

**REVISED SYLLABUS: MSc MICROBIOLOGY, CSJM UNIVERSITY,  
KANPUR**

| COURSE                 | TITLE                                                   | MARKS       |
|------------------------|---------------------------------------------------------|-------------|
| <b>SEMESTER I</b>      |                                                         |             |
| MIC 101                | GENERAL MICROBIOLOGY                                    | 100         |
| MIC 102                | BIOCHEMISTRY                                            | 100         |
| MIC 103                | ANALYTICAL TECHNIQUES AND<br>BIOSTATISTICS              | 100         |
| MIC 104                | CELLULAR MICROBIOLOGY                                   | 100         |
| MIC 105                | PRACTICALS                                              | 100         |
|                        | <b>TOTAL</b>                                            | <b>500</b>  |
| <b>SEMESTER II</b>     |                                                         |             |
| MIC 201                | BACTERIAL METABOLISM AND PHYSIOLOGY                     | 100         |
| MIC 202                | FUNDAMENTALS OF MOLECULAR BIOLOGY                       | 100         |
| MIC 203                | RECOMBINANT DNA TECHNOLOGY                              | 100         |
| MIC 204                | VIROLOGY                                                | 100         |
| MIC 205                | PRACTICALS                                              | 100         |
|                        | <b>TOTAL</b>                                            | <b>500</b>  |
| <b>SEMESTER III</b>    |                                                         |             |
| MIC 301                | MICROBIAL TECHNOLOGY                                    | 100         |
| MIC 302                | MICROBIAL GENETICS                                      | 100         |
| MIC 303                | CELLULAR AND MOLECULAR IMMUNOLOGY                       | 100         |
| MIC 304                | AGRICULTURE AND ENVIRONMENT<br>MICROBIOLOGY             | 100         |
| MIC 305                | PRACTICALS                                              | 100         |
|                        | <b>TOTAL</b>                                            | <b>500</b>  |
| <b>SEMESTER IV</b>     |                                                         |             |
| MIC 401                | INDUSTRIAL MICROBIOLOGY                                 | 100         |
| MIC 402                | MEDICAL MICROBIOLOGY                                    | 100         |
| MIC 403A<br>(Elective) | FOOD MICROBIOLOGY                                       | 100         |
| MIC 403B<br>(Elective) | MICROBIAL GENOMICS, PROTEOMICS AND<br>BIOINFORMATICS    | 100         |
| MIC 404                | PROJECT                                                 | 200         |
| MIC 405                | MOOC- Compulsory (Any one out of the available options) | Grade       |
|                        | <b>TOTAL</b>                                            | <b>500</b>  |
|                        | <b>GRAND TOTAL</b>                                      | <b>2000</b> |

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## SEMESTER - I

### **MIC 101: GENERAL MICROBIOLOGY**

**Unit 1:** History, development and scope of microbiology. Major contributions of scientist to microbiology (Antony van Leeuwenhoek, Lazzaro Spallanzani, John Tyndall, Louis Pasteur, Joseph Lister, Iwanowski, Robert Koch). Pure culture Isolation Techniques; Microscopy and preparation of microbial samples: wet mount, smear; Staining: types; simple and differential staining

**Unit 2** Nutritional requirement and Growth of microorganism: culture media- types, factors affecting growth, Measurement of growth, growth phases, growth kinetics, diauxic growth, synchronous and asynchronous culture; batch, fed batch and continuous culture; Growth of aerobic and anaerobic bacteria. Culture preservation and Culture Collection.

**Unit 3:** Physical and Chemical control of microorganisms: Disinfectants and Sterilization principles. Introduction to Antimicrobial chemotherapy

**Unit 4.** Microbial Taxonomy, Systematics, Phylogeny and Nomenclature. Hierarchical organization of organisms- Haeckel, Whittaker and Woese classification. Numerical and Chemotaxonomy of microorganism. Salient features of archaebacteria and eubacteria. Classification of bacteria according to Bergey's Manual of Determinative Bacteriology.

**Unit 5.** Differentiating features, habitats, reproduction and classification of Mollicutes, Slime Molds, Algae, Fungi, Viruses

#### **Suggested Reading:**

1. Microbiology. Prescott LM, Hurley JP, Klein DA. Microbiology- Edition. McGraw Hill Publication, New York
2. Microbiology. M J Pelczar, Chan, Krieg. 5<sup>th</sup> Edition. Mc Graw Hill
3. Microbiology. RP Singh. Kalyani Publisher
4. Textbook of Microbiology. Dubey & Maheshwari. S Chand Publications.

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## MIC 102: BIOCHEMISTRY

**Unit 1:** Composition, structure and function of biomolecules –carbohydrates-mono, di and polysaccharides, lipids - storage and structural lipids, proteins - amino acids, peptides, primary, secondary, tertiary and quaternary structure of protein, nucleic acids –Nucleotides and nucleic acid structure. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

**Unit 2:** Principles of biophysical chemistry water, ionization of water, weak acids, and weak bases, pH, buffer, Henderson Hasselbalch equation, biological buffer

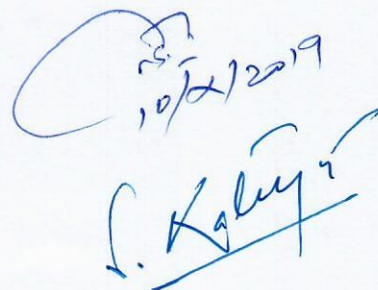
**Unit 3:** Principles of catalysis, enzymes, its classification and enzyme kinetics, Michaelis Menten equation. regulatory enzymes, Allosteric enzymes, enzyme inhibition, mechanism of enzyme catalysis, isozymes ,coenzyme

**Unit 4:** Thermodynamics endergonic and exergonic processes, enthalpy, entropy, free energy change, law of thermodynamics, Bioenergetics, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers

**Unit 5:** Metabolism of carbohydrates (Glycolysis, Kreb cycle, Gluconeogenesis), lipids (beta oxidation, ketone bodies, biosynthesis of fatty acid), amino acids (aminoacid oxidation and urea cycle) nucleotides (degradation and biosynthesis of nucleotides)

### Suggested Reading:

1. Lehninger Principles of Biochemistry, Nelson and Cox, Macmillan Higher education
2. Biochemistry.R.H.Garret and C.H.Grishm Nelson Education ltd.
3. Biochemistry Voet and Voet



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## MIC 103: ANALYTICAL TECHNIQUES AND BIOSTATISTICS

**Unit 1:** Electrophoretic techniques- Theory and application of polyacrylamide and agarose gel electrophoresis, native and SDS PAGE, IEF

**Unit 2:** Chromatography techniques – TLC, paper, column chromatography, gel filtration, ion exchange, HPLC, GLC, partition, affinity, adsorption chromatography

**Unit 3:** Centrifugation techniques – basic principle, type of centrifuge, micro-centrifuge, high speed, ultracentrifuge, preparative centrifugation, (differential and density gradient), analytical centrifugation

**Unit 4:** Spectroscopy techniques – basic principle, instrumentation and biological application of UV-visible spectroscopy, spectrofluorometry, CD, ORD, atomic spectroscopy (absorption and emission), NMR, ESR

**Unit 5:** Radioactivity – radioactive and stable isotopes, radioactive decay, unit of radioactivity, measurement of radioactivity- Geiger muller, solid and liquid scintillation counting, SPA, autoradiography; application of radioisotopes in biochemistry, clinical application

**Unit 6:** Introduction to statistics: mean, median, mode, standard deviation, standard error, probability distribution, chi-square test, t- test, f- test, Analysis of Variance.

### Suggested Reading:

1. Wilson K and Walker J. Principles and Techniques of biochemistry and molecular biology. Cambridge.
2. J. D. Seader and E. J. Henley, Separation Process Principles, 1st Edition (1998), John Wiley & Sons. Inc., New York.
3. Fundamentals of Biostatistics. Khan and Khanum, Shiba Khan. Ukaaz publications
4. Fundamentals of Biostatistics. Veer Bala Rastogi. 3 Ed.

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## MIC 104: CELLULAR MICROBIOLOGY

**Unit 1:** Cell Theory. Differentiate between prokaryotic and eukaryotic cells. Prokaryotes: Cell morphology, Structure, function and synthesis of cell wall, cell membrane, capsules, Endospores, flagella, pili. Storage granule metabolism- volutin, polyhydroxybutyrates and glycogen. Gas vesicles, carboxysomes, magnetosomes and phycobilisomes.

**Unit 2:** Eukaryotes: Structural organization and function of intracellular organelles: Cell wall, cell membrane, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

**Unit 3:** Organization of prokaryotic and eukaryotic genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin.

**Unit 4:** Cell division and cell cycle, cell cycle regulation and control of cell cycle, Cancer and Microbiology.

**Unit 5.** Signal Transduction pathways: Overview and Significance in prokaryotic systems (G protein coupled receptors, and Protein kinases)

### Suggested Reading:

1. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
3. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
5. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
6. Alberts et al. Molecular biology of cell- Bruce Alberts, Cell Biology – Karp, Cell signaling by John T Hancock (Oxford), Darnell, Prescott, Stanier.

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## MIC 105: PRACTICALS

1. Basic rules of a Microbiology Laboratory
2. Basic requirements of a microbiology
3. Study the different parts of a bright field microscope
4. To observe using wet mount preparation for observation of pond algae
5. To perform lactophenol cotton blue staining for observation of fungi
6. Preparation of bacterial smear, fixation of suspension and simple staining for study of bacterial morphology
7. To perform Gram Staining for differentiation of bacteria
8. To study the principle and working of pH meter and preparation of phosphate buffer
9. To study principle, working and types of centrifuges and perform separation of bacterial pellet from supernatant.
10. To study the principle and working of spectrophotometer by turbidometric measurement of bacterial growth
11. To study principle and working of Thin layer chromatography by chlorophyll separation
12. Preparation of nutrient broth and its sterilization
13. Preparation of nutrient agar and pouring of plates
14. To perform serial dilution and isolation of micro-organisms using spread plate technique
15. To perform isolation of pure culture using the streak plate technique
16. To perform pour plate technique
17. Preparation of slants for the preservation of micro-organisms
18. Carbohydrate estimation
19. Protein Coagulation
20. Determination of mean, median and mode of given bacterial population

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## SEMESTER – II

### **MIC 201. BACTERIAL METABOLISM AND PHYSIOLOGY**

**Unit 1:** Transport of nutrients – passive diffusion, facilitated diffusion, active transport (ABC transport, proton and sodium gradient driven active transport), group translocation (phosphotransferase system), iron transport (siderophores); thermodynamics of transport system; bacteriorhodopsin.

**Unit 2:** Photosynthetic pigments; oxygenic and anoxygenic photosynthesis; autotrophy (calvin cycle, reductive TCA cycle, acetyl CoA pathway); chemolithotrophy (H, N, S, Fe oxidations), methanogens, methanotrophs.

**Unit 3:** Central catabolic pathways – glycolysis, pentose phosphate pathway, Entner Doudoroff pathway, Krebs cycle, electron transport system and ATP generation, glyoxylate cycle, fermentation of carbohydrate (homo and heterolactic fermentation), Pasteur effect.

**Unit 4:** Biochemistry of nitrogen fixation – nitrogenase complex, regulation of nitrogenase by oxygen and combined nitrogen sources; genetics of nitrogen fixation - nif genes and their regulation; nitrification; denitrification; pathways of nitrate and ammonia assimilation; sulphur assimilation; phosphate assimilation (Pho system).

**Unit 5:** Stress physiology – adaptations to oxygen toxicity, pH, osmotic pressure, temperature; Donnan equilibrium; quorum sensing related signalling pathways (AHL, AI), bioluminescence, multicellular organization in microbes (coordination in microbes).

#### **Suggested Reading:**

1. Moat A.G. Foster J.W. Spector M.P. 2002. Microbial Physiology (4th ed). Wiley.
2. Caldwell, D.R. 1995 Microbial Physiology and Metabolism, Wm. C. Brown Publishers, U.S.A.
3. White, D., 2003 The Physiology and Biochemistry of Prokaryotes, second edn, Oxford University Press
4. Gottschalk, G. 1985 Bacterial Metabolism, second edn, Springer

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## MIC 202. FUNDAMENTALS OF MOLECULAR BIOLOGY

**Unit 1:** Genetic information and nucleic acids, DNA as the genetic blue print, experimental evidence, Physical and chemical structure of DNA structure, circular and superhelical DNA, denaturation of DNA, renaturation, Hybridization, semiconservative replication.

**Unit 2:** DNA replication, repair and recombination - Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.

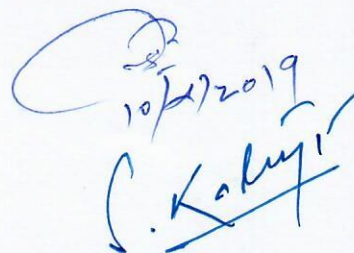
**Unit 3:** RNA synthesis and processing - transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport, transcriptional inhibitors.

**Unit 4:** Protein synthesis and processing - Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins, Protein trafficking

**Unit 5:** Control of gene expression at transcription and translation level - regulating the expression of prokaryotic (*lac*, *trp*, *ara* operon) and eukaryotic genes response element, role of chromatin in gene expression and gene silencing.

### Suggested Reading:

1. George M Malacinski. Freifelder's Essentials of molecular biology. Jones & Bartlett Learning
2. Krebs JE, Goldstein ES, Kilpatrick ST. Lewin's Essential Genes. Jones & Bartlett Learning



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## MIC 203: RECOMBINANT DNA TECHNOLOGY

**Unit 1:** Basic Tool of RDT: Host controlled restriction and modification, Restriction enzymes & its nomenclature, DNA modifying enzymes, Cohesive & Blunt end ligation, Linkers, Adaptors, Homopolymer tailing, c DNA library & Genomic DNA library construction

**Unit 2:** Introduction to cloning: Cloning Vectors-plasmid (pBR322, pUC) Cosmid, Phasmid, Bacteriophage  $\lambda$ , Single stranded DNA Vectors (M 13, f 1, fd), Artificial Chromosomal Vectors (BACs, YACs), Prokaryotic & Eukaryotic Expression Vectors with GST, His, MBPtags, Affinity Purification of recombinant Protein.

**Unit 3:** Gene Transfer Methodologies: Gene Transfer in Plants- Direct/ vectorless, Vector mediated gene transfer (Agrobacterium mediated Binary, Conjugate Vector, Viral Vector) Gene Transfer in animals – Direct/ Vectorless, Vector mediated, Embryonic stem cell gene transfer

**Unit 4:** Labelling & Detection of nucleic acid: End labeling, Random Priming, Nick Translation using radioactive, Nonradioactive probes, Hybridization techniques -Southern Blotting, Northern Blotting, Western Blotting, Dot Blot

**Unit 5:** DNA sequencing, PCR & its types (including real time, reverse transcriptase), Molecular markers (RAPD, RFLP, AFLP), DNA fingerprinting, Applications of RDT in various fields

### Suggested Reading:

1. TA Brown. Gene cloning and DNA analysis. Blackwell Publ.
2. Old and Primrose. Principles of gene manipulation. An introduction to genetic engineering. Blackwell Scientific Publ.

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## MIC 204: VIROLOGY

**Unit 1:** History of Virology; Classification and Morphology of Viruses: Cataloging the virus through virus classification schemes of ICTV / ICNV. Baltimore's Classification; Ultra-structure of viruses: envelop, capsid and nucleic acid; Virus related agents: viroids, virusoids and prions.

**Unit 2:** Cultivation and assay of viruses: Embryonated eggs, experimental animals, cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses: Assay of viruses – Electron Microscopy, Infectivity Assays (Plaque and end-point dilution assay). Serological Assays (ELISA, RIA).

**Unit 3:** Viral Multiplication: Mechanism of virus adsorption, entry and exit into the host cell. Replication strategies of DNA and RNA viruses. latent infections, persistent infections. Lifecycle of bacteriophages-lytic and lysogenic pathways: T series,  $\lambda$ , Mu, M13,  $\phi$ X174; Cyanophages and Mycophages.

**Unit 4:** Pathogenesis of Viruses: Structure, genomic organization, replication cycle; pathogenesis, diagnosis and control. Poxvirus, Adenovirus, Herpes virus, Hepatitis virus, Rota Virus, Picorna virus, HIV, Toga Viruses.

**Unit 5.** Pathogenesis of plant Viruses: TMV, PVX, PVY and insect viruses NPV. Role of insect vectors in transmission of plant viruses. Host cell transformation by viruses and oncogenesis

### Suggested Reading

1. Medical Virology 10 Th Edition by Morag C and Tim bury M C . Churchil Livingstone, London.
2. Introduction to Modern Virology 4th Edition by Dimmock N J, Primrose S. B. Blackwell Scientific Publications. Oxford.
3. Virology 3 rd Edition by Conrat H.F., Kimball P.C. and Levy J.A. Prentice Hall, Englewood Cliff, New Jersey.
4. Text Book on Principles of Bacteriology, Virology and Immunology Topley and Wilsons.
5. Molecular Biology, Pathogenesis and Control by S.J. Flint and others. ASM Press, Washington, D.C.
9. Clinical virology Manual by Steven, S., Adinka, R.L., Young, S.A.

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## MIC 205: PRACTICALS

1. To determine the effect of pH, temperature and salinity on growth of given microbial sample
2. To determine the effect of temperature on growth of given microbial sample
3. To determine the effect of salinity on growth of given microbial sample
4. To determine catalase activity of given microbial culture
5. To perform oxidase activity of given microbial culture
6. To perform oxidative fermentative test for given microbial culture
7. To perform sugar fermentative tests for given microbial cultures
8. To perform negative staining using Nigrosine
9. To perform capsule staining using given microbial sample
10. To perform endospore staining using Schaeffer- Fulton staining method
11. To perform staining of poly hydroxyl alkanoate granules using Sudan Black
12. To observe budding of *Saccharomyces cerevisiae*
13. To determine amylase forming ability of given isolates
14. To determine gelatinase forming ability of given isolates
15. Isolation of rhizobia on CRYEMA media from root nodules
16. Isolation of bacteriophages from sewage/ Ganga water using plaque assay
17. Study of ELISA assay for given viruses.
18. Observation of viral pathogenicity using phase contrast microscope.
19. Isolation of bacterial DNA and its separation using agarose gel electrophoresis
20. To demonstrate *in vitro* transcription assay and *in vitro* translation assay



  
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## SEMESTER – III

### **MIC 301: MICROBIAL TECHNOLOGY**

**Unit 1:** Fermentation technology: microbial growth kinetics in batch, continuous & fed-batch fermentation process. Solid state & submerged fermentation: their advantages & disadvantages. Immobilization of microbial enzymes, whole cells and their industrial applications. Biosensors and biochips.

**Unit 2:** Renewable bioenergy using microorganisms – Methane production by anaerobic digestion of waste organic materials, Bioethanol and biohydrogen production by using microorganisms, Bioleaching, Biohydrometallurgy; Industrial waste water treatment

**Unit 3:** Use of microbes and microbial enzymes in the improvement of nutritive quality of feed; Engineering traits in plants related to stress resistance and nutritional quality improvement; Bt gene technology; frost protection by microbes. Nanoparticle synthesis using micro-organisms.

**Unit 4:** Pharmaceutical Microbiology: Mode of action of antibiotics, antifungal and antiviral drugs; antitumor substances. GMP & GLP in pharmaceuticals; Sterilization of pharmaceutical products. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Safety in microbiology laboratory.

**Unit 5:** Intellectual Property Rights (IPR), Patents, Trademarks, Copyrights, Secrets; Patenting of microbiological materials and GMOs; patenting of genes and DNA sequences; Quality control through WHO. Ethics & Safety of GMO.

#### **Suggested Reading:**

1. Stanbury PF, Whitekar A. and Hall (2006). Principles of Fermentation Technology. Pergaman. McNeul and Harvey.
2. Bhosh, Fiecht er and Blakebrough (2005). Advances in Biochemical Engineering. Springer Verlag Publications.
3. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc., Tata MacGraw Hill, New Delhi.
4. Pharmaceutical Microbiology – Edt. by W.B.Hugo & A. D. Russell Sixth edition. Blackwell scientific Publications.
5. Bernd Rehm (2006). Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Scientific Press.
6. TA Brown. Gene cloning and DNA analysis. Blackwell Publ.

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## MIC 302: MICROBIAL GENETICS

**Unit 1:** Mutation in bacteria, Auxotrophic & conditional lethal mutants, Types of mutation, Physical and chemical mutagens, biochemical basis of mutation, Reversion versus suppression mutation, Different types of DNA repair mechanism.

**Unit 2:** Plasmids: F, col and R plasmids. Function encoded by plasmids, Replication of plasmids, incompatibility, host range, copy number, curing of plasmid, Plasmid as vector for gene cloning

**Unit 3:** Gene transfer mechanisms –Transformation, conjugation and transduction- mechanism and application, Genetic analysis of microbes- bacteria and yeast, complementation, Molecular basis of recombination, Insertion Sequences & Transposons

**Unit 4:** Bacteriophage: Lytic phages T4 & T7, Lysogenic phages lambda and P1 Life cycle, replication, transcription and regulation of gene expression.

**Unit 5:** Acquired and adaptive immunity in bacteria, antiphage defence system, programmed genetic variation, Epigenetics

### Suggested Reading:

1. Snyder L and Champness W. Molecular genetics of bacteria. ASM Press.
2. David Freifelder. Microbial genetics. Jones & Bartlett Publ.

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## MIC 303. CELLULAR AND MOLECULAR IMMUNOLOGY

**Unit 1:** Introduction to the immune system, Physical and chemical barriers, Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. Cytokines and Chemokines, Primary and Secondary lymphoid organs, Complement system

**Unit 2:** Primary and Secondary Immune response. Clonal Selection Theory, Humoral Immunity: structure and function of antibody molecules. Generation of antibody diversity, Activation and differentiation of B cells, B cell signaling, Types of B cells, Memory B cells.

**Unit 3:** T cell Immune response: MHC molecules, antigen processing and presentation, activation and differentiation of T cells, T cell receptors, genetic diversity of T cell response, T cell signaling, types of T cells. Peripheral and Central tolerance, Autoimmunity, Hypersensitivity.

**Unit 4:** Immunotechniques: Precipitation, agglutination and complement mediated immune reactions; ELISA, Western blotting, ELISPOT assay, immunofluorescence, immunoelectron microscopy; CMI techniques: lymphoproliferation assay, MLR, Cell Cytotoxicity assays, FACS, Apoptosis Assay, Use of Transgenic mice and Gene knock outs in immunological assays.

**Unit 5:** Immune response during bacterial )tuberculosis(, parasitic )malaria( and viral )HIV( infections. **Vaccinology:** Active and passive immunization; Hapten & Adjuvants, Types: live, attenuated, killed, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines.

### Suggested Reading:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman
2. Abul Abbas, Adrew Litchman, Shiv Pillai. Cellular and Molecular Immunology. 9<sup>th</sup> Edition. Elsevier.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications.
4. Peter J. Delves (Author), Seamus J. Martin (Author), Dennis R. Burton (Author), Ivan M. Roitt (Author)
5. Roitt's Essential Immunology. 13<sup>th</sup> Edition, Wiley Black Publications.

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## MIC 304: AGRICULTURE AND ENVIRONMENT MICROBIOLOGY

**Unit 1:** Environment microbiology: Role of microbes in environment, microbes in air - aerosol and droplet nuclei, assessment of air quality (impactor and impingement methods). Microbes in water – fresh water, deep sea, estuaries, mangroves, hydrothermal vents, eutrophication.

**Unit 2:** Community ecology: Microbial interactions (symbiosis, mutualism, commensalisms, competition, amensalism, synergism, parasitism and predation), rhizosphere, role of Microorganisms in organic matter decomposition (cellulose, hemicellulose, lignins).

**Unit 3:** Waste treatment: Solid waste treatment – landfill, composting; liquid waste treatment - (aerobic, anaerobic, primary, secondary & tertiary) treatment, advanced treatments (nitrate and phosphate removal). Bioremediation, biodegradation of xenobiotics, bioaccumulation of heavy metals and detoxification.

**Unit 4:** Agriculture microbiology: Plant-microbe (plant growth promoting microorganisms) interaction mechanisms; Diazotrophs for biological nitrogen fixation, symbiotic association formation and Nitrogen fixation; biofertilizers types, application methods and agronomic importance.

**Unit 5:** Major plant disease symptoms caused by fungi, bacteria and viruses. Life cycle, symptoms and control measures of the following diseases: Fungal – *Puccinia graminis*, *Fusarium oxysporum*. Bacterial – *Xanthomonas oryzae*, *Pseudomonas syringae*. Viral– TMV, CaMV. Biopesticides (fungal, bacterial and viral biocontrol agents).

### Suggested Reading:

1. Manual of environmental microbiology, Christon J. Hurst, Ronald L. Crawford Second edition, ASM Press.
2. Agricultural Microbiology: Subba rao
3. Microbial Ecology –Atlas and Bartha.

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### MIC 305: Practicals

1. Isolation and enumeration of aero microflora using settle gravity method
2. Isolation and enumeration of normal microflora from the skin
3. Isolation of *Staphylococcus aureus* using selective and differential media Mannitol Salt Agar
4. Isolation of B hemolytic Streptococci from throat/ sputum sample using Blood Agar
5. Isolation of urease producing isolates
6. Detection of biofilm forming ability of isolates using Congo Red Binding agar
7. Isolation of Enterobacteriaceae from sewage water using EMB/ MacConkeys Agar
8. Presumptive MPN test
9. Determination of Dissolved oxygen and Biological Oxygen Demand of given water sample
10. IMVic and TSI test for differentiation of Enterobacteriaceae
11. Determination of R: S value of rhizospheric soil
12. Isolation and enumeration of isolated from phyllosphere
13. Isolation of phosphate solubilizing bacteria using Pikovaskiya Agar
14. Plant growth promoting products:: HCN, Indole acetic acid
15. Demonstration of antigen antibody precipitation using Widal test
16. Isolation of UV resistant mutants
17. Isolation of antibiotic resistant mutants and their isolation using replica plating method
18. Blood group estimation
19. Isolation of genomic DNA and polymerase chain reaction
20. Preparation of blood smear and identification of leukocytes and Determination of differential leukocyte count of given blood sample

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## SEMESTER – IV

### **MIC 401: INDUSTRIAL MICROBIOLOGY**

**Unit 1:** Screening for production strains, strain improvement, Maintenance of industrially important microorganisms, Scale up and scale down of the fermentation process (shake flask – lab fermenter – pilot plant - production level), Parameters to be scaled-up (fermenter design, media, sterilization of media, etc).

**Unit 2:** Construction and types of fermentors, media, sterilization, inoculum preparation (bacterial, fungal, immobilization), aeration, agitation, foam control. Downstream processing of biologicals, economics of fermentation process, Hygiene and safety.

**Unit 3:** Fermented beverages – beer and wine; Development of industrially important microbial enzymes (amylolytic enzymes, proteases); production of organic acids by microbes (citric acid, acetic acid); industrial production of amino acids (L-lysine, L-glutamate), microbial production of vitamins (B2, B12).

**Unit 4:** Production process of antibiotics (penicillin, streptomycin); industrial production of interferon, microbial production of insulin, vaccine production and formulation, Biotransformation of steroids.

**Unit 5:** Microbial production of polymers (xanthan, dextran), production of bioplastic compound - polyhydroxy alkanates; Generation of microbial biomass as single cell protein, mushroom; production of bacterial, algal and fungal biofertilizers and their application methods.

#### **Suggested Reading:**

1. Casida, L.E., 1984, Industrial Microbiology. Wiley Eastern, New Delhi
2. Prescott and Dunn's.: Industrial Microbiology, AVI Publishing Co. USA.
3. Waites M.J. et al.: Industrial Microbiology, Blackwell Science Ltd.
4. Glazer A.N and Nikaido H.: Microbial Biotechnology, W.N. Freeman and Co.

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