DEPARTMENT OF MICROBIOLOGY

M. SC. MICROBIOLOGY

Programme Outcomes(PO)

After successfully completing **M.Sc. (Microbiology)** Programme students will be able to:

PO1: **Microbiology knowledge**: Apply the knowledge of Microbiology, life sciences and allied subjects to the understanding of microbial life processes and related phenomena.

PO2: **Problem analysis**: Identify research problems, review research literature, and analyse complexities of microbial interactions *in vitro* and *in vivo.*

PO3: **Design/development of research solutions**: Design processes/strategies that meet the specified needs with appropriate consideration for the public health and safety, along with societal and environmental considerations.

PO4: **Conduct investigations of complex problems**: Use research-based knowledge and appropriate research methodology including design of experiments, statistical analysis and interpretation of data, and synthesis of the information to provide valid experimental conclusions.

PO5: **Modern tools usage**: Create, select, and apply appropriate techniques, resources, and ICT tools for understanding of the subject.

PO6: **The post graduate and the society**: Apply reasoning obtained through the contextual knowledge to assess impact of microorganisms on the society, health, etc., and the relevant responsibilities with respect to professional commitments.

PO7: **Environment and sustainability**: Understand the impact of microorganisms in societal and environmental contexts, and understand the need for sustainable development.

PO8: **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the work/research practice.

PO9: **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication**: Communicate effectively on complexities of microorganisms with the scientific community and with society at large, including comprehension, effective report writing and design documentation making effective presentations ,and give and receive clear instructions.

PO11: **Project management and finance**: Demonstrate knowledge and understanding of Microbiology and management principles and apply these to one's own work, as a member and leader in a team.

PO12: **Life-long learning**: Recognise the need for and inculcate the ability to engage in independent and life-long learning in the broadest context of microbiology, and ultimately life.

Programme Specific Outcomes(PSO)

After successfully completing **M.Sc. (Microbiology)** Programme students will be able to:

PSO1: Understand the classification and diversity of microorganisms and the resulting implications in relation to other life forms.

PSO2: Explain the function of microorganisms at the level of the cell, genome, gene, etc., and develop theoretical and practical knowledge in handling the microorganisms and using them as model organisms.

PSO3: Illustrate the intracellular organisation, physiological adaptations, growth and development of different microorganisms.

PSO4: Understand role of microorganisms in the medical field including disease pathology and epidemiology, as well as disease prophylaxis and therapeutics.

PSO5: Understand the role of microorganisms and their applications in medical microbiology, fermentation, genetic engineering, agriculture, as well as environment-related and other biotechnological industries.

PSO6: Impart knowledge of research methodology, including skill developments in scientific writing, data handling and processing, development of research ideas and planning / designing of research projects.

PSO7: Develop proficiency in the experimental techniques and methods of analysis appropriate for their area of specialisation and relate concepts of physics, chemistry and mathematics to microbiology.

Course Outcomes(CO)

M.SC. (MICROBIOLOGY) FIRST YEAR M. SC. SEMESTER I

Course MB 501: Microbial Diversity & Taxonomy

After successfully completing this course, students will be able to:

CO1: Explain the concept of speciation and species evolution.

CO2: Illustrate and measure the microbial diversity.

CO3: Classify bacteria by referring to Bergey's manuals and classify fungi.

CO4: Explore un-culturable bacteria.

CO5: Explain theories of evolution.

Course MB 502: Quantitative Biology

After successfully completing this course, students will be able to:

CO1: Use descriptive statistical interpretation and tabular and graphical data representation.

CO2: Explain concepts of probability, null hypothesis, statistical errors and related terms of inferential statistics.

CO3: Describe concept and application of tests of significance.

CO4: Use appropriate statistical tests for three samples.

CO5: Explain nonparametric tests vis-à-vis parametric tests.

CO6: Understand applications of probability and probability distributions.

Course MB 503: Biochemistry and Metabolism

After successfully completing this course, students will be able to:

CO1: Describe the structural features of proteins and classify proteins.

CO2: Determine the primary structure of polypeptide.

CO3: Explain biochemical techniques like chromatography and electrophoresis.

CO4: Explain molecular biology techniques like PCR and sequencing.

CO5: Illustrate development of *Drosophila* and *Xenopus.*

CO6: Explain morphogenesis and organogenesis in plants.

CO7: Describe structural organisation of cellular organelles and their role in protein trafficking.

CO8: Describe processes in cell cycle and apoptosis.

Course MBTE-12: Experimental Design and Quantitative approached for Biologist (Theory course)

After successfully completing this course, students will be able to:

CO1: Design scientific experiments keeping in mind research methodology and sampling errors.

CO2: Design surveys, experiments based on factorial design, epidemiological studies and clinical trials.

CO3: Present experimental data using tables, graphs and equations.

CO4: Analyse data trends, goodness of fit and explain linear and non-linear models.

CO5: Explain and verify mathematical models and verify them.

Course MBPE-12: Experimental Design and Quantitative approached for Biologist (Practical course)

After successfully completing this course, students will be able to:

CO1: Design mock research proposal.

CO2: Design epidemiological study as a mini project or statistical survey or factorial study.

CO3: Solve problems based on numerical microbiology.

CO4: Prepare and use datasheets and plot graphs using a statistical software (e.g. PAST).

CO5: Analyse data using students *t* test, ANOVA, Chi square test and *F* test using a statistical software (e.g. PAST).

Course MBCP-1: Biochemical Techniques (Practical course)

After successfully completing this course, students will be able to:

CO1: Follow standard operating procedures and safety rules in laboratory.

CO2: Prepare buffers and determine its pK_a.

CO3: Prepare and use datasheets and plot graphs in MS-Excel.

CO4: Analyse data using students *t* test, ANOVA, Chi square test and *F* test in MS-Excel.

CO5: Enrich, isolate and identify extremophiles (alkaliphiles) from natural samples.

CO6: Enrich, isolate and identify extremophiles (thermophiles) from natural samples.

CO7: Study the stages in mitosis and observe polyploidy.

CO8: Identify various developmental stages on embryos using permanent slides.

CO9: Extract protein and exopolysaccharide from bacterial culture.

CO10: Estimate proteins by Bradford method using spectrophotometer.

CO12: Separate hydrolysed protein and EPS sample using paper and thin layer chromatography.

CO13: Carry out SDS-PAGE electrophoresis of proteins or ion-exchange chromatography.

CO14: Interpret Ramachandran Plot and study protein conformations using molecular graphics visualization tool (e.g. PDB).

Course MB 601: Instrumentation and Molecular Biophysics

After successfully completing this course, students will be able to:

CO1: Explain principle and procedures of techniques for preparation of biomolecules.

CO2: Explain principle and procedures of chromatography and electrophoresis techniques for separation and analysis of biomolecules.

CO3: Explain principle and procedures of various spectroscopy techniques.

CO4: Explain principle and procedure of biophysical technique – NMR spectroscopy.

CO5: Explain principle and procedure of biophysical technique – X-ray crystallography.

CO6: Elaborate on the role and use of radioisotopes in biology.

CO7: Explain principle and working of confocal microscopy.

Course MB 602: Molecular Biology

After successfully completing this course, students will be able to:

CO1: Describe eukaryotic RNA processing mechanisms.

CO2: Explain principle and procedures of various molecular techniques.

CO3: Elaborate on the tools involved in genetic engineering.

CO4: Describe use of various vectors involved in DNA cloning and expression.

CO5: Explain procedures for cDNA and genomic library construction.

CO6: Explain concept and applications of genome projects.

CO7: Elaborate on genome projects of human, *E. coli*, yeast, *Plasmodium*, mouse, *Drosophila* and rice.

CO8: Explain gene annotation technique.

Course MB 603: Enzymology, Bioenergetics and Metabolism

After successfully completing this course, students will be able to:

CO1: Explain procedures of protein purification.

CO2: Describe kinetics and allosterism in enzyme-catalysed reactions.

CO3: Elaborate on the laws of thermodynamics.

CO4: Describe the role of high energy compounds in metabolic reactions.

CO5: Classify lipids and explain structure, synthesis and degradation of lipids.

CO6: Classify carbohydrates and explain structure, synthesis and degradation of carbohydrates.

Course MBTE-21: Bioinformatics and Bio-nanotechnology (Theory course)

After successfully completing this course, students will be able to:

CO1: Explain the concept of biological databases.

CO2: Describe and use sequence and structural databases of nucleotides and proteins.

CO3: Use GenBank, PDB and OMIM databases and RASMOL and Ligand Explorer software.

CO4: Explain pair-wise and multiple sequence alignment of nucleotides and proteins.

CO5: Perform database similarity searches using BLAST and FASTA.

CO6: Explain synthesis and application of biogenic nanoparticles.

CO7: Describe properties of nanoparticles and their significance.

CO8: Explain how nanoparticles are charaterised.

CO9: Explain imaging techniques used in characterization of nanoparticles.

Course MBPE-21: Bioinformatics and Bio-nanotechnology (Practical course)

After successfully completing this course, students will be able to:

CO1: Isolate bacterial chromosomal DNA, check its purity and perform agarose gel electrophoresis to detect it.

CO2: Amplify 16S rRNA using PCR and purify the PCR product.

CO3: Understand sequencing of PCR product.

CO4: Perform BLAST analysis of obtained 16S rRNA sequence.

CO5: Draw phylogenetic tree using PhyLip, Mega or other software.

CO6: Synthesise two types of nanoparticles using actinomycetes or fungi or yeast.

CO7: Characterise obtained nanoparticles, and study their antimicrobial and dye-decolourisation activities.

CO8: Synthesise two types of nanoparticles using plant material or plant extract.

CO9: Characterise obtained nanoparticles, and study their antimicrobial and dye-decolourisation activities.

CO10: Analyse nanoparticle characterization data from scientific literature.

Course MBCP-2: Molecular Biology, Enzymology and Instrumentation Techniques

After successfully completing this course, students will be able to:

CO1: Induce beta-galactosidase production, repress glucose utilisation and study diauxic growth in *E. coli.*

CO2: Isolate, quantify and characterise plasmid DNA.

CO3: Construct restriction map of isolated plasmid DNA.

CO4: Cure plasmid DNA from *E. coli* cells having plasmids.

CO5: Annotate genes using online bioinformatics tool.

CO6: Purify amylase or invertase enzyme and prepare purification chart.

CO7: Determine K_m, V_{max} and K_{cat} of the purified enzyme.

CO8: Determine molar extinction coefficient of a biomolecule (e.g. protein).

CO9: Isolate aflatoxin producing organism, and extract and detect it in food.

CO10: Isolate and characterize lipase or cellulose or chitinase producing organism.

CO11: Understand concept of scientific communication and research methodology.

M. SC. (MICROBIOLOGY) SECOND YEAR

Course MB 701T Immunology I:

After successfully completing this course, students will be able to:

CO1: Explain structure and function of cell surface receptors.

CO2: Explain the regulation of immune response.

CO3: Elaborate on experimental immunology techniques.

CO4: Explain tumour immunology related concepts.

CO5: Explain the role of immunity during infection.

CO6: Describe the various immunological disorders.

CO7: Illustrate the mechanisms of immune system evolution

Course MB 702: Molecular Biology I

After successfully completing this course, students will be able to:

CO1: Explain the principles and procedures of tools used in molecular biology.

CO2: Elaborate on the mechanisms involved in fine control of eukaryotic and prokaryotic

transcription.

CO3: Illustrate the various mechanisms involved in RNA processing.

CO4: Describe the types of mobile genetic elements and mechanisms and regulation of transposition.

CO5: Illustrate the protein structure analysis and protein interactions in proteomic studies.

CO6: Explain metabolomics and global biochemical networks.

CO7: Explain principles and procedures of techniques in molecular biology and their applications in cancer diagnostics.

Course MB 703: Industrial Wastewater Treatment

After successfully completing this course, students will be able to:

CO1: Explain the various principles of wastewater treatment.

CO2: Illustrate the pre-treatment and primary treatment of wastewater.

CO3: Illustrate the secondary and tertiary treatment of wastewater.

CO4: Explain the currently existing wastewater treatment processes.

CO5: Elaborate on the environment impact assessment methods and applications.

CO6: Describe advanced, combined and innovative wastewater treatment processes.

Course MB 711: Practical Course based on Immunology, Pharmaceutical Microbiology and Environmental Microbiology

After successfully completing this course, students will be able to:

CO1: Perform immunodiffusion and immunoelectrophoresis to study antigen-antibody interactions.

CO2: Determine titre of iso-antibodies to human blood group antigens.

CO3: Perform density gradient based separation of peripheral lymphocytes.

CO4: Culture lymphocytes *in vitro* and study their proliferation on mitogenic stimulus.

CO5: Culture chick embryo fibroblast cells from fertilized eggs.

CO6: Extract bioactive principles from plants and check their antimicrobial activity.

CO7: Estimate the pollution load of river water or wastewater sample.

CO8: Perform degradation of synthetic wastewater.

CO9: Observe and understand immunological techniques as carried out in industry or institute.

CO10: Observe and understand environment impact assessment of wastewater treatment plant.

Course MB 712: Practical Course based on Molecular Biology (I & II) and Microbial Technology

After successfully completing this course, students will be able to:

CO1: Isolate, detect and characterise plasmid DNA.

CO2: Perform transformation of *E. coli* using plasmid.

CO3: Isolate bacteria from an environmental sample and characterise them using molecular techniques.

CO4: Annotate genes using online bioinformatics tool.

CO5: Study bioconversion by immobilisation of enzyme or whole cell.

CO6: Carry out laboratory-scale production of exopolysaccharide or bioemulsifier.

CO7: Perform biosorption of dyes or metals using dead biomass.

Course MB 801: Pharmaceutical and Medical Microbiology

After successfully completing this course, students will be able to:

CO1: Explain principles and experimental procedures involved in drug discovery and drug development.

CO2: Describe the principles and procedures involved in development and susceptibility testing of anti-infectives.

CO3: Illustrate the role of determinants in microbial pathogenicity.

CO4: Explain the procedures involved in discovery of anti-infectives.

CO5: Explain the concepts of quality assurance and validation in pharmaceutical industry.

CO6: Describe the regulations laid down for biopharmaceuticals and procedures used for obtaining biopharmaceuticals from appropriate biological sources.

CO7: Explain epidemiological and investigational approaches used for emerging infectious diseases.

Course MB 802: Molecular Biology II

After successfully completing this course, students will be able to:

CO1: Explain principles and concepts of genetic genomic and epigenetic studies.

CO2: Describe mechanisms of genomic variation.

CO3: Explain concepts of pharmacogenomics.

CO4: Illustrate the techniques involved in gene cloning studies and describe applications of transgenic plants and animals.

CO5: Describe applications of secondary metabolites obtained using recombinant DNA technology.

CO6: Elucidate the application of genetically modified plants and animals.

CO7: Describe bioremediation through degradation of xenobiotics.

CO8: Explain biomass utilisation for fructose, cellulose and silage production.

CO9: Describe methodologies involved in genomic projects and applications of genomic projects.

Course MB 803: Microbial Technology

After successfully completing this course, students will be able to:

CO1: Illustrate the designing and operation of various bioreactors including applications.

CO2: Describe process variables of bioreactors and their monitoring.

CO3: Explain the upstream, fermentation and downstream processing of microbial processes.

CO4: Describe concepts of intellectual property rights.

CO5: Explain microbial growth characteristics and product formation in microbial processes.

CO6: Describe applications of fungi in industry.

CO7: Illustrate procedures of animal cell culture technology to produce recombinants and monoclonal antibodies.

CO8: Explain concepts of validation of methods in microbial process technology.

Course MB 811 & MB 812: Dissertation Project

After successfully completing this course, students will be able to:

CO1: Inculcate understanding of research problems.

CO2: Refine research aptitude through carrying out in-depth literature survey.

CO3: Refine research aptitude through inputs in development of plans and protocols for the experimentation.

CO4: Refine research aptitude through ability to analyse data and formulate a solution.

CO5: Refine research aptitude through analytical and reasoning abilities of the student for interpretation of data, inputs in discussion.

CO6: Inculcate punctuality and seriousness, as well as meet dead-lines.

CO7: Develop ability to work with others.

CO8: Develop maturity of scientific thoughts.

CO9: Improve both oral and written communication skills.

CO10: Become proficient in presentation skills through use of audio-visual aids, preparation of graphs, charts, models, etc.

CO11: Learn use of scientific language in write-ups and presentations.

CO12: Describe research potential of dissertation work.

CO13: Develop ability to describe results and interpretation, outcome of the study and possible future plans, publication potential of the dissertation work.

CO13: Develop ability to prepare dissertation report using scientific writing.

CO14: Develop ability to give satisfactory responses to the queries from the audience.

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