# M.Sc. Microbiology

## Semester I

<table>
<thead>
<tr>
<th>Semester</th>
<th>Theory</th>
<th>Practical</th>
<th>Name of paper</th>
<th>Contact Hours / week</th>
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<td>L- T- P (Credit)</td>
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<tr>
<td>Semester 1</td>
<td>MScMc 101</td>
<td>Diversity of the microbial world and essentials of microbial physiology and biochemistry</td>
<td>3-0-0 (3)</td>
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<tr>
<td>MScMc 102</td>
<td>Instrumentation and Biophysics</td>
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<tr>
<td>MScMc 103</td>
<td>Molecular Biology and Genetics</td>
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<td>Semester 2</td>
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<td>MScMc 203</td>
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<tr>
<td>MScMc 481</td>
<td>Project</td>
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MScMc-101 Diversity of the microbial world and essentials of microbial physiology and biochemistry
3 Credits

Unit I
Cell Structure (Special emphasis on Cell Wall & Membrane) and Microbial
Diversity Structural differences between different microbial cell types and cellular
organelles; Biochemical/Microscopic/Molecular methods used to differentiate between archaea, eubacteria
and eukaryotes; Cell wall of prokaryotes; Outer membrane of Gram -ve bacteria and control of its synthesis;
Potential targets for drug design.

Unit II
Biomolecules and Principles of Microbial Nutrition Importance of non-covalent interactions in
biological systems; Noninformational and Informational Macromolecules and their
organization; Microbial nutrition; Different types of culture medium; C/N/P balance and making of
culture medium.

Unit III
Bioenergetics and Catabolic Pathways Oxidation-reduction reactions; Electron carriers and cellular
metabolism; High energy compounds and their role in microbial fermentations Enzymes as catalysts;
Cellular metabolites and interconnectivity in biochemical pathways; Respiration and Electron
Transport.

Unit IV
Metabolic diversity Energy from oxidation of inorganic electron donors; Iron oxidation; Methanotrophy and
methylothrophy; Nitrate and Sulfate reduction; Acetogenesis; Methanogenesis; Fermentation-energetics and
redox constraints; Anaerobic respiration; Chlorophylls and other pigments involved in microbial
photosynthesis; Anoxic oxygenic and oxygenic photosynthesis; Autotrophic CO2 Fixation: Calvin cycle, Reverse
Citric Acid cycle, Hydroxy-propionate cycle.

Unit V
Microbial Genetics and Genomics; Mutations and their chemical basis; Mutagens and their use in
Biotechnology; Modes of recombination; Comparative prokaryotic genomics

Texts/References:
7. Thomas M. Devlin: Biochemistry with Clinical Correlations

MScMc-102 Instrumentation & Biophysics 3 Credits

Unit I

**Basic Techniques** - Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques

**Spectroscopy Techniques** - UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy **Infrared Spectroscopy** – Principles of IR spectroscopy, vibrational spectra of biopolymers, Fourier transform of Infra Red spectroscopy, Instrumentation, factors influencing vibrational frequency (Vibronic coupling, H-bond, electronic factors, bond angles, etc)

**NMR Spectroscopy** – Proton magnetic resonance spectra of proteins, 13C NMR spectra of proteins, 31P NMR studies, NMR spectra of nucleic acids, Fourier transform of NMR spectroscopy, Relaxation (ID spectra) **X-Ray Crystallography** – Instrumentation, Fourier transformation, Application

Unit II

**Chromatography Techniques** - TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

**Electrophoretic techniques** - Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit III

**Centrifugation** - Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

Unit IV

**Radioactivity** - Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay.

Unit V
**Advanced Techniques** - Protein crystallization; Theory and methods; API-electrospray and MADI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis

**Molecular Modeling & Molecular Dynamics** – Modeling of Macromolecules, different types of interaction energy, molecular potential, bonding potential, non-bonding potential, potential due to angle, torsional strain, electrostatic interaction, molecular structure of protein, lipid, nucleic acid, carbohydrate, energy minimization (SD, ABNR), molecular dynamics simulation for simple molecules (GROMACS software)

**Method of determination of size & shape of macromolecules** – Molecular electron microscopy, measuring electron diffraction of a solid with Electron Microscope, determination of molecular structure in Electron Microscope, minimizing drying & shrinking artifacts, using symmetry to enhance the Electron Microscope image, High Resolution Autoradiography, X-Ray diffraction

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**Text/References:**

1. Cantor & Schimmel : Biophysical Chemistry (Part I, II & III)
2. A. Lehninger : Principles of Biochemistry

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**M.ScMc 103 Introductory Mathematics & Biostatistics** 3 Credits

**Unit I**

Calculus review Calculus (Quick review of concepts): Review of limits, continuity, differentiability; Mean value theorem, Taylor's Theorem, Maxima and Minima;

Fundamental theorem of Calculus; Improper integrals; Applications to area, volume; Convergence of sequences and series; Power series; Partial Derivatives; Gradient and Directional derivatives; Chain rule; Maxima and Minima.

**Unit II**

Ordinary Differential Equations First order differential equations: Exact equations, Integrating factors and Bernoulli equations.

Second and higher order differential equations Linear ODE's with constant coefficients: the characteristic equations; Cauchy-Euler equations; Linear dependence and Wronskians; Method of
undetermined coefficients; Method of variation of parameters; Laplace transforms: Inverse theorem, shifting theorems, partial fraction

Unit III
Linear Algebra Basics: Vectors, matrices, determinants; Matrix addition and multiplication; Systems of equations: Gauss elimination, Matrix rank, Linear independence, Cramer's rule; Inverse of a matrix: Gauss-Jordan elimination; Eigenvalues and Eigenvectors: characteristic polynomials, eigenvalues of special matrices (orthogonal, unitary, hermitian, symmetric, skew-symmetric, normal). Numerical methods Solution of equations by iteration; Interpolation by polynomials; Piecewise linear and cubic splines; Numeric integration and differentiation; Linear systems: Gauss elimination, Gauss-Siedel, matrix inversion; LU factorization; Matrix eigenvalues; Numerical solution of ODEs: Euler and Runge-Kutta methods, Predictor

Biostatistics

Unit IV
**Probability and Statistics** - Definition of Probability, Relative frequency, Probability distribution (Binomial, Poisson & normal), simple examples.
**Statistics** - **Measure of central tendency** – Mean (for grouped & ungrouped data);
**Measure of dispersion** - Standard Deviation (for grouped & Ungrouped data);
**Sampling theory** – Statistical population, Sample from population, Random sample;
**Statistical Hypothesis** - Test of significance, Test for proportion, means & standard deviations, Chi-square test of goodness of fit, t-test, F-test.
**Correlation & Regression (linear)** - Associated test of significance, simple problems.

Unit V

**Fundamental concepts in applied probability** - Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations (variance known, variance unknown); P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformation Corrector methods; Exposure to software packages like Matlab or Scilab.

**Texts/References**
Unit I

**DNA Structure; Replication; Repair & Recombination** - Structure of DNA - A-, B-, Z- and triplex DNA; Measurement of properties - Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair-enzymes; Photo-reactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

**Prokaryotic & Eukaryotic Transcription** - Prokaryotic Transcription; Transcription unit; Promoters - Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation – Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing: Processing of tRNA and rRNA, Eucaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eucaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing

Unit II

**Post Transcriptional Modifications** - Processing of hnRNA, tRNA, rRNA; 5’-Cap formation; 3’-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

**Translation & Transport** - Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and Degradation.

Unit III

**Mutations; Oncogenes and Tumor suppressor genes** - Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators and biological mutagens; Transposition - Transposable genetic
Unit IV

**Genome organization** - Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA re-association kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting. DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions- Electromobility shift assay; DNasel footprinting; Methyl interference assay

**Bacterial mutants and mutations** - Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations (base pair changes; frameshift; insertions; deletions; tandem duplication); Reversion vs. suppression; Mutagenic agents; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test)

Unit V

**Gene transfer in bacteria** - History; Transduction – generalized and specialized; Conjugation – F, F’, Hfr; F transfer; Hfr-mediated chromosome transfer; Transformation – natural and artificial transformation; Merodiploid generation; Gene mapping; Transposable genetic elements; Insertion sequences; Composite and Complex transposons; Replicative and non-replicative transposition; Genetic analysis using transposons. Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Human genetic diversity; Origin of major human groups.

**Bacteriophages and Plasmids** - Bacteriophage–structure; Assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; Plasmids – natural plasmids; their properties and phenotypes; Plasmid biology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid.

Text/References:

4. G.Stent and R. Calendar, molecular genetics: An Introductory Narrative
PRACTICAL PAPERS

MScMc-191: LAB ON BIOCHEMISTRY & ANALYTICAL TECHNIQUES

1. Determination of pH of unknown solution to prepare an Acetic-NaAcetate Buffer system and validate the Henderson-Hasselbach equation.

2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert’s Law.

3. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.

4. An Enzyme Purification theme (such as E.coli Alkaline phosphatase or any enzyme of the institutions choice).
   (a) Preparation of cell-free lysates & Ammonium Sulfate precipitation
   (b) Enzyme Kinetic Parameters: Km, Vmax and Kcat.
   (c) Column Chromatography/ Ion-exchange Chromatography/ Gel Filtration/ Affinity Chromatography/ Generating a Purification Table
   (d) Assessing purity by SDS-PAGE Gel Electrophoresis.

5. Determination of Molecular weight of Protein by Column chromatography

6. Determination of Surface Tension by Stalagmometer.

7. Determination of Viscosity by Oswald’s Viscometer.

References:

1. Cantor & Schimmel : Biophysical Chemistry (Part I, II & III)
2. Jeremy M. Berg, John L. Tymoczko & Lubert Stryer : Biochemistry

MScMc-192: Microbiology Lab

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Identification and culturing of various microorganisms.
4. Staining and enumeration of microorganisms.
5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen
6. Assay of antibiotics production and demonstration of antibiotic resistance.
7. Isolation and screening of industrially important microorganisms.
8. Determination of thermal death point and thermal death time of microorganisms.
MScMc-193: Molecular biology lab

1. Isolation of genomic DNA
2. Isolation of plasmid DNA
3. Primer designing & PCR amplification
4. RFLP analysis of the PCR product.
5. Restriction digestion of vector (gel analysis)
6. DNA Ligation
7. a. Vector and Insert ligation
   b. Transformation
9. Analysis on SDS-PAGE
10. Southern hybridization with probe and non-radioactive detection.
11. Phage titration

References:
1. Sambrook & Russell: Molecular Cloning; 3rd Ed; 2001

M.Sc Microbiology Semester II

MScMc 201 RDNA TECHNOLOGY & IPR 3 Credits

Unit I
Cloning Vectors - Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; EMBL; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.

Unit II
Cloning Methodologies - Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Farwestern cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression.

Unit III
PCR and Its Applications - Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)
Unit IV

Sequencing methods - Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Unit V

IPR

PATENTS Macro economic impact of the patent system Patent and kind of inventions protected by a patent Patent document and protection inventions. Granting of patent Rights of a patent Searching a patent Drafting of a patent Filing of a patent The different layers of the international patent system (national,regional and international options)

COPYRIGHT General Additional Reading: Latest editions of Designs Act, Copyright RELATED RIGHTS . Distinction between related rights and copyright. Rights covered by copyright

TRADEMARKS What is a trademark. Rights of trademark. signs can be used as trademarks types of trademark function does a trademark perform registered trademark protected for .

INDUSTRIAL DESIGNS Industrial design. Protection provided by industrial designs. Need protect industrial designs

MScMc 202 IMMUNOLOGY 3 Credits

Unit I

Immunology- fundamental concepts and anatomy of the immune system Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue (MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptons; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.

Unit II

Immune responses generated by B and T lymphocytes Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling; Immunological basis of self-non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation-endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system
Unit III

New Generation Antibodies - Multigene organization of immunoglobulin genes, Ab diversity; Antibody engineering; Phage display libraries; Antibodies as in vitro and in vivo probes

CMI and Imaging techniques - CD nomenclature, Identification of immune Cells; Principle of Immunofluorescence Microscopy, Fluorochromes; Staining techniques for live cell imaging and fixed cells; Flow cytometry, Instrumentation, Applications; Cell Functional Assays – lymphoproliferation, Cell Cytotoxicity, Mixed Lymphocyte Reaction, Apoptosis, Cytokine expression; Cell cloning, Reporter Assays, In–situ gene expression techniques; Cell imaging Techniques- In vitro and In vivo; Immuno-electron microscopy; In vivo cell tracking techniques; Microarrays; Transgenic mice, gene knock outs.

Antibody Related Techniques - Immuno-chemistry of Antigens - immunogenecity, Antigenecity, haptens, Toxins-Toxoids, Hapten-carrier system; Genetic basis of immune response; Role and properties of adjuvants, Immune modulators; B cell epitopes; Hybridoma Rabbit, human; Antigen–Antibody interaction, affinity, cross reactivity, specificity, epitope mapping; Immuno assays: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Surface plasma resonance, Biosensor assays for assessing ligand–receptor interaction

Unit IV

Vaccinology Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptid vaccines, conjugate vaccines; Antibody genes and antibody engineering-chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

Unit V

Clinical Immunology

Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity - Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation-Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology - Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency- Primary immunodeficiencies, Acquired or secondary immunodeficiencies.

Texts/References:
Unit I

**Microbes in the Terrestrial Environment** – General characteristics of porous media, Distribution of microbes in different soil zones and their metabolic states, role of microbes in surface soil formation, nutrients cycling, Soil pathogens and diseases in plant and human.

**UNIT II**


**Brief account of microbial interactions** -Symbiosis, neutralism, Commensalism, Competition, Ammensalism, Synergism, Parasitism.

**Unit III**

**Biofertilizers**- Biological Nitrogen fixation- symbiotic and asymbiotic, mass production by *Rhizobium*, *Azotobacter* and Cyanobacteria, nitrifying ammonifying and photosynthetic bacteria, Denitrification of nitrate fertilizers to N₂ and N₂O (a green house gas) by denitrifying bacteria, free living and in association with *Azolla*, Phosphate solubilizing bacteria. Soil anerobic methanogens in rice field, Effect of soil pH and heavy metals on microorganisms, Microbial antagonism in soil, Biological control of soil-borne microbial pathogens

**Unit IV**

**Application of Recombinant Microorganisms in Agriculture**- Agrobacterium and virus mediated gene transfer and improvements of crops **Microorganisms and Agriculture** – Functions of Microorganisms: Putrefaction, Fermentation, and Synthesis, Relationships Between Putrefaction, Fermentation, and Synthesis of biomolecules Classification of Soils Based on the Functions of Microorganisms (Disease-Inducing Soils, Disease-Suppressive Soils, Zymogenic Soils, Synthetic Soils), Controlling the Soil Microflora for Optimum Crop Production and Protection.

**Unit V**

**Eco-friendly Microbes and their utilisation** –Utilization of beneficial Microorganisms in Agriculture, Ice minus bacteria and microbial pesticides

MScMc 204 Microbial Bioinformatics 3 Credits

Unit I
Sequence-alignment related problems. Sequence databases; Similarity matrices; Pairwise alignment; BLAST; Statistical significance of alignment; Sequence assembly; Multiple sequence alignment; Clustal; Phylogenetics: distance based approaches, maximum parsimony. Pattern analysis in sequences Motif representation: consensus, regular expressions; PSSMs; Markov model. Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motif-based finding.

Unit II
Structure-related problems Representation of molecular structures (DNA, mRNA, protein), secondary structures, domains and motifs; Structure classification (SCOP, CATH); Visualization software (Pymol, Rasmol etc.); Experimental determination of structures (X-ray crystallography, NMR); Structure databases; Secondary structure prediction; RNA structure prediction; Mfold; Proteinstructure prediction by comparative modelling approaches (homology modelling, threading); Ab initio structure prediction: force fields, backbone conformer generation by Monte Carlo approaches, side-chain packing; Energy minimization; Molecular dynamics; Rosetta; Structure comparison (DALI, VAST etc.); CASP; Protein-ligand docking; Computer-aided drug design (pharmacophore identification); QSAR; Protein-Protein interactions System-wide analyses: Transcriptomics: Microarray technology, expression profiles, data analysis; SAGE; Proteomics: 2D gel electrophoresis; Mass Spectrometry; Protein arrays; Metabolomics: NMR based metabolic flux analysis.

Unit III
Structural Bioinformatics - Protein structures, Ramachandran plot, protein folding structure function relationship, conformational energy calculations, protein structure predictions, secondary and tertiary, protein structure classification-SCOP, CATH, Immuno-informatics-epitope prediction

Unit IV
Introduction to following DATABASEs & Tools – GenBank, Entrez, Introduction to NCBI Protein and Nucleotide Database, OMIM, PubMed, Expasy server search tools and Databases, PIR, Swissprot, TrEmble, PROSITE, PDB, NDB, KEGG, Complex Carbohydrate Structure Database (CCSD), Molecular visualizing tool (Rasmol, Molmol), Gromacs.

Unit V
Bioinformatics: The Business of Research - Research methodology (focusing on computer-based research); Case studies of areas of current bioinformatics research; Routes to research funding (academic and commercial); Bioinformatics business models

Texts/References:
M.ScMc 204  MEDICAL MICROBIOLOGY    3 Credits

Unit I
Classification of medically important microbes; Bacterial Genetic alterations and drug resistance; Structure and function of immune system including Immune response; Autoimmunity, Hypersensitivity and Immunodeficiency, Different types of antigen-antibody reactions and their utilization in diagnosis in different diseases.

Unit II
Gram-positive cocci, disease produced by them and diagnostic approach; Gram- negative cocci, disease produce by them and diagnostic approach; Mycobacteriaceae, Actinomycetaceae and Corynebacteriaceae; Sporebearing and non-spore bearing anaerobes; Enterobacteriaceae including E coli, Salmonella, Shigella; Vibrios; Pseudomonas; Haemophilus, Bordetella, Brucella, etc

Unit III
Classification of medically important viruses, virus cultivation & demonstration; Viral multiplication Bacteriophage & its application in medicine; Poxviridae, Adenoviridae, Herpesviridae; Hepatitis viruses; Picornaviridae, Rhabdoviridae; Retroviridae; Arboviruses; Oncogenic viruses, Preparation & standardization of viral vaccine

Unit IV
Introduction to medical mycology; Superficial & subcutaneous mycosis; Systemic & opportunistic mycosis; Introduction to parasitic diseases; Protozoan parasites of the intestines

Unit V
Hospital Acquired infection control programme & biological waste management programme.

PRACTICAL PAPERS
MScMc-291: IMMUNOLOGICAL TECHNIQUES

1. Preparation of antigens, Immunization and methods of bleeding, Serum separation, Storage.
2. Antibody titre by ELISA method.
4. Counter current immune electrophoresis
5. Rocket Immuno-electrophrosis.
7. Isolation and purification of IgG from serum or IgY from chicken egg.
8. SDS-PAGE, Immunoblotting, Dot blot assays
10. Separation of leucocytes by dextran method
11. Demonstration of Phagocytosis of latex beads
12. Separation of mononuclear cells by Ficoll-Hypaque
13. Flow cytometry, identification of T cells and their subsets
14. Lymphoproliferation by mitogen / antigen induced
15. Lymphnode Immunohistochemistry (direct and indirect peroxidase assay)
16. Immunodiagnostics using commercial kits
MScMc-292: LAB ON SOIL & AGRICULTURAL MICROBIOLOGY

Looking for efficient Nitrate and Phosphate reducing microbes from water and soil.

1. Cultivation of microbes in nitrate broth from different environmental samples
2. Characterizing the morphology of the consortium
3. Testing the ability of nitrate removal by the consortium.
4. Testing the ability of phosphate accumulation by the consortium
5. Application of the consortium for germination trials for Mung bean in soil free medium.
6. Application of the consortium for germination trials for Mung bean in soil.
7. Testing the consortium for production of phytohormones.
   8. Testing the plants growth in terms shoot length, leaf number, leaf dimension, number of nodes, chlorophyll content, number of nodules, root branching, etc.
9. The effect of PGPB on leaf epiphytic microbial consortia would be test.

MScMc-293: LAB ON BIOINFORMATICS

1. Retrieval of sequences using ENTREZ
2. Sequence analysis using BLAST, Align, Lalign
3. Multiple sequence alignment and Phylogenetic analyzing of housekeeping genes.(Using Clustal, ClustalW etc)
4. Studying 3D structure using RASMOL
5. Homology Modeling using Swiss PDB – Hb, Protease
6. Calculation of Phi and Psi angle - Hb, Protease
7. Docking: protein-protein; protein-small molecules
8. Potential energy calculation of regular structures
9. To mutate protein and energy minimization using Swiss PDB viewer
10. Gene prediction – Gene D’cefer
11. Adhesion protein prediction – Sea path
12. Comparative proteomics and genomics – Proteome calculator
13. Protein annotation - PLHost