

**MOTHERHOOD UNIVERSITY
ROORKEE**

**A STUDY AND EVALUATION SCHEME
OF
MASTER OF SCIENCE IN MICROBIOLOGY
M.Sc. (Microbiology)
[w.e.f. Academic Session 2019-20 onwards]**

Summary

Programme	M.Sc. (Microbiology)
Duration	2 years full time (4 semesters)
Medium	English
Max. Credits	72

**Motherhood University, Roorkee
Master of Science (Microbiology)
Distribution of Courses in Various Semesters
(2 years PG program in Microbiology)**

Semester I

Sr. No.	Subject Code	Subject Name	Effective Teaching			Credit	Evaluation Scheme		
			L	T	P		Internal Assessment	End Term	Total Marks
			Hours/Week						

Theory

1.	MUMMC 101	Elementary Microbiology	3	-	-	3	40	60	100
2.	MUMMC 102	Elementary Biochemistry	3	-	-	3	40	60	100
3.	MUMMC 103	Cytology	3	-	-	3	40	60	100
4.	MUMMC 104	Molecular Biology	3	-	-	3	40	60	100
5.	MUMMC15 1	<i>Lab Course I</i>	-	-	6	3	40	60	100
6.	MUMMC15 2	<i>Lab course II</i>	-	-	6	3	40	60	100
Total			12	-	12	18	240	360	600

Semester II

Sr. No.	Subject Code	Subject Name	Effective Teaching			Credit	Evaluation Scheme		
			L	T	P		Internal Assessment	End Term	Total Marks
			Hours/Week						

Theory

1.	MUMMC 201	Microbes – Growth and Physiology	3	-	-	3	40	60	100
2.	MUMMC 202	Immunology	3	-	-	3	40	60	100
3.	MUMMC 203	Biological Lab Techniques	3	-	-	3	40	60	100
4.	MUMMC 204	Recombinant DNA Technology	3	-	-	3	40	60	100
5.	MUMMC 251	<i>Lab Course I</i>	-	-	6	3	40	60	100
6.	MUMMC 252	<i>Lab course II</i>	-	-	6	3	40	60	100
Total			12	-	12	18	240	360	600

Semester III

Sr. No.	Subject Code	Subject Name	Effective Teaching			Credit	Evaluation Scheme		
			L	T	P		Internal Assessment	End Term	Total Marks
			Hours/Week						

Theory

1.	MUMMC301	Medical Microbiology	3	-	-	3	40	60	100
2.	MUMMC302	Industrial Microbiology	3	-	-	3	40	60	100
3.	MUMMC303(I) (Elective)	Microbial lab Technology	3	-	-	3	40	60	100
	MUMMC303(II) (Elective)	Environmental Microbiology							
4.	MUMMC304(I) (Elective)	Microbial Diversity	3	-	-	3	40	60	100
		MUMMC304(II) (Elective)							
5.	MUMMC351	<i>Lab Course I</i>	-	-	6	3	40	60	100
6.	MUMMC352	<i>Lab course II</i>	-	-	6	3	40	60	100
Total			12	-	12	18	240	360	600

Semester IV

Sr. No.	Subject Code	Subject Name	Effective Teaching			Credit	Evaluation Scheme		
			L	T	P		Internal Assessment	End Term	Total Marks
			Hours/Week						

Theory

1.	MUMMC401	Intellectual Property Rights	3	-	-	3	40	60	100
2.	MUMMC402(I) (Elective)	Food and Dairy Microbiology	3	-	-	3	40	60	100
	MUMMC402(II) (Elective)	Agricultural Microbiology							
4.	MUMMC451	<i>Lab Course I</i>	-	-	6	3	40	60	100
5.	MUMMC452	Dissertations/ Project Work + Viva voce	3	-	6	9	-	-	300
Total			9		12	18	120	180	600

Faculty of Science, Motherhood University

SEMESTER I
MUMMC 101 : MICROBIOLOGY – GENERAL STUDIES

Unit I Historical preview

History of Microbiology. Golden era: contributions of Anton Von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus Beijerinck, Sergei Winogradsky, Alexander Fleming, Selman Waksman; Spontaneous generation conflicts; Current thoughts on microbial evolution including the origin of life; Scope and importance of microbiology. Difference between prokaryotic and eukaryotic microorganisms.

Unit–II Classification

Binomial classification. Whittaker's five kingdom scheme, Three domain system of classification and eight kingdom system of classification, Bergey's system of bacterial classification, Characteristics & Classification of Archaeobacteria & Cyanobacteria.

Unit–III Virology

General characteristics: Acellular microorganisms (Viruses, viroids & Prions), Nomenclature and classification of viruses. Virus as dead as well as alive microorganism. Bacteriophage : structural organization, cultivation, replication, one step growth curve, eclipse phase, phage production.

Unit-IV Microorganism

Cellular microorganisms with emphasis on distribution, occurrence, morphology, mode of reproduction and economic importance.

Bacteria: *Streptococcus*, *Lactobacillus*, *Staphylococcus*, *Spirochaetes*, *Clostridium* *Cyanobacteria*, *Rhizobium*, & *Nitrosomonas*.

Fungi: *Saccharomyces cerevisiae*, *Dictyostelium discoidium*, *Penicillium*, *Aspergillus* & *Candida albicans*.

Algae: *Diatoms* & *Dinoflagellates*.

Protozoa: *Entamoeba*, *Toxoplasma*, *Plasmodium*, *Trypanosomas*, *Leishmania* & *Giardia*.

SEMESTER I
MUMMC 102 : ELEMENTARY BIOCHEMISTRY

Unit-I Chemistry and Bio-energetics

Chemical properties of water: ionization and acid-base chemistry; Laws of thermodynamics: First and second law, concept of free energy; Bioenergetics: Concept of free energy, Standard free energy, Enthalpy, Entropy, High energy phosphate compounds, Phosphate group transfer, Free energy of ATP, Oxidation-reduction, Redox potential; Energy generation in biological systems: Phosphorylation and electron transport chain, Electron carriers, Artificial electron donors, Inhibitors and uncouplers of oxidative phosphorylation, Chemiosmotic theory of ATP synthesis.

Unit-II Carbohydrates and Lipids

Carbohydrates- classification; Structure and general properties : configuration and conformation of monosaccharides, disaccharides, polysaccharides, (structural cellulose, peptidoglycan, storage-glycogen) and glycoproteins;

Lipids : General characters and classification, biosynthesis of saturated and unsaturated fatty acids – α and β oxidation; Structure and functions of triglycerides, phospholipids, glycolipids and steroids.

Unit-III Proteins

Structure of amino acids; Classification of essential amino acids based on polarity; Proteins: structure —secondary tertiary, quaternary& protein folding and stability; Levanthal paradox, Chaperones associated with folding; Properties of proteins: acid - base &

solubility; Ramchandran plot; Methods of purification: General approach; Protein solubility chromatography, electrophoresis & ultracentrifugation. Chemical analysis of microbial cells for- carbohydrates, amino acids, proteins, lipids and nucleic acids; Structure and classification of secondary metabolites: Antibiotics (penicillin, streptomycin etc), alkaloids (Ergot toxins), flavanoids, vitamins and bacterial toxins.

Unit-IV: Enzymes

Enzymes: Classification and Nomenclature, general characteristic of enzymes, mechanism of enzyme action, Isozymes; Mechanism of enzyme catalysis (Acid base and covalent catalysis); enzyme inhibition (Reversible and irreversible), allostery, cofactors, coenzymes, Holoenzymes and prosthetic groups; Enzyme kinetics: Derivation of Michaelis – Menton equation and its significance, Line weaver-Burke plot & Haldane-Briggs relationship. Factors affecting enzyme activity.

SEMESTER I MUMMC 103: CYTOLOGY

Unit I: Cellular organization

Organization, ultrastructure and functions of bacterial cell and its subcellular components, anatomy of peroxisome, and endosomes, pigment containing body; Cytoskeleton: Actin filaments, microtubules and intermediate filaments; Cell motility; Integrating cell into tissue: Cell junctions, Cell- Cell adhesions, Cell – extracellular matrix adhesion; Molecular mechanism of vesicular trafficking.

Unit II: Plasma Membrane and Solute Transport

Plasma membrane: Composition of membrane, Fluid mosaic model, Membrane fluidity, Membrane dynamics, Membrane fusion; Solute transport across membranes: Diffusion (Simple and facilitated), Active transport (Primary and secondary), Pumps and transporters, Ion channels (Ligand gated and voltage gated channels), Trans-epithelial transport, Mechanism of regulation of intracellular transport. Chemical composition of cell walls, cross linkage, porosity, tensile strength, turgor modifications in special types of cells, plasmodesmata, fluid transport between cells.

Unit III: Cell Division

Structure, organization and types of eukaryotic chromosomes, Heterochromatin, euchromatin, polytene chromosomes and lampbrush chromosomes. Cell cycle: Molecular events, Cyclin, CDKs, Checkpoints in cell cycle, Intracellular control of cell cycle events, Abnormalities in cell cycle: Oncogenesis (Causes, proto-oncogenes and tumor suppresser genes, Oncogenic mutations); Cell division: Molecular mechanism of mitosis and meiosis.

Unit IV: Signalling and cell death

Signalling mechanisms (Paracrine, endocrine and autocrine signalling); Mechanism of signal transduction: Signaling molecules, Ligand-receptors interaction, Transmembrane and intracellular signalling, Cell surface receptors (G protein-coupled, enzyme-linked and ion channel-linked receptors), Second messengers and their role in signal transduction, Signal integration and amplification. Necrosis; Autophagy; Senescence; Apoptosis: Mechanisms, Signals triggering apoptosis, Apoptosis inducing factors, Apoptosis in cancer.

SEMESTER II MUMMC 104: MOLECULAR BIOLOGY

Unit –I Nucleic acid

Experimental evidences for nucleic acid as carrier of genetic information. Nucleic acids: DNA structure; Chargaffs rule; Types of DNA; Reannealing and hybridization; DNA replication in

prokaryotes and eukaryotes: Polymerases, replication origin, initiation, elongation and termination; Telomeric DNA; topological properties: linking number, super helicity, mechanism of topoisomerases; Drugs & inhibitors of DNA synthesis. Packaging of DNA into chromosome. Types of RNA: Structural features (mRNA, rRNA, tRNA) and their characteristic;

Unit–II Transcription

Transcription in Prokaryotes - polymerase, promoter, initiation, elongation and termination; Eukaryotes- promoters, initiation, elongation, termination and post translational modification of Mrna [capping & polyadenylation, Splicing: L & Y splicing (Group I and II introns) hRNA using spliceosome/snurposome]; Ribozymes; Inhibitors of transcription.

Unit- III- Translation

Genetic code: Degeneracy of the code, three rules governing the code. Protein synthesis in prokaryotes and eukaryotes: initiation, elongation and termination; Protein synthesis on membrane bound ribosomes: signal hypothesis, post translation modification in ER and Golgi complex; Drugs & inhibitors of protein synthesis.

Unit–IV Gene regulation

Regulation of gene expression: Operon concept, negative & positive regulation, inducers, co- repressors and catabolite repression; Negative regulation-Lac operon; Positive regulation- *Ara* operon; Regulation by attenuation --*trp* operon; Anti termination –N protein and *nut* sites in lambda.

MUMMC 151: LAB COURSE I (Based on Theory Papers MUMMC101 and MUMMC102)

1. Principles and working of instruments (calibration, validation and maintenance), used in microbiology lab.
2. Media preparation and its sterilization.
3. Isolation and enumeration of pure culture of bacteria and fungi from given sample.
4. Isolation and enumeration of bacteriophage from sewage water.
5. Identification of bacterial cell by staining (Simple staining, gram staining and negative staining).
6. Staining of fungal cell, yeast.
7. Study of morphology of algae and its identification.
8. Measurement of bacterial cell size using micrometer.
9. Safety rules of working in lab, handling of chemicals, record of data, calibration, validation and maintenance of instruments.
10. Calculation of moles, molarity, molality and normality of given solution.
11. Calculation of pH of given solution.
12. Preparation of solutions and buffers of different concentrations and pH.
13. Qualitative tests for sugars, amino acids, proteins and lipids in given sample.
14. Quantitative estimation of sugar, amino acids, proteins and lipids in given sample.
15. Determination of acid value, saponification and iodine value of fats and oils.
16. Determination of K_m and V_{max} of given enzyme.
17. Determination of temperature and pH stability of given enzyme.
21. Quantitative estimation of secondary metabolites – flavanoids.

Permanent slides: From bacteria, fungi, algae and protozoans.

**Note: (a) Slides to be prepared for submission wherever possible.
(b) Photographs may be supplemented if slides are not available.**

Reference Books

1. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.
2. Atlas, R.M., Brown, A.E. and Parks, L.C. Laboratory manual of experimental microbiology. Mosby College Publishing Company, St. Louis.
3. Rana SVS. Biotechniques. Rastogi Publications, Meerut.
4. Boyer, R.F. Modern experimental biochemistry. Prentice Hall, New Jersey.
5. Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.
6. Dubey, R.C. And Maheshwari, D.K. 2010, A textbook of Microbiology. S. Chand & Company Pvt. Ltd., New Delhi.
7. Freifelder D. Physical Biochemistry: Application to Biochemistry and Molecular Biology. Freeman Publications.
8. Gerhardt, P. Manual of methods for general bacteriology. ASM Press, Washington, D.C.
9. Holt, J.G. and Krieg, N.R. Bergey's manual of determinative bacteriology. Lippincott Williams and Wilkin, Philadelphia.
10. Jayaraman, J. Laboratory manual in biochemistry. New Age International (P) Limited, New Delhi.
11. Kannan, K. Laboratory manual in general microbiology. Panima, New Delhi.
12. Nelson D. And Cox M.M., 2009, Principles of Biochemistry Edition W.H. Freeman and Company, New York
13. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown, Dubuque.
14. Sawhney, S.K. and Singh, R. Introductory practical biochemistry. Narosa Publishing House, New Delhi.
15. Tortora G.J., Funke B.R. and Benjamin C.L.C., 2008, Microbiology: An Introduction, Cummings Publishing Company.
16. Wilson & Keith. Principles and Techniques of Practical Biochemistry. Cambridge Publications.
17. Wilson, K. and Walker, J.M. Principles and techniques of practical biochemistry. Cambridge University Press, Cambridge.

SEMESTER I

MUMMC 152 : Lab course II

(Based on Theory Papers MUMMC103 and MUMMC104)

PRACTICAL:

1. Study of different stages of mitosis.
2. Study of different stages of meiosis.
3. Study of mechanism of diffusion, exosmosis and endosmosis.
4. Effect of isotonic, hypotonic and hypertonic solutions on cell.
5. Quantitative estimation of DNA by diphenyl amine (DPA) and spectrophotometric method.
6. Quantitative estimation of RNA by orcinol and spectrophotometric method.
7. DNA isolation from different cell types: Microbes and eukaryotic cell (Yeast).
8. Visualization of DNA by agarose gel electrophoresis.
9. Determination of T_m of given DNA sample.
10. Study of effect of temperature and pH on denaturation of DNA.
11. Demonstration of photoreactivation mechanism in bacteria.
12. Isolation of antibiotic resistant bacteria by gradient plate method.
13. Preparation of buffers and solutions (Normality & Molarity).
14. Quantification of DNA (microbes & eukaryotic cell) using spectrophotometer.

15. Microbial DNA denaturation and determination of T_m and G+C content.
16. Agarose gel electrophoresis of bacterial DNA.

Note: (a) Slides to be prepared for submission wherever possible.

(b) Photographs may be supplemented if slides are not available.

Reference Books

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. Molecular Biology of the Cell. Garland Publishing Inc., New York.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. And Walter, P. Molecular biology of the cell. Garland Science, New York.
3. Chaitanya, K.V. Cell and molecular biology: A lab manual. PHI Learning, New Delhi.
4. Clarke, D.P., Molecular Biology. 1st Edition, Elsevier Academic
5. de Robertis, E. D. P. And de Robertis, E.M.F. Cellular and molecular biology. Saunders, Philadelphia.
6. Friefelder D., 1995, Molecular Biology. 2nd Edition. Narosa Publishing House.
7. Gardner E.J., Simmons M.J. and Snustad D.P., 1991, Principles of Genetics. 8th Edition.
8. John Wiley & Sons Inc.
9. Karp, G. Cell and Molecular Biology. Concepts and experiments. John Harris, D., Wiley & sons, New York.
10. Murray, R.G.F., Wood, W.A. and Krieg, N.B. Methods for general and molecular bacteriology. ASM Press, Washington, D.C.
11. Pollard, T.D., Earnshaw, W.C. and Schwartz, J.L. Cell biology. Saunders, Philadelphia.
12. Powar, C.B., Cell Biology. Himalaya Publishing House, New Delhi.

SEMESTER II

MUMMC 201: MICROBES PHYSIOLOGY AND METABOLISM

Unit–I Growth in Microbes

Microbial nutrition & growth: Nutritional categories of microorganisms; Nutritional requirements; Measurement of microbial growth, direct & indirect measurement of microbial Growth; Influence of environmental factors on microbial growth. Microbial stress and its regulation.

Unit-II Respiration in microbes

Respiratory metabolism: Glycolytic pathway of carbohydrates breakdown, glycolysis, (Embden Meyerhoff pathway), Kreb's cycle and Entner – Duoderoff pathway, Phosphoketolase pathway, Pentose phosphate pathway, Oxidative and substrate level phosphorylation, Gluconeogenesis, Glycogen metabolism, glyoxylate cycle, fermentation of carbohydrates and homo- & hetero-lactic fermentation.

Unit-III Bacterial photosynthesis

Classification and Metabolism of photosynthetic bacteria, (Anoxygenic and oxygenic); photoheterotrophs; Members of prochlorophyta; Unclassified bacteria; Photosynthetic pigments: Bacteriochlorophylls ; photosynthetic ETS; mechanism of photosynthesis (cyclic & noncyclic); Calvin Benson cycle.

Unit–IV Nitrogen Metabolism

Nitrogen fixation in symbiotic and free living system; oxygen and hydrogen regulation of nitrogen fixation; nitrification, denitrification and ammonifying bacteria; Pathway of nitrate assimilation in photosynthetic and non photosynthetic systems; transamination and deamination reaction; Synthesis of essential & non essential amino acids and peptidoglycans & polyamines.

SEMESTER II
MUMMC 202: IMMUNOLOGY

Unit –I History of immunology

Historical background; Innate immunity, Adaptive immunity (cell mediated and humoral), Natural and artificial immunity; Active and Passive immunity, Barriers to infection; Phases of Immune responses; Clonal selection hypothesis. Hematopoiesis; Cells and organs of immune system; Lymphoid organs - Primary and Secondary. Immunoglobulin-General structure, Ig isotypes, structure and function.

Unit - II Antigen – Antibodies interaction

Antigens- structure and Properties, Types (Isotypes, Allotypes, idiotypes), Antigen specificity, superantigen, Haptens, Adjuvants. Characteristics of primary antigen- antibody interactions (Precipitations, Agglutinations, RIA, ELISA, immunoelectrophoresis, Crossed antigen-antibody electrophoresis, Western blotting etc). Complement pathways (Classical, alternative and lectin), Biological significance and deficiencies. Hybridoma technology- monoclonal antibodies and its applications; Production of polyclonal antibody and its application.

Unit - III Immunity and vaccine

Mechanism of cell mediated and humoral immunity. MHC types and structure, Exogenous and endogenous antigen capture and presentation to the lymphocytes, Cross presentation of exogenous antigens. Vaccine-Route of immunization, Natural immunization schedule, Types: attenuated and inactivated vaccine, synthetic peptide, DNA vaccine, Recombinant vaccine, subunit vaccine, idio type based vaccine, glycoconjugate vaccine, ISCOM's and plantibodies , vaccine delivery system. Immunity to microbes: Bacteria, Fungi, Virus and Helminthes, Pathogen recognition receptor (PRR) and Pathogen Associated Molecular Pattern (PAMP). Role of immune system in organ transplantation.

Unit - IV Autoimmune deficiencies and Disease

Cytokine (Properties, receptors, cytokine related disease and cytokine -based therapy), Hypersensitivity (Classification, types and disease). Autoimmune diseases- Addison's disease, Graves' disease, Hashimoto's thyroiditis, autoimmune haemolytic anemia; rheumatoid arthritis, Goodpasture's syndrome, Sjögren's syndrome. Immune deficiencies-B cell deficiencies (X-linked agammaglobulinemia, X-linked hyper-IgM syndrome); T cell deficiencies (22q11 deletion syndrome, CDS deficiency); B and T cell deficiencies (Common γ chain deficiency, ADA deficiency).

SEMESTER II
MUMMC 203: MICROBIAL LAB TECHNIQUES

Unit - I Microscopy and biosensors

Microscopy: Principles, properties and application of light microscopy, bright field, dark field, phase contrast and fluorescent microscopy; Principles and application of electron microscopy- transmission and scanning electron microscopy; Newer techniques in microscopy - confocal microscopy, scanning probe microscopy (scanning tunnelling microscope and atomic force microscope). Biosensors: Introduction and principles, First, second and third generation instruments, Cell based biosensors, Enzyme immunosensors, DNA biosensor.

Unit -II Centrifuge

Centrifugation: Basic principles of analytical and preparative centrifuge, differential and density gradient, zonal and isopycnic centrifuge, High speed centrifuge and ultra centrifuge;

Sedimentation coefficient, factors affecting sedimentation coefficient and application. pH meter.

Unit -III Chromatography and Electrophoresis

Chromatography: Principles, types and applications of partition, adsorption, gel filtration, paper and thin layer chromatography; Affinity, ion exchange and gas chromatography; High performance liquid chromatography and Fast Performance Liquid Chromatography (FPLC).

Electrophoresis: Principle, types and applications, frontal and zonal electrophoresis, paper, starch gel, Polyacrylamide and agarose gel electrophoresis; Isoelectric focussing and Isotachopheresis; Two dimensional gel electrophoresis and pulse field gel electrophoresis; Immunological techniques: immunoelectrophoresis, immunodiffusion & immunofluorescence.

Unit - IV Spectroscopy and radioisotopy

Spectroscopy: Basic principles, principles and application of visible, ultraviolet, infrared and mass spectroscopy; Principles and application of NMR and ESR; Principles and application of colorimetry, fluorescence flame photometry, Atomic Absorption spectroscopy & Raman spectroscopy

Radioisotopes -Types ;Radioactive units ; Radioactive Decay - Types and Measurement, Principles and Applications of Geiger Muller counter , Autoradiography.

SEMESTER II

MUMMC 204: RECOMBINANT DNA TECHNOLOGY

UNIT –I Gene

Genome organisation: Prokaryotic genome- nucleoid; Eukaryotic genome: Structure of chromatin, nucleosome, organisation & remodelling and high order organization of chromosomes, centromere & telomere; DNA methylation and gene imprinting; repetitive and non repetitive DNA sequences. Applications of recombinant DNA technology in forensic science, therapeutics and agriculture.

Unit-II Gene repair

Gene: Seymour Benzer experiment, complementation test, cistron, recon & muton; Mutation mapping at molecular level; Mutation: Spontaneous mutation, induced mutation and mutagens, molecular mechanism of mutagens, suppressor, intragenic & intergenic mutation, Isolation and detection of bacterial mutants; DNA repair: direct repair, excision repair (base and nucleotide), mismatch repair, SOS repair and translation DNA synthesis.

Unit–III Sequence Detection, Amplification and Amplification Techniques

Blotting techniques (Methodologies and applications): Southern, Northern and Western blotting; Probe labelling and hybridization; DNA sequencing (Chemical, enzymatic and automated methods); Sequence assembly for whole genome analysis; PCR: Principles; Types of PCR (Principle and applications): Degenerate PCR, Multiplex PCR, Hot start PCR, *In situ* PCR, Nested PCR, Q-PCR, RACE, Real Time PCR, RT-PCR; Site directed mutagenesis (Methods and applications).

Unit-IV Gene transfer

Bacterial transformation (mechanism of transformation, transfection & competence); Transduction: Generalized transduction, specialized transduction & abortive transduction; Bacterial plasmids and its Types, Compatibility and incompatibility, Mobilizable plasmids, Copy number of plasmids, Fertility inhibition, Donation and conduction; Conjugation: effective contact & pili in conjugation, the "F"factor, conjugal transfer process, high frequency recombination (Hfr) strains, the order of chromosome transfer, formation of F'(F prime),

mapping **by** using transformation, transduction and conjugation, Horizontal gene transfer. Regulation of lytic and lysogeny in lambda phage.

MUMMC 251: LAB COURSE I

(Based on Theory Papers MUMMC 201 and MUMMC 202)

Practicals:

1. Physiological differentiation of microorganisms of TSI differential media.
2. Study of nitrification, ammonification.
3. Study of effect of temperature, pH and salt concentration on growth of bacteria.
4. Determination of ability of bacteria to reduce nitrate.
5. Determination of ability of bacteria to produce H₂S.
6. Determination of presence of cytochrome oxidase in bacteria.
7. Isolation and identification of symbiotic nitrogen fixer (Rhizobium) from root nodules.
8. Effect of pH, sugars, amino acids and inorganic ions on spore germination.
9. Determination of concentration of antigen by rocket immunoelectrophoresis.
10. Determination of the presence of specific antibody for its antigen by Dot-ELISA method.
11. Determination of concentration of antigen by sandwich ELISA.
12. Effect of factors-- temperature & pH on bacterial growth.
13. Blood smear preparation & Identification of different WBC.
14. Separation and preservation of serum and plasma.
15. Determination of blood group and Rh factor.
16. Demonstration of agglutination reaction of bacterial cultures by slide agglutination test.
17. Quantitative estimation of antigen by radial immunodiffusion.
18. Detection and quantification of either antibody or antigen by Ouchterlony double diffusion method.
19. Slides: Spleen, thymus, lymph node, ileum- Peyer's patch, Blood cell type's identification.

Note : (a) Photographs to be supplemented on unavailability of slides.
(b) Slides from experiments.

Reference Books:

1. Abbas A.K., Lichtman A.H., Pillai, S. and Saunders, 2007, Cellular and Molecular Immunology. Elsevier.
2. Abbas, A.K. and Lichtman, A.H.H. Basic immunology: Functions and disorders of the immune system. Saunders, Philadelphia.
3. Abbas, A.K., Lichtman, A.H.H. and Pillai, S. Cellular and molecular immunology. Saunders, Philadelphia.
4. Bale J.W., 1994, Molecular Genetics of Bacteria, John Wiley & Sons.
5. Berg J.M., Tymoczko J.L. and Stryer I, 2007, Biochemistry. 6th Edition, W.H. Freeman and Company, New York.
6. Brun, Y.V. and Shimkets, L.J. Prokaryotic development. ASM Press, Washington, D.C.
7. Caldwell, D. R. Microbial physiology and metabolism. Star Publishers, California.
8. Chapel, H., Haeney, M., Misbah, S. and Snowden, N. Essentials of clinical immunology. Wiley, New Jersey.
9. David, W., Drummond, J.T. and Fuqua, C. Physiology and biochemistry of prokaryotes. Oxford University Press, New York.
10. Delves P.J., Martin S.J., Burton D.R. and Roitt I.M., 2006, Roitt's Essential Immunology. 11th edition, Blackwell Publishing/Oxford University Press.
11. Delves, P.J., Martin, S.J., Burton, D.R. and Roitt, I.M. Roitt's essential immunology. Wiley-Blackwell, New Jersey.
12. Foster, J.W. and Spector, M.P. Microbial physiology. John Wiley and Sons, New York.
13. Gardner E.J., Simmons M.J. and Snustad D.P., 1991, Principles of Genetics. 8th Edition. John Wiley & Sons Inc.

14. Gottschalk, G. Bacterial metabolism. Springer-Verlag, New York.
15. Karp, G. Cell and molecular biology- Concepts and experiments. John Wiley and Sons, New York.
16. Kindt, T.J., Goldsby, R.A., Osborne, B.A. and Kuby, J. Kuby immunology. W.H. Freeman and Company, New York.
17. Lengeler, J.W., Drews, G. and Schlegel, H.G. Biology of the prokaryotes. Blackwell Science, New York.
18. Levinson W. and Jawetz E., 2001, Medical Microbiology and Immunology. Lange Publications.
19. Madigan, M.T., Martinko, J.M. and Parker, J. Brock biology of microorganisms. Prentice Hall, New Jersey.
20. Male, D.K. Immunology: An illustrated outline. Elsevier Health Sciences, Philadelphia.
21. Nelson D. L. and Cox M. M., 2009, Lehninger's Principles of Biochemistry, W. H. Freeman.
22. Paul W.E., 2000, Fundamental Immunology. 4th edition, New York. Raven Press.
23. Prescott L.M., Harley J.P. and Klein D.A., 2007, Microbiology, 7th Edition, Mc Graw Hill.
24. Rhodes, P.M. and Stanbury, P.F. Applied microbial physiology: A practical approach. IRL Press, Oxford.
25. Rose, A.H. Advances in microbial physiology. Academic Press, New York.
26. Stryer, 2001, Biochemistry. 5th Edition, W.H. Freeman.
27. Tizard, I.R. Immunology: An introduction. Saunders, Philadelphia.

SEMESTER II

MUMMC 252: Lab course II

(Based on Theory Papers MUMMC 203 and MUMMC 204)

Practicals:

1. Determination of ability of bacteria to produce acidic or neutral end product from glucose.
2. Detection of the presence of either specific antibody or specific antigen in a patient's serum by complement fixation test.
3. Preparation of samples using differential centrifuge.
4. Separation and identification of amino acids by ascending and descending paper chromatography.
5. Studies on pH titration curves of amino acids and acetic acid.
6. Study of microbes under Fluorescent microscope.
7. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC.
8. Separation of bacterial lipids/amino acids/sugars/organic acids by Paper chromatography.
9. Separation of biomolecules by Ion exchange/ Gel permeation/ Affinity chromatography.
10. Isolation of genomic DNA from bacteria/yeast and separation of DNA by gel Electrophoresis.
11. Separation of microbial proteins by gel electrophoresis.
12. Study of UV absorption spectra of macromolecules (protein, nucleic acid & bacterial pigments).
13. Determination of molecular weight of DNA by agarose gel electrophoresis.
14. Separation and determination of molecular weight of proteins by SDS-PAGE.
15. Interpretation of UV spectra, IR spectra, NMR spectra and Mass spectra.
16. PCR amplification of DNA.
17. Restriction digestion of vector and DNA.
18. Ligation of DNA construct and vector.
19. Preparation of competent cells.
20. Demonstration of inducible enzyme β -galactosidase in *E. coli*.
21. Expression of gene in *E. coli*.
22. Determination of similarity between different bacterial isolates using RFLP.

Note : (a) Photographs to be supplemented on unavailability of slides.

(b) Slides from experiments.

Reference Books

1. Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.
2. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown, Dubuque.
3. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.
4. Atlas, R.M., Brown, A.E. and Parks, L.C. Laboratory manual of experimental microbiology. Mosby College Publishing Company, St. Louis.
5. Kannan, K. Laboratory manual in general microbiology. Panima, New Delhi.
6. Holt, J.G. and Krieg, N.R. Bergey's manual of determinative bacteriology. Lippincott Williams and Wilkin, Philadelphia.
7. Recombinant DNA safety guidelines. Department of Biotechnology, Ministry of Science and Technology, Government of India, New Delhi.
8. Hatwal, G. and Anand, S. Instrumental methods of chemical analysis. Himalaya Publishing House, Mumbai.
9. Ford, T.C. and Graham, J.M. An introduction to centrifugation. Bios, New York.
10. Glick, B.R., Pasternak, J.J. and Patten, C.L. Molecular biotechnology: Principles and applications of recombinant DNA. ASM Press, Washington, D.C.
11. Greene, J.J. and Rao, V.B. Recombinant DNA principles and methodologies. Marcel Dekker, New York.
12. Hamilton, R.J. and Sewell, P.A. Introduction to high performance liquid chromatography. Chapman and Hall Limited, London.
13. Jayaraman, J. Laboratory manual in biochemistry. New Age International (P) Limited, New Delhi.
14. Kingsman, S.M. and Kingsman, A.J. Genetic engineering: An introduction to gene analysis and exploitation in eukaryotes. Blackwell Science, Oxford.
15. Message, G.M. Practical aspects of gas chromatography/ mass spectrometry. John Wiley and Sons, New York.
16. Miller, J. Chromatography: Concepts and contrasts. John Wiley and Sons, New York.
17. Miller, J.H. Experiments in molecular genetics. Cold Spring Harbor Lab Press, New York.
18. Pevsner, J. Bioinformatics and functional genomics. Wiley-Blackwell, New Jersey.
19. Reece R.J. Analysis of genes and genomes. John Wiley and Sons, New York.
20. Rost, F.W.D. Fluorescence microscopy. Cambridge University Press, Cambridge.
21. Sambrook, J. and Russell, D.W. Molecular Cloning: A laboratory manual. Cold Spring Harbor Lab Press, New York.
22. Sawhney, S.K. and Singh, R. Introductory practical biochemistry. Narosa Publishing House, New Delhi.
23. Sharma, V.K. Techniques in microscopy and cell biology. Tata McGraw-Hill, New Delhi.
24. Spencer, M. Fundamentals of light microscopy. Cambridge University Press, Cambridge.
25. Straughan, B.B. and Walker, S. Spectroscopy. Chapman and Hall Limited, London.
26. Wilson, K. and Walker, J. Principles and techniques of biochemistry and molecular biology. Cambridge University Press, Cambridge.

SEMESTER III

MUMMC 301 : MEDICAL MICROBIOLOGY

UNIT - I Elementary Medical microbiology

Normal microbial flora of human body (skin, mouth, upper respiratory tract & eye) and its role, Anatomic position of normal flora; Pathogenic properties of bacteria -Colonization, invasion, production of toxins

(exotoxins & endotoxins); Antimicrobial defences of host; Cellular mechanisms of antimicrobial defence; Pathogenesis of viral infections; New vaccine technology, recombinant DNA and protein based vaccines, synthetic peptide vaccines, plant based vaccine, multivalent subunit vaccines and vaccine clinical trials.

Unit – II Bacterial Disease

General characteristics, Morphology, Growth, Pathogenicity, Laboratory diagnosis and Therapy of pathogenic bacteria: *Pneumococci*, *Neisseriae*, *Enteric bacilli*, *Pseudomonas* and other non fermenting bacilli, *Haemophilus*, *Bordetella*, *Clostridia*, *Mycobacteria*, *Actinomycetes*, *Rickettsias*, *Mycoplasmas*, *Shigella*, *Vibrio* & *Yersinia*.

Unit– III Fungal disease

Structure, Reproduction, Pathogenicity, Diagnosis, Therapy and Epidemiology of disease caused by Fungus: *Cryptococcus neoformans*, *Blastomyces dermatitidis*, *Trichophyton*, *Histoplasma capsulatum*, *Coccidioides immitis*, *Candida albicans*, *Aspergillus fumigates*, *Phycomycetes*, *Sporothrix schenckii*, *Eumycotic*, *Mycetoma* & *Microsporium spp.*

Unit -IV Viral disease

Properties, Pathogenesis, Laboratory diagnosis, Epidemiology, Control & Treatment of virus: Herpes virus (*H. simplex*, *H. zoster*, *Epstein-Barr viruses*), Pox viruses, Picornaviruses, Adenoviruses & Rubella virus. Multiplication, Pathogenesis and Oncogenic activity: (a) Oncogenic DNA viruses (Papovaviruses - Papilloma viruses, Hepatitis B virus, Oncogenic Herpes viruses); (b) Oncogenic RNA viruses (Lentivirus, HIV, Primate and Human type C Oncovirus).

SEMESTER III

MUMMC 302 : INDUSTRIAL MICROBIOLOGY

Unit -I Introduction

Historical account of microbes in industrial microbiology; Components of a fermentation process; Sources and characters of industrially potent microbes: their isolation, primary and secondary screening and purification; Strain improvement for the selected organism: mutation and screening of improved cultures, random and strategic screening methods; Microbial growth kinetics in batch, continuous and fed batch fermentation process; Preservation and maintenance of microbial cultures.

Unit: -II Fermentation and Bioreactors

Media formulation, sterilization and optimization. Types of fermentation processes; Solid state and submerged fermentations;; Design of a basic fermenter: bioreactor configuration, design features, individual parts: baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for on- line monitoring, computer control of fermentation process; their advantages and disadvantages; Factors affecting fermentation process; Types of Bioreactor: Stirred tank reactor, Bubble column reactor, Airlift reactor, Packed bed reactor, Fluidized bed reactors, Photo-bioreactors; Raw materials used in industrial fermentation media

Unit - III: INDUSTRIAL PRODUCTS

Production aspects (Microbial strains, substrate, flow diagrams, product optimization and applications): Production of antibiotics (penicillin, D-cycloserine, streptomycin, tetracycline, bacitracin and griseofulvin), amino acid (glutamic acid and lysine), biopolymers (dextran, alginate, xanthan and pullulan) and steroids biotransformation.

Unit - IV MICROBIAL INDUSTRIAL PRODUCTS

Commercial products: organic acids (citric acid); amino acids (glutamic acid and lysine); vitamin (vitamin B12); Industrial enzymes (cellulases, xylanases, amylases and proteases and their applications); Biofuels (ethanol and methane) from organic residues; Biomass (Baker's Yeast and Single Cell Proteins); Antibiotics (penicillin); Biofuels (Ethanol and Methane); Recombinant proteins (Insulin).

III SEMESTER

MUMMC 351 : LAB COURSE-I

(Based on Theory Papers MUMMC 301 and MUMMC 302)

1. Laboratory rules and regulation in Pathological laboratory.
2. Collection of specimen – Basic concepts, Transport containers for anaerobic specimens
a. & collection.
3. Techniques for transfer of clinical specimens & selection of primary culture media, Interpretation of culture.
4. Prevalence of pathogenic microorganisms in clinical sample.
5. Isolation and biochemical characterization of pathogenic bacteria.
6. Isolation and identification of fungal pathogens from clinical specimens.
7. Determination of antimicrobial susceptibility of pathogens by disc diffusion test.
8. Isolation and screening of bacterial and fungal cultures for enzyme production.
9. Media formulation for enhanced enzyme production by microbial culture *via* liquid and solid state fermentation.
10. Carbohydrate fermentation tests (**minimum three**).
11. Study of chemolithotrophs.
12. Litmus milk-homo-fermentation/ hetero-fermentation.
13. Optimization of culture conditions for enhanced enzyme production by microbial culture *via* liquid and solid state fermentation.
14. Monitoring of sugar reduction during wine production.
15. Estimation of alcohol concentration in wine.
16. Identification based on metabolic characteristics.
17. Antibiotic susceptibility testing.
18. New laboratory technologies for detection of infectious diseases.
19. Study of growth curve of microorganism/s.
20. Production of Baker's yeast.
21. Primary Screening techniques (crowded plate) AND Secondary screening techniques.
22. Amino acid production using *E. coli* mutant strains.
23. Use of growth & production media for citric acid production.
24. Isolation of industrially important microorganisms for amylase production.
25. Production of biofuels by microorganism/s.

Note : (a) Photographs to be supplemented on unavailability of slides.
(b) Slides from experiments.

Suggested Books:

1. Casida L. E. J. R., 2015, Industrial Microbiology. New Age International, New Delhi.
2. Crueger W and A. Crueger., 1991, Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates.
3. Reed G., Prescott S. C., Dunn C. G., 1987, Prescott and Dunn's Industrial Microbiology. 4th edition CBS, New Delhi.
4. Shuler M.L. and F. Kargi., 2001, Bioprocess Engineering Basic Concepts. (Prentice Hall International Series in the Physical and Chemical Engineering Sciences) Prentice Hall.
5. Stanbury P. F., Whitaker, A and Hall S. J., 2003, of Fermentation Technology. 2nd edition, reprint ed. Butterworth-Heinemann Principles .

6. Baron S., 1996, Medical Microbiology, 4th ed. Galveston (TX).
7. Geo. F. Brooks & Stephen A. Morse. Jawetz, Melnick, & Adelberg's Medical
8. Microbiology. 26th edition. McGraw-Hill.
9. Kenneth J. Ryan, C. George Ray. Sherris Medical Microbiology, Sedition
10. Murray, P.R., Baron, E.J., Jorgensen, J.H., Pfaller, M.A. and Tenover, R.H. Manual of clinical microbiology. ASM Press, Washington, D.C.
11. Balows, A., Hausler, W.J., Ohashi, M. and Tenover, A. Laboratory diagnosis of infectious diseases: Principles and practice. Springer-Verlag, New York.
12. Faddin, J.F.M. Biochemical tests for identification of medical bacteria. Williams and Wilkins, Baltimore.
13. Baltz, R.H., Demain, A.L and Davies, J.E. Manual of industrial microbiology and biotechnology. ASM Press, Washington, D.C.
14. Leboffe, M.J. and Pierce, B.E. Microbiology: Laboratory theory and application. Morton Publishing Company, Englewood.
15. Singer, S. Experiments in applied microbiology. Academic Press, New York.
16. Kannan, K. Laboratory manual in general microbiology. Panima, New Delhi.
17. Holt, J.G. and Krieg, N.R. Bergey's manual of determinative bacteriology. Lippincott
18. Williams and Wilkin, Philadelphia.

SEMESTER III

MUMMC 303 (I): MICROBIAL LAB TECHNOLOGY

Unit-I MICROSCOPY AND STAINING

Basic principles for preparing microbes for light, and dark field, phase contrast, confocal, fluorescent and electron (transmission and scanning) microscopy; Micrometry; Specimen collection, preparation and basic principles of simple, Gram, negative, capsule, endospore, flagella, acid- fast and fluorochrome staining.

Unit -II STERILIZATION TECHNIQUES

Basic principles and methods of sterilization & disinfection: Control of microorganisms by physical methods: heat, filtration and radiation; Chemical methods: Phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes and sterilizing gases; evaluation of antimicrobial agent effectiveness; Principle and function of Laminar air flow hood (LAF).

Unit-III CULTURE TECHNIQUES

Culture characteristics: Types of culture media, preparation of medium, Minimal requirements, Nutritional types; Methods of isolation and maintenance of pure cultures (Pour plate method, streak plate method & spread plate method); Cultivation of bacteria: aerobic & anaerobic; Growth curve of bacteria; Cultivation and morphology of molds; Yeast morphology; Cultivation and isolation of viruses; Preservation of culture: Short term & long term; Disposal of cultures.

Unit-IV BIOCHEMICAL TESTS

Principle and theory of biochemical activities of the microorganisms: Triple sugar-Iron agar test, ImVic test, Urease test, Catalase test, Oxidase test, Coagulase test, Sugar fermentation test, Hydrogen sulphide test and Nitrogen reductase test.

SEMESTER III

MUMMC 303 (II) : ENVIRONMENTAL MICROBIOLOGY

UNIT - I Microbial diversity

Microbiology of air, soil & water; Microbes in extreme environments; environment induced genetic and physiological adaptation in microbes. Techniques in environmental microbiology: Methods for determination of numbers, biomass and activities of microbes in soil, water, plant surfaces and dead organic materials;

Unit - II Fundamentals of Microbial Ecology

Ecosystem; Biotic and abiotic components; Habitat and Niche; Population and guilds; Concept of community; Stability hypothesis; Intermediate-disturbance hypothesis; Concept of ecological niche; Ecosystem organization: Structure and functions, Primary production, Energy dynamics (Trophic organization and energy flow pathways); Microbial community dynamics: r and k strategies of population selection within communities.

UNIT - III Biodegradation, Bioremediation and Biodeterioration

Microbial degradation of ligno-cellulosic substances, keratin and chitin; Bioremediation techniques: *in situ* (Bioventing, air sparging, liquid delivery system, aerobic bioremediation phytoremediation) and *ex situ* (land farming, composting, biopiling & slurry-phase). Microbial degradation of herbicides, pesticides, hydrocarbons including polycyclic (petroleum, gas production, fossil fuel & polychlorinated biphenyls etc.), oil spills, heavy metals, chlorinated and polychlorinated compounds; Biological treatment of effluents of sugar, pulp and paper industry. Biodeterioration of buildings and monuments of cultural heritage, microbial deterioration of paper, textile, leather, rubber, glass, paints and metals; Principal methods for their protection.

UNIT - IV Waste Water Treatment

Aerobic treatment of waste water (Trickling filters, Rotating biological contractors, Fluidized bed reactors, Activated sludge, Oxidation ponds), anaerobic treatment of waste water (Anaerobic contact digesters, Packed bed reactors, Up-flow anaerobic sludge blanket reactors) Advanced waste water treatment for removal of suspended solids, nutrients (N&P), Oil and grease, Toxic compounds and dissolved inorganic substances, Solid waste disposal (sanitary landfills and composting). Disinfection of potable water supplies and hospital wastes; Bacterial indicators of water safety; Microbial assessment of water quality; Standard for tolerable levels of fecal contamination.

SEMESTER III

MUMMC 304 (I) : MICROBIAL DIVERSITY

Unit – I Microbial Evolution and Diversity

Evolution of early life forms on Earth; Genetic basis for evolution; Stromatolites; Evolution of prokaryotes and eukaryotes, physiological diversity; Prokaryote-eukaryote evolutionary relationship; Tools used for studying culturable and non culturable microbial diversity, Indices (Diversity, dominance and species richness indices). Extremophiles: Characteristic features, classification, physiology, molecular adaptations and applications of acidophiles, alkalophiles, psychrophiles, thermophiles, barophiles, halophiles, oligotrophs, osmophiles, radiophiles, metallophiles and xerophiles.

Unit - II Bacterial Diversity I

Classification of bacteria into different phylums; General characteristics, ecology, physiology and metabolism of bacterial phylums: *Acidobacteria*, *Actinobacteria*, *Aquificae*, *Bacteroidetes*, *Chlamydiae*, *Chlorobi*, *Chloroflexi*, *Chrysiogenetes*, *Deferribacteres*, *Deinococcus-Thermus*, *Dictyoglomi*, *Fibrobacteres*, *Fusobacteria*.

Unit - III Bacterial Diversity II

General characteristics, ecology, physiology and metabolism of bacterial phylums: *Nitrospira*,

Planctomycetes, Proteobacteria, Spirochaetes, Synergistetes, Thermodesulfobacteria, Thermotogae, Verrucomicrobia.

Unit - IV Archaea Diversity

Phylum Euryarchaeota: *Halobacteria, Methanogens, Thermoplasms, Thermococcales*; Phylum Crenarchaeota: *Desulfurococcales, Thermoproteales, Sulfolobales*; Phylum Korarchaeota; Phylum Nanoarchaeota: *Nanoarchaeum*.

Semester III

MUMMC 304(II): RESEARCH METHODOLOGY

Unit – I Experimental Designing

Selection of field of interest for research; its Importance and need; Literature survey; Planning of experimental work: designing of the problem to be undertaken, Defining the aim and objectives of the planned research work, Importance of prior collection of protocols, Time bound frame of work plan, Designing of experimental protocol; Description of strategies to meet the objectives using state-of-the-art techniques and proper citation of standard procedures.

Unit - II Data Collection and Statistical Analysis

Types of data: Qualitative and quantitative data, Primary and secondary data; Site selection for sample collection; Source selection for data acquisition; Sampling techniques: Simple and random sampling, Systematic sampling, Stratified sampling, Multistage sampling, Cluster sampling, Multiphase sampling; Sample size; Recording of data and data summarization; Significance of triplicate readings; Measures of dispersion: Range, Quartile deviation, Mean deviation, Standard deviation, Coefficient of variation; Probability: Random experiment, Events, Sample space, Mutually exclusive events, Independent and dependent events, Statement of addition and multiplication theorems of probability.

Unit - III Biostatistical analysis

Examples of count data (Bacterial cell count, radioactivity count, colony counts and plaque counts); Statistical treatment to count data: Poisson distribution, Skewness and kurtosis, Standard error; Statistical treatment to proportion data (MPN, sterility testing of medicines, therapeutic trial of drugs and vaccines); Properties and uses of tests of significance (T-test, z-test and chi-square tests and independence of attributes, F-test). Standard curves: Correlation, Linear regression (fitting of best line through a series of points), ANOVA. Software application.

Unit - IV Technical Writing

Technical writing: Selection of Appropriate title, Abstract, Introduction, Aims and objectives, Review of literature, Methodology, Results, Discussion, Summary and Conclusions, Bibliography.

Unit - V Basics of Bioinformatics

Bioinformatics: Introduction to various biological databases (Primary, secondary and composite databases); Introduction to biological information system: SRS, ENTREZ; Sequence comparison and alignment: Sequence similarity searching tools (FASTA and BLAST), Multiple sequence alignment and applications; Introduction of data mining: Classification, Clustering, Data collection, Data warehousing, Data processing, Applications of data and genomes mining; Databases: Nucleotide sequence information sources (GenBank, EMBL, EBI, DBJ and UCSC), Protein sequence information sources (PIR, ExPASy, UniProt KB, SwissProt and TrEMBL); Phylogenetic analysis: Phenetic and cladistic approach; Phylogenetic tree construction (Rooted and unrooted method).

SEMESTER III

MUMMC 352 : LAB COURSE-II

(Based on Elective Theory Papers MUMMC 303 and MUMMC 304)

Lab course Based on Elective Theory Papers MUMMC 303 (I) Microbial Lab Technology

Practicals:

1. Laboratory rules and requirement, Bio safety equipments.
2. Microscopy – Dissecting Compound and Phase contrast
3. Preparation of Liquid & solid media.
4. Sterilization of glass wares and media.
5. Purification of culture by Streak plate technique.
6. Pour plate technique and Spread plate technique.
7. Use of selective and differential medium.
8. Cultivation of microorganisms- nutritional & physical requirements; anaerobic cultivation.
9. Cultural characteristics of microorganisms.
10. Isolation and maintenance of pure cultures & Preservation of cultures.
11. Biochemical tests- Iron agar test, ImVic test, Urease test, Catalase test, Oxidase test, Hydrogen sulphide test, Nitrogen reductase test etc.

Note : (a) Photographs to be supplemented on unavailability of slides.

(b) Slides from experiments.

Reference Books:

1. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.
2. Atlas R.M., 1997, Principles of Microbiology. 2nd Edition, Mc Graw Hill Publications.
3. Berg J.M., Tymoczko J.L. and Stryer L., 2007, Biochemistry Edition W.H. Freeman and Company, New York.
4. Davis R.Y. Aderberg E.A. and Ingram J.L., 1991, General Microbiology.
5. Nelson D. and Cox M.M., 2009, Principles of Biochemistry Edition W.H. Freeman and Company, New York.
6. Prescott, L.M., Harley J.P. and Klein D. A., 2007, Microbiology, 7th Edition, Mc Grow Hill.
7. Stainer, General Microbiology, 5th Edition, Printice Hall of India, Pvt. Ltd. New Delhi.
8. Talaro K.P. and Talaro A., 2006, Foundations in Microbiology, Mc Graw Hill Publications.
9. Verlog, Gunsales and Stainer, The Bacteria, Volumes I-V, Academic Press.
10. Wilson K. & Walker J., 2008, Principles and Techniques of Biochemistry and Molecular
11. Biology. 6th Edition, Cambridge University Press.

Lab course Based on Theory Papers MUMMC 303 (II) Environment microbiology

Practicals:

1. Enumeration of micro-organisms from air.
2. Isolation of antibiotic producing microbes from soil sample.
3. Isolation and identification of symbiotic bacteroids of *Rhizobium* sp. from root nodules of leguminous plants.
4. Study of microbial community succession in decomposing litter.
5. Study of symptoms of bacterial diseases of plants.
6. Study of symptoms of fungal diseases of plants.
7. Study of symptoms of viral diseases of plants.
8. Isolation and identification of pathogenic microorganisms from diseased plant sample.
9. Isolation of xenobiotic compound degrading bacteria by enrichment culture technique.
10. Determination of indices of pollution by measuring BOD and COD of different effluents.
11. Bacteriological examination of water (Potable /hospital wastes): a. Presumptive test b. Confirmed test c. Completed test

Note : (a) Photographs to be supplemented on unavailability of slides.

(b) Slides from experiments.

Reference Books:

1. Baker K.H. and Herson D.S., 1994, Bioremediation, McGraw Hills Inc., NY.
2. Christon J.H., 2001, A Manual of Environmental Microbiology, ASM Publications.
3. Clowd D., 1999, Microbial Diversity, Academic Press.
4. Environmental Microbiology, ASM Press. Publishing Inc. Johri B.N., 2000, Extremophiles, Springer Verlag, NY.
5. Hurst C.J., Crawford R.L., Garland J.L., Lipson D.A. and Mills A.L., 2007, Manual of
6. Jjemba P.K., 2004, Environmental Microbiology: Principles and Applications, Science
7. Maier R., Pepper I., and Gerba C., 2008, Environmental Microbiology, Academic Press.
8. Mitchel R., 2009, Environmental Microbiology, 2nd Edition, Wiley-Blackwell.
9. Ralph M.A., 1997, Environmental Microbiology, John Wiley and Sons Inc.
10. Singh A., Kuhad R.C. and Ward O.P., 2009, Advances in Applied Bioremediation, Springer.
11. Varman A.H. and Evans M.G., 2000, Environmental Microbiology, Manson Publishing

Lab exercises Based on Theory Papers MUMMC 304 (I) Microbial diversity

Practicals:

1. Isolation and characterization of thermophilic microorganisms from the given sample.
2. Isolation and characterization of acidophilic and alkalophilic microorganisms.
3. Determination of different microbial community in different habitats.
4. Determination of species richness and evenness in microbial community in different habitats

Note : (a) Photographs to be supplemented on unavailability of slides.

(b) Slides from experiments.

Reference Books

1. Antranikian, G. Biotechnology of extremophiles. Springer- Verlag, New York.
2. Colwd, D. Microbial diversity. Academic Press, New York.
3. da Costa, M.S., Duarate, J.C. and Williams, R.A.D. Microbiology of extreme environments and its potential for biotechnology. Elsevier Applied Science, London.
4. Holt, J.S., Krieg, N.R., Sneath, P.H.A. and Williams, S.S.T. Bergey's manual of determinative bacteriology. Lippincott Williams and Wilkins, Philadelphia.
5. Horikoshi, K. and Grant, W.D. Extremophiles: Microbial life in extreme environments. Wiley-Liss, New York.
6. Kushner, D.J. Microbial life in extreme environments. Academic Press, New York.
7. Madigan, M.T., Martinko, J.M. and Parker, J. Brock biology of microorganisms. Prentice Hall, New Jersey.
8. Satynarayana, T. and Johri, B.N. Microbial diversity: Current perspectives and potential applications. I.K. International (P) Limited, New Delhi.
9. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.

Lab exercises Based on Theory Papers MUMMC 304 (II) Research methodology

Practicals:

1. Description of aim and objectives of the problem.
2. Survey of Literature on the selected problem and its proper citation.
3. A brief account on Review article from a journal.
4. Statistical and graphical representation of data.
5. Calculation of mean, median and mode.
6. Statistical calculation : Linear equation analysis (Regression analysis).
7. Exponential equation analysis (Survival curve).
8. Chi square test.
9. Normal distribution.

10. Data mining using NCBI, SWISSPROT, EBI, PDB and MBLD.
11. Database search- Working on various BLAST programs.
12. Pairwise sequence alignment and multiple sequence alignment.

Note : (a) Photographs to be supplemented on unavailability of slides.
 (b) Slides from experiments.

Reference Books

1. Attwood, T.K. and Smith, D.J.P. Introduction to bioinformatics. Pearson Education Asia, Singapore.
2. Baxevanis A.D and Ouellette, B.F.F. Bioinformatics – A practical guide to the analysis of genes and proteins. Wiley – Interscience, New York.
3. Bhattacharyya, D.K. Research methodology. Excel Books, New Delhi.
4. Bliss, C.I.K. Statistics in biology. McGraw-Hill, New York.
5. Campbell R.C. Statistics for biologists. Cambridge University Press, Cambridge.
6. Daniel, P.S. and Sam, A.G. Research methodology. Gyan Publishing House, New Delhi.
7. Dawson, C. Practical research methods: A user-friendly guide to mastering research techniques and projects. How to Books Limited, London.
8. Glantz, S.A. Primer of biostatistics. McGraw-Hill, New York.
9. Gupta, S. Research methodology and statistical techniques. Deep and Deep Publications, New Delhi.
10. Higgins, D. and Taylor, W. Bioinformatics: Sequence, structure and databanks – A practical approach. Oxford University Press, Oxford.
11. Kumar, R. Research methodology: A step-by-step guide for beginners. SAGE Publications, California.
12. Mount, D.W. Bioinformatics: Sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.
13. Murray, R. How to write a thesis. McGraw-Hill, New York.
14. Singh, Y.K. Research methodology. APH Publishing Corporation, New Delhi.
15. Wardlaw, A.C. Practical statistics for experimental biologists. John Wiley and Sons, New York.

SEMESTER IV

MUMMC 401: INTELLECTUAL PROPERTY RIGHTS

Unit – I Introduction

Introduction to IPR; WIPO; Types of Intellectual Property Rights: Copyrights, Trademarks (Collective marks, certification marks and well-known marks), Industrial designs, Geographical indications, Patents, Plant breeder's rights; Importance and business interest of IPR for industry and academia; Relationship of IPRs with biotechnology; secrets of Trade; Non-disclosure agreements.

Unit - II Protection of Rights, Plant Varieties

Brief of different treaties: Berne convention, Rome convention, WIPO copyright treaty, TRIPS agreement, WIPO performances and phonograms treaty, Madrid agreement, Madrid protocol, Paris convention, Lisbon agreement, Hague agreement, Patent Cooperation Treaty; Relationship between IPR and trade: WTO, TRIPS Agreement, GATT, Enforcement and dispute settlement under the TRIPS agreement, Implication of TRIPS for developing countries in the overall WTO system. Protection of plant varieties: Interface between technology and IPRs in the context of plants, Key features of UPOV 1978, UPOV 1991 and TRIPS with respect to IPRs on plants, Indian law on protection of plant varieties, DUS criteria, *Sui generis* system for protection, Patenting of genetically modified plants, Significance of IPRs in agricultural biotechnology: Case studies;

Unit - III Patents and Acts

Terminology; Patent claims; Patent life and geographical boundaries; Utilization of intellectual patents; patent Licensing; Elements of patentability; Procedure for grant of patent in India, USA and Europe; PCT application; Patent search invention in context of "prior art"; Patent search methods; Patent databases and libraries; Country-wise patent searches (USPTO, EPO, ARIPO and India); Patent mapping; Patent harmonization; Case studies - patents in biotechnology. Patent acts and latest amendments of Indian, European and US patent systems.

Unit – IV Patent Issues in Pharmaceuticals and Patent Infringement

Patent issues in drugs and pharmaceuticals: Generics, Compulsory licensing, Exclusive marketing rights, Bolar provision, Bayh-Dole act, Second medical use; Patent infringement (Case studies, defenses to infringement including experimental use, patent misuse, legal considerations, enforcement measures, patent valuations, competition and confidentiality issues); Assignment of Intellectual Property Rights; Technology Transfer Agreements.

SEMESTER IV

MUMMC 402 (I) : FOOD AND DAIRY MICROBIOLOGY

Unit I Microbes in Food industry

Microbial enzymes in food industry, Tea and coffee fermentations, Vinegar, Wine & Beer production; Food preservation methods, Use of low & high temperature, radiations -- UV, Gamma and Microwave, chemicals and naturally occurring anti microbials. Microbial biomass and single cell proteins; Uses of microbes in meats and poultry products vegetables etc.; Low calorie sweeteners, flavour modifiers & food additives; Food quality monitoring Indian fermented food.

Unit – II Microbes as food contaminants

Important microbes involved in spoilage of food: Meat, poultry, vegetables & dairy products; Microbial deterioration of cereals, pulses, fish & sea foods during storage; Feed for cattle: Use of microbes and microbial enzymes in the improvement of nutritive quality of feed. Toxins: Bacterial and mycotoxins, important microbes secreting toxins, chemical nature of important toxins, their role in food poisoning; Physiology and mechanism of action, modification and detoxification, prevention and control of toxin contamination. Starter cultures- their biochemical activities, Production and preservation of fermented foods- Soya sauce, sauerkraut, meat– sausages & baker's yeast.

Unit-III Microbes in milk and dairy products

Microbiology of milk and milk processing; Microbiology of raw milk, Processed milk, Cream & butter, concentrated milk, flavoured milk & dried milk; Microbiology of ice cream & related products. Starter cultures-Fermented milk, Therapeutic milk, Butter, Yoghurt, Soft cheese & hard cheese; Introduction to probiotics, prebiotics & synbiotics; Quality control in dairy industry; Hazard Analysis Critical Control Point (HACCP). Microbiological examination of raw / pasteurized milk, standard plate count, direct microscopic count and reductase test, composition of milk, sources of contamination of milk, ability of milk to cause diseases.

Unit – IV Microbes as pathogen

Cleaning and sanitizing in milk production & processing; Control of microorganism in dairy processing; Regulatory control of milk & dairy products; Treatment of dairy wastes.

Pathogens: *Arthrobacter* spp., *Bacillus cereus*, *Campylobacter* spp., *Clostridium botulinum*, *Clostridium perfringens*, *Cronobacter (Enterobacter) sakazakii*, *Escherichia coli*, *Listeria monocytogenes*, *Mycobacterium*., *Micrococcus*., *Salmonella* spp, *Staphylococcus aureus* & *Yersinia enterocolitica*, *Aspergillus* spp., *Fusarium* spp.,

Mucor, Penicillin, Geotrichum, Cladosporium, Yeast., Phoma spp., Gluvaromysis, Beberomysis, Alternaria, Eurotium.

SEMESTER IV MUMMC 402 (II): AGRICULTURAL MICROBIOLOGY

Unit - I Soil

Soil and Physico-chemical characteristics of soil; soil microbial diversity: significance and conservation; Effect of agricultural practices on soil organisms; soil chemistry, humus formation; Chemical transformation by microbes: Organic matter decomposition, nutrient mineralization and immobilization; Transformation of carbon and carbon compounds; Availability of phosphorus, sulfur, iron and trace elements to plants; Biological nitrogen-fixation: Rhizobium - Legume Association; N fixation by non-leguminous plants; Microbial products and plant health: PGPR (plant growth promoting rhizobacteria); significance of mycorrhizae; toxin producing microbes (antibiotics, aflatoxin).

Unit - II Biofertilizers and biopesticides

Microbial biofertilizers and biopesticides: Isolation, purification, mass multiplication, inoculum production and method of application of biofertilizer: *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia*; cyanobacterial biofertilizers: *Anabaena, Nostoc, Hapalosiphon*; Mycorrhizal biofertilizers and their importance in agriculture; Algal and other biofertilizers storage, shelf life, quality control and marketing of biofertilizers; Biofertilizers: aiding in phosphorus nutrition; Regulation of ethylene production in roots, Secondary metabolite production; Biopesticides: Source organisms (*Bacillus thuringiensis, Beauveria bassiana, Metarhizium anisopliae, Trichoderma* and Baculoviruses); Production of microbial herbicides: bacterial insecticides, viral insecticides, entomopathogenic fungi & microbial nematodes. Mechanism of biocontrol; Other means of pathogen control: Application of viral proteins in controlling viral diseases, Antisense RNA technology in disease control and RNAi in controlling plant pathogens.

Unit - III Plant disease and control

Disease forecasting and basic principles of plant disease control: Pathology, etiology and control of economically important crop diseases of Blight of rice, Citrus canker, Wilt of potato, *Pythium* seed rot, Grapes downy mildew, Potato early and late blights, Fusarial wilt, Wheat-smut and rust, Tikka leaf spot in groundnut, Common viral diseases of plants (Paddy, cotton, potato, tobacco, cauliflower, tomato and sugarcane); Biochemical and genetic basis of virulence in plant pathogens. Management & storage of agricultural products, post harvest diseases, their prevention and control.

Unit IV Microbes and animals

Microbial interactions in animals: Rumen microbiology, microbial contribution to food digestion; Microbial diseases of farm animals (Anthrax, fowl cholera), their prevention and control, Role of bacteria in agriculture, scavenging, nitrifying, saprophytic, ensilage, fuel producing; Organic matter dynamics in soil: Microbial decomposition of cellulose, hemicellulose and lignin, Factors affecting organic matter decomposition; Quorum sensing bacteria; Principles and mechanism of biological control; Commercial production of bio-pesticides with reference to *Bacillus thuringiensis*.

Semester IV
MUMMC 451: Lab course I
(Lab exercises based on theory paper MUMMC 401)

Practicals

1. Patents online on WIPO site.
2. Case studies of different patents: Basmati, Neem, Turmeric, Novartis gleevec, Cre-lox, Diamond versus Chakrabarty, Round up ready crops.
3. Theoretical exercises for identifying the protection of different elements of a common discovery under different types of IPR.

Reference Books

1. Bently, L. and Sherman, B. Intellectual property law. Oxford University Press, Oxford.
2. Bryant, J.L. Protecting your ideas: The inventor's guide to patents. Academic Press, New York.
3. Durham, A.L. Patent law essentials: A concise guide. Quorum books, Westport.
4. Ganguli, P. Intellectual property rights. Tata Mc-Graw Hill, New Delhi.
5. Gordon, T.T. and Cookfair, A.S. Patent fundamentals for scientists and engineers. CRC Press, Boca Raton.
6. Grubb, P.W. Patents for chemicals, pharmaceuticals and biotechnology: Fundamentals of global law, practice and strategy. Oxford University Press, Oxford.
7. Halpern, S. Fundamentals of United States intellectual property law: Copyright, patent and trademark. Springer-Verlag, New York.
8. Knight, H.J. Patent strategy: For researchers and research managers. John Wiley and Sons, New York.
9. Parulekar, A. and D'Souza, S. Indian patent law: Legal and business implications. MacMillan Press, London.
10. Santaniello, V., Evenson, R.E., Zilberman, D. and Carlson, G.A. Agriculture and Intellectual Property Rights: Economic, institutional and implementation issues in biotechnology. CABI Publications, New York.
11. Shippey, K.C. A short course in international intellectual property rights: Protecting your brands, marks, copyrights, patents, designs and related rights worldwide. World Trade Press, Petaluma.

SEMESTER IV
MUMMC 452: Lab course II

Lab exercises based on theory paper 402 (I) Food and Dairy Microbiology

Practical

1. Microbiological examination of food.
2. Bacterial contamination in milk.
3. Presumptive test for coliforms in milk & butter.
4. Isolation and biochemical identification of microorganisms from contaminated food and dairy samples- Bacteria & fungi.
5. Microorganisms in cheese spoilage.
6. Effect of freezing temperatures on microorganisms in food
7. Determination of bacteria number - Standard plate count and Direct microscopic count
8. Effect of salt concentration on lactic acid production in sauerkraut.
9. Estimation of acidity of vinegar.
10. Assay of quality of milk sample using MBRT test.
11. Adulteration tests for milk.
12. Microbial production of curd.
13. Isolation and identification of *Lactobacillus* from fermented dairy products using differential staining.

**Note : (a) Photographs to be supplemented on unavailability of slides.
(b) Slides from experiments.**

Suggested Books:

1. Adams MR and Moss MO, Food Microbiology. New Age International Ltd.
2. Banwart GJ, Basic Food Microbiology. CBS Publishers & Distributors.
3. Britz T. and Robinson R. K., 2008, Advanced Dairy Science and Technology. Wiley Blackwell.
4. Dubey, R.C. and Maheshwari, D.K., A textbook of Microbiology. S. Chand and Company Pvt. Ltd.
5. Elmer, H. M and James S., 2001, Applied Dairy Microbiology. 2nd edition. CRC Press.
6. Frazier, WC and Westhoff, DC, Food Microbiology. Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. Robinson R K., 2002 Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products. 3rd edition. Wiley.
8. Yousef, A E. and Carlstrom C., 2003, Food Microbiology: A Laboratory Manual. Wiley

Semester IV

MUMMC 452: Lab course II

**Lab exercises based on theory paper 402 (II) Agricultural Microbiology
Practical**

1. Isolation and biochemical identification of *Azotobacter* from soil.
2. Isolation and biochemical identification of *Rhizobium* from root nodule of leguminous plant.
3. Isolation of phosphate solubilizers from soil.
4. Isolation and biochemical identification of PGPR from plant rhizosphere.
5. Determination of siderophore production by PGPR.
6. Study of symptoms of bacterial, fungal and viral diseases of plants.
7. Isolation and identification of pathogenic microorganisms from diseased plant sample.
8. Isolation and enumeration of bacteria and fungi from soil samples.
9. Physico-chemical testing of soil.
10. Microbes in composting.
11. Study of antagonism of micro-organism by dual culture inoculation method.
12. Commercial production of bio-fertilizers.
13. Standard ISI regulations for mass cultivation of bio-fertilizers.
14. Diseases of farm animal (any two).

**Note : (a) Photographs to be supplemented on unavailability of slides.
(b) Slides from experiments.**

Reference Books

1. Rao N.S.S., 1999, Soil Microbiology. Oxford & ISH Publishing Co., New Delhi.
2. Subba Rao, N.S. Soil microorganisms and plant growth. Oxford and IBH Publishing Company, New Delhi.
3. Alexander, M. Introduction to soil microbiology. John Wiley and Sons, New York.
4. Board, N. The complete technology book on biofertilizer and organic farming. National Institute of Industrial Research, India.
5. Sharma, A.K. Biofertilizers for sustainable agriculture. ABD Publishers, Jaipur.
6. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.
7. Tilak, K.V.B.R. Bacterial biofertilizers. IARI Publications, New Delhi.

8. Venkataraman, G.S. Algal biofertilizers and rice cultivation. Today and Tomorrow's Printers and Publishers, New Delhi.
9. Agrios G.N., 1997, Plant Pathology. Academic Press, San Diego.
10. Kahn M. S., Zaidi A. and Mussarrat J., 2009, Microbes in Sustainable Agriculture. Nova Science Publishers
11. Subbarao N.S and Dommergues Y. R., 2000, Microbial Interactions in Agriculture and Forestry. v. 2 Science Publishers U.S
12. Glick B. R., Holguin G, Pattee C. L, 1999, Biochemical and Genetic Mechanisms Used by Plant Growth and Bacteria. Imperial College Press.
13. Christen J.H., 2001, A Manual of Environmental Microbiology. ASM Publications.
14. Cook R.J. and Baker K.F., 1983, The Nature and Practice of Biological Control of Plant Pathogens. America Phytopathological Society Press, St. Paul, MN.
15. Cooper J. E. and Rao J. R., 2007, Molecular Approaches to Soil, Rhizosphere and Plant Microorganism Analysis. CABI Publication.
16. George N. A., 1997, Plant Pathology. 4th edition, Academic Press, New York

SEMESTER IV
MUMMC 452: DESSERTATION

Dissertation work should involve practical work on a selected problem. It must include :

1. Introduction
 2. Review of Literature
 3. Materials & Methods
 4. Results (Statistically analyzed if required)
 5. Discussion
 6. Conclusion
 7. References
- **For evaluation- the dissertation will be sent to External examiner/s.**
 - **Presentation and Viva- Voce of this paper would be a part of the elective practical. The topic are:**
 1. Drug Resistance
 2. Infection and Immunity
 3. Plant- Microbes Interaction
 4. Microbial Diversity
 5. Bioremediation
 6. Pathogenic Microorganisms and Drugs
 7. Food Adulteration and Microbes
 8. Fermented Foods
 9. Food and Enzyme
 10. Microbial Biotechnology
 11. Biomass and Bioenergy Production

Any other topic suggested by departmental committee may also be considered for the dissertation/project work.