APPLIED ENVIRONMENTAL MICROBIOLOGY

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IIT Roorkee

INTENDED AUDIENCE : Students of Civil Engineering, Chemical Engineering, and related sciences, It is an elective course for UG students.
INDUSTRIES APPLICABLE TO : Water and waste water treatment companies such as VA Tech Wabad GMBH, Thermax India, GE Water, Siemens Water, SFC Environmental Technologies Pvt. Ltd., Voltas Ltd.; Biotechnological companies such as: Bharat Biotech International, Biocon, Biotech Consortium India Ltd;Bioremediation companies such as ONGC Teri Biotech Ltd, Chempure Technologies; CPCB, Department of Irrigation and Public Health

COURSE OUTLINE :
This course prepares the student to address pressing environmental challenges by developing a fundamental understanding of the microbial communities and processes in natural and built environments. It lays and builds upon the foundation of basic microbiology, microbial energetics and diversity to applying tools provided by microbiology ranging from traditional to state of art for addressing relevant environmental concerns. It provides an indepth exploration of the diverse role microbes and microbial communities and includes topics such as: cell structure and elements, microbial energetics and diversity, ecology and population dynamics, environmental microbial processes including biogeochemical cycling, and microbes involved in biodeterioration and bioremediation.

ABOUT INSTRUCTOR :
Prof. Gargi Singh is currently working at the interface of microbiology and environmental engineering at IIT Roorkee to address environmental challenges of pathogen ingress in water distribution network and environmental proliferation of antibiotic resistance. In her doctoral research, she applied molecular biology tools including quantitative polymerase chain reaction, isolation, selection, high-throughput sequencing on pyrosequencing and Illumina based platforms, and metagenomics to investigate biodegradation of petroleum and nanocellulose, and sequestration of heavy metals. She is also faculty member of Centre of Nanotechnology at IIT Roorkee, where she is currently teaching environmental statistics and environmental implications of nanotechnology.

COURSE PLAN :
Week1: Introduction; cell elements and composition Cell and its composition, cytoplasmic membrane Prokaryotic cell division Microbes and their environmental niches Historical roots of microbiology Nucleic acids and amino acids DNA structure, replication, and manipulation Protein and its structure Regulation Microbial nutrition Microscopy: Light microscopy, 3D Imaging, AFM, Confocal scanning laser microscopy
Week 2: Microbial energetics and diversity Stoichiometry and bioenergetics Oxidation-reduction NAD, energy-rich compounds and energy storage Mathematics of microbial growth Glycolysis Respiration Citric-acid cycle Catabolic Alternatives Phototrophy, Chemolithotrophy, anaerobic respiration (Nitrate and Sulfate reduction; Acetogenesis; Methanogenesis; Metal, Chlorate, and organic electron acceptors)
Week 3: Microbial metabolism and functional diversity of bacteria Prokaryotic diversity Classical taxonomy Origin of life Tree of life Major catabolic pathways Catalysis and enzymes Energy conservation Sugars and polysaccharides, amino acids, nucleotides, lipids
Week 4: Microbial ecosystems Population, guilds, and communities Environments and microenvironments Microbial growth on surfaces Environmental effects on microbial growth
Week 5: Environmental genomics and microbial ecology; genetic exchange Environmental genomics Microbial ecology Horizontal and vertical gene transfer: Replication, Transformation Transduction
Week 6: Microbial symbiosis and virus, Mutation and its rate ,Genetic recombination, Population dynamics ,Virus ,Viroid, Prion ,Application of environmental microbes
Week 7: Investigations in environmental microbiology: sampling, detection, isolation, taxonomic and functional annotation and quantification; Introductory bioinformatics and data analysis Microbial sampling Culture based and culture independent tools Molecular biology tools: Cloning, amplification, sequencing,Case study
Week 8: Bioremediation and wastewater microbiology, Bioremediation and examples, Acid mine drainage, Enhanced metal recovery, Wastewater microbiology
Week 9: Drinking water microbiology, Drinking water microbiome and treatment, Microbial instability ,Water borne microbial diseases
Week 10: Solid waste microbiology and antimicrobial resistance, Landfills, Leachate, Anaerobic degradation phases, Antimicrobial resistance
Week 11:Epidemiology and biosensors ,Public health, Epidemics, Biosensors ,Wearable biosensors
Week 12:Built microbiology, exposomes and bioinformatics, Exposure routes ,Microbes living around us ,Exposomes Basic bioinformatics, Bioinformatics tools available online