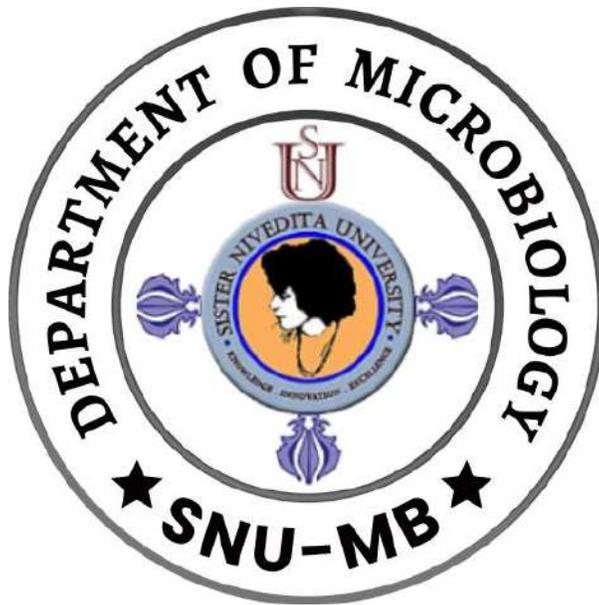


# Sister Nivedita University

## Post Graduate Course Structure for Microbiology

According to UGC-CBCS



**Course Structure for  
M.Sc. in Microbiology**

**Department of Microbiology  
School of Health Science and Translational Research**

## M.Sc. Microbiology Course Structure

Category definition with credit breakup

Semester	Credit					
	CC	DSE	GE	SEC	USC	Total/Sem
First	20	4	4	1	2	31
Second	20	4		1	2	27
Third	24			1	2	27
Fourth	12			1	2	15
Total Credit/ Course	76	8	4	4	8	
<b>Total Credit</b>						<b>100</b>

**CC:** Core Courses; **GE:** General Elective; **SEC:** Skill Enhancement Courses;

**DSE:** Discipline Specific Elective; **USC:** University specified course

### First Year

Category	Course name	Credit	Teaching Scheme		
			L	T	P
<b>Semester – I</b>					
CC – 1	Cell Biology and Cell Signaling	4	3	1	0
CC – 2	Genetic Engineering	4	3	1	0
CC – 3	Molecular Biology	4	3	1	0
CC – 4	Bacteriology and Virology	4	3	1	0
CC – 5	M.Sc. Microbiology Practical – I	4	0	0	8
DSE – 1	Chemistry of Biomolecules	4	3	1	0
GE - 1	Generic Elective	4	4	0	0
USC – 1	Foreign language – I	2	2	0	0
SEC – 1	Mentored Seminar – I	1	1	0	0
<b>Total Credit = 31</b>			<b>Teaching Hour = 35</b>		

## Syllabus for M.Sc. Microbiology

Semester – II					
CC – 6	Enzymes and Metabolism	4	3	1	0
CC – 7	Cellular Immune System	4	3	1	0
CC – 8	Microbial Diversity and Metabolism	4	3	1	0
CC – 9	Genetics of Bacteria and Virus	4	3	1	0
CC – 10	M.Sc. Microbiology Practical – II	4	0	0	8
DSE – 2	Biophysics	4	3	1	0
USC – 2	Foreign language – II	2	2	0	0
SEC – 2	Mentored Seminar – II	1	1	0	0
<b>Total Credit = 27</b>				<b>Teaching Hour = 31</b>	

Category	Course name	Credit	Teaching Scheme		
			L	T	P
Semester - III					
CC – 11	Fermentation and Bioprocess Technology	4	3	1	0
CC – 12	Bioinformatics and Biostatistics	4	3	1	0
CC – 13	Eukaryotic Microbiology	4	3	1	0
CC – 14	Medical Microbiology and Cancer Biology	4	3	1	0
CC – 15	Environmental Microbiology and Ecology	4	3	1	0
CC – 16	M.Sc. Microbiology Practical – III	4	0	0	8
USC – 3	Foreign language – III	2	2	0	0
SEC – 3	Mentored Seminar – III	1	1	0	0
<b>Total Credit = 27</b>				<b>Teaching Hour = 31</b>	
Semester – IV					
CC – 17	Microbiology Master Project / Dissertation	12	0	0	24
USC – 4	Foreign language – IV	2	2	0	0
SEC – 4	Microbiology Master Seminar	1	1	0	0
<b>Total Credit = 27</b>				<b>Teaching Hour = 27</b>	

# Syllabus for M.Sc. Microbiology

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## M.Sc. MICROBIOLOGY

**Program Prerequisite:** Students should have graduation degree in Biological and Allied Sciences with understanding of Physics and Chemistry in life governing processes.

**Duration of Program:** 4 Semesters (In 2 Years).

**Program Educational Objectives:** Competent in applying theoretical and practical hands on approach in Microbiology and Biotechnology. To apply the knowledge in providing solution to health, environmental and research problems. Promote Innovation and Research in cutting edge biotechnological research. To address the problems faced by India and to become a responsible citizen. Promote a strong sense of team spirit and brotherhood for building a strong India. Program Outcomes / Program Learning Outcome (Department Vision) The graduates of Microbiology or Biotechnology student must have: Ability to approach, analyze and bring out scientific solution for a given problem. Knowledge to implement multidisciplinary concepts and ideas for the development of innovative technologies. Expertise to demonstrate leadership, quality and entrepreneurship. Demonstrate technical skills in operation and maintenance of sophisticated instrumentations. Intelligence to protect their innovative research through IPR. Innovation for high quality research on par with international laboratories. Expert to explore scientific projects for need based industry. Capability to bring out good quality research proposal as well as research publications. Student would be competent discipline-specific studies, as well as to begin domain-related employment. To mould a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication. The student graduating with the Degree of M.Sc. Microbiology/ Biotechnology should be able to acquire core competency, The student will enable to learn and demonstrate about basic experimental techniques in classical and modern biotechnology. The students will able to understand and explain various aspects such as Cell and Molecular Biology, Genetic Engineering, Immunology, Biochemistry and Enzymology. The students will gain sound knowledge in various fields including Plant, Animal, Microbial Biotechnology, Bioprocess technology, Medical Biotechnology and Environmental Biotechnology.

**Analytical Ability:** The students will capable of demonstrate the knowledge in understanding research and addressing practical problems. Application of various scientific methods to address different questions by formulating the hypothesis, data collection and critically analyse the data.

**Critical thinking and Problem solving ability:** An increased understanding of fundamental scientific concepts, principles and their applications is expected at the end of this course. Students will become critical thinker and acquire in depth knowledge in problem solving capabilities.

**Digital knowledge:** Students will acquire digital skills and integrate the fundamental concepts with modern biotechnological tools.

**Ethical and Moral Strengthening:** Students will also strengthen their ethical and moral values and shall be able to deal with psychological weaknesses.

**Team Work:** Students will learn team workmanship in order to serve efficiently in institutions, industry and society.

# Syllabus for M.Sc. Microbiology

## Semester – I

### CC-1: Cell Biology and Cell Signaling

Subject Code: 1110020101

Credit: 4 (L3 T1 P0)

Course Component: Theory

Lecture Hour: 48

#### Course Outcomes:

<b>CO1:</b> Find how the cellular system works
<b>CO2:</b> Outline the basic concepts of cell structure, function and signaling
<b>CO3:</b> Identify the structural and functional relations of cell organelles and their relation to cell signaling.
<b>CO4:</b> Compare the interrelations of the cell structure, function with different cell signaling
<b>CO5:</b> Explain the integrated responses of the cell structure, function, signaling and the basic functioning of the living being

Cell Biology and Cell Signalling	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2
CO3	3	3	3	3	3	3	3
CO4	2	3	3	2	3	2	3
CO5	2	2	3	3	3	2	3
Average CO	3	2	3	2	3	2	3

#### Teaching Topics

##### Unit 1: Foundations of Cell Biology

[4 L]

Introduction to Cell Biology and historical milestones; Discovery of the cell and cell theory; Classification of living systems (Prokaryotic vs Eukaryotic cells); Methods for studying cells: light, fluorescence, confocal, electron microscopy, cell fractionation, flow cytometry; Introduction to cell culture techniques and applications.

# Syllabus for M.Sc. Microbiology

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## **Unit 2: Structure and Function of the Cell [8 L]**

Types of cells and basic structural features; Plasma membrane: Fluid Mosaic Model, membrane lipids and proteins; Membrane transport: Passive (diffusion, osmosis, facilitated) and Active transport (pumps, carriers, channels, vesicles); Intracellular compartments: structure and function of different cell organelles; Cytoskeletal and motor proteins.

## **Unit 3: Cell Cycle, Chromatin, and Division [6 L]**

Cell cycle phases and checkpoints; Mitosis and meiosis; Cyclins and CDKs; Chromosome structure and types; Nucleosome organization and role of histones; DNA packaging.

## **Unit 4: Cellular Communication and Membrane Dynamics [8 L]**

Membrane trafficking: vesicular transport, receptor-mediated endocytosis, Cell adhesion molecules, integrins; Types of intercellular communication: direct (gap junctions), indirect (chemical messengers); Autocrine, paracrine, endocrine, and synaptic signalling mechanisms.

## **Unit 5: Signal Reception and Second Messenger Systems [8 L]**

Overview of cell surface and intracellular receptors; Types of cell receptors: membrane-bound (ion-channel, GPCRs, RTKs) and cytoplasmic receptors (nuclear hormone receptors); Second messengers: cAMP, cGMP, IP<sub>3</sub>, DAG, Ca<sup>2+</sup>; Signal amplification and integration

## **Unit 6: Key Signalling Pathways in Eukaryotes [8 L]**

MAPK/ERK pathway; JAK-STAT pathway; PI3K-AKT-mTOR pathway; IP<sub>3</sub>-DAG pathway; Regulation and cross-talk among signalling pathways; Chemotaxis and quorum sensing in bacteria.

## **Unit 7: Cancer and Programmed Cell Death [6 L]**

Apoptosis: intrinsic and extrinsic pathways, perforin-granzyme pathways, Caspase activation and apoptotic signalling; Necrosis and autophagy; Cancer Biology: oncogenes, tumor suppressors, hallmarks of cancer; Cell signalling in tumor progression; Therapeutic targeting of signalling pathways.

### **Suggested Books:**

- 1. Molecular Biology of the Cell – Alberts et al. (Garland Science, 7th Ed.)**
- 2. The Cell: A Molecular Approach – Cooper & Hausman (Oxford University Press, 8th Ed.)**
- 3. Essential Cell Biology – Alberts et al. (W.W. Norton, 5th Ed.)**
- 4. Cell Signalling – Lim, Mayer, and Pawson (Garland Science, 1st Ed.)**
- 5. Molecular Cell Biology – Lodish et al. (W.H. Freeman, 9th Ed.)**
- 6. Signal Transduction – Gomperts, Kramer, Tatham (Academic Press, 2nd Ed.)**

# Syllabus for M.Sc. Microbiology

## CC-2: Genetic Engineering Credit: 4 (L3 T1 P0)

**Component: Theory**

**Lectures Hour : 48**

### Course Outcome

<b>CO 1</b> The course leads to the understanding of procedures that have been developed to exploit our knowledge of the replication and expression of genetic information.
<b>CO 2</b> The paper helps the students to understand the processes involved to identify, isolate, amplify, analyze and express virtually any cellular material, whether it is DNA or RNA or Protein.
<b>CO 3</b> Students will understand the basics of gene cloning, enzymes and vectors' role in genetic engineering, and gene transfer methods.
<b>CO4</b> Acquiring theoretical knowledge in the techniques, tools, application and safety measures of genetic engineering.
<b>CO 5</b> Describes genome mapping and sequencing and methods for gene therapy.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	3	3	3	2	3
CO 2	3	2	3	3	3	2	3
CO 3	3	2	3	3	3	2	3
CO 4	3	2	3	3	3	2	3
CO 5	3	2	3	3	3	2	3
Average CO	3	2	3	3	3	2	3

### Teaching Topics

#### Unit 1: Enzymatic Tools and Techniques

[8 L]

Tools for genetic engineering: general requirements for performing a genetic engineering experiment; Restriction digestion, enzymes: restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; Ligation: cohesive and blunt end ligation; linkers; adaptors; homo polymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes

#### Unit 2: Vectors

[10 L]

Plasmids; Bacteriophages; M13 vectors; PUC19 and Bluescript vectors, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome, YACs, BACs. Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors. Protein purification: His-tag; GST-tag; MBP-tag etc. Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and Pichia vectors system, plant based vectors, Ti and Ri plasmids as vectors, yeast vectors, shuttle vectors.

#### Unit 3: PCR Technologies, Sequencing, and Mutation Detection

[8 L]

PCR and primer design; fidelity of thermostable enzymes; DNA polymerases; Types of PCR Cloning of PCR products; TA cloning vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP, RAPD, AFLP, DNA microsatellite, DNA marker, Polymorphism

# Syllabus for M.Sc. Microbiology

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## **Unit 4: Advanced Cloning Strategies and Hybridization Techniques [6 L]**

Methods used in cloning: Positional cloning, functional cloning, therapeutic cloning, Gateway cloning, Gibson cloning; hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence in situ hybridization.

## **Unit 5: Molecular Interaction Studies and Functional Genomics Tools [8 L]**

Interaction studies: cDNA analysis, Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNaseI footprinting, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

## **Unit 6: Gene Silencing, Transgenics, and Genome Editing Technologies [8 L]**

Gene silencing techniques; Transposon and jumping gene, introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems e.g. fruit flies (*Drosophila*), worms (*C. elegans*), frogs (*Xenopus*), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS.

### **Suggested Books**

- 1. Molecular Biology and Genetic Engineering. P. K. Gupta, Rastogi Publications. Revised Edition, 2020**
- 2. Molecular Cloning: A Laboratory Manual. Michael R. Green, Joseph Sambrook. Cold Spring Harbor Laboratory Press. 4th Edition, 2012**
- 3. Principles of Gene Manipulation and Genomics. Sandy B. Primrose, Richard Twyman. Wiley-Blackwell. 7th Edition, 2006**
- 4. Molecular Biology of the Gene. James D. Watson, Tania A. Baker, Stephen P. Bell et al.. Pearson Education. 7th Edition, 2013**
- 5. Gene Cloning and DNA Analysis: An Introduction. T. A. Brown. Wiley-Blackwell. 7th Edition, 2016**

## **CC-3: Molecular Biology**

**Credit: 4 (L3 T1 P0); Lectures: [48 L]**

### **Course Outcomes:**

<b>CO 1</b>	Understand the structure and organization of DNA and RNA across organisms.
<b>CO 2</b>	Explain the mechanisms of DNA replication, transcription, and translation.
<b>CO 3</b>	Identify types of DNA damage and describe major DNA repair pathways.
<b>CO 4</b>	Describe RNA processing events and RNA-based gene regulation.
<b>CO 5</b>	Summarize the genetic code, translation machinery, and post-translational modifications.
<b>CO 6</b>	Understand the role of epigenetic modifications in gene regulation and disease.

## Syllabus for M.Sc. Microbiology

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Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	2	3	3	3
CO 2	3	3	3	2	3	3	3
CO 3	3	3	3	2	3	3	3
CO 4	3	3	3	2	3	3	3
CO 5	3	3	3	2	3	3	3
CO 6	3	3	3	2	3	3	3
Average CO	3	3	3	2	3	3	3

### **Unit 1: Molecular Architecture of Genetic Material**

**[4 L]**

Historical development of DNA structure from Miescher to Watson–Crick. Structural forms of DNA (A-, B-, Z-DNA), salient features of the double helix. Denaturation, renaturation, and Cot curve analysis. DNA topology: supercoiling, linking number, role of topoisomerases. Organization of DNA in prokaryotes, eukaryotes, viruses. Structure and functions of RNA species, mitochondrial and chloroplast genomes, siRNA, and miRNA.

### **Unit 2: DNA Replication in Prokaryotes and Eukaryotes**

**[10 L]**

Mechanisms of bidirectional and unidirectional replication. Semi-conservative and semi-discontinuous models. Enzymes involved: DNA polymerases, primase, ligase, helicase, telomerase and others. Comparative replication models and replication fork dynamics. Regulation of replication initiation and elongation.

### **Unit 3: DNA Damage and Repair Mechanisms**

**[6 L]**

Types and causes of mutations, Ames test, mutant isolation. DNA repair pathways: base excision repair, nucleotide excision repair, mismatch repair. Role of recombination and trans lesion synthesis in maintaining genomic integrity.

### **Unit 4: Transcriptional Processes in Prokaryotes and Eukaryotes**

**[6 L]**

Basics of transcription and its regulation. Prokaryotic transcription: RNA polymerase, promoter structure. Eukaryotic transcription: RNA polymerases I, II, III; general transcription factors and promoter elements. Chromatin's role in transcriptional control.

### **Unit 5: Post-Transcriptional Processing and RNA Regulation**

**[6 L]**

Introns, exons, RNA splicing and spliceosome machinery. Alternative splicing, mRNA capping, polyadenylation. Processing of rRNA and tRNA. RNA interference: roles of siRNA and miRNA in gene regulation.

### **Unit 6: Genetic Code and Protein Translation**

**[6 L]**

Genetic code properties, codon bias, wobble hypothesis. Translation components and mechanism in prokaryotes and eukaryotes: initiation, elongation, termination. Fidelity and inhibitors of translation.

# Syllabus for M.Sc. Microbiology

## Unit 7: Post-Translational Events and Protein Maturation

[6 L]

Post-translational modifications: phosphorylation, glycosylation, ubiquitination. Protein folding, molecular chaperones, targeting and transport. Protein degradation pathways: ubiquitin-proteasome system and autophagy.

## Unit 8: Epigenetic Regulation

[4 L]

DNA methylation, histone modifications, non-coding RNAs. Epigenetic effects on transcription and translation. Role in development and disease.

### Suggested Books:

1. **Molecular Biology of the Gene** – James D. Watson et al., 7th Edition
2. **Molecular Cell Biology** – Harvey Lodish et al., 9th Edition
3. **Lewin's Genes XII** – Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 12th Edition
4. **Principles of Genetics** – D. Peter Snustad and Michael J. Simmons, 7th Edition
5. **Molecular Biology** – Robert F. Weaver, 5th Edition

## CC-4: Advanced Bacteriology and Virology

Subject Code: 1110020104

Credit: 4 (L3 T1 P0)

Component: Theory

Lectures Hours: 48 L

### Course Outcome

CO 1	Develop a strong understanding about the prokaryotic cell structure and function.
CO 2	Get a better idea about the architecture, classification and cultivation of viruses.
CO 3	Learn the life cycles of the lytic and lysogenic bacteriophages
CO 4	Develop a strong concept about microbial growth and nutrition.
CO 5	Understand the mode of action Of various antibiotics along with the mechanisms Of antimicrobial resistance.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	3	1	3	1
CO 2	3	3	3	3	1	3	1
CO 3	3	3	3	3	1	3	1
CO 4	3	3	3	3	1	3	1
CO 5	3	3	3	3	2	3	1
Average CO	3	3	3	3	1	3	1

# Syllabus for M.Sc. Microbiology

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## Teaching topic

### **Unit 1: Morphology of Bacteria:** [4 L]

Size and shape of bacteria, cell membrane, cell wall, outer membrane, Mesosomes, Slime layer and capsule, bacterial flagella, chemotaxis, genetic material, vacuoles, storage granules, ribosomes, endospores, plasmids, cytoskeletal elements.

### **Unit 2: Microscopy and Staining:** [6 L]

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Scanning and Transmission Electron Microscope. Different staining methods to observe bacterial cells, Simple staining, Differential staining - Principle of Gram Staining and Acid-fast staining, endospore staining, capsule staining, flagella staining.

### **Unit 3: Bacterial Growth and Nutrition:** [6 L]

Binary fission. Bacterial growth curve and its stages. Interpretation of growth curve, concept of generation time, growth measurement techniques, bacterial nutrition, bacterial classification according to nutritional requirements, Nutritional types (definition and example) - Photoautotrophs, Photo organotrophs, Chemolithotrophs (ammonia, nitrite, sulfur, hydrogen, iron oxidizing bacteria); Chemoorganotrophs. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential and enriched media. Pure culture isolation- Streaking, serial dilution and plating methods, maintenance and preservation of pure cultures, cultivation of anaerobic bacteria, Viable but non-culturable bacteria.

### **Unit 4: Effect of environmental factors upon bacterial growth:** [4 L]

Effect of temperature, salt concentration, ultra violet radiation, osmotic pressure, pH, oxygen on bacterial growth.

### **Unit 5: Physical and Chemical control of microbes** [8 L]

Physical methods of controlling microbes - heat, low temperature, filtration and radiation. Chemical methods of controlling microbes – Phenolic compounds, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes, sterilizing gases, chemotherapeutic agents. Discovery of antibiotics, mode of action of antibiotics. Cell wall inhibitors - Penicillins, Cephalosporins, Vancomycin. Cell membrane inhibitors – Polymyxins. Protein synthesis inhibitors - Streptomycin, Tetracyclines, Chloramphenicol, Erythromycin. nucleic acid synthesis inhibitors - quinolones. Metabolic antagonists – Sulfonamides and Trimethoprim. Antifungal antibiotics, antiviral antibiotics, antiprotozoan antibiotics. Development of resistance to antibiotics, microbial assay of antibiotics, determination of Minimal Inhibitory Concentration (MIC) and Minimal Lethal Concentration (MLC) of antibiotics.

### **Unit 6: Nature and Properties of Viruses:** [10 L]

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, satellite viruses and Prions. Theories of viral origin. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses. Bacteriophages Diversity, classification, one step multiplication curve, lytic (T4) and lysogenic

# Syllabus for M.Sc. Microbiology

phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage.

## Unit 7: Viral Transmission and Replication:

[10 L]

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Salient features of viral Nucleic acid: Unusual bases (TMV, T4 phage), overlapping genes ( $\phi$ X174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV). Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna), Assembly with example of Polio virus and T4 phage, maturation and release of virions.

### Suggested Books

1. Microbiology., M. Pelczar
2. Prescott's Microbiology: J.M Willey
3. Fundamental Principles of Bacteriology., A.J Salle
4. General Microbiology., R. Stanier

## CC-5: Microbiology Practical - I

Subject Code: 1110020205

Credit: 4 (L0 T0 P8)

### Course Outcome

<b>CO 1:</b> Develop skills in molecular biology techniques such as DNA isolation, PCR amplification, and gene cloning.
<b>CO 2:</b> Gain expertise in microbiological and biochemical laboratory techniques, including protein isolation, SDS-PAGE, and staining methods.
<b>CO 3:</b> Design and conduct experiments involving recombinant DNA technology, including plasmid transformation and cloning into vectors.
<b>CO 4:</b> Perform advanced microscopy techniques, including Barr body isolation and the study of mitosis and meiosis in plant tissues.
<b>CO 5:</b> Master techniques for nucleic acid and protein quantification, using methods like real-time PCR and protein electrophoresis.
<b>CO 6:</b> Analyze and interpret experimental data for microbiological, molecular, and biochemical applications, fostering problem-solving and critical thinking skills in lab settings.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	3	3	2	3
CO 2	3	3	3	3	3	2	3
CO 3	3	3	3	3	3	2	3
CO 4	3	3	3	3	3	2	3
CO 5	3	3	3	3	3	2	3
CO 6	3	3	3	3	3	2	3
Average CO	3	3	3	3	3	2	3

## Syllabus for M.Sc. Microbiology

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### List of Experiments

1. Isolation of total genomic DNA from plant tissue.
2. Isolation of plasmid DNA from bacterial samples using alkaline lysis method.
3. Primer designing.
4. PCR amplification of a candidate gene from the isolated genomic DNA and analysis of The PCR product by agarose gel electrophoresis.
5. Cloning of the PCR amplified product in pGEM-T Easy vector.
4. Preparation of E. Coli (DH5  $\alpha$ ) competent cells and transformation of plasmid DNA
5. Screening of recombinant clones by blue white screening.
6. Isolation and quantification of protein followed by SDS-PAGE.
7. Demonstration of real-time PCR.
8. Preparation of onion root tip for mitosis and meiosis.
9. Barr body isolation and observation under light microscope.
10. Plaque Assay using agar overlay method.
11. Fungal Staining.
12. Acid-Fast Staining.

# Syllabus for M.Sc. Microbiology

## DSE-1: Chemistry of Biomolecules

Subject Code:

Credit – 4 (4L-0T-0P)

Component Theory

Lecture Hours: 48

### Course Outcomes:

**CO 1:** Understand the significance of biochemistry (bonding, pH, molarity, normality) in the biological system.

**CO 2:** Understand the chemistry of water, diffusion Osmotic pressure and importance of aqueous medium in the biological reactions.

**CO 3:** Describe the chemistry, bonding, thermodynamic stability behind the structures of carbohydrates, lipids, proteins and nucleic acids.

**CO 4:** Describe the different structural Organization Of proteins required for their function.

**CO 5:** Factors affecting protein structures, protein folding and degradation.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	1	3	3	3
CO 2	3	3	3	1	3	3	3
CO 3	3	3	3	1	3	3	3
CO 4	3	3	3	1	3	3	3
CO 5	3	3	3	1	3	3	3
Average CO	3	3	3	1	3	3	3

### Teaching Topics

#### Unit 1: Foundation of Biochemistry:

[8L]

Concepts of molecular structure: atoms and molecules, atomic theory, structure of O, N and H atoms. Atomic structure of Carbon and concept of stereochemistry. Forces in molecules and formation of bonds, types of bonds and interactions. Molecular interactions. Structure and properties of water molecule. Few Landmark experiments like: Miller-Urey Experiment, Hershey-Chase Experiment, Griffith's Experiment and Avery-MacLeod-McCarty Experiment.

#### Unit 2: Carbohydrates and Glycobiology:

[10L]

Concept of carbohydrate and sugar, Structural classification of carbohydrates: Monosaccharides, Disaccharides, Oligosaccharides and Polysaccharides. Fischer projection formulas. Haworth perspective formulas: Hemiacetal and Hemiketal formation, Furan and Pyran structure. Concept of Mutarotation, Stereoisomerization: Anomer, Epimer, Enantiomers and Diastereomers. Uronic acid formation. Reducing and nonreducing sugars. Formation and types of Glycosidic bonds. Structures of Disaccharides: Maltose, Lactose, Sucrose and Trehalose. Homopolysaccharides and heteropolysaccharides, Starch and glycogen. Chitin and dextran. Glycoconjugates: Proteoglycans, Glycoproteins, and Glycolipids. The Sugar Code. Principle of chemical estimation of sugar.

## **Unit 3: Amino Acids and Proteins:**

**[10L]**

Structure and classification of Amino acid residues, Essential and non essential amino acids. Titration of Amino Acids: Amphoteric molecule, Zwitterion, pK values; Isoelectric point. Detection of amino acids: Ninhydrin test. Peptide bond formation and polypeptide. Prosthetic group. Different levels of Protein structure: Primary, Secondary, Tertiary and Quaternary. Polypeptide sequencing: Edman degradation. Three dimensional structure of protein: Conformation of protein. Ramachandran Plot. Multimeric nature of protein. Motifs and domains. Protein folding. Molecular chaperones. Rotational symmetry: cyclic symmetry, dihedral symmetry and icosahedral symmetry. Protein denaturation. Function of proteins (Channel proteins, antibody, enzymes etc.)

## **Unit 4: Lipids:**

**[10L]**

Fatty acids: Structure, nomenclatures and classification. Isomerization in fatty acids. Glycerol and lipid formation. simple, complex, derived lipids. Phospholipids and glycolipids. Plasmalogens and platelet-activating factor. Sphingolipids. Sterols. Lipids as Signals, Cofactors, and Pigments. Prostaglandins, Thromboxanes and Leukotrienes. Properties of lipids: Saponification, Acetyltion, Iodine number, volatile fatty acid number.

## **Unit 5: Nucleic acid:**

**[10L]**

Components of DNA and RNA molecules. Discovery of DNA double helix. Structure of DNA double helix and RNA. Hoogsteen pairing. Fragility of DNA and RNA molecules. Types of DNA structures (A-DNA, B-DNA & Z-DNA). Denaturation of DNA double helix: Cot curve and T<sub>m</sub>, Hyperchromic shift. Different RNA molecules (t-RNA, m-RNA and r-RNA). Modifications in Nucleotides. Mitochondrial and Chloroplast DNA. Detection of DNA/RNA.

### **Suggested Books**

- 1. Principles of Biochemistry., A Lehninger.**
- 2. Textbook of Biochemistry., MD Rafi**
- 3. Biochemistry., L Stryer.**
- 4. Harper's Biochemistry., R. K. Murray**
- 5. Biochemistry., Voet and Voet**

# Syllabus for M.Sc. Microbiology

## Semester – II

### CC – 6: Enzymes and Metabolism

Subject Code: 1110021106

Credit: 4 (L3 T1 P0)

Component Theory

Lecture Hours: 48

#### Course Outcomes:

CO 1: Comprehend the concept of bioenergetics and thermodynamic principles in biology.
CO 2: Understand and evaluating free energy and redox potential in relation to metabolism.
CO 3: Describe the mechanism of enzyme action and different classes of enzymes and factors affecting their function.
CO 4: Understand how enzymes and cofactors function in bioenergetics reactions
CO 5: Understand the mechanisms and regulation Of anabolic and catabolic processes of macromolecules like carbohydrates, protein, lipid and nucleic acids.
CO 6: Describe the central role of ATP.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	2	-	2	2	3
CO 2	3	3	2	-	2	2	3
CO 3	3	3	2	-	2	2	3
CO 4	3	3	2	-	2	2	3
CO 5	3	3	2	-	2	2	3
CO 6	3	3	2	-	2	2	3
Average CO	3	3	2	-	2	2	3

#### Teaching component

**Unit 1:** Thermodynamics and Bioenergetics: Laws of thermodynamics, concept of free energy, entropy and enthalpy. Standard free energy and equilibrium constant. [4 L]

**Unit 2:** Introduction to enzymes: proteins as enzymes, enzymatic activity, enzyme substrate complex, transition state, activation energy, rate constant, binding energy, catalysis of biochemical reactions. Enzyme kinetics,  $K_m$  and  $V_{max}$ , Michaelis – Menten equation. Enzyme inhibition, types of enzyme inhibition. [8 L]

**Unit 3:** Metabolism of sugar molecules: Glycolysis and its control, Fates of pyruvate under aerobic and anaerobic condition. Feeder pathways of glycolysis, Pentose phosphate pathway. Reactions of Citric acid cycle, production of NADH and FADH<sub>2</sub>. Glyoxylate cycle, structure of mitochondria, electron transfer reaction and electron transport chain, regulation of electron transport chain, oxidative phosphorylation and ATP synthesis. Gluconeogenesis, biosynthesis of starch and glycogen. [10L]

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**Unit 4:** Oxidation of fatty acids: activation of fatty acids and transportation to mitochondria, beta oxidation, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, alpha oxidation, omega oxidation, ATP generation calculation. [6 L]

**Unit 5:** Amino acid oxidation: Urea cycle, link between citric acid cycle and urea cycle, Pathways of amino acid degradation, conversion of amino acid to acetyl CoA. Conversion of amino acids to alpha keto glutarate. Conversion of amino acids to succinyl CoA. [6 L]

**Unit 6:** Nucleic acid Metabolism: synthesis of nucleotides, salvage and de-novo pathways. [2 L]

**Unit 7:** Photosynthesis: Site of photosynthesis, basic structure of chlorophyll, absorption and action spectra, role of PSI and PSII, Light reaction, chemiosmosis hypothesis, photophosphorylation, Dark reaction, CO<sub>2</sub> fixation, role of RUBISCO, C<sub>3</sub> and C<sub>4</sub> cycle, 'Kranz' anatomy, CAM pathway, photophosphorylation, bacterial photosynthesis (structure of Bacteriochlorophyll, non-cyclic and cyclic photosynthesis, anoxygenic photosynthesis, Rhodopsin-based phototrophy). [4 L]

## Books

1. Principles of Biochemistry., A Lehninger.
2. Textbook of Biochemistry., MD Rafi
3. Biochemistry., L Stryer.
4. Harper's Biochemistry., R. K. Murray
5. Biochemistry., Voet and Voet

**CC-7: Cellular  
Immunology Subject  
Code: 1110021107  
Credit: 4 (L3 T1 P0)**

## Component Theory

**Lecture Hours: 48**

### Course Outcome:

**CO 1:** Learn the key concepts of immunological mechanisms in detail and how this could be extrapolated towards development of novel therapeutic interventions against various diseases

**CO 2:** Explain different the antigen-antibody interaction based diagnostic test, their sensitivity & specificity and also suggest tests for successful diagnosis Of Ongoing disease in the community.

**CO 3:** Will be able to comprehend the genetic Organization Of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity

**CO 4:** Gain knowledge about the vaccines available for different diseases and their method of preparation, Conventional vaccine vs recombinant vaccine, DNA & RMA vaccines

**CO 5:** Learn the production of chimeric and monoclonal Antibodies production using Hybridoma technology and their applications

**CO 6:** Understand and explain the problems associated with the vaccine development for the infectious diseases for which vaccines are yet to be developed.

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Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	3	2	-	2
CO 2	2	3	3	2	-	-	3
CO 3	2	3	3	3	-	-	3
CO 4	3	-	3	3	3	-	3
CO 5	2	2	3	3	-	-	3
CO 6	3	3	3	3	-	-	3
Average CO	3	3	3	3	-	-	3

### Teaching Topics

#### **Unit 1**

**[4 L]**

Immunology-fundamental concepts: Components of innate and acquired immunology, complement and inflammatory responses, haematopoiesis, organs and cells of the immune system-primary and secondary lymphoid organs, lymphatic systems (MALT & GALT), Major Histocompatibility complex (MHC)- MHC genes, antigen processing and presentation, HLA typing.

#### **Unit 2**

**[4 L]**

Antigen: structure and properties of antigen, antigenicity vs immunogenicity, concepts of epitopes, properties of B cell and T cell epitopes, Antigenic determinants.

#### **Unit 3**

**[6 L]**

Immune responses: Immunoglobulins- Basic structure, classes and subclasses, antigenic determinants, action of antibody, kinetics of immune response, B-cell receptor, B-cell maturation, activation and differentiation, MHC/ HLA; antigen processing and presentation; T-cells, T-cell receptors, T-cell maturation, activation and differentiation, Cell-mediated immune responses, ADCC auto immunity, Cell-cell co- operation, Hapten-carrier system immune-deficiency diseases, monoclonal and polyclonal antibodies, clonal selection theory. Complement activation.

#### **Unit 4**

**[6 L]**

Antigen - Antibody interactions: Precipitation reactions- precipitation reaction in fluids and in gel, radial immunodiffusion (Mancini method), double diffusion (Ouchterlony method), Agglutination- Prozone effect, direct agglutination and passive agglutination.

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## Unit 5

[6 L]

Immunization: Active and passive immunization; Live, killed, attenuated, subunit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein-based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Catalytic antibodies and generation of immunoglobulin gene libraries. Adenovirus Vaccine, mRNA vaccine.

## Unit 6

[6 L]

Genetic-Immuno-regulations: Introduction to tumour immunology, autoimmune disorders. Use of transgenic animals in immunology, experimental immunology, vaccine, development, stem cell technology, Immunodiagnostics.

## Unit 7

[4 L]

Hypersensitivity: Types of hypersensitivity - immediate and delayed hypersensitivity, autoimmune diseases, transplantation and immunity, immunity to infectious agents. Vaccines and Vaccination, types of vaccines including new generation vaccines. Tumor immunology.

## Unit 8

[4 L]

Advanced immunological techniques: ELISA, RIA, Western Blot, Flow cytometry, Immunoblot and Immunofluorescent techniques, FACS, Detection of antigens in living cells (Stem Cell Markers), in situ localization by techniques such as FISH and GISH, Hybridoma technology - production and applications of monoclonal antibodies.

## CC-8: Microbial Diversity and Metabolism

Subject Code: 1110021108

Credit: 4 (L3 T1 P0)

**Component Theory**

**Lecture Hours: 48**

### Course Outcome

CO 1: Understand and have a general idea about the microbial world.
CO 2: Know how the bacterial, viral, fungal and algal world have been classified.
CO 3: Know the different habitat of different microorganism.
CO 4: Compare the different metabolism types among bacteria.
CO 5: Explain the ecological and economical importance of different microorganism.

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Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	2	2	1	3	3
CO 2	3	3	3	1	1	3	3
CO 3	3	3	2	2	3	3	3
CO 4	3	3	3	3	1	3	3
CO 5	3	3	2	2	2	3	3
Average CO	3	3	2	2	2	3	3

### Teaching Topics

#### **Unit 1: Archaeobacteria and Extremophilic bacteria: [6L]**

Characteristics of Archaeobacteria, different classes of Archaeobacteria, Methanogens: cell structure and energy metabolism, Halophiles: cell structure and metabolism, Thermoacidophiles: Sulfolobus, Thermoplasma and Thermoproteus group. Bacteria of extreme environments, Thermophilic, Psychrophilic, Acidophilic, Alkaliphilic, Halophilic, Osmophilic, Barophilic, Xerophilic, Radiorasistant and Hypolith.

#### **Unit 2: Photosynthetic eubacteria: [4L]**

Cyanobacteria: Nitrogen fixation, anoxygenic photosynthesis, pigment synthesis, different groups of Cyanobacteria, Purple bacteria: purple sulfur bacteria and purple non-sulfur bacteria, Green bacteria: green sulfur bacteria and green non-sulfur bacteria.

#### **Unit 3: Chemoautotrophic and Methophilic bacteria: [4 L]**

Nitrifying bacteria, Sulfur oxidizers, Iron bacteria, Hydrogen bacteria, Carboxydobacteria, Chemolithotrophic bacteria, Methophilic bacteria: metabolism and carbon assimilation, methanotrophs and methylotrophs.

#### **Unit 4: Gram negative aerobic and anaerobic bacteria: [4L]**

Aerobic Pseudomonads, *Rhizobium* group, Prosthecate bacteria, *Azotobacter* group, Acetic acid bacteria, Sheathed bacteria, Spirillum group. Gram negative fermentative bacteria: Fumarate respiration, Nitrate respiration, different groups of Gram negative anaerobic bacteria. The Spirochetes, The Rickettsias, The Chlamydias.

#### **Unit 5: Gliding eubacteria, Endospores forming bacteria and The Mollicutes [6 L]**

Myxobacteria, Cytophaga group, Filamentous gliding chemoheterotrophs. The aerobic spore forming bacteria and the anaerobic spore forming bacteria. Cellular structure. Reproduction, metabolism, *Mycoplasma*, *Acholeplasma*, *Spiroplasma*, *Anaeroplasma*, *Ureaplasma*.

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**Unit 6: The Actinomycetes:** [4 L]  
Characteristics of Actinomycetes: Motility, cell wall structure, mycelia actinomycetes, major groups of actinomycetes.

**Unit 7:** [4 L]  
Mechanism of Enzyme actions: Lock and key model, induced fit theory, Factors affecting rates of enzyme mediated reactions, The role of ATP in metabolism, Definitions of growth and generation time, measurement of microbial growth and specific growth rate. Batch and Continuous culture, Phases and types of growth curve and its industrial application. Microbial growth in response to temperature, pH, solute and water activity, oxygen, pressure and radiation.

**Unit 8:** [4 L]  
Classification of bacteria based on nutrients, Membranes of microorganisms, Ion channels, Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport. group translocation and Iron uptake. Concept of aerobic respiration, anaerobic respiration, and fermentation.

**Unit 9:** [4 L]  
Sugar degradation pathways i.e., EMP, ED and Pentose phosphate pathway, TCA cycle and Electron transport chain, Comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors.

**Unit 10:** [4 L]  
Fates of pyruvate, Pasteur effect and industrial importance of fermentation, Alcohol fermentation Lactate fermentation (homo fermentative and hetero fermentative pathways), Concept of linear and branched fermentation pathways. Utilization of Lactose and Galactose, Utilization of Maltose and Mannitol, Degradation of cellulose, starch and glycogen, Conversion of biomass to energy using microorganisms.

**CC-9: Genetics of Bacteria and Virus**  
**Subject Code: 1110021109**  
**Credit: 4 (L3 T1 P0); Lecture Hour: 48**

### Component Theory

#### Course Outcomes:

CO 1: Explain the processes behind mutations and Other genetic changes
CO 2: Identify and distinguish genetic regulatory mechanisms at different levels.
CO 3: Understand plasmid and application of bacterial and eukaryotic plasmids in research.
CO 4: Understand bacterial recombination system including transformation, conjugation and transduction.
CO 5: Explain viral genetics and genetic regulation for interchange between lysogenic and lytic cycle.

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COurse OutcOme	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	-	3	2	3
CO 2	3	3	3	-	3	2	3
CO 3	3	3	3	-	3	2	3
CO 4	3	3	3	-	3	2	3
CO 5	3	3	3	-	3	2	3
Average CO	3	3	3	-	3	2	3

### Teaching component

#### **Unit 1: Prokaryotic Genome:**

**[8L]**

**Transposons** Structure of prokaryotics genome, Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition.

**Plasmids:**Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2  $\mu$  plasmid, plasmid copy number and its regulation, plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, curing of plasmids, Application of Plasmid in genetic engineering

#### **Unit 2: Bacterial Recombination**

**[5L]**

Mechanisms of Genetic Exchange, Transformation - Discovery, mechanism of natural competence, Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping, Transduction - Generalized transduction, specialized transduction, mathematical problems related to conjugation, transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

#### **Unit3: Operon system:**

**[8L]**

Gene regulation and operon theory in prokaryotes, **repressible operons**, Inducible Operon, *lac* operon, *gal* operon, *trp* operon, *ara* operon.

#### **Unit4: Mutation and Repair:**

**[6L]**

Spontaneous (Spontaneous mutation Luria - Delbruck's Fluctuation Test) and induced mutations, Mutagenic agents - Physical, Chemical and Biological (Phage-mu). Genetic Techniques to detect mutations in bacteria and fungi (isolation and characterization of nutritional auxotrophic mutation); Different forms of mutations and how they arise (tautomeric shift, base analog, alkylating agent, apurinic lesions, UV radiation and thymine dimers, replicational error), Ames test is used the assess the mutagenecity of compounds. Repair: reversal of UV damage in prokaryotes: photoreactivation, base excision and nucleotide excision repair, post replicational repair, mismatch repair, SOS repair, error prone repair.

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## Unit 5: Viral Genome:

[6L]

The construction of Viral genome, Packaging of the genome material, Regulation of viral genome, decision between lytic and lysogenic life cycle.

## CC-10: Microbiology Practical- II Subject Code:1110021210 Credit: 4 (L0 T0 P8)

### Course Outcomes:

CO 1: Acquire skills to carry out molecular biology and rDNA technology experiments using analytical techniques.

CO 2: Gain understanding and acquire skills on techniques associated with proteomics.

CO 3: Understand the state the principles and perform the routine Immunology procedures performed in the clinical laboratories.

CO 4: Evaluate laboratory test Outcomes and determine the validity of the test results Obtained for blood group-ing, Widal Test, etc.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	2	2	3	2
CO 2	3	3	3	3	2	3	2
CO 3	2	2	3	3	3	2	3
CO 4	2	2	3	3	3	2	3
Average CO	3	3	3	3	3	3	3

### List of Experiments

1. Study of fossils- Horses and birds.
2. Verification of Hardy-Weinberg equilibrium in a population by chi square analysis.
3. Chemical cell disruption and extraction of intracellular products
4. Gel analysis/ assay for dialysed product
5. Chromatography
6. Karyotyping and gene analysis
7. Ouchterlony double diffusion
8. ELISA and RIA.
9. Isolation and characterization of Bacterial cells.

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**DSE-2: Biophysics Subject Code: 2110021102**

**Credit – 4 (4L-0T-0P); Lecture: 40 L**

### Component Theory

#### Course Outcomes:

CO 1 Illustrate the basic principle and techniques to understand the biological problem.
CO 2 Identify the physical principles responsible for maintaining the basic cellular function.
CO 3 Understand the applications of biophysics and principle involved in bio instruments.
CO 4 Describe the methodology involved in bio-techniques.
CO 5 Describe the applications of bio instruments.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	3	3	3	2	3
CO 2	3	2	3	3	3	2	3
CO 3	3	1	3	3	3	2	3
CO 4	3	1	2	3	3	2	3
CO 5	3	1	3	3	3	2	3
Average CO	3	1	3	3	3	2	3

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## **Unit 1: Colligative property:**

[6 L]

Overall concept of Surface tension, Viscosity, Measurement of pH, Radioactive labelling & counting, Autoradiograph.

## **Unit 2: Microscopy:**

[12L]

Introduction to optics, principles of image formation, light microscopy techniques, principles of fluorescence, digital imaging, confocal microscopy, TIRF, STORM/PALM, STED, FRET-FLIM, and FRAP techniques, structured illumination, two-photon fluorescence, second harmonic generation, vibrational imaging, scanning probe microscopy (SPM) techniques, atomic force microscopy (AFM), electron microscopy (SEM, TEM and STEM), and X-ray microscopy/microCT., Application of spectroscopy in various biological fields.

## **Unit 3: X-Ray Crystallography:**

[4 L]

X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell, Concept of different crystal structure, Application of crystallization.

## **Unit 4: Spectroscopy:**

[12 L]

Concept of Stoke's shift and Jablonski diagram. UV-Visible spectroscopy: working principle, Instrumentation, and applications, IR spectroscopy: working principle, Instrumentation, and applications, ESR spectroscopy: working principle and applications, NMR Spectroscopy– Basic principle of NMR spectroscopy, Experimental technique & instrumentation, Chemical shift, Hyperfine splitting, Relaxation process. Absorption Spectroscopy– Simple theory of the absorption of light by molecules, Beer- Lambert law, Instrumentation for measuring the absorbance of visible light, Factors affecting the absorption properties of a Chromophore. Flowcytometry.

## **Books**

1. Upadhyay and Upadhyay, Biophysical chemistry-Principle and techniques.
2. Gale Rhodes, Crystallography made crystal clear.

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## Semester III

### CC-11: Fermentation and Bioprocess Technology

Subject Code: 1110022111

Credit: 4 (L3 T1 P0)

Course Component: Theory

Lecture Hour: 48

#### Course Outcomes:

**CO1:** Demonstrate an understanding of the historical development, industrial relevance, and components of integrated bioprocess systems, including upstream and downstream operations.

**CO2:** Explain the principles of fermentation processes, types of bioreactors, and control of key operational parameters in microbial cultivation and product formation.

**CO3:** Apply stoichiometric and kinetic models to analyze microbial growth, product formation, and energy utilization in bioprocesses.

**CO4:** Design and evaluate fermentation media and sterilization strategies with respect to microbial requirements and industrial-scale operations.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1	3	1	2	3	2	3
CO 2	3	3	3	2	3	1	2
CO 3	2	3	1	3	3	3	3
CO 4	1	2	1	2	1	2	3
Average CO	2	3	2	2	3	2	3

#### Teaching Topics

##### Unit I: Introduction to Bioprocess Technology

[6L]

Historical development of bioprocess technologies, role of bioprocess engineer in the biotechnology industry, concept of Bioprocess, outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses, generalized process flow sheets. A brief survey of organisms, processes, products and market economics relating to modern industrial biotechnology.

##### Unit II: Fermentation processes

[8L]

General requirements of fermentation processes; Isolation, preservation and improvement of industrially important micro-organisms, development of inoculum for industrial fermentations. Different types of fermentations: Batch, Fed Batch and Continuous, Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations Components of a typical bio-reactor, Types of bioreactors- Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

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## **Unit III: Basic Bioreactor Design and operations** [6L]

Mechanical design of reactors, heat transfer and mass transfer equipment; Design considerations for maintaining sterility of process streams and process equipment, Spectrum of basic bioreactor operations: Enzyme immobilization techniques; Bioconversion using immobilized enzyme preparation; Bioconversion in batch, Fed-batch and continuous bioreactors; Mass transfer in immobilized cell/enzyme reactor

## **Unit IV: Metabolic Stoichiometry and Energetics** [6L]

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass available, electron balances, yield coefficient of biomass and product formation, maintenance coefficients, energetics analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

## **Unit V: Media Design and Sterilization for Fermentation Process** [6L]

Designing of media for fermentation processes, Types of media, design and usage of various commercial media for industrial fermentations, thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air, design of sterilization equipment.

## **Unit VI: Kinetics of Microbial Growth and Product Formation** [6L]

Phases of cell growth in batch cultures, simple unstructured kinetic models for microbial growth, Monod model, growth of filamentous organisms. Growth associated (primary) and nongrowth associated (secondary) product formation kinetics, Leudeking-Piret models, substrate and product inhibition on cell growth and product formation.

## **Unit VII: Downstream Processing** [10L]

Selection of unit operation with due consideration of physical, chemical and biochemical aspect of biomolecules, basic review of bioprocess designing ,Primary separation and recovery processes: Cell disruption methods for intracellular products, removal of insoluble, biomass (and particulate debris) separation techniques, flocculation and sedimentation, centrifugation and filtration methods, Product resolution / fractionation: Introduction to adsorptive chromatographic separations processes, electrophoretic separations, hybrid separation technologies (electrochromatography), Product finishing: precipitation/crystallization, mixing, dialysis, distillation and drying. Ultracentrifugation as a separation technique for fractionation of cells and proteins, Introduction to Process Analytical Technology (PAT) and Quality by Design (QbD). Scale down, monitoring and Validation of bioprocesses.

### **Suggested Books:**

1. Stanbury P. F, Whitaker and Haul S. J., "Principles of fermentation technology", Butterworth Heinemann Ltd.
2. Bioprocess Engineering: Basic Concepts" by Michael L. Shuler
3. Industrial Microbiology., Casida, Lester Earl

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4. Industrial microbiology 4ed; Prescott and Dunn
5. Pelczar M. J., Chan E.C.S. and Kreig N.R., "Microbiology", Tata McGraw Hill

## CC-12: Bioinformatics and Biostatistics

Subject Code: 1110022112

Credit: 4 (L3 T1 P0)

Course Component: Theory

Lecture Hour: 48

### Course Outcomes:

CO 1	Understand the basic concept of bioinformatics and its significance in biological data analysis.
CO 2	Understand basic algorithms and methodologies used in pairwise and multiple sequence alignments.
CO 3	Understand the basic concept of biostatistics and its significance in biological data analysis.
CO 4	Understand basic algorithms and methodologies used in Optimization Of process parameters. To apply statistics to the experiments being carried out and principles of statistics for designing microbiological experiment, statistical analysis, and interpretation of results
CO 5	To get familiar with various computation tools of biostatistics

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	-	3	1	3
CO 2	3	3	3	-	3	1	3
CO 3	3	3	2	2	3	2	3
CO 4	3	3	2	3	3	2	3
CO 5	3	3	2	3	3	2	3
Average CO	3	3	2	2	3	2	3

### Unit I: Introduction to Unix & C Programming

[10L]

Introduction to command-based operating system, Unix basics: file system, commands (ls, cd, cp, mv, rm, mkdir, pwd), Text editors: nano, vim, or gedit, File permissions and directory structure, C Programming Fundamentals, C Programming Basics: Variables, constants, and data types and conversion, Conditional statements: if-else statements, Looping constructs: while, for, do loops.

### Unit II: Fundamentals of Bioinformatics: Databases and Sequence Analysis

[7L]

Scope and applications of Bioinformatics, Introduction to Biological database: Introduction to sequence data bank - Uniprot-KB, NBRF-PIR, SWISSPORT, EMBL, DDBJ. Structural database - PDB, NDB, PubChem. Biological background for sequence analysis, Basic concepts of sequence similarity and alignment, Scoring matrices: PAM, BLOSUM, Pairwise alignment: Needleman-Wunsch, Smith-Waterman algorithm, Multiple sequence alignment: CLUSTALW, MUSCLE, Construction of Phylogenetic tree.

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## **Unit III: Structural Bioinformatics [7L]**

Introduction to molecular visualization software (e.g., PyMOL, VMD), Sequence-structure relationships, Homology modeling and comparative protein structure prediction, Molecular docking and its application, Basics of molecular dynamics simulations.

## **Unit IV: Statistical Methods [8L]**

Measures of Central tendency and Dispersion; Properties of Standard Normal Distribution, Normal Approximation to the Binomial Distribution, Normal Approximation to the Poisson Distribution, Permutations and Combinations, Hypothesis testing, Tests of significance: Student's t test, F-statistics, Chi square test.

## **Unit V: Regression and Correlation Analysis [8L]**

Regression and Correlation Methods: General Concepts, Fitting Regression Lines— The Method of Least Squares, Inferences About Parameters from Regression Lines, Assessing the Goodness of Fit of Regression Lines, The Correlation Coefficient, Statistical Inference for Correlation Coefficients, Multiple Regression

## **Unit VI: Analysis of Variance and Experimental Design [8L]**

Introduction to the One-Way Analysis of Variance: One-Way ANOVA—Fixed Effects Model, Hypothesis Testing in One-Way ANOVA, Comparisons of Specific Groups in One-way ANOVA, Two-Way ANOVA, The Kruskal-Wallis Test; Statistical optimization of process parameters: Factors in Biological Systems, Steps in Designing an Experiment, Response Surface methods; ANOVA Post Hoc Tests.

## **Suggested Books**

- 1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.**
- 2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. WileyBlackwell.**
- 3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.**
- 4. Understanding Biostatistics, Kallen A, 2011.**
- 5. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.**
- 6. Fundamental of Biostatistics by Khan**
- 7. Biostatistical Methods by Lachin**

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## CC-13: Eukaryotic Microbiology

Subject Code: 1110022113

Credit: 4 (L3 T1 P0)

### Component Theory

Lecture Hours [48 L]

#### Course Outcome:

CO 1 Understand the microbial world.
CO 2 Know how fungi, algae and protists have been classified.
CO 3 Know the different habitat of different eukaryotes.
CO 4 Compare the different nutrition types among different eukaryotes.
CO 5 Explain the ecological and economical importance of algae, fungi and protists.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	2	1	1	3	3
CO 2	3	2	3	2	2	3	3
CO 3	3	3	1	2	3	3	3
CO 4	3	3	2	3	2	3	3
CO 5	3	2	3	3	3	2	3
Average CO	3	2	2	2	2	3	3

### Teaching Topics

#### Unit 1: Eukaryotic Cell Biology:

[4 L]

Eukaryotic Cell Structure and the Nucleus; Mitochondrion & Hydrogenosome; Chloroplast; Endosymbiosis; Assembly of Eukaryotic Cell

#### Unit 2: Algal Cell Structure & Significance

[6 L]

Distribution, morphology and classification of Algae; Isolation from soil and water; algal ecology, Media and methods used for culturing algae, measurement of algal growth, strain selection and large-scale cultivation, Symbiotic algae: Lichens.

#### Unit 3: Algal Ecosystem

[6 L]

Introduction structure & their environmental significance; Dinoflagellates, Diatoms, Euglenoids, Red algae, green algae, Brown algae. Coral reef and sea sponges. Structure and reproduction of *Spirogyra*, *Euglena*, *Exuviaella*, Diatoms, *Sargassum* and *Porphyra*. Biofuel production.

#### Unit 4: Fungal Cell Structure

[5 L]

An introduction to Fungi: General features of Fungi, Classification of Fungi, Life cycle of

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selected Fungi (Aspergillus, Penicillium, Yeast). Structure of Fungal cells. Hyphae and nonmotile and motile cells, spores, dormancy, growth of population and colonies, effect of environment on growth, prevention of fungal growth.

### **Unit 5: Fungal Cell Behaviour** [7 L]

Structure of Fungal cells and growth; Hyphae and non-motile unicells, motile cells, spores, dormancy, growth of population and colonies, Mechanism of growth in Fungi, Measurement and kinetics of growth, nutritional and environmental requirements; Prevention of fungal growth. Heterothallism, parasexuality, sex hormones in fungi; physiological specialization, phylogeny of fungi. Thigmotropism and Chemotropism in Fungal cells.

### **Unit 6: Fungal Cell Interaction** [5 L]

Fungi and ecosystem: Saprophyte, substrate groups and nutritional strategies, substrate successions, fungi and bioremediation, parasitism, mutualism and symbiosis with plants and animals, fungal-microbe interaction. Industrial applications of fungal cells.

### **Unit 7: Protozoa in General** [5 L]

Introduction, structure and significance, Protozoans' characteristics, classifications and general account. Pathogenic protozoans and parasitism in protozoans. Leishmania, Trichomonas, Entamoeba, Plasmodium, cultivation of protozoa.

### **Unit 8: Plasmodium Infection** [5 L]

Ultrastructure and life cycle of Plasmodium in invertebrate and vertebrate hosts. Comparative account of various human species of Malaria pathogens, symptom, treatment and control.

### **Unit 9: Protozoan Infection** [5 L]

Trypanosoma: Structure and Life cycle, polymorphism in human and invertebrate's host pathogens and therapy, Leishmania, systematic position, morphology, kala-azar, symptoms and pathogen. Entamoeba histolytica as monogen parasite, pathogenesis, host parasite interactions.

### **Suggested books**

- 1. General Microbiology., R.Stanier**
- 2. Brock Biology of Microorganisms**
- 3. Prescott's Microbiology., J. M Willey**
- 4. Microbiology., Tortora**
- 5. Microbiology., M. Pelczar**
- 6. Atlas RM. (1997). Principles of Microbiology. 2 nd edition. WMT. Brown Publishers.**
- 7. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.**

# Syllabus for M.Sc. Microbiology

## CC – 14: Medical Microbiology and Cancer Biology

Subject Code: 1110022114

Credit: 4 (L3 T1 P0)

Component Theory

Lecture hours [48 L]

Course Outcome:

<b>CO 1:</b> Elicit the infections of various organs and systems of the human body and learn etiology, pathogenesis and laboratory diagnosis of local infections.
<b>CO 2:</b> Understand and analyse various infections of skin, soft tissue and wound and compare & evaluate serological and molecular diagnostic methods.
<b>CO 3:</b> Understand antibacterial therapy and prophylaxis.
<b>CO 4:</b> Understand the nature of cancer and the (molecular) processes underlying cancer formation and progression and explain the role of gene mutations play in the development of cancer.
<b>CO 5:</b> Gain knowledge about the principles underlying anti-cancer therapies.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO1</b>	2	3	2	3	2	-	3
<b>CO2</b>	2	3	3	3	-	-	-
<b>CO3</b>	2	3	3	3	-	-	3
<b>CO4</b>	3	-	3	3	3	-	3
<b>CO5</b>	2	3	3	3	-	-	2
<b>CO6</b>	3	2	3	3	-	-	3
<b>Average CO</b>	3	3	3	3	-	-	3

### Teaching topics

#### **Unit 1: Foundations of Microbial Pathogenesis**

[4L]

Defining infection: Colonization vs. Invasion vs. Disease. Sources of infection and modes of transmission, Host-microbe interactions: Commensalism, mutualism, parasitism. Normal flora, Ecological principles governing microbial establishment in the host. Establishing Infection: Portals of entry and their specific microbial adaptations.

#### **Unit 2: Bacterial Virulence Determinants: Colonization and Adhesion**

[4L]

Molecular mechanisms of bacterial adherence to host cells and tissues. Specific adhesins (pili, fimbriae, surface proteins) and their host receptors. Biofilm formation as a strategy for colonization and persistence. Environmental cues and regulation of adhesin expression. Mechanisms of bacterial invasion of host cells: Zipper vs. Trigger mechanisms; Defining pathogenicity and virulence, Conceptual understanding of LD50, ID50,

#### **Unit 3: Molecular Mechanisms of Bacterial Pathogenicity**

[6L]

Lipopolysaccharide (LPS): Structure, recognition, and signaling pathways. Endotoxin: Clinical relevance of endotoxin in Gram-negative infections. Structure and classification of exotoxins (e.g., AB toxins, pore-forming toxins), Diphtheria toxin, Cholera toxin: Receptor binding, internalization,

## Syllabus for M.Sc. Microbiology

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and enzymatic activity within host cells; Virulence Genes and Pathogenicity Islands (PAIs): Organization of virulence genes: Clusters and pathogenicity islands, Mechanisms of PAI acquisition: Horizontal gene transfer (HGT).

### **Unit 4: Emergence and re-emergence of bacterial diseases [3L]**

Conceptual understanding of emergence and re-emergence. Role of HGT and PAIs in the evolution of new virulent strains (e.g., *V. cholerae* O139, EHEC). Impact of antimicrobial resistance on re-emergence (e.g., X-MDR *M. tuberculosis*, MRSA), Ecological and environmental factors contributing to pathogen emergence.

### **Unit 5: Antimicrobial Agents [6L]**

Antibiotics: Mechanisms of Action: Detailed mechanisms of action of antibiotics inhibiting cell wall biosynthesis (e.g., penicillin, cephalosporin, vancomycin), Inhibition of nucleic acid metabolism (e.g., quinolones, rifampicin), inhibiting of protein synthesis (targeting ribosomes: aminoglycosides, tetracyclines, macrolides, chloramphenicol, etc.). Mechanisms of resistance to these classes of antibiotics.

### **Unit 6: Viral infection: [3 L]**

The cytocidal growth cycle, Attachment, Penetration; Receptor mediated endocytosis, Fusion with cytosolic plasma membrane, Uncoating, New virion generation; Mode of transcription of animal viruses; Lytic and Lysogenic cycle; Assemble and release; Non cytocidal infection; Abortive infection; Latency; Important Viral disease; Adenoviruses, Herpesviruses, Poxviruses, retroviruses.

### **Unit 4: Fungal and Parasite infection [4L]**

Fungal pathogens, Types of Fungal infection; Superficial mycoses, Subcutaneous mycoses, Systemic mycoses; Pathogenicity and Diagnosis; Ringworm; Candidosis and Histoplasmosis.

Pathogenic mechanism of parasite infection; Tissue damage, Physiological effect; Important Parasite infection: Malaria, Sleeping sickness, Leishmaniasis, Giardiasis.

### **Unit 6: Fundamentals of cancer biology [6 L]**

Cancer terminology & classification; Cellular origins of cancer; Properties of cancer cells: altered growth control, sugar metabolism, survival; Tumor microenvironment; Chemical, physical & biological carcinogens; Hallmarks of cancer; Metastasis: steps & mechanisms

### **Unit 7: Molecular & Genetic Basis of Cancer [6L]**

Cancer critical genes: cancer critical genes and tumor suppressor genes identification of cancer critical genes; Malignant Transformation and Role of Somatic Mutations, Epigenetic mechanisms in cancer; multistage colon cancer model, Cancer Stem Cells.

### **Unit 8: Cancer and the immune system [6L]**

Hodgkin's and non-Hodgkin's lymphoma, Acute and chronic leukaemia, Tumor specific Vs tumor associated antigen, NK cells & macrophages in tumour recognition, Immune surveillance theory, Tumour evasion strategies, Principles and advances in cancer immunotherapy.

# Syllabus for M.Sc. Microbiology

## Suggested Books:

1. Ananthanarayan & Paniker's Textbook of Microbiology, 8th Ed., Orient Longman, India; 2009
2. Jawetz, Melnick, & Adelberg's Medical Microbiology by Carroll KC, Hobdon JA, Miller S, Morse SA, Mietzner TA. 27th edition. Lange Publication, 2016.
3. Bacterial Pathogenesis: A molecular approach by Wilson BA, Salyers AA, Whitt DD, Winkler ME. 3rd edition. American Society for Microbiology Press, Washington, DC USA, 2011.
4. The Biology of Cancer: Robert A. Weinberg, 2<sup>nd</sup> edition, Garland Science
5. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics: Lauren Pecorino, 5<sup>th</sup> edition, Publisher: Oxford University Press.

## CC-15: Environmental Microbiology and Ecology

Subject Code: 1110022115

Credit: 4 (L3 T1 P0)

Component Theory

Lecture [48L]

### Course Outcome:

<b>CO 1:</b> Understand basic concepts of Microbiome: Microbes in soil, water, air and biological environments.
<b>CO 2:</b> Study the significance of bioremediation, biodegradation.
<b>CO 3:</b> Gain knowledge on water quality and wastewater treatment.
<b>CO 4:</b> The knowledge of development of ecological framework as a scientific subject and its relation to levels of biological Organization.
<b>CO 5:</b> In-depth knowledge of population ecology, community ecology and ecosystem ecology which forms the basis of ecological applications in the field and society such as conservation programs, existing laws and regulations to arrest deterioration of the natural world.
<b>CO 6:</b> Understanding of behavior and its effect on the life history of an Organisms

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	2	2	3	2	3
CO 2	3	3	3	2	2	2	3
CO 3	3	3	3	2	2	2	3
CO 4	3	3	3	1	1	1	3
CO 5	3	3	3	1	1	1	3
CO 6	3	3	3	1	1	1	3
Average CO	3	3	3	2	2	2	3

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## Teaching topics

### **Unit – 1 Microbial Environments**

[8L]

#### **1.1 Soil as a Microbial Environment**

Biotic Stresses and Abiotic Stresses, Distribution of Microorganisms in Soil, Microorganisms in Subsurface Environments: Microorganisms in Shallow Subsurface Environments, Microorganisms in Deep Subsurface Environments

#### **1.2 Aeromicrobiology**

Important Airborne Pathogens, Important Airborne Toxins, Aerosols, Nature of Bioaerosols, Extramural Aeromicrobiology: Agriculture, Waste Disposal, Microbial Persistence in the Air: Relative Humidity: Temperature, Radiation, Oxygen, OAFs, and Ions

#### **1.3 Aquatic Environments**

Microbial Habitats in the Aquatic Environment, Planktonic Environment, Benthic Habitat, Microbial Mats, Biofilms

#### **1.4 Extreme Environments**

Low Temperature Environments, High Temperature Environments, Environments Based on Chemoautotrophy, Acidic Environments, Acid Mine Drainage

### **Unit -2 Microbial Interactions with Environment and Nutrient Cycling** [6L]

Biogeochemical Cycling: Biogeochemical Cycles, Gaia Hypothesis; Nitrogen Cycle, Nitrogen Reservoirs, Nitrogen Fixation, Ammonia Assimilation (Immobilization) and Ammonification (Mineralization), Nitrification, Nitrate Reduction; Carbon Cycle, Carbon Reservoirs, Carbon Fixation and Energy Flow, Carbon Respiration; Biofertilizers and biopesticides

### **Unit-3 Bioremediation of pollutants and Wastewater treatment** [8L]

Environmental Law; Biodegradability: Genetic Potential, Toxicity, Bioavailability; Environmental Factors Affecting Biodegradation; The essential, toxic and non-toxic metals in the environment; Microbial Metal Transformations: Oxidation–Reduction, Methylation; Mechanisms of Microbial Metal Resistance; Physicochemical Methods of Metal Remediation.

The Nature of Wastewater (Sewage); Properties of Sewage (BOD/COD); Oxidation Ponds; Sludge Processing; Water Treatment Processes; Organic Carbon and Microbial Growth in Distribution Systems

### **Unit -4 Microorganisms as environmental indicators** [8L]

The Concept of Indicator Organisms; Standards and Criteria for Indicators; Potential Indicator Organisms, Microbial Source Tracking

### **Unit 5: Introduction to Ecology** [2 L]

History of ecology, levels of organization, laws of limiting factors, study of physical factors, biosphere.

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## Unit 6: Population Ecology

[4 L]

Types of population, unique and group attributes of population: demographic factors, life tables, fecundity tables, survivorship curves, dispersal and dispersion. Geometric, exponential and logistic growth, equation and patterns, r and K strategies, population regulation - density-dependent and independent factors, population interactions: Gauss's principle, Lotka-Volterra equation for competition.

## Unit 7: Behavioural Ecology

[3 L]

Innate and learned behaviour, Social behaviour, Chronobiology, biological rhythm, Methods of studying behaviours: ad libitum observations, focal animal sampling, scan animal sampling, etc.

## Unit 8: Community Ecology

[3 L]

Community characteristics: species diversity, abundance, dominance, richness, vertical stratification, ecotone and edge effect, ecological succession.

## Unit 9: Ecosystem

[3 L]

Types of ecosystems, food chain: detritus and grazing food chains, linear and Y-shaped food chains, food web, energy flow through the ecosystem, ecological pyramids and ecological efficiencies. Energy flow and biogeochemical cycles.

## Unit 10: Applied Ecology

[3 L]

Biodiversity and extinction, natural history of India, wildlife and conservation strategies. Management strategies for tiger conservation, Wild life protection act (1972)

## Suggested Books

1. Krebs, Charles J - Ecology\_the experimental analysis of distribution and abundance- Pearson (2014)
2. Michael Begon, Robert W. Howarth, Colin R. Townsend. 2014. Essentials of Ecology- Wiley.
3. Ellison, Aaron M. Gotelli, Nicholas J - A primer of ecological statistics-Sinauer Associates, Inc., Publishers (2018)
4. Manual of Environmental Microbiology (ASM Books Book 33) 4th Edition, Cindy H. Nakatsu, Robert V. Miller, Suresh D. Pillai
5. Environmental Microbiology 3rd Edition, Ian L. Pepper, Charles P. Gerba, Terry J. Gentry
6. Wastewater Engineering- Treatment, disposal and Reuse. Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi

# Syllabus for M.Sc. Microbiology

## CC-16: MSc. Microbiology Practical-III

Subject Code: 1110022216

Credit 4 (0L-0T-8P)

### Course Outcomes

<b>CO1:</b> Demonstrate proficiency in operating laboratory-scale bioreactors and applying scale-up principles for microbial fermentation processes.
<b>CO2:</b> Apply biochemical and analytical techniques for enzyme immobilization, characterization, and their application in pollutant remediation.
<b>CO3:</b> Utilize bioinformatics tools for sequence retrieval, alignment, and construction of phylogenetic trees to interpret molecular evolution.
<b>CO4:</b> Interpret protein structures using computational tools and relate structural features to biological functions.
<b>CO5:</b> Perform and analyze statistical hypothesis testing and process optimization using statistical designs of experiments (DOE).
<b>CO6:</b> Isolate, identify, and characterize microbial populations from environmental and clinical sources and assess their antibiotic resistance profiles.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	3	3	2	3
CO 2	3	3	3	3	3	2	3
CO 3	3	3	3	-	3	1	3
CO 4	2	1	2	3	2	1	2
CO 5	3	3	2	3	3	2	3
CO 6	3	3	3	3	2	2	3
Average CO	3	3	3	3	3	2	3

### List of Practicals

1. Laboratory fermenter operation, scale-up of selected strain
2. Production and purification alcohol and acids
3. Enzyme immobilization and its characterization
4. Sequence retrieval from the database and its analysis till phylogenetic tree construction.
5. 3D protein structure determination
6. Test of Significance: Students t test, F test, Chi square test.

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7. Process parameter optimization using statistical design of experiments (DOE)
8. Microbial removal of metals and organic pollutants from water and soil
9. Extraction and characterization of enzymes for bioremediation of organic / inorganic pollutants in aquatic system.
10. Preparation of algal culture and its cultivation
11. Study of natural microflora of human throat and skin. Identification of the isolates through biochemical procedures and determination of antibiotic sensitivity profile of the isolates.

### Semester - IV

#### CC-17: Microbiology Master Project/Dissertation

**Credit: 12 (L0 T0 P24)**

#### **Component: Project**

**Course Prerequisite:** Student should have passed all theory and practical courses. A basic knowledge about the subject and discipline of interest should be there. Student must be aware of good laboratory practices with skills to perform laboratory experiments.

**Course Outcome:** At the end of this course a student will be able to understand and analyse various aspect of biological world. This will also help the student to decide their field of interest for academic and industrial purpose.