Pre-Conference Workshop

On

"Genomics, Metagenomics & Bioinformatics in Microbial Ecology"

Organized by

International Society for Microbial Ecology (ISME) &

Indian Network for Soil Contamination Research (INSCR)

In collaboration with

Acharya Narendra Dev College (ANDC)

April 02, 2024

REPORT

A pre-conference workshop on "*Genomics, Metagenomics & Bioinformatics in Microbial Ecology*" was organized by the International Society for Microbial Ecology (ISME) & Indian Network for Soil Contamination Research (INSCR) in collaboration with Acharya Narendra Dev College (ANDC), University of Delhi on April 02, 2024. This workshop was organized with various modules designed for UG/PG/PhD students to provide them with detailed knowledge of different bioinformatics tools for genomics data analysis, phylogeny, metagenomics, etc. This workshop was organized with the motive to upskill young minds for students who are keen on learning Bioinformatics. A total of 64 participants attended the workshop in offline mode at the computer lab of ANDC (List attached in the end).

Program Schedule

Workshop on "Genomics, Metagenomics & Bioinformatics in Microbial Ecology"

Time	Event/Topic	Speaker/Resource Person
09:00-09:05	Introductory Remarks and Welcome Address	**Prof. Ravi Toteja** *Officiating Principal* *Acharya Narendra Dev College* *University of Delhi*
09:05-09:15	Introduction to ISME & Activities in India	**Prof. Rup Lal** *Senior ISME Ambassador, India* *Acharya Narendra Dev College* *University of Delhi*
09:15-09:30	Introduction to Speaker & ISME Journals	**Dr. Utkarsh Sood** *Assistant Professor* *Kirori Mal College* *University of Delhi*
09:30-10:00	Message from Editor	**Prof. Thulani Makhalanyane** Editor in Chief, Reviews and Perspectives The ISME Journal Professor, Stellenbosch University
10:00-10:30	Role and Importance of Computational Biology in Microbial Ecology	**Prof. Rup Lal** *Senior ISME Ambassador, India* *Acharya Narendra Dev College* *University of Delhi*
10:30-10:45	Tea Break	

The pre-conference workshop was started with an introductory remark and welcome address by **Prof. Ravi Toteja**, Officiating Principal, Acharya Narendra Dev College (ANDC), University of Delhi. Prof. Toteja welcomed all the participants and gave opening remarks about the importance of such a program to be run along with the academic endeavours of the students and the need for such a workshop for students to inculcate interdisciplinary abilities. This was followed by Introduction to ISME and Activities of ISME held in INDIA for propagating microbial ecology by Prof. Rup Lal, Senior ISME Ambassador, ANDC, University of Delhi. The talk provided attendees with valuable insights into ISME's role in advancing microbial ecology research globally and its specific activities and collaborations within India. By sponsoring workshops worldwide and promoting excellence in research, ISME plays a pivotal role in advancing scientific knowledge and addressing societal challenges through microbial ecology.

Hands-on Workshop "Genomics, Metagenomics & Bioinformatics in Microbial Ecology"		
10:45-11:30	eDNA Extraction: First Step towards Genomics	**Dr. Punyasloke Bhadury** *Professor, Young ISME Ambassador* *Indian Institute of Science Education and Research (IISER), Kolkata*
11:30-12:30	Genome Assembly and Annotation	**Dr. Utkarsh Sood** *Assistant Professor* *Kirori Mal College* *University of Delhi*
12:30-13:20	Lunch Break	
13:30-14:15	**Plenary Talk** **Prof. Rino Rappuoli** (Scientific Director, Fondazione Biotecnopolo di Siena, Italy) ***Chairpersons**: Prof. T. Ramamurthy, Prof. Rup Lal & Prof. Ravi Toteja* ***"The power of microbes and a sustainable planet"***	
14:15-14:50	Sequence alignment and Phylogeny and Functional Genomics	**Dr. Helianthous** *Assistant Professor* *Ramjas College* *University of Delhi*
14:50-15:25	Culturomics and Metagenomics: Two sides of the same coin!	**Roshan Kumar** *PG Department of Zoology* *Magadh University*
15:25-16:00	Proteomics: Protein Modelling	**Dr. Nirjara Singhvi** *School of Allied Sciences* *DBUU*
16:00-16:30	Protein design for biotechnology	**Dr. Phoebe Oldach** *Global Research Team Lead* *Basecamp Research, UK*
16:30-17:00	Role of AI in Bacterial Taxonomy and Genomics	**Dr. Princy Hira** *Maitreyi College,* *University of Delhi*
17:00-17:05	*Concluding Remarks*	**Dr. Seema Makhija** *Professor* *Acharya Narendra Dev College*
17:05-17:15	*Queries* *& Best Interjector Award*	--

Afterwards, **Dr. Utkarsh Sood**, Kirori Mal College, University of Delhi introduced the different ISME journals and provided an in-depth overview of the journals affiliated with the International Society for Microbial Ecology (ISME). The session aimed to familiarize attendees with the diverse range of journals available under the ISME umbrella, their scope, and their significance in advancing microbial ecology research worldwide.

Then, a recorded message was given by **Prof. Thulani Makhalanyane**, Editor in chief, Reviews and Perspectives, The ISME Journal & Professor at Stellenbosch University. He provided attendees with valuable insights into the frontiers of microbial ecology research and the role of ISME journals in advancing the field. By sharing expertise, best practices, and perspectives on current trends and challenges, the editor empowered attendees to navigate the complex landscape of microbial ecology research and contribute meaningfully to scientific knowledge and innovation.


Pics 1-2: Prof. Ravi Toteja and Prof. Rup Lal gave a welcome address and introduction to ISME respectively.

Following this **Prof. Rup Lal** gave a talk on "Role and Importance of Computational Biology in Microbial Ecology". Knowing the significance of computational biology in the field of microbial ecology amazed the young researchers and students. He inspired the students to start venturing into the computational tools that will become very important in the coming years to do good science. After this talk, everyone headed for a tea break.

A hands-on workshop on "Genomics, Metagenomics and Bioinformatics in Microbial Ecology" was started after the talk from Prof. Rup Lal. First, there was a lecture by **Prof. Punyasloke Bhadury**, Young ISME Ambassador, Indian Institute of Science Education and Research (IISER), Kolkata, on *eDNA extraction: the first step towards Genomics*. The talk on eDNA extraction provided a comprehensive understanding of the principles, techniques, and applications of extracting environmental DNA as the first step toward genomics research.

Then, **Dr. Utkarsh Sood** conducted a hands-on session on Genome assembly and annotation. He explained the principle, and terminology of sequencing technologies focused on bacterial genomes. He explained Illumina sequencing in detail and demonstrated genome assembly for a bacterial genome on a Linux-based system. For assembly ABySS software was used and all the related terminologies and interpretation of obtained results were discussed. The session ended with an online demonstration of annotation (assigning functional significance) of the obtained assembled genome using RAST (Rapid Annotation using Subsystem Technology) which is a fully-automated service.

After this session, everyone headed for a lunch break. Soon after the break, we had a plenary talk by Prof. Rino Rappuoli, Scientific Director, Fondazione Biotechnopolo di Siena, Italy on "The power of microbes and a sustainable Planet" which was chaired by Prof. T. Ramamurthy, Prof. Rup Lal and Prof, Ravi Toteja.

Pics 3-6: Lecture on the importance of computational biology and hands-on exercise on genome assembly and annotation

Afterward, the pre-conference workshop resumed with a session on "*Concepts of phylogeny and taxonomy*" by Dr. Helianthous, Ramjas College, University of Delhi. Following that, the students were taught about the genotypic, phenotypic, and chemotaxonomic markers used to classify bacterial species into taxa using a polyphasic approach. The importance and drawbacks of using the 16S rRNA gene sequence to create phylogenetic trees were next discussed. The benefits of employing genomic-based approaches to analyze the 16S rRNA gene sequence were then described, including two types of Phylogenomic methods: whole genome and core genome. Following that, approaches based on the entire genome, such as Average Nucleotide Identity (ANI) and Average Amino Acid Identity (AAI) were discussed. Students were given genome Data of five strains of *Deinococcus* spp. (both genome sequence and protein sequences) on which they did hands-on in making phylogenomic matrices using Kostas ANI and AAI calculators. The results so obtained were then visualized and explained to students. Afterward, the Newick tree was downloaded and then visualized on Interactive Tree of Life (iTOL). Students were also taught to use iTOL's user-friendly tabs for annotating trees as per their needs. Following this, students were explained the importance of designation of genes into functional pathways. Then students attained hands-on experience in running functional analysis and were taught to use the data given to them to run on KAAS followed by this on the MinPATH server. The resultant data produced was then curated for heatmap construction to analyze the comparative functional profile of *Deinococcus* spp.

Dr. Roshan Kumar's presentation explored the utilization of multi-omics data for hypothesis generation and analytical strategies. He discussed various omics datasets, including genomics (whole-genome sequencing, exome sequencing, single nucleotide polymorphisms, etc.), metagenomics (shotgun sequencing, amplicon sequencing, metagenome-assembled genomes, etc.), culturomics (isolate characterization), transcriptomics (RNA sequencing), and epigenetics (DNA methylation, chromatin immunoprecipitation sequencing, etc.). To illustrate his points, Dr. Kumar provided an example demonstrating how microbiomes can transfer from one individual to another. He discussed an experiment where gnotobiotic chickens were colonized with an inoculum from feral chickens, and the subsequent changes in the microbiome were analyzed over time using metagenomics techniques. Additionally, Dr. Kumar offered an overview of transcriptomics analysis, highlighting differentially expressed genes under varying culture conditions. He also presented an epigenetics analysis that examined chromatin marks and DNA methylation profiles across the genome.

Thereafter, **Dr. Nirjara Singhvi** led an engaging hands-on session on protein structure modeling, utilizing the SwissModel online server. The session aimed to provide participants with practical insights into the process of predicting and analyzing protein structures, a crucial aspect of molecular biology and drug discovery. During the session, Dr. Singhvi adeptly navigated participants through the intricacies of using the SwissModel server. She elucidated the significance of protein structure prediction in understanding biological function, protein-protein interactions, and rational drug design. Participants were introduced to the fundamentals of homology modeling, a technique employed to predict the 3D structure of a protein based on its similarity to known protein structures. Through interactive demonstrations, Dr. Singhvi elucidated the step-by-step process of submitting a protein sequence to the SwissModel server and interpreting the generated models. Moreover, the session delved into the importance of structural validation and quality assessment in ensuring the reliability of predicted models. Dr. Singhvi shared valuable insights into various tools and techniques for assessing model accuracy and identifying potential errors.

This session was followed by "*Introduction to Protein design*" by **Dr. Phoebe Oldach**, which started by highlighting how designed proteins can play important roles in the development of important new technologies, from novel therapeutics such as gene editing systems to enzymes allowing for biocatalysis for greener chemistries. The module covered important considerations to consider before working with protein design (parameters under which the protein will be used such as host, pH, production scale, IP space, biosecurity, and data ethics). The module then covered recent advances in AI tools for protein design, highlighting the two-step process of structure generation followed by sequence design, and pointing students toward web tools for running RFDiffusion and ProtMPNN.

Next, the presentation on the *"Role of AI in bacterial taxonomy and genomics"* by **Dr. Princy Hira**, Assistant Professor, Maitreyi College, University of Delhi provided attendees with valuable insights into the transformative potential of AI-driven approaches in microbial research. By automating tasks such as species identification, genome annotation, and phylogenetic analysis, AI algorithms are revolutionizing the way researchers classify and characterize bacterial species, paving the way for discoveries and applications in microbial ecology, biotechnology, and public health. Also, a healthy discussion between the participants and resource persons to clear all the doubts of the participants succeeded in the sessions.

Pics 7-10: Hands on sessions by Dr. Helianthous Verma, Dr. Nirjara Singhvi and Dr. Phoebe Oldach.

In the end, **Prof. Seema Makhija** gave concluding remarks and announced the name of the best interjector, ***Mr. Merwin Mammen Mathew from Jamia Millia Islamia***.

Pic 11: Group Photograph of ISME workshop resource persons and participants