M.Sc. Microbiology

Semester I

Semester	Theory	Practical	Name of paper	Contact Hours / week (Credit) L- T- P (Credit)
Semester 1	MScMc 101		Diversity of the microbial world and essentials of microbial physiology and biochemistry	3-0-0 (3)
	MScMc 102		Instrumentation and Biophysics	3-0-0 (3)
	MScMc 103		Molecular Biology and Genetics	3-0-0 (3)
	MScMc 104		Introductory mathematics and Biostatistics	3-0-0 (3)
		MScMc 191	Biochemistry and Analytical Techniques	0-0-8 (4)
		MScMc 192	Microbiology	0-0-8 (4)
		MScMc 193	Molecular Biology	0-0-8 (4)
Semester 2	MScMc 201		rDNA Technology & IPR	3-0-0 (3)
	MScMc 202		Immunology	3-0-0 (3)
	MScMc 203		Agricultural Microbiology	3-0-0 (3)
	MScMc 204		Microbial Bioinformatics	3-0-0 (3)
		MScMc 291	Immunology	0-0-8 (4)
		MScMc 292	Soil and Agriculture Microbiology	0-0-8 (4)
		MScMc 293	Bioinformatics	0-0-8 (4)
Semester 3	MScMc 301		Medical Technology	3-0-0 (3)
	MScMc 302		Fermentation Technology	3-0-0 (3)
	MScMc 303		Industrial Microbiology	3-0-0 (3)
	MScMc 304		Food Microbiology	3-0-0 (3)
		MScMc 391	Bioreactor operations	0-0-8 (4)
		MScMc 392	Food and Environmental Microbiology	0-0-8 (4)
		MScMc 381	Summer Internship	(2+2)
		MScMc 382	Seminar leading to project/ Project Proposal Presentation	(2)
Semester 4	MScMc 401		Environmental Microbiology	3-0-0 (3)
	MScMc 402 (Elective)		Advanced Industrial Microbiology	3-0-0 (3)
	MScMc 403 (Elective)		Phyllosphere Microbiology	3-0-0 (3)
	MScMc 404 (Elective)		Advanced Food Microbiology	3-0-0 (3)
	MScMc 405 (Elective)		Advanced Microbial Recycling of water	3-0-0 (3)
		MScMc 491	Grand Viva	(4)
		MScMc 481	Project	(2+4)

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 DiversityStructural differences between different microbial cell types and cellular organelles;Biochemical/Microscopic/Molecular methods used to differentiate between archae, 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 methylotrophy; Nitrate and Sulfate reduction; Acetogenesis; Methanogenesis; Fermentation-energetics and redox constraints; Anaerobic respiration; Chlorophylls and other pigments involved in microbial photosynthesis; Anoxygenic 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:

1. **M.T. Madigan and J.M. Martinko, Brock Biology of Microorganisms, 11th edition, Pearson Prentice-Hall, 2006.**
2. **L. Stryer, Biochemistry, 4th Edition, Freeman, 2002.**
3. **G. Gottschalk, Bacterial Metabolism, 2nd Edition, Springer-Verla**
4. **Jeremy M. Berg, John L. Tymoczko & Lubert Stryer: Biochemistry**
5. **Lehninger – David L. Nelson & Michael M. Cox: Principles of Biochemistry**
6. **David E Metzler: Biochemistry – The Chemical Reactions of Living Cells**
7. **Thomas M. Devlin: Biochemistry with Clinical Correlations**

8. **Charles Rascriver, Arthur L. Beaudet, William S. Sly & David Valle: The Metabolic basis of inherited diseases**

MScMc-102 Instrumentation & Biophysics 3 Credits

Unit I

Basic Techniques - Buffers; Methods of cell disintegration; Enzyme assays andcontrols; 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

Text/References :

1. **Cantor & Schimmel : Biophysical Chemistry (Part I, II & III)**
2. **A. Lehninger : Principles of Biochemistry**
3. **Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.**
4. **Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.**
5. **D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.**
6. **R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.**
7. **Selected readings from Methods in Enzymology, Academic Press.**

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

1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th Edition, ISE Reprint, Addison-Wesley, 1998.
2. E. Kreyszig, Advanced engineering mathematics,8th Edition, JohnWiley, 1999.
3. W. E. Boyce and R. DiPrima, Elementary Differential Equations, 8th Edition, JohnWiley, 2005.

M.ScMc 103 MOLECULAR BIOLOGY & GENETICS 3 Credits

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; Eukaryotic 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

GENETICS

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; DNaseI 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); Reversionvs. 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.

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Text/References:

1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.

2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.

3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002

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 Chromatagraphy/ 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**
3. **David E Metzler : Biochemistry – The Chemical Reactions of Living Cells**

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: Molecularbiology 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
8. Transformation of recombinant plasmid preperation.
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 1

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, haptens; 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, Flurochromes; Staining techniques for live cell imaging and fixed cells; Flow cytometry, Instrumentation, Applications; Cell Functional Assays – lymphoproliferation, Cell Cytotoxicity, Mixed Lymphocyte Reaction, Apoptotosis, 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:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology,4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.

MSc Mc203 AGRICULTURAL MICROBIOLOGY 3 Credits

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

Microbial Metabolism - Conversion of light energy into chemical bond energy-Photosystems I & II. production of ATP Cyano-bacteria and green algae. Role of bacterio-chlorophyll phycocyanin, phycoerythrin and carotenoids in photosynthetic bacteria and cholorphylls in green algae. Photosynthesis in anaerobic and sulphur bacteria. Biological N_2-fixation by Free living anaerobic (*Clostridium*), facultatively anaerobic (*Azospirillum*) and aerobic (*Azotobacter*), N_2-fixers associated with stem, root and leaf, Symbiotic N_2-fixation in legumes and non- legumes by *Rhizobium* and *Frankia*, N_2-fixation by cyanobateria. Requirement of ATP, O_2-sensitivity and inhibition by ammonia and nitrogenous substance in the case of nitrogenase, The peculiarity of alternate nitrogenase of *Streptomyces thermoautotrophicus*,

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 N_2 and N_2O (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

EM Technology - Effective Micro-organisms, EM-BOKASHI, EM-COMPOST, EM-5, EM-X, Recycling.

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, Ramchandran 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:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis 2nd Edition, CSHL Press, 2004.
2. A. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 2nd Edition, John Wiley, 2001.
3. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss, 2003.
4. P. E. Bourne and H. Weissig. Structural Bioinformatics. Wiley. 2003

M.ScMc 204 MEDICAL MICROBIOLOGY 3 Credits

Unit 1

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; Enterobacteriaceaeincluding 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, Preperation & standardizatiion 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 programe & 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.
3. Double diffusion, Immuno-electrophoresis and Radial Immunodiffusion.
4. Counter current immune electrophoresis
5. Rocket Immuno –electrophorrsis.
6. Complement fixation test.
7. Isolation and purification of IgG from serum or IgY from chicken egg.
8. SDS-PAGE, Immunoblotting, Dot blot assays
9. Blood smear identification of leucocytes by Giemsa stain
10. Separation of leucocytes by dextran method
11. Demonstration of Phagocytosis of latex beads
12. Separation of mononuclear cells by Ficoll-Hypaque
13. Flowcytometry, identification of T cells and their subsets
14. Lymphoproliferation by mitogen / antigen induced
15. Lympnode 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