ETERNAL UNIVERSITY

(ESTABLISHED UNDER HIMACHAL PRADESH GOVERNMENT ACT NO.3 OF 2009)

BARU SAHIB
HIMACHAL PRADESH

WORLD PEACE THROUGH VALUE BASED EDUCATION

AKAL COLLEGE OF BASIC SCIENCES

M. SC. MICROBIOLOGY SYLLABUS (REVISED)

(APPROVED VIDE ITEM 81/25/2023 IN THE 81st ACADEMIC COUNCIL MEETING HELD ON 22nd JUNE 2023)

(TO BE EFFECTIVE FROM THE ACADEMIC SESSION 2023-24 ONWARDS)

ETERNAL UNIVERSITY
BARU SAHIB

Course Curriculum
M.Sc. Microbiology

(Two Year Full-Time PG Programme)

DEPARTMENT OF MICROBIOLOGY
AKAL COLLEGE OF BASIC SCIENCES

Revised June, 2023
(w.e.f. from Academic Session 2023-24)

Program Structure

M.Sc. Microbiology

(w.e.f. Academic Session 2023-24)

SEMESTER – I							
S.N.	**Course Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1.	Core	MICRO-511	General Microbiology	3	0	0	3
2.	Core	MICRO-515	Bacteriology	3	0	0	3
3.	Core	MICRO-516	Virology	3	0	0	3
4.	Core	MICRO-517	Mycology	3	0	0	3
5.	Practical	MICRO-518	Basic Techniques in Microbiology	0	0	3	3
6.	Core	BIOCHEM-511	General Biochemistry	3	0	0	3
7.	Skill Enhancement	BT-505	Computational Biology and Biostatistics	3	0	0	3
			Sub-total	**18**	**0**	**3**	**21**

L: Lecture, T: Tutorial, P: Practical, C: Credits

SEMESTER – II							
S.N.	**Course Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1.	Core	MICRO-513	Immunology	3	0	0	3
2.	Core	MICRO-523	Microbial Genetics	3	0	0	3
3.	Core (Any one)	MICRO-524	Molecular Biology & Genetic Engineering	3	0	0	3
		MICRO-525	Genomics and Proteomics				
		BIOCHEM-526	Advanced Enzymology				
4.	Core	MICRO-526	Medical Microbiology	3	0	0	3
5.	Practical	MICRO-527	Medical Microbiology & Immunology Techniques	0	0	3	3
6.	Practical	MICRO-529	Microbial Genetics & Molecular Biology Techniques	0	0	3	3
7.	Seminar	MICRO-591*	Synopsis Seminar / Project Seminar	1	0	0	1
			Sub-total	**13**	**0**	**6**	**19**

*Non-credit course

Note: Students should submit their choice of Thesis or Course work in the beginning of 2nd semester.

SEMESTER – III							
S.N.	**Course Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1.	Core	RM-599	Research Methodology	3	1	0	4
2.	Core	MICRO-531	Industrial Microbiology	3	0	0	3
3.	Core	MICRO-532	Food Microbiology	3	0	0	3
4.	Core	MICRO-534	Environmental Microbiology	3	0	0	3
5.	Practical	MICRO-535	Food, Industrial & Environmental Microbiology Techniques	0	0	3	3
6.	Core	MICRO-536	Microbial Physiology and Biochemistry	3	0	0	3
7.	Seminar	MICRO-591	Credit Seminar	1	0	0	1
8.	Skill Enhancement (Any one)	MICRO-537	Microbial Biotechnology	3	0	0	3
		BIOCHEM-529	Biotechniques and Bioinstrumentation				
		MICRO-539	Microbiological Quality Control				
			Sub-total	**19**	**1**	**3**	**23**

Note: Student should opt for either Option-A or Option-B in 4th semester as per choice submitted earlier in 2nd semester

SEMESTER – IV (Option-A: Without Thesis)							
S.N.	**Course Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1.	Core	MICRO-541*	Emerging Concepts in Microbiology	3	0	0	3
2.	Practical	MICRO-542*	Advanced Techniques in Microbiology and Biotechnology	0	0	2	2
3.	Practical	MICRO-543*	Field and Exploratory Microbiology	0	0	2	2
4.	Skill Enhancement (Any one)	MICRO-544*	Pharmaceutical Microbiology	3	0	0	3
		MICRO-545*	Biofertilizers and Biopesticides				
5.	Project	MICRO-546*	Project Work	0	0	10	10
			Sub-total	**6**	**0**	**14**	**20**
			GRAND TOTAL	**56**	**1**	**26**	**83**

*Non-credit course

SEMESTER – IV (Option-B: With Thesis)							
S.N.	**Course Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1.	Research	MICRO-600*	Thesis	0	0	20	20
			Sub-total	**0**	**0**	**20**	**20**
			GRAND TOTAL	**50**	**1**	**32**	**83**

*Non-credit course

MICRO-511: General Microbiology | Sem-I

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[9 Hrs]**

History of microbiology and contributions of eminent microbiologists, Different branches and disciplines of microbiology, Scope and career opportunities in microbiology. Microbial classification, Carl Woese's Three Domain System, LUCA & microbial evolution, Endosymbiotic theory of origin of eukaryotic cells, Difference between prokaryotic and eukaryotic microorganisms. Acellular microorganisms: viruses, viroids, prions.

UNIT- II **[9 Hrs]**

Principle and components of microscope, Types of microscopy, Difference between light microscopy and electron microscopy. Concepts of moist heat sterilization (autoclaving), dry heat sterilization, Pasteurization, Disinfectants, Antiseptics, Sanitizers, Pure culture techniques.

UNIT- III **[8 Hrs]**

Bacteria: habitats, morphology, arrangements, Gram-positive & Gram-negative cell walls, lipopolysaccharide, capsule, flagella, cytoplasmic structures, endospore. Important phyla and species of bacteria. Photosynthetic bacteria. Archaea: habitats, morphology, cell wall structure, pigments, Differences between bacteria and archaea, Important groups of archaea: methanogens, halophiles, acidophiles, psychrophiles, hyperthermophiles, Nanoarchaea, ARMAN.

UNIT- IV **[8 Hrs]**

Algae: characteristics, habitats, classification, cell structure, photosynthetic pigments, modes of reproduction, green algae, diatoms, dinoflagellates, seaweeds, importance of algae.
Fungi: morphology (molds, yeasts, mushrooms), habitats, classification, cell wall structure, reproduction and importance of fungi, lichens, mycorrhiza. Protozoa: characteristics, habitats, morphology, reproduction, important examples, ecological importance, major protozoal diseases.

UNIT- V **[8 Hrs]**

Beneficial microbes, fermented foods, antibiotics, bacteriocins, biofertilizers, probiotics, synbiotics, Single Cell Proteins, biopesticides, bioinsecticides, bioremediation, vaccines, Mission Indradhanush, Concepts of pathogen, infectious diseases, pandemic, epidemic, Important infectious diseases of human and their causative agents, Mosquitoes-borne diseases, Zoonotic infections, Food infections, Food intoxications, COVID-19 pandemic, Antibiotic resistance, ESKAPE pathogens.

Recommended Books/Readings

- **Brock Biology of Microorganisms** by Michael Madigan et al., Pearson Education, 16th Edition (2021).
- **Microbiology: An Introduction** by Gerard Tortora et al., Pearson Education, 13th Edition (2019).
- **Prescott's Microbiology** by J. Willey, K. Sandman, D. Wood., McGraw-Hill, 12th Edition (2023).
- **Talaro's Foundations in Microbiology** by Barry Chess, McGraw-Hill, 11th Edition (2021).
- **A Textbook of Microbiology** by R.C. Dubey & D.K. Maheshwari, S. Chand & Co., 4th Edition (2016).

MICRO-515: Bacteriology | Sem-I

L	T	P	C	Theory: 42 Hrs	Total Marks
3	0	0	**3**		100

UNIT- I **[9 Hrs]**

General characteristics, habitats, morphology and arrangements of bacteria, Cell membrane structure and functions, Composition and structure of Gram-positive and Gram-negative cell walls, Lipopolysaccharide, capsule, flagella, nucleoid, ribosomes, magnetosomes, inclusion bodies, Endospore: structure, sporulation process and unique characteristics.

UNIT- II **[9 Hrs]**

Bacterial culture media: natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Pure culture of bacteria by agar plating techniques, Cultivation, maintenance and preservation, Lyophilization, Microbial culture collections, Cultivation of anaerobic bacteria, Non-cultivable bacteria, Obligate endosymbionts.

UNIT- III **[7 Hrs]**

Nutritional requirements in bacteria, Nutritional categories: autotrophic, heterotrophic, lithotrophic. Bacterial growth and mode of reproduction. Bacterial growth curve, Phases of growth, generation time, specific growth rate.

UNIT-IV **[8 Hrs]**

Bacterial classification, systematics and taxonomy, Evolutionary chronometers, 16S rRNA sequences. Brief account of ICNP, ICSP, LPSN & IJSEM. New valid names of bacterial phyla, Important characteristics of Pseudomonadota, Actinomycetota, Bacillota, Cyanobacteria, Bacteriodota, Mycoplasmatota, Spirochaetota, Rickettsiae, Chlamydia, Cable bacteria.

UNIT- V **[9 Hrs]**

Archaea: evolution, habitats, morphology, cell membrane, cell wall, pigments, Differences between bacteria and archaea, Important groups of archaea: methanogens, halophiles, acidophiles, psychrophiles, hyperthermophiles. Nanoarchaea, ARMAN, Important genera of archaea: *Sulfolobus*, *Methanobacterium*, *Methanopyrus*, *Pyrococcus*, *Halobacterium, Halococcus*. Rumen methanogens. Ecological, geobiochemical and industrial importance of archaea.

Recommended Books/Readings

- **Brock Biology of Microorganisms** by Michael Madigan et al., Pearson Education, 16th Edition (2021).
- **Microbiology: An Introduction** by Gerard Tortora et al., Pearson Education, 13th Edition (2019).
- **Prescott's Microbiology** by J. Willey, K. Sandman, D. Wood., McGraw-Hill, 12th Edition (2023).
- **Talaro's Foundations in Microbiology** by Barry Chess, McGraw-Hill, 11th Edition (2021).
- **A Textbook of Microbiology** by R.C. Dubey & D.K. Maheshwari, S. Chand & Co., 4th Edition (2016).
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Practical Handbook of Microbiology** by L. Green & E. Goldman, CRC Press, 4th Edition (2021).
- **Bergey's Manual of Systematics of Archaea and Bacteria** by Whitman B (Ed). https://www.bergeys.org/publications/; DOI: 10.1002/9781118960608 (2015).

MICRO-516: Virology | Sem-I

L	T	P	C	Theory: 42 Hrs	Total Marks
3	0	0	**3**		100

UNIT- I **[8 Hrs]**

History of virology and contributions of eminent virologists, Discovery of viruses, Theories of viral origin**,** Viral taxonomy and nomenclature, International Committee on Taxonomy of Viruses (ICTV), Baltimore classification (1970s), ICTV 15-rank classification hierarchy, Sub-viral agents: viroids, satellites and prions.

UNIT- II **[8 Hrs]**

Capsid symmetry, morphology and ultrastructure of viruses, Enveloped and non-enveloped viruses, Viral genome diversity (linear, circular, double and single stranded), Positive and negative sense of RNA genomes, Genome complexity.

UNIT- III **[9 Hrs]**

Retroviruses, Oncogenic viruses, Bacteriophages and their significance, Structure of TMV, Hepatitis B virus, HIV, COVID-19 virus, Poliovirus, Rabies virus, Ebola virus, Influenza virus, Human papillomavirus, M13, Mu and Lambda phage. Plant viruses: examples of important viral diseases of plants, Animal viruses: classification and examples of important diseases,

UNIT-IV **[8 Hrs]**

Viral replication cycles (lytic and lysogenic), Replication in RNA viruses, Prophage, Viral genome integration in host DNA, Latency in viral life cycle, Virus-host interactions: cytopathic effects of viral infections, inclusion bodies, chromosomal aberrations, Immunological responses of host against virus infection.

UNIT- V **[9 Hrs]**

Antiviral compounds and their mode of action, General methods of isolation, identification, characterization and cultivation (embryonated eggs, experimental animals, and cell cultures) of viruses. Advanced methods of viral detection.

Recommended Books/Readings

- **Brock Biology of Microorganisms** by Michael Madigan et al., Pearson Education, 16th Edition (2021).
- **Mims' Medical Microbiology and Immunology** by Goering RV et al., Elsevier, 6th Edition (2019).
- **Clinical Virology** by Richman DD, Whitley RJ, Hayden FG, ASM Press, 4th Edition (2017).
- **Manual of Clinical Microbiology** by Carroll KC, ASM Press, 12th Edition (2019).
- **Introduction to Modern Virology** by N.J. Dimmock et al., Blackwell Publishing, 7th Edition (2016).
- **Virology: Principles and Applications** by Carter J and Saunders V., Wiley, 2nd Edition (2013).
- **Microbiology: An Introduction** by Gerard Tortora et al., Pearson Education, 13th Edition (2019).
- **Prescott's Microbiology** by J. Willey, K. Sandman, D. Wood., McGraw-Hill, 12th Edition (2023).
- **Talaro's Foundations in Microbiology** by Barry Chess, McGraw-Hill, 11th Edition (2021).

MICRO-517: Mycology | Sem-I

L	T	P	C	Theory: 42 Hrs	Total Marks
3	0	0	**3**		100

UNIT- I **[9 Hrs]**

History of mycology, Contributions of eminent mycologists and plant pathologists, General characteristics, habitats, diversity and morphology of fungi, Yeasts, Molds, Mushrooms, Fungi-like organisms (water molds or Oomycetes), Structure of hypha, mycelium, yeast cell, fleshy fungi.

UNIT- II **[8 Hrs]**

Classification of Kingdom Fungi, Microsporidia, Chytridiomycota (aquatic fungi), Glomeromycota (symbiotic mycorrhizal fungi), Zygomycota (zygote-forming fungi), Ascomycota (sac fungi), Basidiomycota (club fungi), Brief description of *Microsporidium, Rhizopus, Penicillum, Aspergillus, Saccharomyces, Agaricus, Glomus, Neocallimastix, Puccinia graminis*.

UNIT- III **[8 Hrs]**

Fungal growth: spore germination, apical growth, Spitzenkörper, hyphal branching, Yeast cell transverse division, Nutritional requirements of fungi, Mode of nutrition (saprobic, fermentative, anaerobic, parasitic, endophytic), Sugar fermentation by yeasts. Fungal reproduction: vegetative spores, asexual spores & sexual spores, Sex organs in fungi, Organization of fungal genomes.

UNIT-IV **[9 Hrs]**

Fungal interactions, Lichens: characteristics, types, examples & importance, Mycorrhiza: ectomycorrhiza, endomycorrhiza (AM) mycorrhiza, species involved & ecological significance. Plant pathogenic fungi and important diseases, Mycotoxins. Human fungal diseases: superficial mycoses, Tineas, sub-cutaneous mycoses, systemic mycoses.

UNIT- V **[8 Hrs]**

Mycotechnology: fermented foods, alcoholic beverages, mycoproteins, edible mushrooms, nutraceuticals, organic acids, vitamins, antibiotics, statins, food colours, enzymes, mycoherbicides, fungal insecticides & mycorrhizal inoculants. Role of fungi in agriculture, biodegradation of plant materials & agro-wastes by fungi.

Recommended Books/Readings

- **Talaro's Foundations in Microbiology** by Barry Chess, McGraw-Hill, 11th Edition (2021).
- **A Textbook of Microbiology** by R.C. Dubey & D.K. Maheshwari, S. Chand & Co., 4th Edition (2016).
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Introductory Mycology** by C.J. Alexopoulos et al., Wiley India, 4th Edition (2002)
- **An Introduction to Mycology** by Mehrotra and Aneja, New Age International, 3rd Edition (2023).
- **Fungi: Biology and Applications** by Kevin Kavanagh (ed.), Wiley-Blackwell, 3rd Edition (2018).

MICRO-518: Basic Techniques in Microbiology | Sem-I

L	T	P	C	Practical: 84 Hrs	Total Marks 100
0	0	3	**3**		

List of Practicals/Experiments

1. Microbiology laboratory general rules and safety guidelines.
2. Principle and applications of Autoclave, BOD incubator, Hot air oven, Laminar air flow, and Spectrophotometer.
3. Study of components and functioning of a compound light microscope, Phase contrast microscope, Fluorescent microscope and Electron microscope.
4. Simple staining of bacteria using methylene blue stain.
5. Gram's staining of two different bacterial species.
6. Preparation of simple culture media e.g. Nutrient agar and Potato dextrose agar.
7. Preparation of liquid culture media (nutrient broth, peptone water).
8. Enumeration and isolation of pure cultures of bacteria by pour, spread and streak plate techniques.
9. Isolation and identification of bacteria from food, soil and water samples.
10. Growth curve of *Escherichia coli* and *Bacillus subtilis*.
11. Study of active ingredients of commonly available disinfectants, antiseptics and sanitizers by chemical analysis.
12. Microscopic examination of green algae, diatoms and protozoa from water samples.
13. Microscopic examination of molds using lactophenol cotton blue staining method.
14. Study of *Amoeba*, *Entamoeba*, *Leishmania* and *Plasmodium* using permanent mounts/photographs.
15. Isolation of fungi from soil samples, decaying plant matter, wooden logs and wall surfaces.
16. Morphological and cultural characterization of yeast and molds.
17. Study of structure of important phages, plant viruses and animal viruses using electron micrographs.

Recommended Books/Readings

- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology** by K.R. Aneja, New Age International., 6th Edition (2022).
- **Practical Handbook of Microbiology** by L. Green & E. Goldman, CRC Press, 4th Edition (2021).
- **Parasitology: Protozoology and Helminthology** by Chatterjee KD, CBS Publishers, 13th Edition (2019).
- **Mackie and McCartney Practical Medical Microbiology** by Collee JG, Elsevier, 14th Edition (2007).

BIOCHEM-511: General Biochemistry | Sem-I

L	T	P	C	Theory: 42 Hrs	Total Marks
3	0	0	**3**		100

UNIT- I **[8 Hrs]**

Fundamental principles governing life; structure and biological functions of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Vander Waals forces.

UNIT- II **[9 Hrs]**

Classification, structure and function of carbohydrates, lipids and nucleic acids. Primary, secondary and tertiary structures of proteins. Protein folding and stability. Protein sequencing. Structure and biological functions of vitamins.

UNIT- III **[9 Hrs]**

General introduction to techniques for determination of structure of biopolymers. Enzymes classification and mechanism of action, regulation, factors affecting enzyme action. Hormones and their mode of action. Bioenergetics.

UNIT-IV **[8 Hrs]**

Oxidative phosphorylation, photosynthesis and respiration. General metabolism of carbohydrates, proteins and lipids.

UNIT- V **[8 Hrs]**

DNA replication, transcription and translation. Recombinant DNA technology.

Recommended Books/Readings

- **Lehninger's Principles of Biochemistry** by Nelson & Cox, W. H. Freeman & Co., 7th Edition (2017).
- **Biochemistry** by Mathews et al., Pearson Education, 4th Edition (2013).
- **Fundamentals of Biochemistry** by Voet D, John Wiley, 5th Edition (2016).
- **Biochemistry** by Berg, W. H. Freeman & Co., 9th Edition (2019).
- **Harper's Illustrated Biochemistry** by Rodwell, McGraw Hill, 31st Edition (2018).

BT-505: Computational Biology and Biostatistics | Sem-I

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[8 Hrs]**

Introduction and definition of biostatistics, concept of variables in biological systems, collection, classification, tabulation, graphical and diagrammatic representation of numerical data, measure of central tendency, measure of dispersion, correlation and regression, linear and quadratic regressions, concept of standard errors. Hypothesis testing (null & alternative hypothesis).

UNIT- II **[8 Hrs]**

Test of significance based on Z, $\chi 2$, t and F statistics, correlation and regression, curve fitting by least squares methods.

UNIT- III **[10 Hrs]**

Introduction, biological and chemical databases: Database models, storage, mining and retrieval, Laboratory Information management systems (LIMS). Protein and gene information resources-PIR, SWISSPROT, PDB, GenBank, DDBJ, protein structures and drug discovery. DNA microarrays, databases, data management cluster analysis.

UNIT-IV **[8 Hrs]**

Introduction to sequence comparison, global and multiple sequence alignment, multiple sequence alignment using FASTA, Sequence alignment using CLUSTAL W, BLAST and PSI BLAST, Use of sequences to determine phylogenetic relationship.

UNIT- V **[8 Hrs]**

Gene finding algorithms and softwares. Hidden Markov Models (HMM), annotation of genomic and protein sequences prediction of protein secondary and tertiary structures. Protein-Protein interactions, proteomics, protein microarrays chips and data analysis.

Recommended Books/Readings

- **Bioinformatics: Sequence, Structure & Databanks** by Higgins & Taylor, Oxford Univ Press, 1st edn (2000).
- **Fundamental Concepts of Bioinformatics** by Krane & Raymer, Pearson Education, 1st edn (2003).
- **Bioinformatics** by Baxevanis AD & Ouellette BF, Wiley India, 3rd edn (2011).
- **Bioinformatics: Methods and Applications** by S.C. Rastogi, PHI Learning Press, 4th edn (2013).
- **Biostatistics** by Arora PN & Malha PK, Himalaya Publishing, 1st edn (2015).

MICRO-513: Immunology | Sem-II

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[10 Hrs]**

History of immunology, Contributions of eminent immunologists, Innate and adaptive immunity, Active and passive immunity. Hematopoietic stem cells, Primary lymphoid organs (Bone marrow, Thymus), Secondary lymphoid organs (Lymph node, Spleen, MALT); T cell, B cell, NK cell, Macrophages, Dendritic cells, Granulocytes vs Agranulocytes; Neutrophil, Eosinophil, Basophil.

UNIT- II **[7 Hrs]**

Characteristics of antigens, types, examples, haptens, epitopes, T-dependent and T-independent antigens, superantigens, Different classes of antibodies (IgG, IgA, IgE, IgD, IgM); Antigenic determinants on antibodies. (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and chimeric antibodies.

UNIT- III **[9 Hrs]**

Structure and functions of major histocompatibility complex, MHC I & II molecules, Antigen processing and presentation, Complement system, Primary and secondary immune responses, Humoral immunity and Cell-mediated immunity, Immune tolerance, CTL and NK cells functions.

UNIT-IV **[8 Hrs]**

Autoimmune diseases and important examples, Hypersensitivity reactions (anaphylaxis, allergies, Type II, Type III and Type IV), Immunodeficiencies and important examples. Immunological methods: agglutination, immunoelectrophoresis, precipitation, ELISA, ELISPOT, Widal test, VDRL test, Western blotting.

UNIT- V **[8 Hrs]**

Immunization: active immunization and passive immunization, Vaccines: ideal properties, components, types, adjuvants, manufacturers. List of vaccine-preventable diseases, Vaccines administered under UIP and Mission Indradhanush, COVID-19 vaccines, Toxoid, Antitoxins, Immunotherapy: rabies HRIG, anti-D immunoglobulins.

Recommended Books/Readings

- **Kuby Immunology** by Jenny et al., W.H.Freeman & Co Ltd, 8th Edition (2022).
- **Roitt's Essential Immunology** by Peter Delves et al., Wiley-Blackwell, 13th Edition (2017).
- **Jawetz, Melnick & Adelberg's Medical Microbiology** by Stefan Riedel et al., McGraw Hill, 28th Edn (2019).
- **Talaro's Foundations in Microbiology** by Barry Chess, McGraw-Hill, 11th Edition (2021).
- **Microbiology Fundamentals- A Clinical Approach** by Cowan and Smith, McGraw-Hill, 4th Edition (2022).
- **Manual of Clinical Microbiology** by Carroll KC, ASM Press, 12th Edition (2019).
- **Mims' Medical Microbiology and Immunology** by Goering RV et al., Elsevier, 6th Edition (2019).
- **Mackie and McCartney Practical Medical Microbiology** by Collee JG, Elsevier, 14th Edition (2007).

MICRO-523: Microbial Genetics | Sem-II

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[8 Hrs]**

Bacterial chromosome (nucleoid), Genome organization of important prokaryotic microbes and eukaryotic microbes, Horizontal gene transfer: Transformation, Conjugation and Transduction.

UNIT- II **[9 Hrs]**

Mutations and mutagenesis in microorganisms, Types of mutations, Physical and chemical mutagens, Molecular basis of mutations, Functional mutants (loss and gain of function mutants), Significance of mutations. Reversion and suppression, Ames test, Mutator genes.

UNIT- III **[9 Hrs]**

Mobile genetic elements, Plasmids: F plasmid, R plasmids, col plasmids, Ti plasmids, yeast plasmids, virulence plasmid, degradative plasmid, Plasmid replication and partitioning, Host range and copy number of plasmids, Phase variation system, CRISPR-Cas9 system.

UNIT-IV **[8 Hrs]**

Phage genetics: features of T4, Mu, Lambda phage genome, Genetic basis of lytic and lysogenic switch of phage lambda, Applications of phages in genetic engineering, Replicating and non-replicating adenovirus vectors for vaccine development.

UNIT- V **[8 Hrs]**

Prokaryotic transposable elements: Insertion Sequences, composite and non-composite transposons, Replicative and Non-replicative transposition, Mu transposon, Yeast (Ty retrotransposon), Uses of transposons and transposition.

Recommended Books/Readings

- **Lewin's Genes XII** by Krebs JE, Goldstein ES, Kilpatrick ST, Jones & Bartlett Learning, 12th Edition (2018).
- **Molecular Genetics of Bacteria** by Snyder L, Peters JE, Henkin TM, ASM Press, 4th Edition (2013).
- **Lehninger Principles of Biochemistry** by Nelson DL, Cox MM. Macmillan Learning., 8th Edition (2021).
- **Microbial Genetics** by Maloy SR, Cronan JE and Friefelder D, Narosa Publishing, 2nd Edition, (2012).
- **Gene Cloning and DNA Analysis: An Introduction** by Brown TA, Wiley-Blackwell, 7th Edition (2016).
- **Prescott's Microbiology** by J. Willey, K. Sandman, D. Wood., McGraw-Hill, 12th Edition (2023).
- **Talaro's Foundations in Microbiology** by Barry Chess, McGraw-Hill, 11th Edition (2021).
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Practical Handbook of Microbiology** by L. Green & E. Goldman, CRC Press, 4th Edition (2021).

MICRO-524: Molecular Biology and Genetic Engineering | Sem-II

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[8 Hrs]**

Discovery of DNA as genetic material, Chargaff's rules, Building blocks of DNA: deoxyribose, purines, pyrimidines, nucleosides, nucleotides, phosphodiester bonds, hydrogen bonds. Salient features of double helix model of DNA by Watson and Crick, Mitochondrial DNA and chloroplast DNA. Structure and types of RNA, Genome organization in RNA viruses.

UNIT- II **[9 Hrs]**

Replication of DNA in bacteria, Bidirectional and unidirectional replication, semi-conservative, semi-discontinuous replication, Concept of replisome, DNA polymerases, DNA ligase, primase, telomerase). Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ (theta) mode of replication and other accessory proteins, Mismatch and excision repair.

UNIT- III **[9 Hrs]**

Transcription (RNA synthesis): concept of gene, cistron, promoter and operator, RNA polymerase and transcription unit, introns and exons, RNA splicing and spliceosome. Protein synthesis (translation): ribosomes, mRNA, tRNA, Shine-Delgarno sequence in bacteria, Initiation, elongation and termination of polypeptides. Post-translational modifications and its significance.

UNIT-IV **[7 Hrs]**

Regulation of gene expression in bacteria, Transcriptional regulation, Inducible and repressible operons, Lac operon of *E. coli*, Tryptophan operon, Sporulation in *Bacillus*, Yeast mating type switching, DNA methylation and histone acetylation mechanisms.

UNIT- V **[9 Hrs]**

Molecular cloning, Cloning vectors: phages. plasmids, cosmids, YAC, BAC, Cloning strategies: cloning of genomic DNA, cDNA cloning, selection and characterization of clones, gene probes, labeling. PCR: principle, types and role in molecular biology, Blotting techniques (Southern, northern and western blotting), Overexpression systems for recombinant proteins.

Recommended Books/Readings

- **Lewin's Genes XII** by Krebs JE, Goldstein ES, Kilpatrick ST, Jones & Bartlett Learning, 12th Edition (2018).
- **Molecular Genetics of Bacteria** by Snyder L, Peters JE, Henkin TM, ASM Press, 4th Edition (2013).
- **Lehninger Principles of Biochemistry** by Nelson DL, Cox MM. Macmillan Learning., 8th Edition (2021).
- **Microbial Genetics** by Maloy SR, Cronan JE and Friefelder D, Narosa Publishing, 2nd Edition, (2012).
- **Gene Cloning and DNA Analysis: An Introduction** by Brown TA, Wiley-Blackwell, 7th Edition (2016).
- **Prescott's Microbiology** by J. Willey, K. Sandman, D. Wood., McGraw-Hill, 12th Edition (2023).
- **Molecular Biology and Biotechnology** by Gupta PK, Rastogi Publications, 1st Edition (2015).
- **Molecular Biology of the Gene** by James D. Watson, Pearson, 7th Edition (2017).

MICRO-525: Genomics and Proteomics | Sem-II

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[9 Hrs]**

Introduction to gene, genome and genomics, Structure and organization of prokaryotic and eukaryotic genome, Tools to study genome diversity (PCR & RFLP), Methods of DNA extraction, DNA sequencing by Maxam & Gilbert method, Sanger Di-deoxy method, Fluorescence method, Shot-gun approach, Pyrosequencing, Next-generation sequencing, Whole genome sequencing.

UNIT- II **[8 Hrs]**

Single Nucleotide Polymorphisms (SNPs), Expressed sequenced tags (ESTs), DNA Chips, Functional genomic studies with model systems (*E. coli, Saccharomyces, C. elegans*), Strategies for major genome sequencing projects, approaches and assembly methods, Gene analysis and annotation.

UNIT- III **[8 Hrs]**

Interference RNA, RNA silencing, SiRNA, applications in functional genomics, medicine and gene knockouts. Gene editing, CRISPR-Cas9, Transcriptomics and expression profiling, RNA profiling, Microarray (cDNA and protein microarray), Molecular markers: RFLP, RAPD, AFLP, SCAR, CAPS, microsatellites and SNPs.

UNIT-IV **[9 Hrs]**

Introduction to proteomics, Analysis of proteome by 2-D PAGE, Mass spectrometry, Protein sequencing method (Edman degradation, MALDI TOF/TOF), Identification and characterization of novel proteins, Protein engineering, Importance and applications of proteomics.

UNIT- V **[8 Hrs]**

Sequence databases, search engines and software package in proteomics, Post translational modifications in proteins, Protein localization Protein-protein interactions: Yeast two hybrid system, phage display, affinity based methods, Applications of proteome analysis in drug development, toxicology, disease-related proteins and disease diagnosis.

Recommended Books/Readings

- **Principles of Gene Manipulation and Genomics** by Primrose SB, Twyman RM., Wiley, 7th Edition (2014).
- **Essential Genetics and Genomics** by Daniel Hartl, Jones & Bartlett Learning, 7th Edition (2020).
- **Lewin's Genes XII** by Krebs JE, Goldstein ES, Kilpatrick ST, Jones & Bartlett Learning, 12th Edition (2018).
- **Lehninger Principles of Biochemistry** by Nelson DL, Cox MM. Macmillan Learning., 8th Edition (2021).
- **Gene Cloning and DNA Analysis: An Introduction** by Brown TA, Wiley-Blackwell, 7th Edition (2016).
- **Molecular Biology of the Gene** by Watson JD, Baker TA, Bell SP., Pearson Edu, 7th Edition (2017).
- **Molecular Cloning: A Laboratory Manual** by Sambrook J, Green MR., CSH Lab, 4th Edition (2012).
- **Principles of Proteomics** by Richard Twyman, Garland Science, 2nd Edition (2013).
- **Principles and Techniques of Biochemistry and Molecular Biology** by Wilson and Walker, Cambridge University Press, 7th Edition (2010).

BIOCHEM-526: Advanced Enzymology | Sem-II

L	T	P	C	Theory: 42 Hrs	Total Marks
3	0	0	**3**		100

UNIT- I **[9 Hrs]**

Enzyme nomenclature and classification. Enzyme compartmentalization in cell organelles, measurement of enzyme activity. Theory of enzymatic catalysis, specificity, concept of active site and enzyme substrate complex. Different approaches for determining active site amino acid, proximity and orientation.

UNIT- II **[8 Hrs]**

Isolation and purification of enzymes. Mechanism of enzyme reactions. Effect of different factors affecting enzyme activity, Transition state theory.

UNIT- III **[9 Hrs]**

Cofactors, coenzymes their structure and role, enzyme kinetics, enzyme inhibition and activation, multi-enzyme complexes.

UNIT-IV **[8 Hrs]**

Role of enzymes in regulation of metabolism, Allosteric enzymes and their kinetics, enzyme engineering, Bi-functional enzymes.

UNIT- V **[8 Hrs]**

Applications of enzymes in chemical and food industry, enzyme immobilization, biosensors and clinical applications of enzymes.

Recommended Books/Readings

- **Biochemistry** by Satyanarayana U & Chakrapani U, Elsevier, 4th Edition (2013).
- **Enzymology** by Devasena T, Oxford University Press, 1st Edition (2013).
- **Enzyme Technology** by Shanmugam et al., I.K. International Publishing, 2nd Edition (2012).
- **Fundamentals of Enzymology by** Price & Stevens **,** Oxford University Press**,** 7th Edition (2003).
- **Enzymes: Biochemistry, Biotechnology and Clinical Chemistry** by Palmer & Bonner, Woodhead Publishing**,** 2nd Edition (2007).
- **Enzyme Kinetics: A Modern Approach** by Maragoni, John Wiley & Sons, 1st Edition (2003).

MICRO-526: Medical Microbiology | Sem-II

L	T	P	C	Theory: 42 Hrs	Total Marks
3	0	0	**3**		100

UNIT- I **[7 Hrs]**

History of medical microbiology, Normal microbiota of body and its importance, Concepts of Infectious diseases, Communicable diseases, Types of diseases, Pandemic, Epidemic, Infection, Pathogen, Pathogenicity, Virulence factors, Vector and reservoir of diseases, Opportunistic infections, Neglected Tropical Diseases (NTDs), Nosocomial infections, Zoonotic infections.

UNIT- II **[7 Hrs]**

Sources of infections: endogenous & exogenous, Routes of transmission of pathogens, Portal of entry and exits of pathogens. Collection, transport and culturing of clinical samples, Methods and tests for sample analysis, Transport media, Important diagnostic tests: ELISA, PCR, RT-PCR, DNA probes, Blood culture systems (BACTEC, VersaTREK, BacT/Alert), Rapid Diagnostic Kits.

UNIT- III **[10 Hrs]**

Human bacterial diseases, Etiology, transmission, lab diagnosis, prophylaxis and treatment of *Streptococcus pneumoniae*, *Corynebacterium diphtheriae*, *Haemophilus influenzae*, *Mycobacterium tuberculosis*; *E. coli* O157:H7, *Salmonella* Typhi, *Vibrio cholerae*, *Helicobacter pylori*, *Bacillus anthracis*, *Yersinia pestis*, *Clostridium tetani* and *Treponema pallidum.*

UNIT-IV **[10 Hrs]**

Human viral diseases, Etiology, transmission, lab diagnosis, prophylaxis and treatment of Polio, Hepatitis B, Rabies, HIV-AIDS, COVID-19, Dengue, Rotaviral diarrhea, Chickenpox.
Fungal diseases of human and their causative agents, Cutaneous mycoses, Systemic mycoses and Opportunistic mycoses, Protozoal diseases of human: malaria, amoebiasis, leishmaniasis, sleeping sickness and toxoplasmosis. Helminth infections of human.

UNIT- V **[8 Hrs]**

Properties and mode of action of important antibiotics, bacteriocins, antifungal drugs, antiviral drugs, antiprotozoal drugs, anthelmintic drugs. Antibiotic resistance, Mechanisms of antibiotic resistance, ESKAPE pathogens, AMR, MDR, MRSA, ESBLs producing bacteria, Phage therapy.

Recommended Books/Readings

- **Jawetz, Melnick & Adelberg's Medical Microbiology** by Stefan Riedel et al., McGraw Hill, 28th Edn (2019).
- **Manual of Clinical Microbiology** by Carroll KC, ASM Press, 12th Edition (2019).
- **Mims' Medical Microbiology and Immunology** by Goering RV et al., Elsevier, 6th Edition (2019).
- **Ananthanarayan & Paniker's Textbook of Microbiology** by Kahungo R, Universities Press, 10th Edn (2017).
- **Mackie and McCartney Practical Medical Microbiology** by Collee JG, Elsevier, 14th Edition (2007).
- **Talaro's Foundations in Microbiology** by Barry Chess, McGraw-Hill, 11th Edition (2021).
- **Microbiology Fundamentals- A Clinical Approach** by Cowan and Smith, McGraw-Hill, 4th Edition (2022).
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2019).

MICRO-527: Medical Microbiology and Immunology Techniques	Sem-II

L	T	P	C	Practical: 84 Hrs	Total Marks
0	0	3	**3**		100

List of Practicals/Experiments

1. Identification and differentiation of Gram-negative bacteria by IMViC tests.
2. Biochemical characterization of bacteria by oxidase, catalase and sugar fermentation tests.
3. Isolation of bacteria from water samples on EMB agar and MacConkey agar.
4. Study of bacterial flora of skin using mannitol salt agar.
5. Determination of antibiotic susceptibility of bacteria by Kirby-Bauer method.
6. Determination of ESBLs production by bacteria using Double-Disc Synergy Test.
7. Determination of minimal inhibitory concentration (MIC) of an antibiotic against bacteria.
8. Study of hemolysis by streptococci on blood agar.
9. Study of viral transport media.
10. Identification of ABO blood groups.
11. Study of Total Leukocyte Count & Differential Leukocyte Count of given blood sample.
12. Preparation of serum and plasma from given blood sample.
13. Demonstration of ELISA and immunoelectrophoresis.
14. Demonstration of kits based on antigen-antibody reactions (Malaria card, viral detection card).
15. Study of different vaccines available against COVID-19.
16. Study of various stages of malarial parasite using permanent blood smear slides.
17. Microscopic examination of stool samples for protozoan and helminth parasites.
18. Study of insect vectors of microbial diseases using preserved specimens/slides/photographs.

Recommended Books/Readings

- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology** by K.R. Aneja, New Age International., 6th Edition (2022).
- **Practical Handbook of Microbiology** by L. Green & E. Goldman, CRC Press, 4th Edition (2021).
- **Parasitology: Protozoology and Helminthology** by Chatterjee KD, CBS Publishers, 13th Edition (2019).
- **Mackie and McCartney Practical Medical Microbiology** by Collee JG, Elsevier, 14th Edition (2007).
- **Manual of Clinical Microbiology** by Carroll KC, ASM Press, 12th Edition (2019).
- **Mims' Medical Microbiology and Immunology** by Goering RV et al., Elsevier, 6th Edition (2019).
- **Ananthanarayan & Paniker's Textbook of Microbiology** by Kahungo R, Universities Press, 10th Edn (2017).

MICRO-529: Microbial Genetics and Molecular Biology Techniques	Sem-II

L	T	P	C	Practical: 84 Hrs	Total Marks
0	0	3	**3**		100

List of Practicals/Experiments

1. Demonstration of bacterial conjugation.
2. Demonstration of bacterial transformation and transduction.
3. Preparation of competent *E. coli* cells for transformation.
4. Preparation of master plate and replica plate.
5. Study of effect of UV radiations on bacterial cell growth.
6. Isolation of plasmid DNA from *E. coli.*
7. Isolation of genomic DNA from bacterial culture.
8. Demonstration of Ames test.
9. Restriction digestion of DNA and analysis by agarose gel electrophoresis.
10. Ligation of DNA fragments by DNA ligase.
11. Designing of PCR primers for DNA amplification.
12. Cloning of DNA in *E. coli* and selection of recombinants using blue-white screening.
13. Amplification of bacterial DNA by PCR using specific primers.
14. Demonstration of Southern blotting (DNA hybridization).
15. Demonstration of Northern blotting (RNA hybridization).
16. Demonstration of SDS-PAGE analysis of bacterial proteins.
17. Demonstration of Western blotting (immunoblotting).

Recommended Books/Readings

- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology** by K.R. Aneja, New Age International., 6th Edition (2022).
- **Practical Handbook of Microbiology** by L. Green & E. Goldman, CRC Press, 4th Edition (2021).
- **Cell and Molecular Biology: Concepts and Experiments** by Karp G, Wiley, 8th Edition (2015).
- **Molecular Cloning: A Laboratory Manual** by Sambrook J, Green MR., CSH Lab, 4th Edition (2012).
- **Lewin's Genes XII** by Krebs JE et al., Jones & Bartlett Learning, 12th Edition (2018).

MICRO-591: Synopsis Seminar | Sem-II

(Applicable to those students who have opted for Thesis)

L	T	P	C
1	0	0	**1**

The Major Advisor will be allocated to the students in the start of second semester by the Dean of the college. Students will be assigned the research topic by their respective advisor. Students have to make a powerpoint presentation on the research topic assigned to them which will be notified by the office of the Dean. The students will be evaluated by advisory committee members and faculty of the department/college and then average marks will be awarded to the student. The criteria of seminar evaluation proforma are given below:

Sr. No.	Evaluation Criteria	Max Marks
1.	Originality and creativity	15
2.	Organization and logical presentation of ideas	25
3.	Presentation (Oral presentation and delivery)	25
4.	Knowledge and familiarity with subject matter	15
5.	Quality and neatness of slides, charts and graphs	10
6.	Response to the questions/queries	10
	Total	**100**

Satisfactory grade will be awarded on securing minimum 60 marks out of 100. Four copies of the synopsis duly approved by the advisory committee will be submitted by the student in the office of Dean for its final approval before the start of the third semester.

MICRO-591: Project Seminar | Sem-II

(Applicable to those students who have NOT opted for thesis)

L	T	P	C
1	0	0	**1**

An advisor will be allocated to the students in the start of second semester by the Dean of the college. Students will be assigned the project work by their respective advisor. Students have to make a powerpoint presentation on the topic assigned to them which will be notified by the office of the Dean. The students will be evaluated by advisory committee members and faculty of the discipline and then average marks will be awarded to the student. The criteria of seminar evaluation proforma are given below:

Sr. No.	Evaluation Criteria	Max Marks
1.	Originality and creativity	15
2.	Organization and logical presentation of ideas	25
3.	Presentation (Oral presentation and delivery)	25
4.	Knowledge and familiarity with subject matter	15
5.	Quality and neatness of slides, charts and graphs	10
6.	Response to the questions/queries	10
	Total	**100**

Satisfactory grade will be awarded on securing minimum 60 marks out of 100. Four copies of the project work outline duly approved by the departmental committee will be submitted by the student in the office of Dean for its final approval before the start of the third semester.

RM-599: Research Methodology | Sem-III

L	T	P	C	Theory: 42 Hrs Tutorial: 14 Hrs	Total Marks 100
3	1	0	4		

UNIT- I

Research: need, importance, types of research -fundamental v/s applied and impact of research. Research prioritization – objectives, process of research. Qualitative and quantitative research. Ethics with respect to science and research. Committee on Publication Ethics (COPE). Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals.

UNIT- II

Qualities of a good research worker. Research as career, current status and future prospects of research. Process of selecting research problem; survey of literature; allied and critical literature, research infrastructure. Good Laboratory Practices (GLPs). Sampling design; types of sampling & their advantages/disadvantages, recording of observations; measurement and scaling techniques.

UNIT- III

Measures of central tendencies and relationships, sources and collection of primary & secondary data, storage and analysis of data. Pie chart, histogram and figures plotting. Formulation and types of hypotheses & their testing. Chi (χ^2) test, Z - test, t- test, F-test. Correlation, rank correlation and regression analysis, ANOVA- test of significance and error analysis. Absolute error, relative error, percentage error.

UNIT-IV

Computer and informatics: introduction, word processing, excel, power point presentation. Information resources and various databases. Introduction to statistical software(s). LATEX. Impact factor and indexing data base. Different search engines in Library for research articles. Web of science, web browsing. Scopus organization of reference material using endnote; bibliography. Scientific misconduct: Falsification, fabrication and plagiarism (FFP), IPR and patent application. Entrepreneurship.

UNIT- V

Selecting research problem and preparation of synopsis as per guidelines of university. Research paper and thesis writing. Compilation and presentation of results, writing & publication of research paper. Multidisciplinary and multi-institutional research; writing research proposal for external funding. Demonstration of departmental research activities through pictures, charts, research project reports and instrumentation. PG scholarship funding agencies Govt. of India. Post Doctoral Fellowships (PDFs).

Recommended Books:

1. Gupta D. D, A.M. Moon and M.K. Gupta. An Outline of Statistical Theory (Vol. I/II).
2. Gupta S.P. Statistical Methods. Sultan Chand Publications.
3. Gurumani N. Research Methodology: For Biological Sciences. MJP Publisher.
4. Kothari C.R. Research Methodology: Methods and Techniques. New Age International.
5. Kothari C.R.and K.F. Hatt. Methods in Social Research.
6. Kumar Pranesh, Daroga Singh and Padam Singh. Handbook of Sampling. IASRI Publications.
7. Kumar R. Research Methodology: A Step-by-Step Guide for Beginners. Sage Publications Limited.
8. Laake P, Benestad HB, Olsen BR, (Editors). Research Methodology in the Medical and Biological Sciences. Academic Press.
9. Murthy C. Research Methodology, Vrinda Publication Pvt. Ltd. New Delhi.
10. Sharma Jai Narain. Research Methodology. Deep & Deep Publications.

MICRO-531: Industrial Microbiology | Sem-III

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[9 Hrs]**

Historical developments in industrial microbiology, Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates.

UNIT- II **[8 Hrs]**

Types of fermentation processes: solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors: laboratory, pilot-scale and production fermenters, Constantly stirred tank fermenter and Air-lift fermenter.

UNIT- III **[8 Hrs]**

Measurement and control of fermentation parameters: pH, temperature, dissolved oxygen, foaming and aeration, Down-stream processing: cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.

UNIT-IV **[9 Hrs]**

Industrial microbial fermentation products: Upstream and downstream processing, microorganisms involved, media, fermentation conditions for industrial production of ethanol, citric acid, acetic acid, penicillin, glutamic acid, vitamin B_{12}, alcoholic beverages and enzymes.

UNIT- V **[8 Hrs]**

Enzyme immobilization: methods of immobilization, advantages and applications of immobilization, Applications of immobilized enzymes (glucose isomerase and penicillin acylase), Enzymes in biosensors. Medical applications of enzymes.

Recommended Books/Readings

- **Industrial Microbiology** by Casida LE, New Age International, 2nd Edition (2019).
- **Prescott & Dunn's Industrial Microbiology** by Reed G, CBS Publishers, 2nd Edition (2004).
- **Modern Industrial Microbiology and Biotechnology** by Okafor N, Okeke BC, CRC Press, 2nd Edition (2017).
- **Principles of Fermentation Technology** by P.F. Stanbury et al., Butterworth-Heinemann, 3rd Edition (2016).
- **Brock Biology of Microorganisms** by Michael Madigan et al., Pearson Education, 16th Edition (2021).
- **A Textbook of Microbiology** by R.C. Dubey & D.K. Maheshwari, S. Chand & Co., 4th Edition (2016).
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Practical Handbook of Microbiology** by L. Green & E. Goldman, CRC Press, 4th Edition (2021).
- **Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology** by K.R. Aneja, New Age International., 6th Edition (2022).

MICRO-532: Food Microbiology | Sem-III

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[8 Hrs]**

Foods as a substrate for microorganisms, Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, Natural flora and source of contamination of foods, Microbial spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods.

UNIT- II **[10 Hrs]**

Food preservation: need and importance, Physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging. Chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins, Biopreservation of foods.

UNIT- III **[8 Hrs]**

Food fermentations: dairy starter cultures, lactic and non-lactic starters, mesophilic and thermophilic starters. Fermented foods: yogurt, kumiss, kefir, cheese, sauerkraut, kimchi, pickle, sausage, soy sauce and tempeh. Probiotics: microorganisms used, health benefits, importance.

UNIT-IV **[8 Hrs]**

Food-borne diseases and health impact, Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *E. coli* O157:H7, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*.

UNIT- V **[8 Hrs]**

Food safety laws, Food safety and quality management system, HACCP system, Indicators of food microbial quality and safety, Hurdle technology in food industry, Microbiological and rapid detection methods of food-borne pathogens in foods.

Recommended Books/Readings

- **Food Microbiology** by Adams MR, Moss MO, Peter M, RSC, 4th Edition (2015).
- **Food Microbiology: Fundamentals and Frontiers** by Doyle, ASM Press, 5th Edition (2019).
- **Food Microbiology** by Frazier WC, Westhoff DC, Vanitha NM, McGraw-Hill, 5th Edition (2017).
- **Modern Food Microbiology** by Jay JM, Loessner MJ, Golden DA, Springer New York, 7th Edition (2006).
- **Fermented Milk and Dairy Products** by Puniya AK, CRC Press, 1st Edition (2015).
- **Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology** by K.R. Aneja, New Age International., 6th Edition (2022).

MICRO-534: Environmental Microbiology | Sem-III

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[9 Hrs]**

Structure and function of microbiota of different ecosystems: Soil ecosystem, Fresh water and marine habitats, Atmospheric microbes, Animal environment, Extreme habitats and extremophiles: microbes thriving at high & low temperatures, pH, high pressure, salinity, & low nutrient levels.

UNIT- II **[8 Hrs]**

Microbial interactions: mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-plant interactions: Symbiotic and non-symbiotic interactions, Microbe-animal interactions: microbes in ruminants, nematophagus fungi, obligate endosymbionts of insects, symbiotic luminescent bacteria.

UNIT- III **[8 Hrs]**

Biogeochemical cycling: Carbon cycle: microbial degradation of cellulose, hemicelluloses, lignin and chitin. Nitrogen cycle: nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: phosphate immobilization and solubilization, Microbes involved in Sulphur, Iron and manganese cycling.

UNIT-IV **[9 Hrs]**

Solid waste management: sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment processes, Biodegradation, Bioremediation.

UNIT- V **[8 Hrs]**

Coliforms (indicator organisms), Microbiological quality of water: safety of potable water, standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for fecal coliforms, Membrane filtration technique and Presence-absence test.

Recommended Books/Readings

- **Brock Biology of Microorganisms** by Michael Madigan et al., Pearson Education, 16th Edition (2021).
- **Environmental Microbiology** by Pepper IL, Gerba CP, Gentry TJ, Academic Press, 3rd Edition (2014).
- **Microbial Ecology: Fundamentals & Applications** by Atlas and Bartha, Pearson, 4th Edition (2011).
- **Manual of Environmental Microbiology** by Yates MV et al., ASM Press, 4th Edition (2016).
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology** by K.R. Aneja, New Age International., 6th Edition (2022).

MICRO-535: Food, Industrial & Environmental Microbiology Techniques | Sem-III

L	T	P	C	Practical: 84 Hrs	Total Marks
0	0	3	3		100

List of Practicals/Experiments

1. Qualitative analysis of milk quality by MBRT test.
2. Study of bacterial load of milk samples by standard plate count.
3. Isolation of spoilage microorganisms from different food products.
4. Lactophenol Cotton Blue transparent tape technique for identification of fungi from food samples.
5. Preparation of yogurt/dahi using lactic starter cultures.
6. Preparation of sauerkraut from cabbage by microbial fermentation.
7. Production and estimation of lactic acid by *Lactobacillus* and *Streptococcus* spp.
8. Study of different parts of a pilot scale fermenter/bioreactor.
9. Study of yeast fermentation for the production of ethanol.
10. Microbial fermentation for production and estimation of amylase and protease.
11. Microbial fermentation for production and estimation of glutamic acid and citric acid.
12. Demonstration of upstream and downstream processing of industrial fermentations.
13. Screening of industrially important microorganisms from soils.
14. Isolation of cellulase producing fungi from soil.
15. Study of symbiotic and non-symbiotic nitrogen fixing bacteria from root nodules and soil.
16. Isolation and characterization of PGPR
17. Study of microbiological quality of water by MPN test.
18. Study of microbiological quality of water by Presence-Absence test.

Recommended Books/Readings

- **Brock Biology of Microorganisms** by Michael Madigan et al., Pearson Education, 16th Edition (2021).
- **Environmental Microbiology** by Pepper IL, Gerba CP, Gentry TJ, Academic Press, 3rd Edition (2014).
- **Microbial Ecology: Fundamentals & Applications** by Atlas and Bartha, Pearson, 4th Edition (2011).
- **Manual of Environmental Microbiology** by Yates MV et al., ASM Press, 4th Edition (2016).
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology** by K.R. Aneja, New Age International., 6th Edition (2022).

MICRO-536: Microbial Physiology and Biochemistry | Sem-III

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[9 Hrs]**

Microbial growth and measurement, Batch culture, Continuous culture, Synchronous growth, Diauxic growth curve**.** Effect of physical factors on microbial growth: temperature (psychrophiles, mesophiles, thermophiles, extremophiles), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), pressure (barophiles).

UNIT- II **[8 Hrs]**

Microbial nutrition: nutrient uptake and transport, Autotroph/Phototroph and Heterotrophs, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, Photolithoautotroph, Photoorganoheterotroph,

UNIT- III **[8 Hrs]**

Microbial metabolism: aerobic respiration, Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle. Electron transport chain: components, comparison of mitochondrial and bacterial ETC. Biosynthesis of macromolecules.

UNIT-IV **[9 Hrs]**

Anaerobic respiration, dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction); Fermentation: alcohol fermentation and Pasteur effect; Lactate fermentation, Linear and branched fermentation pathways.

UNIT- V **[8 Hrs]**

Chemolithotrophic and phototrophic metabolism: Aerobic and anaerobic chemolithotrophy, Methanogenesis, Phototrophic metabolism: Groups of phototrophic microorganisms, anoxygenic *vs.* oxygenic photosynthesis, Photosynthesis in green sulfur bacteria, purple sulfur bacteria, cyanobacteria and algae.

Recommended Books/Readings

- **Microbiology: An Introduction** by Gerard Tortora et al., Pearson Education, 13th Edition (2019).
- **Talaro's Foundations in Microbiology** by Barry Chess, McGraw-Hill, 11th Edition (2021).
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology** by K.R. Aneja, New Age International., 6th Edition (2022).
- **Microbial Physiology** by Moat AG, Foster JW & Spector MP, Wiley, 4th Edition (2011).
- **Bacterial Metabolism** by Gottschalk G., Springer-Verlag, 2nd Edition (2012).
- **Microbial Physiology** (2008) Reddy SR and Reddy SM., 1st edition, Scientific Publishers India.

MICRO-591: Credit Seminar | Sem-III

L	T	P	C
1	0	0	**1**

The course covers the current and emerging concepts in various sub-disciplines of basic and applied microbiology. Class teacher/Course Instructor will be allocated to the students in the start of the semester and the topics will be assigned to each student by the class teacher. Students will collect the information (research articles, reviews, books, thesis etc.) related to assigned topic and will submit the printed copy of the assignment/topic to the class teacher. Students will have to make a powerpoint presentation on the topic as notified by concerned Incharge/HOD/Dean well in advance. The seminar should be delivered before the commencement of End-term examination. The students will be evaluated by three faculty members and then average marks will be awarded to the student.

The criteria of seminar evaluation proforma are as given below:

Sr. No.	Evaluation Criteria	Max Marks
1.	Originality and creativity	15
2.	Organization and logical presentation of ideas	25
3.	Presentation (Oral presentation and delivery)	25
4.	Knowledge and familiarity with subject matter	15
5.	Quality and neatness of slides, charts and graphs	10
6.	Response to the questions/queries	10
	Total	**100**

Result of Credit Seminar (marks out of 100) will be submitted along with necessary documents to the Controller of Examinations office for declaration of the semester result.

MICRO-537: Microbial Biotechnology | Sem-III

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[9 Hrs]**

Microbial biotechnology: scope and applications, Use of prokaryotic and eukaryotic microorganisms in biotechnological applications. Recombinant DNA technology: DNA isolation, vector designing, cloning, amplification and gene expression. Genetically engineered microbes for industrial applications, Industrial workhorses.

UNIT- II **[8 Hrs]**

Microbial biotechnology for agriculture and food security: Endophytic microbes, rhizospheric microbes, phyllospheric microbes, mycorrhizae, plant growth promoting microbes-biofertilizers, Microbial production of biopesticides.

UNIT- III **[8 Hrs]**

Recombinant microbial production processes in pharmaceutical industries: insulin, streptokinase, recombinant vaccines (Hepatitis B vaccine), microbial polysaccharides, antimicrobials, polyesters, bioplastics, Microbial biosensors.

UNIT-IV **[8 Hrs]**

Microbial based transformation of steroids and sterols, Bio-catalytic processes and their industrial applications: high fructose syrup, cocoa butter substitute, lactose-free milk products.

UNIT- V **[9 Hrs]**

Bio-ethanol and bio-diesel production from lignocellulosic waste and algal biomass, Biogas production: methane and hydrogen production using genetically modified microbial cultures. Genetically improved microorganisms used in bioremediation, Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents.

Recommended Books/Readings

- **Brock Biology of Microorganisms** by Michael Madigan et al., Pearson Education, 16th Edition (2021).
- **Practical Handbook of Microbiology** by L. Green & E. Goldman, CRC Press, 4th Edition (2021).
- **Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology** by K.R. Aneja, New Age International., 6th Edition (2022).
- **Microbial Biotechnology: Fundamentals of Applied Microbiology** by Glazer AN, Nikaido H, Cambridge University Press, 2nd Edition (2012).
- **Manual of Industrial Microbiology and Biotechnology** by Baltz RH et al., ASM Press, 3rd Edition (2010).
- **Industrial Microbiology** by Casida LE, New Age International, India, 2nd Edition (2016).
- **Principles of Fermentation Technology** by Stanbury P, Butterworth-Heinemann, 3rd Edition (2016).
- **Molecular Biotechnology** by Glick BR, Pasternak JJ and Patten CL, ASM Press, 4th Edition (2010).

BIOCHEM-529: Biotechniques and Bioinstrumentation | Sem-III

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[9 Hrs]**

Principle and components of a microscope, Micrometry, Brightfield and Darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (TEM and SEM).

UNIT- II **[9 Hrs]**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion-exchange chromatography and affinity chromatography, GLC, HPLC.

UNIT- III **[9 Hrs]**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

UNIT-IV **[7 Hrs]**

Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range, Colorimetry and turbidometry.

UNIT- V **[8 Hrs]**

Native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram and Agarose gel electrophoresis.

Recommended Books/Readings

- **Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology** by Hofmann A., Clokie S. Cambridge University Press, 8th Edition (2018).
- **Lehninger Principles of Biochemistry** by Nelson and Cox, W.H. Freeman, 7th Edn (2017).
- **Biochemistry** by Voet D and Voet JG, Wiley USA, 4th Edition (2011).
- **Harper's Illustrated Biochemistry** by K. Botham, McGraw-Hill, 31th Edition (2018).
- **Lab Manual in Biochemistry, Immunology & Biotechnology** by Nigam & Ayyagari, Tata McGraw-Hill (2007).
- **Molecular Cloning: A Laboratory Manual** by Sambrook & Green, CSH Lab, 4th Edition (2012).

MICRO-539: Microbiological Quality Control | Sem-III

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[9 Hrs]**

Microbiology laboratory in industrial production units: components, instruments, tools, specific purpose areas. Laboratory safety guidelines, Do's and Don'ts in microbiology laboratory. Good Laboratory Practices, Good Microbiological Practices, Good Documentation Practices.

UNIT- II **[8 Hrs]**

Biosafety cabinets: working of biosafety cabinets, using protective clothing, Specifications for BSL-1, BSL-2, BSL-3 and BSL-4 labs. Biohazardous wastes: types, classification, segregations, colour coding, methodology of disinfection, autoclaving & incineration.

UNIT- III **[8 Hrs]**

Detection of microbes in food and pharmaceutical samples: culture and microscopic methods: standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products. Molecular methods: nucleic acid probes, PCR based detection, biosensors.

UNIT-IV **[9 Hrs]**

Detection of pathogenic microorganisms in food & water: enrichment culture technique, Detection of specific pathogens on XLD agar, SS agar, Mannitol salt agar, EMB agar, MacConkey agar; Ascertaining microbial quality of milk by MBRT and other rapid detection methods.

UNIT- V **[8 Hrs]**

Hazard analysis of critical control point (HACCP): principles, flow diagrams, limitations. Microbial Standards for Different Foods and Water: BIS standards for common foods and drinking water.

Recommended Books/Readings

- **Hugo and Russell's Pharmaceutical Microbiology** by B.F. Gilmore, S.P. Denyer., Wiley-Blackwell, 9th Edition (2023).
- **Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices** by Baird RM, Hodges NA and Denyer SP, Taylor & Francis, 1st Edition (2000).
- **FSSAI Manuals** https://www.fssai.gov.in/home/food-testing/food-testing-manual.html.
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Manual of Clinical Microbiology** by Carroll KC, ASM Press, 12th Edition (2019).
- **Pharmaceutical Quality Control Microbiology: A Guidebook to the Basics** by Scott Sutton, Parenteral Drug Association, 1st Edition (2017).

MICRO-541: Emerging Concepts in Microbiology | Sem-IV

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[9 Hrs]**

Introduction to "Omics" technologies, Genomics, transcriptomics, proteomics, metabolomics, metagenomics and their applications in microbiology, Next Generation Sequencing (NGS) Technology: methods and techniques and their applications in microbiology, Whole genome sequencing, Platforms for NGS sequencing.

UNIT- II **[8 Hrs]**

Microbial genomes, Evolution of mitochondria and plastids, Metagenome and metagenomics, Biofilms, Gut microbiome, Rhizospheric microbiome, Endophytes, Microbial genome projects, Quorum sensing, Type IV secretion in bacteria, Molecular targets of antibiotics. Mechanisms of action of bacterial toxins. Genetic regulation of microbial secondary metabolites.

UNIT- III **[8 Hrs]**

Novel microbial groups: polyextremophiles, Endosymbionts of insects, Anammox bacteria, anaerobic rumen fungi, hydrocarbon-degrading microbes, methanogenic archaea, Fungi-like organisms (FLO), Giant viruses, Emerging human pathogens, Case study of COVID-19.

UNIT-IV **[8 Hrs]**

Microbial cell factories, Biosensors, Microbial fuel cell, Microalgae and biofuels, Artificial lab-designed microbial cells (*Mycoplasma*, *MiniBacillus* etc.), Probiotics, Biocement, Marine microbes as untapped source of bioactives, Edible vaccines, Novel immune-therapeutics.

UNIT- V **[9 Hrs]**

Industrially and ecologically important microbes: *Streptomyces*, *E. coli*, *Prochlorococcus*, *Saccharomyces cerevisiae*, *Bacillus* spp., *Lactobacillus* spp., *Corynebacterium glutamicum*, *Deinococcus*, *Methanopyrus kandleri*, *Wolbachia*, *Rhizobium*, *Azotobacter*, *Azospirillum*,
Genetic improvement and metabolic engineering of industrial workhorses.

Recommended Books/Readings

- **Brock Biology of Microorganisms** by Michael Madigan et al., Pearson Education, 16th Edition (2021).
- **Talaro's Foundations in Microbiology** by Barry Chess, McGraw-Hill, 11th Edition (2021).
- **Principles of Gene Manipulation and Genomics** by Primrose SB, Twyman RM., Wiley, 7th Edition (2014).
- **Essential Genetics and Genomics** by Daniel Hartl, Jones & Bartlett Learning, 7th Edition (2020).
- **Lewin's Genes XII** by Krebs JE, Goldstein ES, Kilpatrick ST, Jones & Bartlett Learning, 12th Edition (2018).
- **Lehninger Principles of Biochemistry** by Nelson DL, Cox MM. W.H. Freeman and Co., 7th Edition (2017).
- **Gene Cloning and DNA Analysis: An Introduction** by Brown TA, Wiley-Blackwell, 7th Edition (2016).
- **Molecular Cloning: A Laboratory Manual** by Sambrook J, Green MR., CSH Lab, 4th Edition (2012).
- **Principles of Proteomics** by Richard Twyman, Garland Science, 2nd Edition (2013).
- **Principles and Techniques of Biochemistry and Molecular Biology** by Wilson and Walker, Cambridge University Press, 7th Edition (2010).

MICRO-542: Advanced Techniques in Microbiology and Biotechnology | Sem-IV

L	T	P	C	Practical: 56 Hrs	Total Marks
0	0	2	**2**		100

List of Practicals/Experiments

1. Screening of microbes for plant growth promoting attributes.
2. Mass multiplication and inoculums production of biofertilizers.
3. Preparation of solid and liquid based bioinoculants/biofertilizers.
4. Isolation of genomic DNA from *E. coli.*
5. Preparation of competent *E. coli* cells for transformation.
6. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
7. Cloning of DNA insert and blue-white screening of recombinants.
8. Designing of primers and amplification of DNA by PCR.
9. Demonstration of Southern blotting.
10. Resolution and visualization of bacterial proteins by SDS-PAGE.
11. Study of biofilm formation by bacteria.
12. Identification of RNA viruses by RT-PCR.
13. Microbiological evaluation of pharmaceutical and food products.
14. Bacterial endotoxin (pyrogen) testing by gel clot method.
15. Determination of D value and Z value for heat sterilization of pharmaceuticals.
16. Laboratory diagnosis of malaria infection by rapid detection kits.
17. Study of a microbial biosensor device.

Recommended Books/Readings

- **Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices** by Baird RM, Hodges NA and Denyer SP, Taylor & Francis, 1st Edition (2000).
- **FSSAI Manuals** https://www.fssai.gov.in/home/food-testing/food-testing-manual.html.
- **Manual of Clinical Microbiology** by Carroll KC, ASM Press, 12th Edition (2019).
- **Pharmaceutical Quality Control Microbiology: A Guidebook to the Basics** by Scott Sutton, Parenteral Drug Association, 1st Edition (2017).
- **Gene Cloning and DNA Analysis: An Introduction** by Brown TA, Wiley-Blackwell, 7th Edition (2016).
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Practical Handbook of Microbiology** by L. Green & E. Goldman, CRC Press, 4th Edition (2021).

MICRO-543: Field and Exploratory Microbiology | Sem-IV

L	T	P	C	Practical: 56 Hrs	Total Marks
0	0	2	**2**		100

Students are required to prepare the record file of various activities performed during the semester. Performance of the students will be evaluated on the basis of mid-sessional practical examinations and end-semester practical examinations.

Suggested activities/action plan

1. Visit to a milk processing plant/industry.
2. Visit to Akal bakery to learn about preparation and processing of bakery products.
3. Visit to a local mushroom production farm.
4. A visit to any educational institute/university/science centre related to microbial sciences.
5. Participation in Swachh Bharat Abhiyan and sanitization drives.
6. Educational tour to a diagnostic laboratory/clinical laboratory.
7. Visit to liquid- waste treatment plant and solid-waste disposal facility.
8. Industrial visit to a biopharmaceutical industry located in HP and nearby states.
9. Visit to vaccination camps organized in university campus and nearby localities.
10. Online search of websites of microbiology organisations, societies and journals.
11. Societal Engagement Programs/Social Outreach to schools for microbiology awareness.
12. To attend online/offline scientific seminar/conferences/workshops related to microbiology.
13. Visit to a production unit/manufacturing plant/working unit of biofuels or green energy.
14. Participation in science fair, science exhibition, talent search program and job fair.
15. Participation in microbiology quiz
16. Database of National fellowships, scholarships and examinations for microbiology students.
17. Awareness about microbiology job opportunities through print and electronic media.

Recommended Books/Readings

- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology** by K.R. Aneja, New Age International., 6th Edition (2022).
- **Brock Biology of Microorganisms** by Michael Madigan et al., Pearson Education, 16th Edition (2021).
- **Environmental Microbiology** by Pepper IL, Gerba CP, Gentry TJ, Academic Press, 3rd Edition (2014).
- **Microbial Ecology: Fundamentals & Applications** by Atlas and Bartha, Pearson, 4th Edition (2011).
- **Manual of Environmental Microbiology** by Yates MV et al., ASM Press, 4th Edition (2016).

MICRO-544: Pharmaceutical Microbiology | Sem-IV

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[8 Hrs]**

Pharmaceutically important microorganisms, Brief introduction to biopharmaceuticals: antibiotics, growth factors, hormones, vitamins, therapeutic enzymes, recombinant proteins, biosimilars, APIs, sera, plasma, monoclonal antibodies and vaccines.

UNIT- II **[8 Hrs]**

Microbial production of pharmaceuticals, Primary metabolic products, Secondary metabolic products, Industrial scale fermentation processes, GLP and GMP for pharmaceuticals production, Regulatory agencies: FDA, CDSCO, DCGI, Indian Pharmacopoeia Commission, NPPA.

UNIT- III **[10 Hrs]**

Antibiotics and synthetic antimicrobial agents. Antifungal agents, Antiviral drugs, Peptide antibiotics, Synthetic antibiotics, Antiprotozoal agents, Anthelmintic drugs.

UNIT-IV **[8 Hrs]**

Drug discovery and development, Drug designing, Combinatorial synthesis, Computer aided design (CAD), Preclinical and Clinical trials; Toxicity testing, High Throughput Screening (HTS), Pharmaco-genomics.

UNIT- V **[8 Hrs]**

Methods of sterilization of pharma products, Stabilizers, emulsifiers, adjuvants, excipients and preservatives in biopharmaceutical products. Preservative monographs. Preservative stability and efficacy.

Recommended Books/Readings

- **Hugo and Russell's Pharmaceutical Microbiology** by B.F. Gilmore, S.P. Denyer., Wiley-Blackwell, 9th Edition (2023).
- **Manual of Industrial Microbiology and Biotechnology** by Baltz RH et al., ASM Press, 3rd Edition (2010).
- **Molecular Biotechnology** by Glick BR, Pasternak JJ and Patten CL, ASM Press, 4th Edition (2010).
- **Microbiology and Sterility Assurance in Pharmaceuticals and Medical Devices** by Madhu Raju Saghee et al., Business Horizons (2011).
- **A Textbook of Pharmaceutical Microbiology** by Prahlad Mehra, I K Int. Publishing (2011).
- **Textbook of Drug Design and Discovery** by Krogsgaard et al., Taylor and Francis, London (2004).
- **Essential Microbiology for Pharmacy and Pharmaceutical Science** by Hanlon & Hodges, Wiley Blackwell (2013).

MICRO-545: Biofertilizers and Biopesticides | Sem-IV

L	T	P	C	Theory: 42 Hrs	Total Marks 100
3	0	0	**3**		

UNIT- I **[9 Hrs]**

Biofertilizers: general characteristics and historical aspects. Advantages over chemical fertilizers. Ideal features of biofertilizers, Microbes used as biofertilizers. Current status of use and applications of biofertilizers in India and abroad. Commercial production of biofertilizers.

UNIT- II **[8 Hrs]**

Symbiotic N_2 fixing bacteria, *Rhizobium*: isolation, characteristics, types, mass production and field application for legume/pulses plants. *Anabeana-Azolla*: isolation, characterization, mass multiplication, role in rice cultivation, field applications, Non-leguminous crop symbiosis.

UNIT- III **[8 Hrs]**

Associative N_2 fixing bacteria (*Azospirillum*) and free-living N_2 fixing bacteria (*Azotobacter*): isolation, characteristics, mass inoculums, production and field applications. Phosphate and potassium solubilizing microbes: isolation, characterization, mass production, field applications.

UNIT-IV **[8 Hrs]**

Mycorrhizal biofertilizers: importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Propagation techniques, Mass production of VAM, field applications of ectomycorrhizae and VAM**.**

UNIT- V **[9 Hrs]**

Biopesticides: microbes used as biopesticides and their advantages over synthetic pesticides; *Bacillus thuringiensis, Beauveria bassiana, Metarhizium, Trichoderma viride*: production, field applications; Viruses as biopesticides (*Cydia pomonella* granulovirus): cultivation and field applications, Plant-Incorporated Protectants (PIPs). Biofungicides.

Suggested Books/Readings

- **Biofertilizers and Biopesticides in Sustainable Agriculture** by BD Kaushik et al.. CRC Press, USA (2020)
- **Microbiology: A Laboratory Manual** by Cappuccino J, Welsh C, Pearson Edu, 12th Edition (2021).
- **Biotechnology of Biofertilizers** by Kannaiyan S, CHIPS, Texas (2003).
- **Hand Book of Microbial Biofertilizers** by Rai MK., CRC Press, 1st Edition (2008).
- **Bioinoculants for Sustainable Agriculture and Forestry** by Reddy, Scientific Publishers, 1st Edition (2002).
- **Soil Microorganisms and Plant Growth** by Subba Rao NS, Oxford and IBH Publishing, 4th Edition (2005).
- **Advanced Environmental Biotechnology** by Aggarwal SK, APH Publication (2005).

MICRO-546: Project Work | Sem-IV

L	T	P	C	Practical: 280 Hrs	Non-credit Course
0	0	10	**10**		

Objectives:

This course is designed to provide an exposure to the students about ongoing research in basic and applied areas of microbiology. It will impart skills on planning, performing, analyzing and data interpretation of experiments. Students will also acquire proficiency in reading research articles, preparing powerpoint presentations and giving oral presentations.

Guidelines:

1. In the second semester, student will be given an orientation about the aim and objectives of the project work. The student will develop the outline of the project work for approval by the Dean of the college.

2. The student will perform the assigned project work in the fourth semester under the supervision of Advisor.

3. The student will prepare the final project work report and will submit to the Dean of the College.

4. The student will make a presentation at Department/College level before the Evaluation Committee comprising of faculty members of the department and/or other allied departments of the college.

5. The student will submit five hard copies of the report in spiral-bound / comb-bound form along with the soft copy to the advisor.

6. The final result of student in Satisfactory or Unsatisfactory form will be submitted to the Controller of Examinations by the Advisor. Satisfactory grade will be awarded on securing minimum 60 marks out of 100.

The project report preparation and evaluation criteria to be followed are as under:

Marks given by Advisor: 40 marks

S/N	Particulars	Marks
(a)	Attendance	**10**
(b)	Experimental work performance	**10**
(c)	Data presentation and quality	**10**
(d)	Data analysis and interpretation	**10**

Marks given by Evaluation Committee: 60 marks

S/N	Particulars	Marks
(e)	Evaluation of submitted project report	**30**
(f)	Presentation of project report	**20**
(g)	Response to the questions	**10**

Note: To get satisfactory grade in the Project Work course, the student must obtain minimum 60% marks.

MICRO-600: Thesis	Sem-IV

L	T	P	C
0	0	20	**20**

Students are required to start working on their thesis during semester III and will finish the assigned research work in semester IV. Students will work on a research topic assigned to them by their Major Advisor with a purpose to develop a collective approach to study, analyze and solve the problem. Students are required to submit their thesis in hard-bound form at the end of the semester.

Thesis will be forwarded by the Dean of the College to one of the external expert/examiner out of the panel of experts submitted by the major advisor. The suggestions made by the external expert will be incorporated in the thesis by the student and five hard copies will be submitted in the office of Dean. Thereafter, the Dean of the College will arrange internal viva-voce examination to be conducted by the advisory committee of the student under the chairmanship of the Dean. Result of viva-voce in **Satisfactory** or **Unsatisfactory** form will be submitted along with necessary documents to the Controller of Examinations office for declaration of the semester result.

Suggested Journals/Resources/Databases

Research journals

- Annual Review of Microbiology
- Nature
- Cell
- Science
- Nature Microbiology
- Nature Microbiology Reviews
- Antonie van Leeuwenhoek
- PLOS Pathogens
- Journal of Antibiotics
- Trends in Microbiology
- Infection & Immunity
- Frontiers in Microbiology
- Environmental Microbiology
- Applied Microbiology and Biotechnology
- Journal of Bacteriology
- Journal of Microbiological Methods
- Microbial Biotechnology
- World Journal of Microbiology & Biotechnology
- Applied and Environmental Microbiology
- Microbiology and Molecular Biology Reviews
- International Journal of Systematic & Evolutionary Microbiology
- Journal of Industrial Microbiology & Biotechnology
- Letters in Applied Microbiology
- Enzyme Microbial Technology
- Bioresource Technology

Research databases

- Pubmed/Medline
- ScienceDirect
- J-stage
- SpringerLink
- IngentaConnect
- Google Scholar
- Current Contents
- Scopus
- Biological Abstracts

Examination Evaluation Scheme
&
Tentative Marks Distribution

CREDITS L+T+P	THEORY			PRACTICALS		
	Total	**Mid-Sessional**	**End Term**	**Total**	**Mid-Sessional**	**End Term**
1+0+0 **2+0+0** **3+0+0** **4+0+0** **5+0+0** **6+0+0**	100	40 (30+10[#])	60	-	-	-
0+0+1	0	0	0	100	50	50
1+0+1	50	20 (15+5[#])	30	50	-	50
2+0+1	65	25 (20+5)	40	35	-	35
3+0+1	75	30 (25+5)	45	25	-	25
4+0+1	80	35 (30+5)	45	20	-	20
0+0+2	0	0	0	100	50	50
1+0+2	35	15 (10+5[#])	20	65	-	65
2+0+2	50	20 (15+5)	30	50	-	50
3+0+2	60	25 (20+5)	35	40	-	40
0+0+3	0	0	0	100	50	50

#Assignment