Secretary

R-915
13.8.2026

UNIVERSITY OF CALCUTTA

Notification No. CSR/91/2026

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of his powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 05.08.2026, approved the syllabus of 2-year (Four Semester) M.Sc. Course of Study in Microbiology, under NEP guidelines, as laid down in the accompanying pamphlet.

The above syllabus shall take effect from the academic session 2026-2027 and onwards.

12/08/2026

SENATE HOUSE
Kolkata-700073
12.08.2026

Prof.(Dr.) Debasis Das
Registrar

M. Sc. (Microbiology) under University of Calcutta

Proposed course distribution across semesters as per UGC recommendation of PG courses under NEP 2020

Semester I	Name of the course	Marks	Credits
Coursework	MCB411: Molecular Biology and Enzymology	40+10 P	4
	MCB412: Eukaryotic Microbiology and Host-Microbe Interaction	40+10 IA	4
	MCB413: Microbial Metabolism and its industrial application	40+10 IA	4
	MCB414: Ecology and Biodiversity	40+10 P	4
	MCB415: IPR & Bioethics, Biosafety, Spectroscopy, Microscopy & Statistics	40+10 IA	4
	TOTAL	250	20

Semester II	Name of the course	Marks	Credits
Coursework	MCB421: Regulation of Gene Expression	40+10 IA	4
	MCB422: Immunology	40+10 P	4
	MCB423: Microbes in sustainable agriculture and development	25	2
	MCB424: Virology	25	2
	MCB425: Genetics and Genomics	40+10 P	4
	MCB426: Cloning and overexpression of a protein	40+10 IA	4
	TOTAL	250	20

Semester III	Name of the course	Marks	Credits
Coursework	MCB511: Antimicrobials	25	2
	MCB512: Cell Biology	40+10 P	4
	MCB513: Computer Application and Bioinformatics	40+10 P	4
	MCB514: Proteomics	40+10 IA	4
	MCB515: Medical Biotechnology and Gene Therapy	40+10 IA	4
	MCB516: Indian Knowledge System Related to Microbiology	25 IA	2
	TOTAL	250	20

Semester IV	Name of the course	Marks	Credits
Coursework	MCB521: Grant writing	100	8
	MCB522: Semester away for internship Project (External supervisor): 50; Dissertation and Seminar: 100	150	12
	TOTAL	250	20

[RM is Research Methodology; IA is Internal assessment; and P is Practical]

Soumalee Basu 27.7.26

Ratan Lakshmi 27/7/26.

27/7/26

27.7.26

Prasenjit Das 27.7.26

MCB411: Molecular Biology and Enzymology (FM: 50)

Unit 411.1: Replication of prokaryotic and eukaryotic DNA

DNA replication in prokaryotes and eukaryotes: General features and enzymology; detailed mechanisms of initiation, elongation and termination; experiments underlying each step and role of individual factors; telomerases: maintenance of genome integrity and role in cancer.

Unit 411.2: Transcription in prokaryotes

RNA polymerase subunits, initiation, elongation and termination (rho-dependent and independent) of RNA synthesis; gene regulation in prokaryotes: *lac*, *ara* and *trp* operons, antitermination, attenuation and other influences of translational apparatus on the process of transcription; various protein motifs involved in DNA-protein interactions during transcription.

Unit 411.3: Translation in prokaryotes and eukaryotes

Processing of mRNA for translation and involvement of different translational factors at different stages of the process. Fidelity of translation, inhibitors of protein synthesis in prokaryotes and eukaryotes.

Unit 411.4: Enzymes

Introduction, enzyme purification techniques, active site, concept of energy barriers, cofactor and different kinds of enzyme inhibitors; enzyme kinetics, two substrate kinetics, three substrate kinetics, deviation from linear kinetics, rapid kinetics; association and dissociation constants; use of isotopes in enzyme mechanism analysis; effect of pH and temperature.

Unit 411.5: Ligand binding studies

Allosteric model of enzyme regulation; substrate induced conformational change in enzyme

Lab-work: Determination of enzyme concentration by different methods, determination of native molecular weight, determination of K_m, V_{max}, specific activity and influence of inhibitors.

MCB412: Eukaryotic Microbiology and Host-Microbe Interaction (FM: 50)

Unit 412.1: Important human and veterinary parasites

Life cycle and biology of *Plasmodium, Entamoeba, Leishmania, Wuchereria, Fasciola, Schistosoma,* host parasite interaction.

Protozoa: Classification of Protozoa, general biology of protozoal cell, process of reproduction in common protozoal classes, importance of protozoa in soil and water ecosystem.

Unit 412.2: Elements of Mycology

General classification of fungi, fungal cell structure, structure and biology of fungal spores of different kinds, reproduction in fungi, mycotoxins, common mycotic infections in human: superficial, subcutaneous, cutaneous, and systemic mycoses.

Unit 412.3: Bacterial Pathogenesis

Pathogenic bacteria, bacterial diseases, mechanism of pathogenesis, prophylaxis, therapy etc. (*Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Neisseria*, *Corynebacterium*, *Bacillus*, *Clostridium*,) enterobactriacae (*Shigella*, *Salmonella*, *E. coli*), *Vibrio* etc., *Mycobacterium* etc. Acute diarrheal diseases, food poisoning, Meningitis, tuberculosis, diphtheria, leprosy, urinary tract infection, cystic fibrosis, typhoid, enteritis (in *Helicobacter pylori*), gastritis, cholera, pneumonia.

Unit 412.4: Plant-microbe interactions

Rhizosphere and phyllosphere microorganisms and their interactions with plants; Symbiotic vs non-symbiotic nitrogen fixation, symbionts and their cognate hosts, regulation of nitrogen fixation in a symbiotic vs a non-symbiotic N fixer; mechanism of inception of symbiosis, symbiosis vs pathogenesis. Plant pathogens (bacterial, fungal, algal and mycoplasmal); mechanisms of plant pathogenicity, beneficial association between plant and microorganisms (association of plants with cyanobacteria, actinomycetes and fungi). Human-microbe mutualism and disease, manipulation of host cell pathways by bacterial and parasitic pathogens. Different types of secretory bacterial pathways.

MCB413: Microbial Metabolism and its Industrial Application (FM: 50)

Unit 413.1: Bacterial photosynthesis

Different types of photosynthetic bacteria, photopigments, paths of carbon and electron in bacterial photosynthesis); metabolism of energy reserve compounds (polyglycans, poly- and b-hydroxybutyrate).

Unit 413.2: Metabolic energetics

basic differences in anaerobic and respiratory kinds of energy metabolism; electron transport system; basic mechanisms of ATP synthesis; energy conservation in chemolithotrophic bacteria (*Nitrobacter*, *Nitrosomonas*, *Thiobacilli* including *Thiobacillus ferrooxidans*, methanogens, hydrogen oxidizing bacteria); respiratory metabolism- Embden-Meyerhoff pathway, Entner-Doudroff pathway, phosphoketolase pathway, glyoxalate pathway, Krebs‟ cycle, oxidative and substrate level phosphorylation, reverse TCA cycle, gluconeogenesis-Pasteur effect.

Unit 413.3: Energy metabolism and microbial growth

Growth yield coefficients, theoretical growth yield; fermentation of carbohydrates-homo and heterolactic fermentations- mixed acid, propionic acid, butyric acid, acetone-butanol etc. fermentations, substrate level phosphorylation in anaerobic energy metabolism; transport processes.

Unit 413.4: Bioprocess Engineering

Introduction to Bioprocess Engineering, Bioreactors, and Membrane Bio reactors, Isolation, preservation, and Maintenance of Industrial Microorganisms. Types of Fermentation processes: Analysis of batch, Fed-batch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.

Unit 413.5: Downstream processing

Introduction, removal of microbial cells and solid matter, foam preparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, Membrane process, Drying and Crystallization, whole cell immobilization and their industrial applications: Immobilized enzymes, enzymes in aqueous and non-aqueous media, Bioconversion and biotransformation

Unit 413.6: Industrial production of important chemicals

Alcohol (ethanol), Acids (citric, acetic, and gluconic), solvents (glycerol, acetone, and butanol) antibiotics (ampicillin, streptomycin and tetracycline), macrolides, anticancer antibiotics, amino acids (lysine, glutamic acids).

MCB414: Ecology and Biodiversity (FM: 50)

Unit 414.1: Evolution of environment and Origin of life

Diversification of life and speciation; Classifying organisms: Concepts of phenetics and cladistics; Principles of ecological organization; Basics of structural & functional ecology; Concept of Population genetics; Basic approach to evolutionary biology and behavioral ecology; Evolutionary principles and stable strategies; types of selections.

Unit 414.2: Biodiversity

Levels of biodiversity: alpha, beta and gamma diversity, Values and ethics of biodiversity; Global patterns of biodiversity, hotspots of biodiversity and mega-diversity country; Biogeographic zones in India; factors influencing local and regional biodiversity, Biodiversity documentation. Threat to species diversity, Extinction vortex, Causes of extinction; Population viability analysis; Red Data Book, Biodiversity conservation approaches: Local, National and International, In situ and ex situ conservation, Concept of protected area network, Selecting protected areas, criteria for measuring conservation value of areas, Sanctuary, National Park and Biosphere reserves; Design and management of protected areas; Threats to wildlife conservation and wildlife trade; Tools for wildlife research, Wildlife threat, Use of Radiotelemetry and Remote sensing in wildlife research Perception on Bioresource; Legal binding of biological materials- concept of Biopatents.

Unit 414.3: Environmental Biotechnology

Understanding biotechnology, Concept and outlines of various applications- GM crops and GMO: Environmental implications; Biodegradation, Phytoremediation: types and applications Bio-fuel production, Bio fertilizer, Bio pesticides; Integrated Pest Management.

Unit 414.4: Microorganisms and environmental pollutants

Overall process of biodegradation, Environmental biomonitoring and indicator microorganisms, biodegradation of organic pollutants, anaerobic biodegradation, in-situ and ex-situ bioremediation, case studies of microbial remediation, lagoon and Vadose zone bioremediation, surface bioremediation of soils and sludge, applied bioremediation and industrial applications, developing bioremediation technologies.

Unit 414.5: Concept of Metal pollution and remediation

Microorganisms and metal pollutants, metal – microbial interaction and metal remediation; Microbial transformation of pesticides. Waste treatment – modern wastewater treatment,

traditional methods, wetlands and aqua-culture systems, Surface Bioremediation of soil and sludge.

Lab-work: Preparation of metagenomic DNA from environmental samples, selective isolation of photoautotrophs, lithoautotrophs, nitrogen fixing and phosphate solubilizing bacteria.

MCB415: IPR& Bioethics, Biosafety, Spectroscopy, Microscopy & Statistics (FM: 50)

Unit 415.1: Introduction to Intellectual Property Rights

Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR - patentable and non patentable - patenting life - legal protection of biotechnological inventions World Intellectual Property Rights Organization (WIPO).

Bioethics: Role of bioethics in research. Prevention and management of plagiarism, fabrication/manipulation of data, conflict of interest, socio-cultural and behavioral conflicts during the conduct of research. Authorship & patenting/commercial rights and conflicts. Bioethical norms governing research related to animals and humans.

Unit 415.2: Principles of Biosafety

Biosafety guidelines and regulations (National and International); GMOs LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

Unit 415.3: Spectroscopy

Interaction of Electromagnetic radiation with matter: scattering and absorption, Principles and applications of absorption spectra, Instrumentation of UV-Vis absorption spectrophotometer, Analysis of biomolecules using UV-Vis spectroscopy, Colorimetry and Turbidometry, Introduction to emission spectroscopy: Fluorescence and Phosphorescence and their applications in biology.

Unit 415.4: Microscopy

Lenses and bending of light; the principles and uses of different microscopy; Simple and compound microscope; Light Microscope: Bright Field, Dark Field, Phase Contrast Microscope; Fluorescence Microscope, Confocal Microscope; Transmission Electron Microscope, Scanning Electron Microscope, Atomic Force Microscope.

Unit 415.5: Biostatistics with R

Descriptive statistics –Mean, median, mode; Standard deviation, variance; Percentiles, quartiles

Inferential statistics –t-test, ANOVA, chi-square test, correlation analysis, Regression analysis.

MCB421: Regulation of Gene Expression (FM: 50)

Unit 421.1: Chromatin organization

cis acting sequences in transcriptional control, *trans* control of transcription, Tissue specific regulation of transcription, histone code, DNA methylation and histone acetylation mechanisms. Imprinting, GAL gene regulation and mating type switching in *S. cerevisiae.*

Unit 421.2: Translational controls in eukaryotic gene regulation
Translational regulation of intracellular GCN4 level, regulation of translation, 5' and 3' UTR and their role in transcriptional and translation regulation.

Unit 421.3: Regulation of eukaryotic transcription
Polymerases I, II and III, assembly of polymerases in different types of promoters, steps in RNA synthesis and cotranscriptional processes. Different modes of mRNA, tRNA splicing, discussion on various snRNPs, capping, polyadenylation and other processing events in eukaryotes

Unit 421.4: RNA editing
Discussion on ribozyme; mechanism of RNA interference; regulation of gene expression by miRNA and piRNA pathways.

MCB422: Immunology (FM: 50)

Unit 422.1: Introduction to immune system
Concept of innate and adaptive immunity, cells, tissues and organs of the immune system, antigens, antibodies, complements, T and B -cell receptors, MHC molecules.

Unit 422.2: Mode of immune response
Mechanism of innate immunity, antigen presentation, cell mediated immunity, regulation of the immune response, cell collaboration in antibody response. Defense against infectious agents: virus, bacteria and protozoa.

Unit 422.3: Immune response against tissues
Immunological tolerance, autoimmunity and auto immune diseases, transplantation and rejection, Hypersensitivity; Type I, Type II, Type III, and Type IV.

Unit 422.4: Vaccines
Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, RNA vaccines, plant-based vaccines, reverse vaccinology, peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Cell based vaccines. Transfusion of immunocompetent cells, vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine.

Unit 422.5: Immuno-techniques
Immunostaining, RIA, ELISA, FACS, Hybridoma technology etc.

Lab-work: ELISA, Immuno-electrophoresis, western blot, Immunofluorescence, Immunohistochemistry

MCB423: Microbes in Sustainable Agriculture and Development (FM: 25)

Unit 423.1: Environmental Protection and Waste Management

Bioremediation: Microbial degradation of petroleum hydrocarbons, pesticides, dyes, and heavy metals. Waste Management: Microbial treatment of sewage, industrial effluents, and solid waste. E-waste and Emerging Pollutants: Microbial consortia for degradation and detoxification of electronic waste and emerging contaminants. Case Studies: Success stories of microbial bioremediation projects in India and abroad.

Unit 423.2: Agriculture and Food Production

Biofertilizers: *Rhizobium*, *Azospirillum*, Azotobacter, and phosphate-solubilizing bacteria. Biopesticides: *Bacillus thuringiensis*, *Trichoderma*, *Pseudomonas*, and *Beauveria* species. Microbial Antagonism: Mechanisms of competition, antibiosis, and induced systemic resistance. Microbiome Engineering: Role of plant-associated microbiomes in crop productivity and resilience.

Unit 423.3: Energy and Resources

Biofuels: Microbial production of bioethanol, biobutanol, and biodiesel from renewable feedstocks. Renewable Energy: Principles and applications of microbial fuel cells and hydrogen-producing microbes. Resource Recovery: Conversion of organic wastes into bioenergy and value-added products.

Unit 423.4: Health and Other Products

Probiotics: Microbial strains, mechanisms, and applications in human and animal health. Pharmaceuticals: Microbial sources of antibiotics, enzymes, and vaccines. Food Additives and Natural Products: Microbial pigments, flavors, vitamins, and nutraceuticals. Industrial Biotechnology: Role of microbes in producing biodegradable plastics and green chemicals.

Unit 423.5: Ecosystem Services

Biogeochemical Cycles: Microbial mediation in nitrogen and phosphorus cycling; nitrification, denitrification, and phosphate solubilization. Carbon Sequestration: Microbial roles in soil carbon stabilization and greenhouse gas mitigation. Microbial Indicators: Monitoring ecosystem health through microbial diversity and function.

MCB424: Virology (FM: 25)

Unit 424.1: Introduction to animal viruses

Methods of culturing animal viruses, Viral classifications, viral pathogenesis and their mechanisms, factors in pathogenesis and transmission.

Unit 424.2: Emerging infections

Discussion on replication strategies of viruses from different classes: poliovirus, influenza virus, coronaviruses, varicella and HSV, Dengue, HIV, Hepatitis B virus.

MCB425: Genetics and Genomics (FM: 50)

Unit 425.1: Mendelian Principles

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudo-allele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, incomplete dominance and co-dominance, multiple alleles, epistasis, penetrance and expressivity, epigenetic controls.

Unit 425.2: Characteristics of Chromosomes

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome.

Unit 425.3: Linkage and Chromosome mapping

Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four strand stage, Molecular mechanism of crossing over, mapping, chi square test for linkage, recombination frequency and map construction.

Unit 425.4: Extra-Chromosomal Inheritance

Rules of extra nuclear inheritance, Organelle heredity - Chloroplast mutations in *Chlamydomonas*, mitochondrial, mutations in *Saccharomyces*, Maternal effects – Shell coiling in *Limnaeaperegra,* Infectious heredity - Kappa particles in *Paramecium*

Yeast genetics: isolation and characterization of auxotrophic and temperature sensitive mutants, synthetic lethality, meiotic mapping, multicopy suppression.

Unit 425.5: Yeast genetics

Isolation and characterization of auxotrophic and temperature sensitive mutants, synthetic lethality, meiotic mapping, multicopy suppression, tetrad analysis in yeast and recombination mapping with tetrad, mapping with molecular markers.

Unit 425.6: Pedigree analysis

Two or more genes: Independent assortment, dihybrid cross, Genetic interactions: Two factor interaction, epistatic interaction, non-epistatic interaction, interactions with three or more factors.

Unit 425.7: Genomics

Introduction to genomics; Mapping genomes: Genetic mapping -molecular markers- RFLP, SSLP, SNPs, basis to genetic mapping; Physical mapping: Restriction mapping and optical mapping, FISH, RH and STS Mapping, Genome sequencing, assembly and annotation; Human genome project; Brief Overview of Structural, functional and comparative genomics; Application of genome data in forensics, disease diagnosis and genetic counseling.

Lab-work: Prediction of RNA structure, primer designing, ORF analysis, protein binding site prediction, isolation of auxotrophs.

MCB426: Cloning and overexpression of a protein (FM: 50)

Students will identify one bacterial enzyme, for which a spectrophotometric assay is available. They will have to obtain the peptide and nucleotide sequences for the enzyme and design PCR primers. After isolation of genomic DNA from the bacteria, they will have to run a PCR reaction with appropriate controls and the product will have to be cloned first in a cloning factor and subsequently in an expression vector, with an expression tag. Best expression conditions will have to standardized with IPTG and confirmed by western blotting using antibody against the expression tag. Following affinity purification, the activity of the enzyme will be assessed through spectrophotometric assay. The students will be required to submit a detailed progress report of the work followed by viva voce. Both the written report and viva voce will be taken into consideration for evaluation.

MCB511: Antimicrobials (FM: 25)

Unit 511.1: Pharmacokinetics and pharmacodynamics

Introduction of pharmacodynamics and pharmacokinetics, Receptor-ligand relationship in antibiotic or drugs, Agonist and antagonists, combinatorial application Vs synergistic or antagonistic relation. Therapeutic index, dose determination.

Unit 511.2: Antibiotics and their application

Definition, phenomenon of antibiotics, concept of secondary metabolites. Role of antibiotics in the producer organism. Assay of antibiotics: chemical versus microbiological assay system, different methods of antibiotic assays (serial dilution, photometric and agar-diffusion methods) - theory and practice; Chemical and biochemical modification of antibiotic structures: development of antibiotics (different generations of antibiotics) taking penicillins and chloramphenicols as parent compounds. Phenomenon of antibiotic resistance. Different biochemical mechanisms of resistance development, multiple-drug resistance, its genetics and chemical significance. Biochemical modes of action of antibiotics acting as inhibitors of ribosomal function (as for example aminoglycosides, tetracyclines, puromycin, choloramphenicol, microlides etc.), inhibitors of nucleic acid metabolism (actinomycin D, mitomycin C etc.), inhibitors of cell wall biosynthesis (penicilline, bacitracins etc.) and inhibitors of membrane function (polyenes, tunicamycin, ionophores etc.).

Unit 511.3: Antibiotic Resistance

Usage of antibiotics in preventive and curative measures on crops, livestock and human. Rise of AMR, concept of MDR, XDR, PDR strains, ARGs, Resistome, Future strategies to mitigate rise of AMR.

MCB512: Cell Biology (FM: 50)

Unit 512.1: Structure and organization of cells (brief discussion)

Plasma membrane, cell wall, cytoskeleton, mitochondria, nucleus; nuclear pore complex and nuclear transport, extra cellular matrix

Unit 512.2: Microbial cell division

Microbial cell division and its control, bacterial sporulation and germination.

Unit 512.3: Regulation of eukaryotic cell cycle

Eukaryotic cell cycle and regulation at different check points, programmed cell death, proteostasis.

Unit 512.4: Cell signaling

Bacterial two component system: quorum sensing, chemotaxix, receptor-ligand interactions and subsequent activation of signalling pathways in eukaryotes; GPCR activation, receptor tyrosine kinase and receptor associated with tyrosine kinase activation, NF-kB activation, protein sorting and targeting in eukaryotic cells

Lab-work: Live and dead cell staining, staining of the nucleus, subcellular localization of proteins by fluorescent tagging, nuclear -cytosolic fractionation

MCB513: Computer Application and Bioinformatics (FM: 50)

Unit 513.1: Computer Application

Basic idea to work on Linux platform – basic concept of OS. Simple shell commands.

Unit 513.2: Sequence Analysis

Concept of homology, paralogy, orthology, analogy and xenology; Comparison of sequences of protein/DNA – Pairwise alignment: local and global alignment; Concept of indel, affine gap penalty; Database search algorithm, significance of hits, Karlin Altschul equation; Multiple sequence alignment, concept of consensus, interpretation with regular expression, concept of protein profile and PSSM, algorithm of PSI-BLAST. PHI-BLAST and other forms of BLAST. Kyte-Doolittle plot and Hopp-Woods plot- prediction of localization of a protein, prediction of TMD.

Unit 513.3: Phylogenetic tree construction

Concept of tree, reading and interpreting phylogenetic trees, distance-based (UPGMA and NJ) and character-based methods (MP or ML) for the construction of phylogenetic trees, judging strength of clades (with BS or PP values) in a tree.

Unit 513.4: Protein structure prediction

Secondary, tertiary and quaternary structure prediction –concept of propensity in Chou-Fasman method; Tertiary structure prediction -homology modeling, threading and ab initio method; Quaternary structure prediction - protein-protein docking – rigid and flexible.

Unit 513.5: Drug designing

Protein-ligand docking; Computer-aided drug designing (CADD) -structure-based drug designing (SBDD); Ligand-based drug designing (LBDD); Fragment-based drug designing (FBDD).

Lab-work: Pairwise alignment- local and global alignment using Smith-Waterman and Needleman-Wunsch algorithm respectively. Comparison of the results with reference to percentage identity, percentage gaps etc.

Comparison of the different BLOSUM matrices.

Cross dot plot to identify regions of similarity/identity and self dot plot to identify repeats.

Two BLAST searches - one using a house keeping protein and another using a rare protein. Comparison of the results with reference to elements of the search list.
Study of the CATH and SCOP database to write a report followed by classification of a given protein.
Hydropathy plot of a globular and a membrane protein followed by a comparison of the two plots.
Identification of consensus sequence through multiple sequence alignment.
Using the multiple sequence alignment for the construction of phylogenetic tree.
Secondary structure prediction using Chou-Fasman and other methods.
Tertiary structure prediction using homology modelling and threading.
Docking –protein-protein, protein-ligand or DNA-ligand.

MCB514: Proteomics (FM: 50)

Unit 514.1: Mass spectroscopy

Principles of mass spectrometry, m/z ratio, Time of Flight analysis, MALDI and ESI Mass spectrometry, mass spectrometry as an indispensable tool for proteomics; 2-D Gel electrophoresis.

Unit 514.2: Nuclear magnetic resonance spectroscopy

Basic principles, chemical shift, spin-spin interaction, NOE, 2D-NMR, NOESY, COSEY.

Unit 514.3: Crystallography

Principle of X-ray diffraction, scattering vector, structure factor, phase problem, reciprocal lattice and Ewald sphere, Miller indices, zone axes, crystal lattice, Laue equations, Bragg's law, special properties of protein crystals, model building, refinement and R-factor.

MCB515: Medical Biotechnology and Gene Therapy (FM: 50)

Unit 515.1: Diagnosis of diseases

Disease diagnosis by PCR, LCR and immunological assays. Detection of genetic, Neurogenetic disorders involving Metabolic and Movement disorders. Treatment-products from recombinant and non-recombinant organisms, Interferons, Antisense therapy, cell penetrating peptides.

Unit 515.2: Gene therapy

Types of gene therapy, somatic versus germline gene therapy, mechanism of gene therapy, ex vivo and in vivo therapies; vectors used in gene therapy: viral vector: retroviruses, adenoviruses, adeno-associated viruses, lentiviruses; non-viral vector: naked DNA, polymersomes, polyplexes.

Unit 515.3: Cancer

Origin and Terminology, different forms of cancers, modulation of cell cycle in cancer, Oncogenes and Cancer Induction, Metastasis and Malignancy, Growth factors related to cancerous transformation. Role of telomerases in cancer. Detection of cancer using biochemical assays and tumor markers. Different forms of therapy: chemotherapy, radiation therapy, stem cell therapy. Detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Detection of mutations in neoplastic diseases MCC, SSCP, DGGE, PTTC. Use of signal targets towards therapy of cancer.

Unit 515.4: Cell culture

Introduction, cell culture laboratory-design, layout and maintenance. Equipment and Instrumentation. Four levels of bio safety and their requirements. Types of culture media, composition, preparation and metabolic functions. Role of CO_2, Serum, supplements, growth factors (EGF, PDGF). Serum and protein free defined media. Culture and maintenance of primary and established cell lines. Biology of cultured cells; cell adhesion, cell proliferation and differentiation. Characterization of cultured cells; viability, cytotoxicity, growth parameters, cell death and apoptosis. Scaling up of animal cell culture, Cell synchronization, and transfection of DNA. Application of animal cell culture.

Unit 515.5: Gene Editing

Limitations of genetic engineering; Genome engineering using Zinc Finger Nuclease (ZFN) Technology; Transcription activator-like effector nuclease (TALEN) Technology; Clustered regularly interspaced shortpalindromic repeats (CRISPR)/Cas9 technology: target identification, gRNA design, donor design, applications in treating human diseases: Human cell engineering-Thalassemia, SCID, Haemophilia, etc.

MCB516: Indian Knowledge system related to Microbiology (FM: 25)

Unit 516.1: Introduction to Indian Knowledge Systems: Concept of Indian Knowledge Systems (IKS); Evolution of scientific thought in ancient India; Traditional biological knowledge in classical literature; Importance of indigenous knowledge in sustainable science and scientific validation of traditional knowledge.

Unit 516.2: Traditional Fermentation and Food Microbiology: History of fermentation in India Indigenous fermented foods- Curd, Idli and Dosa, Dhokla, Kinema, Gundruk, Rice beer and traditional fermented beverages; Microorganisms involved; Nutritional and probiotic significance; Food preservation using traditional methods; Microbial concepts in Ayurveda; Gut microbiota and Ayurvedic dietary principles; Medicinal plants with antimicrobial activity; Traditional household disinfectants-Neem, Turmeric, Tulsi.

Unit 516.3: Indigenous Agricultural and Environmental Microbiology: Traditional composting practices; Vermicomposting; Biofertilizers in Indian agriculture; Rhizosphere microbes in traditional farming; Natural pest management; Sustainable microbial technologies inspired by traditional practices.

MCB521: Grant writing (FM: 100)

A grant proposal on any relevant topic in biology will have to be prepared by students following the format of National Institute of Health, USA. The students will also be required to defend the proposal before a panel of experts. Both the written proposal and its defense will be taken into consideration for evaluation.

MCB522: Semester Away for Internship (FM: 150)

Students will do Internship in laboratories outside for the whole semester.

Programme Educational Objectives (PEOs)

PEO1. Demonstrate advanced knowledge and understanding of microbiology, molecular biology, immunology, genetics, genomics, microbial physiology, ecology, biotechnology and related interdisciplinary sciences.
PEO2. Apply microbiological concepts and modern laboratory techniques to address problems in healthcare, agriculture, industry, environmental sustainability and biotechnology.
PEO3. Develop competence in scientific investigation, critical thinking, data analysis, bioinformatics, and research methodology for pursuing doctoral research or careers in academia, research institutions and industry.
PEO4. Exhibit ethical conduct, biosafety, biosecurity, intellectual property awareness and responsible research practices while contributing to scientific advancement and societal welfare.
PEO5. Develop communication, leadership**Eukaryotic Microbiology & Host-pathogen Interaction**
MCB412
Prof. Krishnendu Acharya/ Dr. Sandipan Ganguly, entrepreneurship, grant writing and lifelong learning skills necessary for professional excellence and innovation.

Programme Outcomes (POs)

PO1. Knowledge- Acquire comprehensive knowledge of microbial diversity, physiology, genetics, molecular biology, immunology, biotechnology and microbial ecology.
PO2. Scientific Reasoning- Apply scientific principles to formulate hypotheses, design experiments and interpret microbiological data.
PO3. Laboratory Competence- Perform advanced microbiological, molecular, biochemical and immunological techniques using modern instrumentation.
PO4. Research Skills- Plan, execute and analyze independent research using appropriate experimental and statistical methods.
PO5. Computational Skills- Utilize bioinformatics, computational biology and modern software tools for biological data analysis.
PO6. Critical Thinking - Critically evaluate scientific literature and solve complex biological problems using evidence-based approaches.
PO7. Communication - Communicate scientific concepts effectively through oral presentations, scientific writing and publication-quality reports.
PO8. Ethics and Professionalism- Practice biosafety, biosecurity, research ethics, intellectual property rights and environmental responsibility.
PO9. Teamwork and Leadership - Function effectively as an individual or team member in multidisciplinary environments.
PO10. Lifelong Learning - Recognize the importance of continuous learning and adapt to emerging scientific developments.

Programme Specific Outcomes (PSOs)

PSO1. Understand microbial diversity, physiology, metabolism, genetics, genomics and host–microbe interactions at molecular and cellular levels.
PSO2. Apply microbiological principles in medical, industrial, agricultural and environmental biotechnology.
PSO3. Design and perform molecular biology experiments including cloning, protein expression, genomics, proteomics and bioinformatics analyses.
PSO4. Investigate microbial pathogenesis, antimicrobial resistance, immune responses and therapeutic interventions.
PSO5. Develop research proposals, conduct independent research, interpret scientific data and communicate findings effectively.

COURSE OUTCOMES (COs)

Semester I

MCB411: Molecular Biology and Enzymology

CO1. Explain molecular mechanisms governing DNA replication, transcription and translation.
CO2. Describe enzyme structure, kinetics, regulation and catalytic mechanisms.
CO3. Analyze molecular interactions involved in gene regulation and protein synthesis.
CO4. Apply enzymological principles in biotechnology and molecular diagnostics.
CO5. Perform molecular biology and enzymology experiments using modern laboratory techniques.

MCB412: Eukaryotic Microbiology and Host–Microbe Interaction

CO1. Describe biology and diversity of fungi, protozoa and other eukaryotic microbes.
CO2. Explain mechanisms of microbial pathogenesis and host defense.
CO3. Analyze host–pathogen interactions at cellular and molecular levels.
CO4. Evaluate microbial virulence strategies and immune evasion mechanisms.
CO5. Interpret recent advances in host–microbe interactions.

MCB413: Microbial Metabolism and its Industrial Application

CO1. Explain microbial metabolic pathways and their regulation.
CO2. Analyze energy generation and biosynthetic pathways.
CO3. Evaluate industrial fermentation processes.
CO4. Apply metabolic engineering concepts in biotechnology.
CO5. Assess industrial applications of microbial metabolites.

MCB414: Ecology and Biodiversity

CO1. Explain microbial diversity and ecosystem functioning.
CO2. Describe microbial interactions in terrestrial and aquatic environments.
CO3. Analyze microbial roles in biogeochemical cycles.
CO4. Evaluate ecological approaches for environmental sustainability.
CO5. Assess microbial biodiversity using modern molecular tools.

MCB415: IPR & Bioethics, Biosafety, Spectroscopy, Microscopy & Statistics

CO1. Explain principles of intellectual property rights and research ethics.
CO2. Demonstrate biosafety and laboratory safety practices.
CO3. Interpret spectroscopic and microscopic data.
CO4. Apply statistical methods for biological data analysis.
CO5. Evaluate ethical issues in microbiological research.

Semester II

MCB421: Regulation of Gene Expression

CO1. Explain mechanisms regulating gene expression in prokaryotes and eukaryotes.
CO2. Describe transcriptional and post-transcriptional regulation.
CO3. Analyze epigenetic regulation.
CO4. Interpret gene regulatory networks.
CO5. Evaluate modern approaches for studying gene regulation.

MCB422: Immunology

CO1. Describe innate and adaptive immune responses.
CO2. Explain antigen recognition and immune signaling.
CO3. Analyze immune disorders and hypersensitivity.
CO4. Evaluate vaccine development and immunotherapy.
CO5. Apply immunological techniques in diagnostics and research.

MCB423: Microbes in Sustainable Agriculture and Development

CO1. Explain roles of beneficial microbes in agriculture.
CO2. Describe biofertilizers, biopesticides and PGPR.
CO3. Analyze microbial contributions to sustainable farming.
CO4. Evaluate microbial technologies for environmental sustainability.
CO5. Assess applications of microbial inoculants in agriculture.

MCB424: Virology
CO1. Explain viral structure, classification and replication.
CO2. Describe virus–host interactions.
CO3. Analyze viral pathogenesis.
CO4. Evaluate antiviral strategies and vaccines.
CO5. Apply virological techniques in diagnostics and research.

MCB425: Genetics and Genomics
CO1. Explain principles of microbial genetics.
CO2. Analyze genome organization and evolution.
CO3. Apply genomic technologies for biological research.
CO4. Interpret next-generation sequencing data.
CO5. Evaluate comparative and functional genomics.

MCB426: Cloning and Overexpression of a Protein
CO1. Explain principles of recombinant DNA technology.
CO2. Design cloning strategies.
CO3. Perform recombinant protein expression and purification.
CO4. Analyze protein characterization techniques.
CO5. Apply recombinant technologies in biotechnology.

Semester III
MCB511: Antimicrobials
CO1. Explain mechanisms of antimicrobial action.
CO2. Describe antimicrobial resistance mechanisms.
CO3. Analyze susceptibility testing methods.
CO4. Evaluate strategies to combat antimicrobial resistance.
CO5. Assess discovery and development of novel antimicrobials.

MCB512: Cell Biology
CO1. Describe structure and function of eukaryotic cells.
CO2. Explain intracellular signaling pathways.
CO3. Analyze cell cycle and apoptosis.
CO4. Evaluate cellular responses during infection.
CO5. Apply cell biology techniques in research.

MCB513: Computer Application and Bioinformatics
CO1. Explain computational tools used in microbiology.
CO2. Retrieve and analyze biological databases.
CO3. Perform sequence alignment and phylogenetic analyses.
CO4. Apply structural bioinformatics and molecular docking.
CO5. Interpret bioinformatics data for biological research.

MCB514: Proteomics
CO1. Explain protein structure and proteome organization.
CO2. Describe mass spectrometry-based proteomics.
CO3. Analyze protein expression and post-translational modifications.
CO4. Interpret proteomic datasets.
CO5. Evaluate applications of proteomics in microbiology and medicine.

MCB515: Medical Biotechnology and Gene Therapy
CO1. Explain molecular basis of gene therapy.
CO2. Describe genome editing technologies.
CO3. Analyze therapeutic vectors and delivery systems.
CO4. Evaluate applications of medical biotechnology.
CO5. Assess ethical and regulatory aspects of gene therapy.

MCB516: Indian Knowledge System Related to Microbiology
CO1. Explain traditional Indian knowledge related to microbiology and biotechnology.

CO2. Describe microbiological basis of indigenous fermentation, agriculture and traditional medicine.
CO3. Critically evaluate traditional practices using modern scientific evidence.
CO4. Analyze the contribution of Indian Knowledge Systems to sustainable development.
CO5. Appreciate the integration of indigenous knowledge with contemporary microbiological research.

Semester IV

MCB521: Grant Writing

CO1. Identify contemporary research problems in microbiology.
CO2. Develop competitive research proposals with clear objectives and methodology.
CO3. Prepare realistic budgets and project timelines.
CO4. Critically evaluate funding opportunities and proposal review criteria.
CO5. Demonstrate scientific writing and presentation skills required for successful grant applications.

MCB522: Semester Away Internship, Dissertation and Seminar

CO1. Apply theoretical knowledge to real-world research or industrial problems.
CO2. Demonstrate competence in advanced laboratory techniques and data analysis.
CO3. Conduct independent research following ethical and biosafety guidelines.
CO4. Prepare a dissertation in the format of a scientific research report.
CO5. Present and defend research findings effectively before an expert audience.