Dr. B. Lal Institute of Biotechnology

Research Project Details

Project: Wastewater based epidemiology for surveillance of pathogens like SARS-CoV-2 and ESKAPE bacteria

Wastewater based epidemiology (WBE) is based on the principle that if an individual is infected by any pathogen which is shed off in any form of excretions (e.g. feces, urine or phlegm) which are disposed through the wastewater network in a community, these pathogen can be detected in the wastewater without identifying the individuals. This approach is specially useful for monitoring the ailments which are either very rarely tested by clinical testing or those where the disease spreads faster than the manifestations of critical symptoms in individuals. Thus WBE has been shown useful in predicting disease hotspots communities of spread as the presence of pathogens can be detected as early as 2-3 weeks before the disease is spread into the whole city giving authorities the unique ability to contain and manage the widespread epidemics and pandemics like COVID-19. Our group has been involved in surveilling monitoring and predictions of COVID-19 waves in Jaipur and many other cities of India. We are also trying to monitor the community spread and presence of nosocomial pathogens dubbed ESKAPE pathogens by the World Health Organisation.

Project: Nanoparticle-mediated delivery of redox modulating agents to alveolar lungs cells: an effective strategy to treat chronic obstructive pulmonary diseases (COPD)

Bidi smoking is prevalent in rural parts of Rajasthan. It is a major cause of respiratory illness including inflammatory diseases of lungs, particularly chronic obstructive pulmonary diseases (COPD). COPD is a leading cause of mortality characterized by oxidative stress which is generated by bidi/cigarette smoke complex. Bidi smoke concentrate (BSC) contains thousands of chemical constituents which increase the intracellular level of reactive oxygen species (ROS) in lungs epithelial cells that activate various ROS sensitive signaling pathways which lead to redox imbalance which leads to cell death and inflammatory conditions in lungs. Nanoparticle conjugated antioxidants could provide a targeted delivery thereby increasing its efficacy. The present project is focused on application of polymeric Nanoparticle based on PLGA-PVA complex. The project involves entrapment of anti-oxidant enzymes on the Nanoparticle and their

efficacy on A549 lung cancer cell lines. The major objectives of the project include synthesis of Nanoparticle-enzyme complex and BSC followed by treatment of cells stressed with BSC with these nano-complexes. Besides, entry of these NPs and the mechanism behind the activity of these Nano-complexes is also to be analyzed.

Project: ESKAPE pathogens in India: existence, correlation, diagnosis & treatment

ESKAPE pathogens are a group of six highly virulent and antibiotic resistant (gram positive and gram negative) bacterial pathogens including *Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa* and *Enterobacter spp*. These pathogens cause life-threatening nosocomial or community-acquired infections affecting almost all the major systems of the human body including respiratory, urinary systems as well as skin. The economic burden of antimicrobial resistance is expected to rise by 10-fold to about 10 million by 2050. The high population density in India along with compromised medical and sanitation facilities may lead to spread of these infections further deteriorating the existing conditions. With this background and the access to the data as well as the clinical samples from Dr. B. Lal Clinical Laboratory Pvt. Ltd., we intend to determine the infection rate and the status of these infections in the area under the study. Therefore, the objectives of this study include **Presence of these pathogens in the Indian population**, **Co-infectivities and co-morbidities of these pathogens, Emergence of drug resistant isolates in hospital and community acquired infections**, **Novel treatment strategies via drug repurposing** and **Diagnostic targets for these pathogens.**

Project: Understanding the molecular mechanisms of wastewater treatment by Vermifiltration

Vermifilters are sustainable alternatives to the conventional wastewater treatment plants. These systems have been shown to decrease many toxic organic components by degrading them. They have been shown to successfully decrease the bacterial load in the treated wastewater and increase the overall quality of the treated wastewater as a source of irrigation. This treatment of wastewater employs biodegradation of the components by earthworms and microbes present in the active layer of the vermifilter. Our group is trying to understand the mechanisms behind these biodegradation reactions and delineate the roles of each biological agent in the treatment system.

Project: To evaluate and compare the use of treated waste water and organic fertilizers prepared Indigenously on the growth and productivity of vegetables

In recent years, wastewater recycling in agriculture has gained importance as component of agricultural water supply in several water- scarce countries. Wastewater reuse not only provides significant amount of irrigation water, but also reduces the environmental threat related to the effluents discharge into water bodies. Other point is that treated wastewater also constitutes a reliable source of nutrients like nitrogen, phosphorus and potassium and organic matter useful for the fertility and the productivity of the soil. Currently, we are working on the **use of treated waste water** and organic fertilizers prepared indigenously, which are tested on vegetables plants for its reuse in agriculture field. It's been determined that how different water samples affect seedlings of various plants in terms of growth, microbiological population and different biochemical parameters with following.

Project: Tissue culture of medicinally important plants and effects of hormones in growth and secondary metabolite analysis

Tissue culture of medicinal plants is commonly implemented in the herbal and pharmaceutical industries to produce active compounds. Natural products with medicinal value are gradually gaining importance in clinical research due to their well-known property of no side effects as compared to drugs. Currently, lab is working with *Tinospora cordifolia. Tinospora cordifolia* commonly known as Giloy, belongs to family *Menispermaceae* is a large, deciduous climbing shrub with greenish yellow typical flowers. A variety of active components derived from the plant like alkaloids, steroids, di-terpenoid lactones, aliphatic and glycosides have been isolated from different parts of plants like root, stem, etc. Micropropogation is done to maintain the population of this plant in the nature, to grow plantlets *in vitro* in the laboratory in aseptic condition and for the production of secondary metabolites which is widely used for the pharmaceutical purpose. Explants are cultivated *in vitro* on a nutrient medium that meets the explants' nutritional requirements, added with different amounts of hormones. Further their secondary metabolites are analyzed and compared *in vitro* and *in vivo.*

Project: To develop organic compost and utilize in organic farming for sustainable development and growing plant hydroponically

Agriculture and its related sectors is the largest livelihood provider in India, more so in the vast rural areas. Sustainable agriculture, in terms of food security, rural employment, and environmentally sustainable technologies such as soil conservation, sustainable natural resource management and biodiversity protection, are essential for holistic rural development. Environmental sustainability is to conserve natural resources by developing alternate sources of the things that damage the environment which will help in reducing pollution and harms to the environment. Sustainable development has three major goals:

1. To promote development without causing harm to environment
2. To conserve the natural recourses
3. To adopt new environmental friendly practices.

We are following organic practices in growing vegetables in field like in summer Brinjal, Cucumber, Ridged gourd, Bottle gourd, Indian round gourd, Bitter gourd, Pumpkin, Beans, Lady finger, Capsicum, Corn, Cluster bean, chili, Ground nut, etc. and in winter Spinach, fenugreek, mustard, Radish, Coriander, Cabbage, Cauliflower, Beetroot, Lettuce, Cherry Tomato, Runner bean, Broccoli, Carrot etc.

Hydroponics is a farming practise in which plants are cultivated in nutrient-fortified water rather than soil. They are a method of growing plants in the lab that uses less water. By permitting precise control of environmental parameters such as temperature and pH balance, as well as enhanced nutrient and water exposure, the plant grows effectively. It involves use of nutrient solutions that are custom-made for the demands of the plant being cultivated.

Project: Zero Waste Management

Dr. B. Lal Institute of Biotechnology always promotes sustainability and work as a research think tank for fulfilling sustainable development goals. We have developed a policy for Zero Waste Principles to promote the highest and best use of materials to eliminate waste and pollution, emphasizing a closed-loop system of production and consumption, moving in logical increments toward the goal of zero waste. The aim is to segregate the waste and turning to value

added resources via green technologies such as vermifilter, composting & vermicomposting and ultimately turning to circular economy.

Project: Mechanistic Insights of Bioremediation of Industrial Wastewater using Metagenomic approach

To enhance sustainability and reduce environmental toxicity, industrial wastewater is treated using environmentally friendly methods such as bioremediation and vermifiltration. The technology is a cost-effective and sustainable environmental remediation method that employs naturally occurring microbes to breakdown dangerous harmful chemical compounds into less toxic or harmless forms.