray Vigyan Yatra and Outreach Activities-IISF-2020

CSIR-IITR and CSIR-NBRI jointly organized "Acharya Prafulla Chandra Ray, Vigyan Yatra and Outreach Activities" as part of the 6th India International Science Festival (IISF 2020) on December 18, 2020 through the virtual platform. Dr Satish C. Dwivedi, Hon'ble Minister of State (Independent Charge), Basic Education, Government of Uttar Pradesh was the Chief Guest on this occasion. Shri Shreyansh Mandloi, Organizing Secretary and National Coordinator of Vigyan Yatra, informed the gathering that the Vigyan Yatra was organized in 32 cities in the country as part of promotional activities of IISF-2020. The prime objective of this event was to ignite the thoughts of the visitors and create awareness about various scientific knowledge bases. It provided a platform to showcase innovative ideas and scientifically solve contemporary issues by aspiring students, research scholars, teachers and young scientists. On this occasion, Dr A K Aggarwal, Acting Director, Remote Sensing Applications Centre, Lucknow, informed the audience about various achievements of the institute in the field of GIS mapping and satellite imaging services. Simultaneously, Dr C M Nautiyal, INSA Advisor, New Delhi and Vice President, Vigyan Bharti, The Awadh Prant, remembered Acharya Prafulla Chandra Ray and his important contributions to the country. He said that Acharya Ray established the first modern Indian research school in chemistry and is considered the father of chemistry in India. He also stressed on the need for popularization of science among young minds to make the country self-reliant in future. Dr Nautiyal also spoke about various schemes and programs being run by the Government of India and the Department of Science and Technology for young researchers and innovators. He said that programs like IISF will provide an international platform to explore new horizons in science and technology development. During the programme, various short films depicting the services and laboratories of CSIR-IITR and CSIR-NBRI were also screened. Earlier, welcoming the guests, Professor S K Barik, Director, CSIR-NBRI and CSIR-IITR, Lucknow and President, Vigyan Bharati, The Avadh Prant, informed the participants about the biodiversity program along with the science festival. He mentioned that the theme of IISF-2020 was 'Self-reliant India and Science for Global Well-being'.

Students of Kendriya Vidyalaya and other schools were present in large number on this occasion under CSIR Jigyasa program through online mode.

National Scientific Seminar on Drinking Water: Problems and Redressal-2021

L-R: Professor S.K. Barik, Shri Brijesh Pathak, Smt Sanyukta Bhatia, Dr D. Parmar

A two-day National Scientific Symposium on Drinking Water: Problems and Solutions was organized at CSIR-Indian Institute of Toxicology Research (CSIR-IITR), Lucknow on January 18-19, 2021. The entire symposium was conducted in Hindi. The symposium was inaugurated by Chief Guest, Shri Brijesh Pathak, Hon'ble Cabinet Minister and Smt. Sanyukta Bhatia, Mayor, Lucknow. In his address, the Honorable Cabinet Minister highlighted the importance of drinking water for human health and emphasized on water conservation. Smt. Sanyukta Bhatia, Mayor, Lucknow in her address, said that increasing population and dwindling water resources are a matter of great concern. Professor S K Barik, Patron and Director, CSIR-IITR in his address underlined the current challenges being faced world over related to drinking water. He further mentioned that scientists should focus more on developing cheaper and effective technologies for clean water. He encouraged conducting more such symposia in Hindi, the official language so that the information shared in such scientific platforms is available to the general public. He further suggested that to save drinking water, a holistic approach is required involving rainwater harvesting and groundwater recharging. Dr Devendra Parmar, Chief Scientist, CSIR-IITR and Chairman of the Organizing Committee said that drinking water is important for life and thus the symposium, will benefit common people by educating them on prevention of problems related to drinking water.

The two-day event involved 5 scientific and 2 technical sessions with 18 scientific lectures. Students from different institutions participated in e-poster session and

Shri Brijesh Pathak inaugurating the event by lighting of lamp

Shri Brijesh Pathak delivering his chief guest lecture

Professor SK Barik presenting a momento to Shri Brijesh Pathak

Smt Sanyukta Bhatia addressing the gathering

Prof. SK Barik, presenting a momento to Smt Sanyukta Bhatia

Shri VK Upadhyay delivering a talk

Professor SK Barik, presenting a momento to Shri V.K. Upadhyay

presented their views on water pollution, sources and its conservation. The valedictory session on January 19, 2021 was chaired by Shri VK Upadhyay, Director, Ground Water Department, Uttar Pradesh. Ms Preeti Chaturvedi, Senior Scientist, CSIR-IITR and Convener of the seminar introduced the guests. In his talk, Shri Upadhyay underlined the major efforts taken by Ground Water Department to conserve and restore the ground water table. He further said that the Ground Water Board is working closely with CSIR-IITR for conservation and sanitation of ground water. He stressed on public participation for the cleanliness and conservation of water. In his concluding remarks Professor S K Barik, Director, CSIR-IITR thanked the chief guest and the organizing committee for conducting the symposium on this important and relevant subject.

Global Bio-India Summit Virtual Road Show-2021

The Department of Biotechnology and its Public Sector Undertaking, Biotechnology Industry Research Assistance Council (BIRAC) has been organizing the Global Bio-India summit as a big biotechnology conglomeration for showcasing and exhibiting the biotechnological advances of India to the international community since 2019. In view of the Covid-19 pandemic, the Global Bio-India summit was held through the virtual medium from March 1 – 3, 2021. To support this mega virtual event, a virtual road Show with the theme "The Role of CSIR in Biotechnological Innovation and Bioentrepreneurship in India" was organized by CSIR-IITR, Lucknow on February 24, 2021. Several pioneering scientists and young entrepreneurs presented their views, ideas, and efforts on various translational aspects for the promotion of biotechnological innovation and bioentrepreneurship.

During the event, activities of various CSIR labs and centers in promotion of innovation and bioentrepreneurship were showcased. Dr Devendra Parmar, Chief Scientist, CSIR-IITR welcomed the online participants which was followed by several insightful presentations made by scientists of various CSIR institutions such as Dr Madhusudana Rao (Atal Incubation Centre, Hyderabad), Mr Ankush Varma (CSIR-IIIM, Jammu), Dr Mahesh Gupta (CSIR-IHBT, Palampur), Dr Ramjee Pallelle (CSIR-CCMB, Hyderabad) and Dr R Parthasarathi (CSIR-IITR, Lucknow). The scope

L-R: Dr R. Parthasarathi, Dr D. Parmar and Dr N. Manickam

and aim of the Global Bio-India event were presented in detail by Dr Bhuvnesh (BIRAC). The session was followed by a discussion with three successful entrepreneurs - Dr Pawan (Aarna Biomedical Products), Dr Atul (Alfa Corpuscles), and Dr Rachna (MicroGO). The event concluded with the address by Dr N Manickam, Chief Scientist, CSIR-IITR, Lucknow. He reiterated that the biotechnology sector of India is considered as the sunrise sector of our economy and it is high time to drive the focus of various CSIR laboratories of India to work with young entrepreneurs and play an important role in achieving India's target of becoming a USD 5 trillion economy by 2025. Dr R Parthasarathi, Incharge-Scientist, CSIR-IITR-BIONEST, and Convener of the event stressed on creation of a bioenterneurship ecosystem to enable translation of bioscience to bioeconomy for realizing Atmanirbhar Bharat.

Snapshot of the online event

National Technology Day-2020

Every year, 11th day of May is celebrated as the National Technology Day, as India successfully tested nuclear bombs in Pokhran on May 11, 1998. The celebrations highlight the important role of technological innovations in our daily lives and encourage students to embrace Science as a career option. The event also highlights the significant milestones of our scientists and engineers in the field of science and technology.

CSIR-Indian Institute of Toxicology Research (CSIR-IITR), Lucknow celebrated the National Technology day with all students, staff, and scientists through CSIR-IITR's social networking platform. The 'Technology Day Lecture' was delivered by Professor Thalappil Pradeep, Institute Professor and Professor of Chemistry, Department of Chemistry, Indian Institute of Technology Madras, a pioneer in the area of molecular

materials and surfaces. Keeping in mind the present situation, he delivered an intriguing lecture entitled "Innovations in academic institutions during and after the pandemic". Expressing his views on the occasion, he said that looking at the pandemics of past, science and technology has always provided the solution. He added that "the world today needs sustainable solutions such as sustainable livelihood, food, new packaging material, self-contained homes with more focus on health".

World Environment Day-2020

Nature's biodiversity and its contribution to the well being of mankind is our heritage and it is imperative on our generation that we offer the same to future generations to come. However, over the years, nature's safety net has been stretched to breaking point and the diversity of ecosystems and the numerous benefits we derive from it are fast declining at an alarming rate. However not all is lost and there is still time to make a difference. The need of the hour is to "re-imagine and reinvent" at every level from local to global. Transformative change is the way ahead to ensure that nature is restored, conserved and used sustainably. This was the theme of the 24th Dr C. R. Krishnamurthy Memorial Oration on Reimagining and Reinventing A Post-COVID World delivered as a Webinar by Padma Vibhushan Dr R. A. Mashelkar, FRS, National Research Professor and Former Director General, Council of Scientific and Industrial Research (CSIR) during the World Environment Day Celebrations at CSIR-Indian Institute of Toxicology Research (CSIR-IITR) Lucknow. The current global pandemic is a wakeup call to make such a change; a fundamental, system-wide reorganization across technological, economic and social factors, he said. Presiding over the function, Dr Shekhar C. Mande, Director General CSIR and Secretary, DSIR, Ministry of Science and Technology, Government of India highlighted the contributions made by CSIR towards a safer and secure post-Covid world. Sharing his thoughts, Professor AlokDhawan, Director,

CSIR-IITR urged the scientific community to redouble their efforts in making the world a better place. The institute also released the reports on Pre Monsoon Assessment of Ambient Air Quality of Lucknow City and Gomti Water quality assessment during lockdown period.

Hindi Week-2020

The inaugural function of Hindi Week celebrations was organized in the hybrid mode on September 14, 2020. On the occasion, Dr Alok Dhawan, Director of the institute, while addressing all the scientific, technical and administrative staff and research students stressed upon the importance of the day. He said that Hindi is a very rich and strong language and was accepted as the official language of the Union on September 14, 1949. He urged everyone to ensure usage of maximum Hindi in all meetings, scientific discussions and day to day work. He further said that scientific work being done in the institute should be accessible to the common people through the simple Hindi language, so that they can get the benefit of scientific achievements. He informed the staff about the remarkable achievements of the Institute in the field of Official Language Implementation and said that our Institute is the only scientific institute in 'A' region to be awarded Second Prize under the category "Rajbhasha Kirti" for 2019-20 by Government of India, Ministry of Home Affairs, Department of Official Language for the Official Language Magazine of the institute 'Vishvigyan Sandesh (Volume 31 and 32)'. Among three thousand offices having more than 50 staff, the institute received Third Prize in the northern region-2 (Uttar Pradesh and Uttarakhand) under the category Regional Official Language Awards for 2018-19 by Government of India, Ministry of Home Affairs, Department of Official Language. He further informed that the Government of India, Ministry of Home Affairs, Department of Official Language, Town Official Language Implementation Committee, Lucknow (Office-3) awarded First Prize for official work in Official Language Implementation in the Institute and Second Prize for 'Vishvigyan Sandesh (Volume 31)' for 2019-20. He further shared the information that a book 'Vishvigyan Anusandhan ke Naye Aayaam' on the research work of the institute was published in Hindi in 2018. He appealed to take pledge to work in official language as much as possible on Hindi day. During Hindi week from September 14 – 20, 2020, 31 prizes in 9 competitions including essay writing, debate, Hindi knowledge of non-Hindi speaking staff, composition of poetry / story, translation, presentation etc. and 11 prizes for work in Hindi were awarded to encourage the staff and students as an incentive.

CSIR Foundation Day-2020

The entire world is currently going through a tumultuous period with the scourge of the Covid-19 global pandemic spreading far and wide. History is replete with numerous examples of how Science has improved the very existence and standard of living over centuries. In a country as large as ours, a strong foundation laid on Science and Technology is essential to ensure better lives to a billion plus people. Echoing similar thoughts, Dr Sanjay Singh, CEO Gennova Biopharmaceuticals Limited, Pune delivered the CSIR Foundation Day Lecture titled, "Scientific Temper in Changing Times". He was speaking at the 79th Foundation Day Celebrations of The Council of Scientific and Industrial Research at CSIR–Indian Institute of Toxicology Research (CSIR-IITR).

The celebrations were in virtual mode given the pandemic situation and several senior members of the

scientific community, former Director-General and former Directors of CSIR Institutions, including Professor Samir K Brahmachari, Former Director General, CSIR; Dr VP Kamboj, Former Director, CSIR-CDRI; Dr PK Seth, Former Director, CSIR-IITR; Dr Abhay Deshpande, Global Director, Innovation & Strategy Jai Research Foundation; Dr RC Srimal, Former Director, CSIR-IITR; and Dr MK Bhat, Director, NCCS Pune graced the occasion. Dr DevendraParmar, Chief Scientist, CSIR-IITR and Chairperson, Organizing Committee, welcomed the gathering and introduced the speaker.

55th Annual Day Celebration

Dr Alok Dhawan, Director, CSIR-IITR presenting the annual report of the institute of the year 2019-20

Dr SC Mande, Director General, CSIR delivering the 24th Professor Sibte Hasan Zaidi oration

CSIR–Indian Institute of Toxicology Research, the premier toxicology institute in the country, celebrated its 55th Annual Day on November 04, 2020. Considering prevailing scenario of the COVID–19 Global Pandemic, the celebrations were organized using the MS Teams platform. Professor Alok Dhawan, Director of the institute welcomed the gathering and presented the annual report of the institute for the year 2019-2020. He apprised the gathering about several success stories of the institute in the year gone by, especially mentioning the Institute's contribution in the fight against the scourge of COVID-19, contributing in all the five verticals that CSIR is involved in. He said that 'Service to Industry' has been the focus of the institute since its inception and with changing times the institute is now focusing on cutting edge technologies of organoids, 3D Organ/Tissue Printing, Machine Learning and Artificial Intelligence. CSIR–IITR has also been contributing to the different national mission programmes like Skill India, Namami Gange, Swachh Bharat, Swasth Bharat, among others.

On the occasion, the CSIR-IITR Annual Report and the Post Monsoon Environment Status Report of Lucknow City were also released. Several staff members and associates of CSIR-IITR were recognized for their distinguished service to the institute and honoured on the occasion.

Dr Shekhar C. Mande, Secretary, DSIR and Director General, Council of Scientific & Industrial Research,

New Delhi was the Chief Guest of the function and delivered the 24th Professor Sibte Hasan Zaidi Oration in memory of the first director of the institute. In his oration, he complemented the role played by CSIR-IITR in addressing the requirements of various industries over the years. He also enlisted success stories of CSIR in the fight against the COVID-19 Pandemic, naming a few: Feluda Diagnostic Kit, Favipiravir Anti Viral Tablets, Swasth Vayu Ventilator, Aarogyapath App, Vaccine Development etc.

Dr C.M. Gupta, Former Director, CSIR-IMTECH and CSIR-CDRI, Distinguished Professor, Institute of Bioinformatics and Applied Biotechnology, Bengaluru and Chairman, Research Council, CSIR-IITR, Lucknow was the Guest of Honour for the event. In his presidential address, Dr Gupta reminiscenced his long association with CSIR–IITR and expressed his happiness on the enormous strides the institute has made in the realm of toxicology. In this day and age of knowledge and technology intensive methods and processes, it is indeed heartening to see that CSIR–IITR has already laid the groundwork to use cutting edge technologies in its pursuits, he said.

6th International Toxicology Conclave-2020

Professor Alok Dhawan, Director, CSIR-IITR addressing the audience online

As a part of CSIR-IITR's 55th Annual Day Celebrations, the Institute organized the 6th International Toxicology Conclave (ITC-2020) on November 05, 2020 with a focus on Artificial Intelligence for Health Research and Environmental Safety Decisions (ARISE). The role of AI as an enabler in health research, predictive toxicology modeling, ensuring food safety and evolving green chemistry solutions were discussed threadbare as a part of the conclave. In his opening remarks Professor Alok Dhawan, Director, CSIR – Indian Institute of Toxicology Research reiterated the critical role of big data analytics in predictive toxicology. Data quality and data relevance are key to its utility in mitigating toxicity challenges, he said. Delivering the keynote address on Artificial Intelligence in Health and Environmental Research, Dr GN Sastry, Director, CSIR – North East Institute of Science and Technology, Jorhat opined that Artificial Intelligence and Machine Learning are now integral to any new age technology/method that may be employed in health research and safety evaluation.

The first lecture, delivered by Dr Barry Hardy, CEO, Edelweiss Connect, Switzerland dwelt upon the processes to ensure fulfilling the goals of green deal by green design. This was followed by lectures on Predictive ecotoxicology modeling of pharmaceuticals by Professor Kunal Roy, Jadavpur University, Kolkata; Protein-ligand interactions using ML tools by Dr. V Subramanian, CSIR – Central Leather Research Institute, Chennai and use of genomes and population studies by Dr Vinod Scaria, CSIR – Institute of Genomics and Integrative Biology, New Delhi. The post-lunch CSIR-IITR-Bionest session involving industry, start-ups, and industry partners included a young scientist forum and presentations by Dr Priyanka Banerjee, University of Berlin; Dr Sunil Kumar, SAI Life; Mr Ajit Deshpande, Rise Analytics and Dr Rukmini Kumar, Vantage Research. The research scholars' community was represented by Ms Himakshi

L-R: Dr Barry Hardy, Dr GN Sastry and Dr Alok Dhawan deliberating during ITC-2020

Sarma of CSIR – North East Institute of Science and Technology, Jorhat, and Ms. Shweta Singh, CSIR – Indian Institute of Toxicology Research, Lucknow with their lectures on Informatics and Modelling on COVID-19 Drug Development and Computational Toxicology for Food Safety, respectively. Dr D Parmar, Chief Scientist, CSIR–IITR, and Chairman of the ITC-2020 welcomed the distinguished speakers, participants and shared the genesis of the conclave. Dr R Parthasarathi, Principal Scientist, CSIR-IITR, coordinated the conference with the special focus on AI in toxicology and proposed the vote of thanks.

National Science Day-2021

L-R: Dr N Manickam, Professor SK Barik, Lt. Gen (Dr) Vipin Puri, Dr Ravi Ram Krishtipati

Lt. Gen (Dr) Vipin Puri addressing the audience

Professor SK Barik, Director, CSIR-IITR presenting momento to Lt. Gen (Dr) Vipin Puri

Professor SK Barik addressing the audience

"Challenge the Status Quo, Always ask Why / How" was the "Take Home Message" of the National Science Day Lecture delivered by Lt. Gen. (Dr) Bipin Puri, PVSM, VSM (Retd), Vice-Chancellor, King George's Medical University, Lucknow during the National Science Day celebrations at CSIR-IITR. In his address, Lt Gen (Dr) Puri said that a judicious combination of out of the box thinking, enterprising initiatives, and hard work are the key to scientific success. Quoting the much loved former President of our country, Dr APJ Abdul Kalam, he said that Science is a beautiful gift to humanity and one should always strive to use it for the larger good of all mankind. Dr Puri reiterated that the recently introduced Science, Technology, and Innovation Policy (STIP) will lay the foundation for successful pursuits of the scientific community of this great country.

In his welcome address, Dr N. Manickam, Chief Scientist, CSIR–IITR and Chairman, Organizing Committee, spoke about the genesis of Science Day

celebrations in the country. He said India celebrates National Science Day on February 28th every year to commemorate the discovery of the Raman Effect by Nobel laureate and Indian Physicist Sir Chandrashekhara Venkata Raman on February 28, 1928. Delivering the Presidential Address, Dr SK Barik, Director CSIR–IITR and CSIR-NBRI, Lucknow opined that the potential of any scientific discovery/ invention is only realized when it contributes towards fulfilling human needs and alleviating obstacles in the path to progress. He exhorted the scientific community to rededicate themselves towards achieving the goal of "Atmanirbhar Bharat".

International Women's Day-2021

International Women's Day was organized on March 8, 2021 at CSIR-IITR, Lucknow. Dr Madhu Dixit, Former Director, CSIR-CDRI, Lucknow and National Chair, Translational Health Sciences and Technology Institute (THSTI), Faridabad was the Chief Guest on the occasion. Dr Dixit in her address shared the experience of successful leadership of various women who have achieved high success and awards in science and technology. She mentioned the work of women scientists from the early nineteenth century to the present, such as Professor Gagandeep Kang (Fellow, Royal Society of Chemistry), Professor Renu Swarup (Secretary, Department of Biotechnology, Government of India). Earlier, Professor S K Barik, Director, CSIR-IITR welcomed the gathering. In his presidential address, Professor Barik, said that instead of mega events, women empowerment is possible by small and basic reforms. Dr Sanghamitra Bandopadhyay, Principal

L-R: Dr Sanghamitra Bandyopadhyay, Professor SK Barik, Dr Madhu Dixit, Dr Jyotsna Singh

Dr Madhu Dixit delivering a lecture

Women Scientist and officers sharing their views

Professor SK Barik addressing the audience

Professor SK Barik presenting a momento to Dr Madhu Dixit

Scientist, CSIR-IITR emphasized the contribution of women in COVID-19 at the international level. Many women scientists and administrative officers of CSIR-IITR family also shared their experiences on the challenges during the COVID pandemic on this occasion.

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Dr Devendra Parmar
Chief Scientist
Member and Official Language Officer

Dr Kailash Chandra Khulbe
Senior Principal Scientist

Mr Nikhil Garg
Senior Principal Scientist

Dr Natesan Manickam
Chief Scientist

Dr Akshay Dwarakanath
Senior Principal Scientist

Dr Alok Kumar Pandey
Principal Scientist

Mr K. Prasad Sharma
Controller of Administration

Dr Gyanendra Mishra
Controller of Finance & Accounts

Mr Satyendra Kumar Singh
Stores & Purchase Officer
(Upto August 27, 2020)

Mr Ravi Shankar Chaudhari
Stores & Purchase Officer
(From October 27, 2020)

Mr Yogendra Singh
Principal Technical Officer
(Upto December 31, 2020)

Mr Raj Kumar Upadhyay
Senior Technical Officer (3)

Mr Rakesh Singh Bisen
Incharge, Knowledge Resource Centre

Mr Vivek Srivastava
Security Officer

Mr Prem Prakash
Section Officer
(General)
(Upto August 31, 2020)

Mrs Rashmi Rathore
Section Officer
(Establishment)

Secretary
Shri Chandra Mohan Tewari
Hindi Officer

Right to Information Act-2005

RTI Act-2005 is being implemented properly in the institute since its inception. Following officials have been designated as per the requirement of the act:

w.e.f. May 2020

Dr Kailash Chandra Khulbe
Senior Principal Scientist
CSIR-Indian Institute of Toxicology Research
Vishvigyan Bhawan, 31, Mahatma Gandhi Marg
Lucknow, Uttar Pradesh
0522-2628228
kckhulbe@iitr.res.in

Appellate Authority, CSIR-IITR

Dr Yatendra Kumar Satija
Scientist
CSIR-Indian Institute of Toxicology Research
Vishvigyan Bhawan, 31, Mahatma Gandhi Marg
Lucknow, Uttar Pradesh
0522-2217625
yk.satija@iitr.res.in

Central Public Information Officer, CSIR-IITR

Dr Ravi Ram Kristipati
Principal Scientist
CSIR-Indian Institute of Toxicology Research
Vish Vigyan Bhavan, 31 Mahatma Gandhi Marg
Lucknow, Uttar Pradesh

Assistant Central Public Information Officer, CSIR-IITR

Mr Nikhil Garg
Senior Principal Scientist
CSIR-Indian Institute of Toxicology Research
Vishvigyan Bhawan, 31, Mahatma Gandhi Marg
Lucknow, Uttar Pradesh
nikhil@iitr.res.in

Transparency Officer, CSIR-IITR

Suo-Moto disclosure has been done on institutional website. A total of 95 applications were received and responded during the FY 2020-21. Six appeals were made before the Appellate Authority. Online returns are filed on time as per the schedule of the act.

Standing Publications, Ethics and Scientific Vigilance Committee (SEC)

Chairman

Dr D. Parmar

Members

Shri Nikhil Garg

Dr Kailash C. Khulbe

Dr Chetna Singh

Dr Debabrata Ghosh

Dr Amit Kumar

Mrs Rashmi Rathore

Shri Ram Narayan

Dr Ravi Ram Kristipati
Ethics Officer
Member Secretary

Ms Deeksha Singh

Ms Neha Gupta

Professor Saroj Kanta Barik
Director

Dr Yogeshwer Shukla
Chief Scientist

Dr Devendra Parmar
Chief Scientist

Dr Ganesh Chandra Kisku
Chief Scientist

Dr Natesan Manickam
Chief Scientist

Dr Vinod Praveen Sharma
Senior Principal Scientist

Shri Nikhil Garg
Senior Principal Scientist

Dr Kailash Chandra Khulbe
Senior Principal Scientist

Dr Ratan Singh Ray
Senior Principal Scientist

Dr Vinay Kumar Khanna
Senior Principal Scientist

Er Altaf Husain Khan
Senior Principal Scientist

Dr Mahendra Pratap Singh
Senior Principal Scientist

Dr Akshay Dwarakanath
Senior Principal Scientist


Dr Devendra Kumar Patel
Senior Principal Scientist


Dr Aditya Bhushan Pant
Senior Principal Scientist


Dr Chetna Singh
Senior Principal Scientist


Dr CSN Kesavachandran
Senior Principal Scientist


Dr Dhirendra Singh
Principal Scientist


Dr Rajnish Kumar Chaturvedi
Principal Scientist


Dr Sanghamitra Bandyopadhyay
Principal Scientist


Dr Ravi Ram Kristipati
Principal Scientist


Dr Alok Kumar Pandey
Principal Scientist


Dr Ramkrishnan Parthasarathi
Principal Scientist


Dr Kausar Mahmood Ansari
Principal Scientist


Dr Raja Gopal Rayavarapu
Senior Scientist


Dr Amit Kumar
Senior Scientist


Dr Anurag Tripathi
Senior Scientist


Dr Abhay Raj
Senior Scientist


Dr Mahadeo Kumar
Senior Scientist


Dr Jyotsna Singh
Senior Scientist


Dr Aruna Satish
Senior Scientist


Dr Vikas Srivastava
Senior Scientist


Dr Nasreen Ghazi Ansari
Senior Scientist

Dr Satyakam Patnaik
Senior Scientist

Dr Debabrata Ghosh
Senior Scientist

Dr Preeti Chaturvedi Bhargava
Senior Scientist

Dr Sandeep Kumar Sharma
Senior Scientist

Dr Smriti Priya
Senior Scientist

Dr Manoj Kumar
Senior Scientist

Dr Somendu Kumar Roy
Senior Scientist

Dr Anbumani Sadasivam
Senior Scientist

Dr Sheelendra Pratap Singh
Senior Scientist

Dr Neeraj Kumar Satija
Senior Scientist

Dr Pradeep Kumar Sharma
Senior Scientist

Dr Prabhanshu Tripathi
Senior Scientist

Dr Anjenya Ayanur
Scientist

Dr Beena Vamadevan
Scientist

Dr Yatendra Kumar Satija
Scientist

Dr Srikanth Bojjagani
Scientist

Dr Ashish Dwivedi
Scientist

Dr Akhilesh Kumar Yadav
Scientist

Technical Staff (Group III)

Dr Anvita Shaw
Principal Technical Officer

Dr Prem Narain Saxena
Principal Technical Officer

Shri Satgur Prasad
Principal Technical Officer

Smt Sumita Dixit
Principal Technical Officer

Dr Pradeep Kumar
Principal Technical Officer

Shri Satya Prakash Dhruva
Senior Technical Officer (3)

Shri Rakesh Singh Bisen
Senior Technical Officer (3)

Shri Ram Narayan
Senior Technical Officer (3)

Shri Sakendra Kumar Purshottam
Senior Technical Officer (3)

Shri Raj Kumar Upadhyay
Senior Technical Officer (3)

Shri Pradeep Kumar Singh
Senior Technical Officer (1)

Smt Kalpana Padalia
Technical Officer

Shri Pankaj Ramji Jagdale
Technical Officer

Shri Sandeep Kumar
Technical Officer

Shri Shyam Kumar Pal
Technical Officer

Shri Syed Ibrahim Meeran
Technical Officer

Shri Jay Shankar
Technical Officer

Shri Puneet Khare
Technical Officer

Smt Nidhi Arjaria
Technical Officer

Shri Sandeep Negi
Technical Officer

Shri Gubla Naga
Venkata Satyanarayana
Technical Officer

Shri Sarfraj Ahmed
Technical Assistant

Smt Kanchan Sonkar
Technical Assistant

Smt Deepshikha Srivastava
Technical Assistant

Dr Sumana Y. Kotian
Technical Assistant

Ms Deepshi Chaurasia
Technical Assistant

Technical Staff (Group II)


Shri Lakshmi Kant
Senior Technician (2)


Shri Kaleem Uddin
Senior Technician (2)


Shri Balkishan
Senior Technician (2)


Shri Satya Ram
Senior Technician (2)


Smt Mumtaz Jahan
Senior Technician (2)


Shri Ashok Kumar Pathak
Senior Technician (2)


Shri Prem Singh
Senior Technician (2)


Shri Budhiram Prasad
Senior Technician (2)


Shri Umesh Chandra Srivastava
Technician (2)


Shri Pradeep Shukla
Senior Technician (2)


Shri Pramod Kumar
Senior Technician (2)


Shri Syed Husain Nasir Naqvi
Technician (2)


Shri Jagdish Chandra Awasthi
Technician (2)


Shri Syed Hasnain Nasir Naqvi
Technician (2)


Shri Rajeev Sriavastava
Technician (2)


Shri Chandra Sehkar Singh
Technician (2)


Shri Abhishek Rawat
Technician (2)


Shri Shiv Prakash Rahi
Technician (2)


Shri Sushil Kumar Saroj
Technician (2)

Lab Assistants/Attendants/Support Staff

Shri Hari Ram
Lab Assistant

Shri Naushad Ahmed
Lab Assistant

Shri Vikas Barua
Group D

Shri Ram Sajeevan
Group D

Shri Rajesh Kumar
Wash Boy

Shri Ravindra
MTS

Shri Sinod Kumar
Bearer

Shri Rajendra Yadav
Bearer

Administrative Staff


Shri K. Prasad Sharma
Controller of Administration


Dr Gyanendra Mishra
Controller of Finance & Accounts


Smt Kanaklata Mishra
Finance & Accounts Officer


Shri Dharm Raj
Finance & Accounts Officer


Shri Kul Karan Singh
Section Officer (S&P)


Shri Chandra Shekhar Kandpal
Section Officer (F&A)


Smt Rashmi Rathore
Section Officer (G)


Shri Chandra Mohan Tiwari
Hindi Officer


Shri Vivek Srivastava
Security Officer


Shri Mohammad Aslam
Private Secretary


Smt Kusum Lata
Private Secretary


Shri Devesh Chandra Saxena
Asstt. Section Officer (G)


Shri Shitla Shankar Shukla
Assistant Section Officer (G)


Shri Ganga Prasad
Assistant Section Officer (G)


Shri Ajay Prasad
Assistant Section Officer (G)


Shri Pawan Kumar
Assistant Section Officer (G)

Shri Amit Kumar
Assistant Section Officer (G)

Shri Narendra Singh
Senior Secretariat Assistant (G)

Shri Ugra Sen Assistant
Section Officer (F&A)

Shri Anuj Deep
Assistant Section Officer (F&A)

Shri Kusehar Prasad
Assistant Section Officer (S&P)

Shri Manoj Tiwari
Assistant Section Officer (S&P)

Shri Ramendra Kumar
Assistant Section Officer (S&P)

Shri Sandeep Kumar Pal
Junior Secretariat Assistant

Smt Vijya Suresh
Private Secretary

Smt Balbeer Kaur
Senior Stenographer

Smt Archna Agarwal
Senior Stenographer

Shri Ram Bilas
Senior Stenographer

Smt Suman Yadav
Senior Stenographer

Shri Tanuj Joshi
Junior Stenographer

Superannuation

Dr Debapratim Kar Chowdhuri
Chief Scientist
31.05.2020

Smt Syamala Das
Senior Technician (2)
31.05.2020

Dr Shyamal Chandra Barman
Chief Scientist
30.06.2020

Shri Mahesh Yaday
Group C/MTS
30.06.2020

Shri Tajuddin Ahmad
Senior Technician (2)
30.06.2020

Shri Abdul Rahman
Technician (2)
31.07.2020

Shri AK Nigam
ASO
31.07.2020

Shri Prem Prakash
Private Secretary
31.08.2020

Shri SL Yadav
Technician (2)
31.08.2020

Shri Brij Mani Pandey
Technician (2)
30.09.2020

Shri Mohan Lal
Senior Technician (2)
30.09.2020

Dr Alok Dhawan
Director
20.11.2020
(Voluntary Retirement)

Shri Parvez Ahmad Khan
Senior Technician (2)
30.11.2020

Shri Yogendra Singh
Principal Technical Officer
31.12.2020

DST Inspire Faculty/ National Postdoctoral fellows/Women Scientists/Project Scientist/Project Research Associates

Dr Kavita Seth
DST Women Scientist

Dr Manisha Mishra
DST Inspire Faculty

Deepti Chopra
National Postdoctoral Fellow

Paramjeet Singh
Research Associate

Pankaj Chowdhary
Research Associate

Vineeta Sharma
Project Research Associate

Abhilasha Kanojia
Project Research Associate

Manisha Bhateria
Project Research Associate

Praveen G
Project Scientist

Research Scholars/Project Associates


Abdul Atiq Siddiqui


Abhishek Mishra


Abik Nandi


Aditya Kumar


Aditya Kumar Kar


Aditya Pankaj


Ajit Kumar Rai


Akash Kumar


Alika Sarkar


Alina Zehra


Amrita Singh


Anchal Chauhan


Anil Kumar Singh


Anjali Singh


Ankit Gupta


Ankit Kumar


Ankit Kumar


Annapurna Maurya


Anshika Gupta


Anuj Pandey


Anurag Sinha


Anushka Pandey


Aparna Singh Kushwaha


Apeksha Vikram


Apoorva Saxena


Arunima Sharma


Ashish Kumar Sonkar


Ashutosh Yadav


Asmita Garg


Asthika Sachan


C. Yahavi


Chamanpreet Kaur


Deeksha Singh


Deeksha Singh


Deepak Sachan


Dhvani Yadav


Divya Singh


Durgesh Mourya


Garima Singh


Gaurav Chaturvedi


Gaurav Prajapati


Gayatri Bagree


Hafsa Hashmi


Hamid Kamal Khan


Harshita Pandey


Humaira Ahmad


Imran Ahmad


Indra Dev


Irfan Ali


Ishrat Jahan Saifi


Ishu Singh


Jagriti Shukla


Jamal Ahmed Ansari


Jasleen Kaur


Jitendra Vishwakarma


Julee Verma


Kainat Fatima


Kajal Karsauliya


Kamini Shivhare


Kamlesh Maurya


Kapil Mandrah


Kavita Dubey


Kavita Koshta


Kavita Krishna


Keerti Gupta


Krishna Gautam


Manoj Kumar


Marhaba


Meetali Sinha


Minal Chaturvedi


Mirat Ul Fatima


Mohd. Faizan


Mohammad Fareed Khan


Mohammad Imran Ansari


Monika Seth


Musharraf Ali Khan


Nabojit Das


Neeraj Rawat


Neha Gupta


Neha Singh


Nida Moin


Nidhi Sachan


Nirmesh Srivastava


Nivedita Maddheshiya


Nupur Mishra


Nuzhat Bano


Onila Lugun


Opalina Roy


Oyashvi Verma


Pallavi Gupta


Pallavi Srivastava


Pankhi Vatsa


Pawankumar Rai


Phool Mala


Pooja Yadav


Priya Saxena


Priyanka Rana


Radhika Singh


Rahul Verma


Rajib Kumar Dey


Rashmi Pandey


Ravi Kumar Tiwari


Ravi Singh


Ravindra Singh Thakur


Renu Negi


Richa Singh


Salil Srivastava


Sana Sarkar


Sandeep Kumar


Sanjeev Yadav


Sarika Yadav


Saumya Mishra


Saumya Shukla


Saumya Mishra


Saurabh Pal


Saurabh Singh


Saurabh Singh


Saurabh Tiwari


Shaivya Kushwaha


Shalini Sharma


Shambhavi Jha


Shraddha Pandit


Shristee Gupta


Shubhendra Kumar Mishra


Shweta Singh Chauhan


Siddhartha Gangopadhyay


Siraj Fatima


Snigdha Gupta


Sonam Chandra


Srishti Mehrotra


Sukhveer Singh


Surabhi Jaiswal


Sushmita Tiwari


S.S. Kalikinkar Mahanta


Swati Tripathi


Tausif Khan


Tridiv Katiya


Tripana Das


Uzair Ahmad Ansari


Varsha


Varsha Singh


Varsha Tripathi


Ved Prakash


Veena Jain


Vishal Kamboj


Vishnu Sathyan


Vivek Kumar Gaur


Zain Ali


Zeeshan Arif

Obituary

CSIR-IITR family deeply mourns the demise of the following members:

Shri Machh Narain
Lab Assistant

Shri Satyendra Kumar Singh
Stores & Purchase Officer

(As on 31/03/2021)

Scientific Staff Group IV	50
Technical Staff Group III	26
Technical Staff Group II	19
Lab Assistants/Attendants	02
Adminsitrative Staff	30
Support Staff	06
Total	**133**

DST Inspire Faculty / Women Scientist / National Post Doctoral Fellow / Research Associate	08
Research Scholars & Project Fellows	153
Total	**161**

External Cash Flow (ECF) : (FY 2020-21)

Rs. in Lakhs

Government	1047.688
Foreign	1.994
Industries	0101.019
Total	**1150.701**

Government Budget (FY 2020-21) : 5939.545

सत्यमेव जयते

NATIONAL REFERENCE LABORATORY

Certificate of Recognition

The Food Safety Authority recognizes

CSIR-Indian Institute of Toxicology Research, Lucknow

as National Reference Laboratory in the area of

Toxicological evaluation/risk assessment of neutraceuticals etc.

for a period of three years from 08-08-2019

Pawan Agarwal
CEO, FSSAI

fssai
FOOD SAFETY AND STANDARDS AUTHORITY OF INDIA
Inspiring Trust, Assuring Safe & Nutritious Food
Ministry of Health and Family Welfare, Government of India

150 YEARS OF CELEBRATING THE MAHATMA

Eat Right India
सही भोजन. बेहतर जीवन.

National Accreditation Board for Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

CSIR-INDIAN INSTITUTE OF TOXICOLOGY REASEARCH, LUCKNOW

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

VISHVIGYAN BHAWAN 31, MAHATMA GANDHI MARG, LUCKNOW, UTTAR PRADESH, INDIA

in the field of

TESTING

Certificate Number: TC-7103

Issue Date: 24/09/2020 **Valid Until:** 23/09/2022

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

सत्यमेव जयते

National Good Laboratory Practice (GLP) Compliance Monitoring Authority (NGCMA)
Department of Science and Technology
GOVERNMENT OF INDIA

Certificate of GLP Compliance

This is to certify that

GLP Test Facility, CSIR-Indian Institute of Toxicology Research
Gheru Campus, Sarojini Nagar Industrial Area, Kanpur Road
Lucknow – 226008, Uttar Pradesh (India)

is a GLP certified test facility in compliance with the NGCMA's Document No. GLP-101 "Terms & Conditions of NGCMA for obtaining and maintaining GLP certification by a test facility" and OECD Principles of GLP.

The test facility conducts the below-mentioned tests/ studies:

- **Toxicity Studies**
- **Mutagenicity Studies**
- **Environmental Toxicity Studies on Aquatic and Terrestrial Organisms**
- **Analytical and Clinical Chemistry Testing**

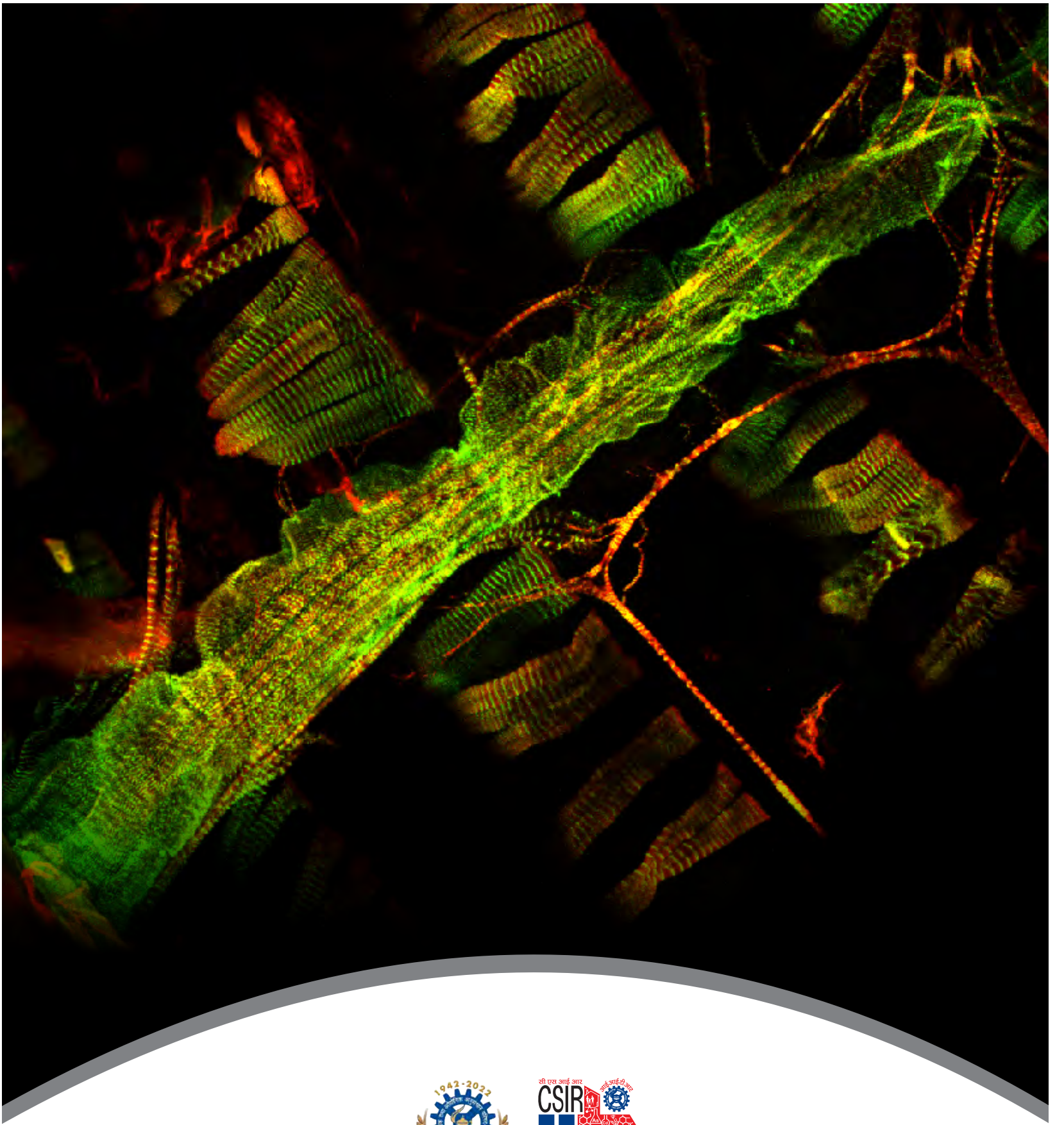
The specific areas of expertise, test items and test systems are listed in the annexure overleaf.

Validity: June 5, 2020 – June 4, 2023

Certificate No. : GLP/C-154/2020
Issue Date : 13-10-2020

भारत सरकार ★ Govt. of India
National GLP Compliance Monitoring Authority
Dept. of Science and Technology

(Dr. Neeraj Sharma)
Head, NGCMA



सीएसआईआर-भारतीय विषविज्ञान अनुसंधान संस्थान
CSIR-INDIAN INSTITUTE OF TOXICOLOGY RESEARCH

विषविज्ञान भवन, 31, महात्मा गाँधी मार्ग, लखनऊ-226001, उ.प्र., भारत
VISHVIGYAN BHAWAN, 31, MAHATMA GANDHI MARG, LUCKNOW-226001, U.P., INDIA