ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

Model Syllabus for 4-Year UG Honours in B.Sc. (Biotechnology) as Major in consonance with Curriculum framework w.e.f. AY 2025-26

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COURSE STRUCTURE (for Semester I to VI)

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Introduction to Cell Biology and Genetics	3	3
			Introduction to Cell Biology and Genetics-Practical	2	1
		2	Biological Chemistry	3	3
			Biological Chemistry-Practical	2	1
	II	3	Microbiology	3	3
			Microbiology-Practical	2	1
		4	Basic Immunology	3	3
			Basic Immunology-Practical	2	1
II	III	5	Biophysical Techniques	3	3
			Biophysical Techniques-Practical	2	1
		6	Basic Molecular Biology	3	3
			Basic Molecular Biology-Practical	2	1
		7	Genetic Engineering	3	3
			Genetic Engineering-Practical	2	1
	IV	8	Bioinformatics, Biostatistics & Bioethics	3	3
			Bioinformatics, Biostatistics & Bioethics-Practical	2	1
		9	Basics of Plant Biotechnology	3	3
			Basics of Plant Biotechnology-Practical	2	1

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
		10	Basics of Animal Biotechnology	**3**	**3**
			Basics of Animal Biotechnology-Practical	**2**	**1**
III	**V**	**11**	Industrial Biotechnology	**3**	**3**
			Industrial Biotechnology-Practical	**2**	**1**
		12 A	Medical Biotechnology	**3**	**3**
			Medical Biotechnology-Practical	**2**	**1**
		OR			
		12 B	Marine Biotechnology	**3**	**3**
			Marine Biotechnology-Practical	**2**	**1**
		13 A	Nano Biotechnology	**3**	**3**
			Nano Biotechnology-Practical	**2**	**1**
		OR			
		13 B	Biofertilizers and Biopesticides Production	**3**	**3**
			Biofertilizers and Biopesticides Production-Practical	**2**	**1**
	VI	**14 A**	Pharmaceutical Biotechnology	**3**	**3**
			Pharmaceutical Biotechnology-Practical	**2**	**1**
		OR			
		14 B	Food and Nutritional Biotechnology	**3**	**3**
			Food and Nutritional Biotechnology-Practical	**2**	**1**
		15 A	Genomics & Proteomics	**3**	**3**
			Genomics & Proteomics-Practical	**2**	**1**
		OR			
		15 B	Environmental Biotechnology	**3**	**3**
			Environmental Biotechnology-Practical	**2**	**1**

Note: In the III Year (during the V and VI Semesters), students are required to select a pair of electives from one of the Two specified domains. For example: if set 'A' is chosen, courses 12 to 15 to be chosen as 12 A, 13 A, 14 A and 15 A or if set 'B' is chosen, It is to be chosen as 12 B, 13 B, 14 B and 15 B to ensure in-depth understanding and skill development in the chosen domain, students must continue with the same domain electives in both the V and VI Semesters.

SEMESTER - I

COURSE 1: INTRODUCTION TO CELL BIOLOGY AND GENETICS

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce students to the structure and function of prokaryotic and eukaryotic cells.
2. To provide knowledge on cellular organelles and their roles in cell physiology.
3. To explain the principles of genetics, including Mendelian laws and chromosome organization.
4. To describe mutagenesis, DNA damage, and repair mechanisms.
5. To create awareness about the cell cycle, cancer biology, and cell signaling processes.

Learning Outcomes:

After completing this course, students will be able to:

1. Identify and describe the structure of different types of cells and their components.
2. Explain the functions of cell organelles and mechanisms of cell transport.
3. Apply Mendelian principles and recognize deviations in inheritance patterns.
4. Analyze causes of mutations and describe DNA repair mechanisms.
5. Compare normal and cancer cells, and explain the regulation of cell cycle and apoptosis.

Syllabus

Unit I
Cell as a basic unit of living organism; Cell wall Structure, chemical composition and function. Glycocalyx. Structure and Function of Cell membranes; Brief description of viral, bacterial, fungal, plant and animal cells.

Unit II
Sub-cellular organization of eukaryotic cell: Nucleus, nuclear envelope, transport across nuclear membrane; Nucleolus; cytosol, endoplasmic reticulum, chloroplast, mitochondria, vacuoles, ribosomes, peroxisomes, lysosome and golgi complex; Cell Transport: Active and Passive transport, phagocytosis, pinocytosis, exocytosis. Chromosomes: Morphology, Structural Organization; Specialized chromosomes- Salivary gland & lamp brush chromosomes.

Unit III
Mendel Experiments, Mendel Laws and Deviations: Incomplete Dominance and Co-dominance; Concept of multiple alleles; Structure of prokaryotic and Eukaryotic chromosomes. Eukaryotic chromosome organization, histone proteins.

Unit IV

Mutagenesis - Spontaneous and induced (Chemical and physical) mutations; Mutations- point mutations, frameshift mutations; Factors affecting DNA damage; Repair Mechanisms - Light induced repair, Excision repair and mismatch repair and SOS repair.

Unit V

Phases of the eukaryotic cell cycle - Mitosis and Meiosis; Regulation of cell cycle-checkpoints. Basics of Cancer Development (Concept of Angiogenesis and Metastasis) and Cancer causative agents. Proto- oncogenes, oncogenes. Differences between cancer cell and normal cell. Programmed Cell Death. Introduction to cell signaling.

Reference books:

- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter – *Molecular Biology of the Cell* – Garland Science.
- Geoffrey M. Cooper and Robert E. Hausman – *The Cell: A Molecular Approach* – ASM Press & Sinauer Associates.
- Gerald Karp – *Cell and Molecular Biology: Concepts and Experiments* – John Wiley & Sons.
- De Robertis, E.D.P. and De Robertis, E.M.F. – *Cell and Molecular Biology* – Saunders College Publishing.
- Snustad, D.P. and Simmons, M.J. – *Principles of Genetics* – John Wiley & Sons.
- Gardner, E.J., Simmons, M.J. and Snustad, D.P. – *Principles of Genetics* – John Wiley & Sons.
- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. – *Molecular Cell Biology* – W.H. Freeman and Company.

SEMESTER - I

COURSE 1: INTRODUCTION TO CELL BIOLOGY AND GENETICS

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Principle and utilization of microscope
2. Preparation of blood smear and observation of cells
3. Study of divisional stages in mitosis
4. Study of divisional stages in meiosis
5. Observation of differences between stained bacterial cells and cells in onion peels
6. Observation of permanent slides of bacterial, fungal, plant and animal cells
7. Problem solving in genetics
8. Human Karyotype analysis
9. Simple Mendelian traits in humans and pedigree analysis

SEMESTER - I

COURSE 2: BIOLOGICAL CHEMISTRY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce students to the structure and properties of nucleic acids and their biological significance.
2. To explain the chemistry and classification of carbohydrates, lipids, porphyrins, heme, and chlorophylls.
3. To provide knowledge on amino acids, protein structure, and conformational analysis.
4. To develop understanding of enzyme classification, kinetics, inhibition, and mechanisms of action.
5. To describe bioenergetics, ATP, and central metabolic pathways including glycolysis, TCA cycle, and oxidative phosphorylation.

Learning Outcomes:

After completing this course, students will be able to:

1. Describe the chemical structure and structural variations of nucleic acids.
2. Classify and explain the structures and functions of carbohydrates, lipids, and porphyrins.
3. Explain the properties and structural organization of proteins using the Ramachandran plot.
4. Analyze enzyme kinetics, substrate specificity, and different types of enzyme inhibition.
5. Understand the principles of bioenergetics and summarize major energy-yielding metabolic pathways.

Syllabus

UNIT I

Nucleic Acids: Chemical structure and base composition of nucleic acids (DNA and RNA). Chargaff's rules. Watson Crick Model (B-DNA), deviations from Watson-Crick model. Alternative forms of DNA (A-DNA and Z-DNA). Forces stabilizing nucleic acid structures, (hydrogen bonds and hydrophobic associations).

UNIT II

Carbohydrates: Definition, classification, nomenclature of carbohydrates, structures of monosaccharides, disaccharides and polysaccharides. Concept and examples of heteropolysaccharides.

Lipid: Structure of saturated and unsaturated fatty acids, triglycerides, phospholipids, Chemistry of Porphyrines, Heme and Chlorophylls.

UNIT III

Amino acids and Proteins: Structure of amino acids occurring in proteins, classification of amino acids (pH based, polarity based and nutrition based) physico-chemical properties of amino acids. Primary, Secondary, Tertiary & Quaternary structure of proteins. Ramachandran Plot.

UNIT IV

Enzymes: Terminology: Active site, allosteric site, Holoenzyme, apoenzyme, coenzyme, substrate, inhibitor, activator, modulator etc. Classification and nomenclature of enzymes. Substrate Specificity (bond specificity, group specificity, absolute specificity, stereospecificity), lock and key and induced fit models. Enzyme kinetics: Michaelis-Menten equation, effect of substrate concentration, effect of enzyme concentration, effect of pH and temperature, temperature. Enzyme inhibition (reversible inhibition types – competitive, uncompetitive and non-competitive), brief idea of irreversible inhibition.

UNIT V

Bioenergetics: Concept of free energy, Entropy, Enthalpy & Redox Potential. Concept of high energy bonds (structure of ATP). Glycolysis, Kreb's cycle, Gluconeogenesis: Bypass reactions., Electron transport chain, Oxidative phosphorylation.

Reference books:

- Lehninger, A.L., Nelson, D.L. and Cox, M.M. – *Principles of Biochemistry* – W.H. Freeman and Company.
- Voet, D. and Voet, J.G. – *Biochemistry* – John Wiley & Sons.
- Stryer, L. – *Biochemistry* – W.H. Freeman and Company.
- Satyanarayana, U. and Chakrapani, U. – *Biochemistry* – Elsevier / Books and Allied (Indian edition).
- Zubay, G. – *Biochemistry* – Wm. C. Brown Publishers.
- Garrett, R.H. and Grisham, C.M. – *Biochemistry* – Brooks/Cole, Cengage Learning.
- Conn, E.E. and Stumpf, P.K. – *Outlines of Biochemistry* – John Wiley & Sons.

SEMESTER - I

COURSE 2: BIOLOGICAL CHEMISTRY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Introduction to basic instruments (Principle standard operation procedure) demonstration and record
2. Calculation of molarity, normality, and molecular weight of compounds.
3. Qualitative analysis of carbohydrates (sugars)
4. Quantitative analysis of carbohydrates
5. Quantitative estimation of protein - Lowery method
6. Estimation of DNA by diphenylamine reagent
7. Estimation of RNA by orcinol reagent
8. Assay of protease activity
9. Preparation of starch from potato and its hydrolyzation by salivary amylase

SEMESTER - II

COURSE 3: MICROBIOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce the history and development of microbiology along with contributions of key scientists.
2. To explain the principles and applications of different types of microscopy.
3. To study the structure, morphology, and special features of bacteria, including staining techniques.
4. To provide knowledge on microbial nutrition, growth, cultivation, and methods of microbial control.
5. To introduce viruses, their structure, replication, classification, and transmission with examples of human diseases.

Learning Outcomes:

After completing this course, students will be able to:

1. Summarize the historical contributions of Pasteur, Koch, and Jenner in microbiology.
2. Differentiate between light, phase contrast, dark field, fluorescent, and electron microscopy.
3. Describe bacterial morphology, cell structures, plasmids, endospores, and staining methods.
4. Identify nutritional requirements, growth phases, and apply sterilization and disinfection techniques.
5. Explain the structural organization, replication strategies, and transmission of viruses including modern examples.

Syllabus

UNIT I
History, Development and Microscopy
History and development of microbiology: contributions of Louis Pasteur, Robert Koch and Edward Jenner. Microscopy: Compound microscopy: Numerical aperture and its importance, resolving power, oil immersion objectives and their significance. Principles and applications of dark field, phase contrast, fluorescent microscopy. Electron microscopy: Principle, ray diagram and applications, TEM and SEM, comparison between optical and electron microscope, limitations of electron microscopy.

UNIT II
Bacteria: Bacterial morphology and subcellular structures, general morphology of bacteria, shapes and sizes, generalized diagram of typical bacterial cell. Slime layer and capsule, difference between the structure and function. Cell wall of Gram +ve and Gram -ve cells. General account of flagella and fimbriae. Chromatin material, plasmids; definition and kind

of plasmids (conjugative and non-conjugative) F, R, and Col plasmids. Endospores: Detailed study of endospore structure and its formation, germination, basis of resistance.
Staining: Acidic, Basic and Neutral stains. Simple and Gram Staining, Acid fast staining, Flagella staining, Endospore staining.

Unit III

Microbial Nutrition: Basic nutritional requirements. Composition of Natural and Synthetic Media. Selective and Differential media, Enriched media, Enrichment media. Factors Affecting Growth of Microbes: pH, Temperature, Salinity. Classification of microorganisms based on nutrition and temperature.

UNIT IV
Microbial growth and control: Growth rate and generation time, details of growth curve and its phases. Measurement of growth. Pure cultures and cultural characteristics. Maintenance of pure culture. Microbial Control: Sterilization (Physical and chemical methods of sterilization), disinfection, sanitization, germicide, microbistasis, antiseptics and antimicrobials.

UNIT V:
Viruses: Properties and General characteristics of Viruses. Classification of viruses on the basis of nucleic acids composition. Basic Structure of Lamda and M13 DNA Virus. Brief idea of lytic cycle and lysogeny. **Viral Transmission:** Different modes (dengue, SARS-CoV-2) and their preventive measures.

Reference books:

- Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. – *Microbiology* – Tata McGraw-Hill Publishing Company.
- Prescott, L.M., Harley, J.P. and Klein, D.A. – *Microbiology* – McGraw-Hill Higher Education.
- Cappuccino, J.G. and Sherman, N. – *Microbiology: A Laboratory Manual* – Pearson Education.
- Willey, J.M., Sherwood, L.M. and Woolverton, C.J. – *Prescott's Principles of Microbiology* – McGraw-Hill.
- Tortora, G.J., Funke, B.R. and Case, C.L. – *Microbiology: An Introduction* – Pearson Education.
- Powar, C.B. and Daginawala, H.F. – *General Microbiology* – Himalaya Publishing House.
- Ananthanarayanan, R. and Paniker, C.K.J. – *Textbook of Microbiology* – Universities Press (for medical aspects).

SEMESTER - II

COURSE 3: MICROBIOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Cleaning and preparation of glassware
2. Observation of permanent slides using microscope
3. Preparation of nutrient agar medium for bacteria
4. Preparation of PDA medium for fungal culture
5. Sterilization techniques (autoclave, hot air oven, filter)
6. Isolation of bacteria from soil
7. Simple staining technique
8. Differential staining technique
9. Microbial counting by Haemocytometer
10. Identification of different bacteria
11. Motility test by hanging drop
12. Biochemical identification of bacteria
13. Preparation of pure culture by slab, slant, streak culture

SEMESTER - II

COURSE 4: BASIC IMMUNOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce the fundamentals of the immune system, immune cells, and immune organs.
2. To explain the structure, types, and diversity of antibodies and the nature of antigens.
3. To describe mechanisms of humoral and cell-mediated immunity, cytokines, and MHC molecules.
4. To provide knowledge about hypersensitivity, autoimmunity, vaccination, and different types of vaccines.
5. To familiarize students with immunological techniques and applications of monoclonal antibodies.

Learning Outcomes:

After completing this course, students will be able to:

1. Explain the organization of the immune system and differentiate innate and acquired immunity.
2. Describe antibody structure, types, and antigenic determinants.
3. Analyze mechanisms of humoral, cell-mediated, and NK cell-mediated immune responses.
4. Differentiate between types of hypersensitivity and explain the principles and applications of vaccination.
5. Apply knowledge of immunological techniques for antigen-antibody interactions and monoclonal antibody production.

Syllabus

UNIT I

Immune System: History and Scope of Immunology. Types of Immunity: Innate and Acquired. Cells of immune system: T cells, B cells. Organs of the Immune system: Bone marrow, spleen, thymus, MALT, lymph node.

UNIT II

Antibody and Antigen: Antibodies: Structure and Types of Antibodies (IgG, IgM, IgA, IgE, IgD). Monoclonal and Polyclonal antibodies. Antibody diversity. Antigens: Types of Antigens. Antigenicity (factors affecting antigenicity). Antigenic determinants – adjuvants and haptens, epitopes.

UNIT III

Immunity: Humoral immunity. Cell-mediated immunity – T Cell-mediated immunity, NK cell-mediated immunity, ADCC. Brief description of cytokines and interleukins. Major Histocompatibility Complex (MHC) – Structure and functions of Class I and Class II MHC molecules.

UNIT IV

Hypersensitivity and Vaccination: General features of hypersensitivity, various types of hypersensitivity. Autoimmunity. Vaccination: Discovery, principles, and significance. Types of Vaccines – Live, attenuated, killed, toxoids, recombinant-based (mRNA and Protein).

UNIT V

Immunological Techniques: Antigen-antibody reactions: Precipitation, agglutination, complement fixation, immunodiffusion – Radial immune diffusion, Ouchterlony double immune diffusion, ELISA, RIA, immunoelectrophoresis, Rocket electrophoresis. Hybridoma technology: Monoclonal antibodies and their applications in immunodiagnostics.

Reference books:

- Kuby, J. – *Immunology* – W.H. Freeman & Company.
- Abbas, A.K., Lichtman, A.H. and Pillai, S. – *Cellular and Molecular Immunology* – Elsevier.
- Roitt, I., Brostoff, J. and Male, D. – *Immunology* – Mosby Publications.
- Ananthanarayanan, R. and Paniker, C.K.J. – *Textbook of Microbiology* – Universities Press (for immunology basics).
- Kindt, T.J., Goldsby, R.A. and Osborne, B.A. – *Kuby Immunology* – W.H. Freeman.
- Delves, P.J., Martin, S.J., Burton, D.R. and Roitt, I.M. – *Roitt's Essential Immunology* – Wiley-Blackwell.

SEMESTER - II

COURSE 4: BASIC IMMUNOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Antigen–antibody reaction–determination of Blood group, Cross reactivity
2. Pregnancy test
3. Widal test
4. Ouchterlony immunodiffusion
5. Radial immuno diffusion
6. ELISA
7. Production of antibodies and their titration

SEMESTER - III

COURSE 5: BIOPHYSICAL TECHNIQUES

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce the principles and applications of spectrophotometry in biological research.
2. To explain the theory, instrumentation, and uses of different types of chromatography.
3. To familiarize students with the principles and applications of electrophoresis techniques.
4. To provide knowledge about centrifugation methods, rotors, centrifuge types, and their applications.
5. To describe tracer techniques, radioactivity measurements, autoradiography, and the use of non-radioactive labels.

Learning Outcomes:

After completing this course, students will be able to:

1. Understand the principles of light absorption and apply UV-visible spectrophotometry.
2. Differentiate between various chromatographic techniques and apply them for biomolecule separation and analysis.
3. Perform and interpret results from gel electrophoresis, SDS-PAGE, isoelectric focusing, and related techniques.
4. Apply centrifugation methods for separation and analysis of cellular and molecular components.
5. Explain the principles of tracer techniques, radioactivity measurement, and non-radioactive labeling methods in biotechnology.

Syllabus

UNIT I

Spectrophotometry: Spectrum of light, absorption of electromagnetic radiations, Beer-Lambert's law: derivation and deviations, extinction coefficient, colorimeter, instrumentation of UV and visible spectrophotometry, double beam spectrometer, dual-wavelength spectrometer, applications of UV and visible spectrophotometry.

UNIT II

Chromatography: Principle, instrumentation and applications of paper chromatography, thin layer chromatography, gel filtration chromatography, ion-exchange chromatography, affinity chromatography, high performance liquid chromatography (HPLC).

UNIT III

Electrophoresis: Migration of ions in electric field, factors affecting electrophoretic mobility, gel electrophoresis: types of gels, agarose gel electrophoresis, SDS-PAGE and Native-PAGE electrophoresis and their applications, isoelectric focusing, two-dimensional electrophoresis, pulsed-field gel electrophoresis.

UNIT IV

Centrifugation: Basic principles of centrifugation, types of rotors, types of centrifuges: clinical, high-speed and ultracentrifuges, preparative centrifugation: differential and density gradient centrifugation, analytical centrifugation and their applications.

UNIT V

Tracer Techniques: Radioactive and stable isotopes, rate of radioactive decay, units of radioactivity, measurement of radioactivity: Geiger-Muller counter, autoradiography, non-radioactive compounds: fluorescein, biotin, digoxigenin and their applications in biotechnology.

Reference books:

- Keith Wilson and John Walker – *Principles and Techniques of Biochemistry and Molecular Biology* – Cambridge University Press.
- R. K. Murray et al. – *Harper's Illustrated Biochemistry* – McGraw Hill (for basics of spectrophotometry and biochemistry techniques).
- David J. Holme and Hazel Peck – *Analytical Biochemistry* – Pearson Education.
- Boyer, R. – *Modern Experimental Biochemistry* – Pearson.
- Plummer, D.T. – *An Introduction to Practical Biochemistry* – Tata McGraw Hill.
- S. K. Sawhney and R. Singh – *Introductory Practical Biochemistry* – Narosa Publishing House.
- Ghosh, T.K. – *Biophysical Chemistry* – Books and Allied (for tracer techniques and centrifugation).

SEMESTER - III

COURSE 5: BIOPHYSICAL TECHNIQUES

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Separation of plant pigments and amino acids by paper chromatography
2. Separation of lipids of TLC
3. Quantification of DNA using Spectrophotometer
4. Quantification of RNA using Spectrophotometer
5. Agarose gel electrophoresis

SEMESTER - III

COURSE 6: BASIC MOLECULAR BIOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To understand the experimental proof that DNA is the genetic material.
2. To study genome organization in prokaryotes and eukaryotes.
3. To explain the processes of DNA replication, transcription, and translation.
4. To understand the regulation of gene expression in prokaryotic and eukaryotic systems.
5. To develop a basic understanding of molecular mechanisms underlying heredity and protein synthesis.

Learning Outcomes:

After completing this course, students will be able to:

1. Describe experiments that established DNA as the genetic material.
2. Compare the genome structure of prokaryotes and eukaryotes.
3. Explain the mechanism of DNA replication, transcription, and translation.
4. Discuss the regulation of gene expression using operon models.
5. Apply knowledge of molecular biology to understand genetic processes in living organisms.

Syllabus

Unit I

Genome Structure: Experiments to prove DNA as genetic material (Griffith experiment, Hershey- Chase experiment). Genome Organization: Prokaryotic and Eukaryotic genomes. Concept of Gene, Genome and Genome size with respect to Prokaryotic and Eukaryotic genomes.

Unit II

DNA Replication: Proof of semiconservative replication. Enzymes Involved in DNA Replication: DNA polymerase I, II and III, Helicases, Topoisomerases, single strand binding proteins, primase. Mechanism of DNA Replication (Prokaryotic and Eukaryotic). M13 Viral DNA Replication (Rolling circle method).

Unit III

Transcription: Basic features of transcription, the structure of prokaryotic RNA polymerases – Prokaryotic and Eukaryotic. Concept of core enzyme, hollo enzyme, and sigma factor. Concept of promoter – TATA Box, -10 and -35 sequences). Transcription Mechanisms: Prokaryotic and Eukaryotic. Post Transcriptional Modifications in Eukaryotes. Concept of Reverse Transcription.

Unit IV

Translation: Genetic code: Features of genetic code, Structure of mRNA, brief structure of tRNA. Codon-anticodon interaction - the Wobble Hypothesis. Mechanism of Translation - Prokaryotic and Eukaryotic. Initiation, elongation, termination protein.

Unit V

Gene Regulation: Clustered genes the operon concepts - Negative and positive control of the Lac Operon, trp operon, Control of gene expression. Poly and Mono cistronic mRNA.

Reference books:

- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. & Losick, R. (2017). *Molecular Biology of the Gene*. 7th Edition, Pearson Education.
- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. & Martin, K. (2021). *Molecular Cell Biology*. 9th Edition, W.H. Freeman and Company.
- Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2017). *Lewin's Genes XII*. Jones & Bartlett Learning.
- Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. & Walter, P. (2014). *Molecular Biology of the Cell*. 6th Edition, Garland Science.
- Primrose, S.B. & Twyman, R.M. (2006). *Principles of Gene Manipulation and Genomics*. 7th Edition, Blackwell Publishing.
- Berg, J.M., Tymoczko, J.L., Gatto, G.J. & Stryer, L. (2019). *Biochemistry*. 9th Edition, W.H. Freeman and Company.
- Weaver, R.F. (2018). *Molecular Biology*. 6th Edition, McGraw Hill Education.

SEMESTER - III

COURSE 6: BASIC MOLECULAR BIOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Effect of UV radiations on the growth of microorganisms.
2. Determination of absorption maxima of DNA and RNA and their quantification
3. Quantitative estimation of RNA
4. Quantitative estimation of DNA
5. Isolation of plasmid DNA from bacteria
6. Isolation of genomic DNA from *E. coli*
7. Isolation of DNA from sheep liver
8. Isolation of DNA from plant leaves (Rice or Tobacco or any other plant)
9. Separation of DNA by Agarose gel Electrophoresis
10. Purity analysis of the Nucleic acids

SEMESTER - III

COURSE 7: GENETIC ENGINEERING

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce the principles, scope, and applications of genetic engineering.
2. To study molecular tools such as enzymes, cloning vectors, and transformation methods.
3. To understand hybridization techniques, PCR, and their applications in research.
4. To learn strategies for construction of genomic/cDNA libraries and protein expression.
5. To explore advanced genetic manipulation techniques such as CRISPR, site-directed mutagenesis, and next-generation sequencing.

Learning Outcomes:

After completion of this course, students will be able to:

1. Explain the history, scope, and tools used in genetic engineering.
2. Describe cloning vectors and transformation techniques in bacteria, yeast, plants, and animals.
3. Apply hybridization and PCR techniques for molecular analysis.
4. Construct and analyze genomic and cDNA libraries for gene studies.
5. Evaluate modern techniques such as CRISPR-Cas9, gene silencing, and next-generation sequencing.

Syllabus

UNIT – I

History, scope, and recent developments in Genetic Engineering. Molecular tools in genetic engineering – Restriction enzymes: Endonucleases and Exonucleases. DNA Modifying enzymes. Ligation (cohesive-end and blunt-end ligation), use of linkers and adaptors. Guidelines and strategies in plant and animal genetic engineering.

UNIT – II

Cloning vectors: Definition, properties and types. Plasmid vectors – pUC19 and pBR322. Phage vectors – λ (lambda) and M13. Cosmid vectors, shuttle vectors, and expression vectors. YAC vectors (*Saccharomyces cerevisiae* as a model) and BAC vectors (*E. coli*). Bacterial transformation. Screening and selection of recombinants – GUS and GFP assisted selection.

UNIT – III

Hybridization techniques: Probes (radioactive and non-radioactive) and their labelling. DNA labelling methods – Nick translation, random priming, and primer extension. Southern blotting and Northern blotting – principles and applications. Polymerase Chain Reaction (PCR): Principle, types of PCR, and applications.

UNIT – IV

Construction of genomic and cDNA libraries. Vector engineering – role of promoters. Codon optimization and *in vitro* translation. Strategies for protein overexpression in bacteria, yeast, insects, plants, and mammalian cell lines.

UNIT – V

Chromosome engineering and targeted gene replacement. Gene editing – CRISPR-Cas9. Manipulation of gene regulation and gene silencing. Site-directed mutagenesis. DNA sequencing methods – Maxam-Gilbert (chemical method), Sanger's method, and Next Generation Sequencing (NGS) with applications.

Reference books:

1. Brown, T.A. (2016). *Gene Cloning and DNA Analysis: An Introduction*. 7th Edition, Wiley-Blackwell.
2. Primrose, S.B. & Twyman, R.M. (2006). *Principles of Gene Manipulation and Genomics*. 7th Edition, Blackwell Publishing.
3. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. & Losick, R. (2017). *Molecular Biology of the Gene*. 7th Edition, Pearson Education.
4. Glick, B.R., Pasternak, J.J. & Patten, C.L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 4th Edition, ASM Press.
5. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. & Walter, P. (2014). *Molecular Biology of the Cell*. 6th Edition, Garland Science.
6. Weaver, R.F. (2018). *Molecular Biology*. 6th Edition, McGraw Hill Education.
7. Channarayappa, C. (2014). *Molecular Biotechnology: Principles and Practices*. Universities Press, India.

SEMESTER - III

COURSE 7: GENETIC ENGINEERING

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Problem solving related to restriction enzymes sites in Genetic engineering.
2. Transformation in Bacteria using plasmid
3. Restriction digestion of DNA and its electrophoretic separation.
4. Ligation of DNA molecules and their testing using electrophoresis.
5. Activity of DNAase and RNAse on DNA and RNA.
6. Isolation of Plasmid DNA
7. Demonstration of PCR

SEMESTER - IV

COURSE 8: BIOINFORMATICS, BIOSTATISTICS & BIOETHICS

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce the scope of bioinformatics and its role in biological research.
2. To provide knowledge of genomics, proteomics, and systems biology concepts.
3. To familiarize students with databases, BLAST, drug design, and phylogenetic tools.
4. To train students in statistical methods for data collection, analysis, and interpretation.
5. To create awareness about bioethics, biosafety, and intellectual property rights in biotechnology.

Learning Outcomes:

After successful completion of this course, students will be able to:

1. Explain the fundamentals of bioinformatics and its applications.
2. Use biological databases, BLAST, and computational methods in biotechnology research.
3. Apply statistical tools like central tendency, probability, and hypothesis testing.
4. Perform tests such as t-test, ANOVA, chi-square, correlation, and regression for biological data.
5. Demonstrate understanding of bioethical issues, biosafety practices, and intellectual property rights.

Syllabus

Unit – I

Scope of computers in biological research. Introduction to Bioinformatics: definition, nature and scope of bioinformatics. Bioinformatics versus computational biology. Concept of genomics and proteomics. Branches of Bioinformatics.

Unit – II

Basic concepts of systems biology. Types of databases and their applications in biotechnology. Sequence similarity search using BLAST. Overview of computer-aided drug design. Computational phylogenetics (PHYlip) and its applications.

Unit – III

Data collection and measurement of central tendency (mean, median and mode). Dispersion (standard error and standard deviation). Probability and distribution (Poisson and binomial distributions. Normal distribution).

Unit – IV

Population and sampling, test of significance, and test of hypothesis. Student t-test for small samples. ANOVA and chi-square test for analysis. Correlation and regression.

Unit – V

Bioethics in human and animal experimentation, cloning and stem cell research. Animal rights and welfare. Biosafety -Introduction to biological safety cabinets and biosafety levels. Primary containment for biohazards and strategies for their management (GLP, GMP). Intellectual Property Rights (IPRs).

Reference Books

1. Mount, D.W. (2004). *Bioinformatics: Sequence and Genome Analysis*. 2nd Edition, Cold Spring Harbor Laboratory Press.
2. Lesk, A.M. (2017). *Introduction to Bioinformatics*. 5th Edition, Oxford University Press.
3. Rastogi, S.C., Mendiratta, N. & Rastogi, P. (2019). *Bioinformatics: Methods and Applications*. 5th Edition, PHI Learning Pvt. Ltd.
4. Gupta, S.P. (2012). *Statistical Methods*. 43rd Edition, Sultan Chand & Sons.
5. Bailey, N.T.J. (1995). *Statistical Methods in Biology*. 3rd Edition, Cambridge University Press.
6. Beauchamp, T.L. & Walters, L. (2008). *Contemporary Issues in Bioethics*. 7th Edition, Cengage Learning.
7. Singh, B.D. (2012). *Biotechnology: Expanding Horizons*. Kalyani Publishers.

SEMESTER - IV

COURSE 8: BIOINFORMATICS, BIOSTATISTICS & BIOETHICS

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Mean, Median, Mode
2. Standard deviation, Standard error
3. Testing of hypotheses regarding population mean
4. Testing of hypotheses about the difference between population means
5. Chi-square test
6. Testing of Correlation Coefficient
7. Fitting of simple linear regression
8. ANOVA
9. Sequence retrieval (protein and gene) from NCBI
10. Similarity search using BLASTN, BLASTP
11. Structure download (protein and DNA) from PDB

SEMESTER - IV

COURSE 9: BASICS OF PLANT BIOTECHNOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To understand the principles of plant tissue culture and its applications.
2. To study specialized tissue culture techniques such as micropropagation, haploid culture, and protoplast fusion.
3. To learn different methods of genetic transformation in plants.
4. To explore the development and applications of transgenic plants.
5. To examine the use of plant biotechnology in production of valuable compounds, biofuels, and in sustainable agriculture, along with ethical and biosafety considerations.

Learning Outcomes:

After completing this course, students will be able to:

1. Explain the basic principles of plant tissue culture and its significance.
2. Apply micropropagation, haploid culture, and protoplast fusion techniques in plant improvement.
3. Differentiate between direct and indirect methods of plant genetic transformation.
4. Analyze the role of transgenic plants in agriculture, health, and environment.
5. Discuss applications of plant biotechnology in molecular farming, biofuels, biocontrol, and biofertilizers, and evaluate related ethical and biosafety issues.

Syllabus

Unit I
Plant Tissue Culture: Principles of plant tissue culture. Totipotency, differentiation, dedifferentiation, redifferentiation. Sterilization techniques, Types of culture media and composition of MS medium. Callus culture, organogenesis, somatic embryogenesis

Unit II
Specialized Plant Tissue Culture Techniques: Micropropagation and its applications. Haploid culture – anther and pollen culture, doubled haploids and their applications. Protoplast culture and fusion – somatic hybridization, cybrids. Cryopreservation and germplasm conservation

Unit III
Plant Genetic Transformation Methods: Direct gene transfer methods – particle bombardment, electroporation, microinjection. Indirect Gene Transfer Method - Agrobacterium tumefaciens and Ti plasmid, Ri plasmid. Agrobacterium-mediated gene transfer

Unit IV

Transgenic Plants and Applications: Transgenic plants for insect resistance (Bt crops). Transgenic plants for herbicide tolerance. Transgenic plants for disease resistance and stress tolerance. GMO Foods, Ecological impact of transgenic plants

Unit V

Applications of Plant Biotechnology: Therapeutic proteins, Edible vaccines, biofortification, and molecular farming. Phytochemical products from plants- Secondary Metabolites (Alkaloids, Flavonoids, Terpenoids). Bioethanol and biodiesel production. Biocontrol and Biofertilizers. Ethical issues and biosafety regulations in Plant biotechnology

Reference books:

1. Bhojwani, S.S. & Razdan, M.K. (1996). *Plant Tissue Culture: Theory and Practice*. Elsevier.
2. Gamborg, O.L. & Phillips, G.C. (1995). *Plant Cell, Tissue and Organ Culture: Fundamental Methods*. Springer.
3. Chawla, H.S. (2009). *Introduction to Plant Biotechnology*. 3rd Edition, Oxford & IBH Publishing.
4. Slater, A., Scott, N. & Fowler, M. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants*. 2nd Edition, Oxford University Press.
5. Singh, B.D. (2015). *Biotechnology: Expanding Horizons*. Kalyani Publishers.
6. Glick, B.R., Pasternak, J.J. & Patten, C.L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 4th Edition, ASM Press.
7. Razdan, M.K. (2003). *Introduction to Plant Tissue Culture*. Science Publishers.

SEMESTER - IV

COURSE 9: BASICS OF PLANT BIOTECHNOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Plant culturemedia and composition of MS media
2. Raising of aseptic seedlings
3. Induction of callus from different explants
4. Plant propagation through Tissue culture (shoot tip and Nodal culture)
5. Establishing a plant cell culture (both in solid and liquid media)
6. Suspension cell culture

SEMESTER - IV

COURSE 10: BASICS OF ANIMAL BIOTECHNOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To provide knowledge about the scope, importance, and laboratory requirements for animal cell culture.
2. To introduce students to various animal cell culture techniques and their applications.
3. To understand the role of stem cells and tissue engineering in regenerative medicine and organ culture.
4. To study transgenic animal production methods, cloning, and reproductive biotechnologies.
5. To explore applications of animal biotechnology in molecular farming, pharmaceuticals, and disease models, while addressing ethical and biosafety issues.

Learning Outcomes:

After completing this course, students will be able to:

1. Explain the principles of animal cell culture, media composition, and growth requirements.
2. Perform and differentiate between primary, secondary, continuous, and suspension cell cultures, including preservation and contamination control.
3. Analyze the applications of stem cells, scaffolds, and bioreactors in tissue engineering.
4. Describe the production of transgenic animals, animal cloning techniques, and reproductive biotechnology methods.
5. Evaluate the applications of animal biotechnology in health, pharmaceuticals, livestock improvement, and discuss related ethical and biosafety concerns.

Syllabus

Unit I
Animal Cell Culture: Scope and importance of animal biotechnology. Laboratory organization, and Equipment required. Composition and Types of Animal Cell Culture Media (BSS, RPMI-1640). Role of carbon dioxide, serum, and growth factors in cell culture. Application of antibiotics and growth supplements

Unit II
Cell Culture Techniques: Primary culture, secondary culture, continuous cell lines, and suspension cultures. Sub-culturing, cytotoxicity and cell viability assays. Contamination in cell culture and control measures, cryopreservation methods

Unit III

Stem Cells and Tissue Engineering: Embryonic and adult stem cell culture and its application. Biocompatible Materials and their applications for Scaffolds preparation used in Organ culture and 3D culture models. Bioreactors for large-scale animal cell culture

Unit IV

Transgenic Technology: Transgenic animal production methods – microinjection, viral vectors. Animal cloning techniques – nuclear transfer, case studies (e.g., Dolly). Invitro fertilization in livestock. Gene targeting, gene silencing, and knock-out techniques

Unit V

Applications of Animal Biotechnology: Molecular Farming: Hormone production in livestock, Production of vaccines and pharmaceutical compounds. Role of animal models in disease diagnosis and treatment. Ethical, regulatory and biosafety issues in animal biotechnology

Reference books:

1. Freshney, R.I. (2015). *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*. 7th Edition, Wiley-Blackwell.
2. Masters, J.R.W. (2000). *Animal Cell Culture: Practical Approach*. 3rd Edition, Oxford University Press.
3. Butler, M. (2004). *Animal Cell Culture and Technology*. 2nd Edition, Taylor & Francis.
4. Davis, J.M. (2011). *Animal Cell Culture: Essential Methods*. Wiley-Blackwell.
5. Glick, B.R., Pasternak, J.J. & Patten, C.L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 4th Edition, ASM Press.
6. Singh, B.D. (2015). *Biotechnology: Expanding Horizons*. Kalyani Publishers.
7. Portner, R. (2007). *Animal Cell Biotechnology: Methods and Protocols*. Humana Press.

SEMESTER - IV

COURSE 10: BASICS OF ANIMAL BIOTECHNOLOGY

Practical **Credits: 3** **3 hrs/week**

Practical Component:

1. Cell count by haemocytometer.
2. Establishing primary cell culture of chicken embryo fibroblasts.
3. Animal tissue culture– maintenance of established cell lines.
4. Animal tissue culture– virus cultivation.
5. Estimation of cell viability by dye exclusion (Trypan blue).

SEMESTER - V

COURSE 11: INDUSTRIAL BIOTECHNOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To provide fundamental knowledge of microorganisms and their improvement for industrial use.
2. To introduce principles of bioreactor design and fermentation methods.
3. To study industrial production processes for ethanol, citric acid, and alcoholic beverages.
4. To understand large-scale production of enzymes, SCP, and antibiotics.
5. To explore the biotechnological production of amino acids, vitamins, hormones, and recombinant vaccines.

Learning Outcomes:

After completing this course, students will be able to:

1. Explain isolation, screening, and preservation techniques for industrially important microorganisms.
2. Demonstrate understanding of bioreactor types, principles, and fermentation strategies.
3. Analyze industrial processes for ethanol, citric acid, and alcoholic beverage production.
4. Describe the large-scale production of enzymes, SCP, and antibiotics.
5. Evaluate the role of biotechnology in producing amino acids, vitamins, hormones, and vaccines with industrial applications.

Syllabus

Unit I
Isolation, Screening of Industrially Important Microorganisms and its Preservation. Strategies for Strain Improvement. Synthetic and Natural Medium, Precursors, Antifoams. Sterilization Methods and Inoculum Preparation.

Unit II
Definition of bioreactor, basic principles of bioreactor. Types of bioreactors and types of fermentation methods - batch, continuous, fed-batch and semi-continuous bioreactors.

Unit III
Ethanol Production by Fermentation using Molasses, Starchy Substances. Production of Alcoholic Beverages like Beer and Wine. Production of Citric Acid by Submerged and Solid-State Fermentations.

Unit IV
Production of Industrially Important Enzymes viz., Amylases and Proteases. Backer's Yeast and SCP Production. Production of Antibiotics: Penicillin, Streptomycin

Unit V
Industrial production of Essential Amino Acids (Glutamic Acid); Vitamins (B12), Hormones (Insulin, Human Growth Hormone) Recombinant Vaccines.

Reference books:

1. Crueger, W. & Crueger, A. (2000). *Biotechnology: A Textbook of Industrial Microbiology*. 2nd Edition, Panima Publishing.
2. Stanbury, P.F., Whitaker, A. & Hall, S.J. (2016). *Principles of Fermentation Technology*. 3rd Edition, Elsevier.
3. Casida, L.E. (2019). *Industrial Microbiology*. Reprint Edition, Scientific International.
4. Patel, A.H. (2012). *Industrial Microbiology*. 2nd Edition, Macmillan.
5. Singh, B.D. (2015). *Biotechnology: Expanding Horizons*. Kalyani Publishers.
6. Waites, M.J., Morgan, N.L., Rockey, J.S. & Higton, G. (2001). *Industrial Microbiology: An Introduction*. Wiley-Blackwell.
7. Glazer, A.N. & Nikaido, H. (2007). *Microbial Biotechnology: Fundamentals of Applied Microbiology*. 2nd Edition, Cambridge University Press.

SEMESTER - V

COURSE 11: INDUSTRIAL BIOTECHNOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Isolation of industrially important microorganisms from soil.
2. Isolation of amylase producing organisms from soil.
3. Production of α– amylase from *Bacillus Spp*. By shake flask culture.
4. Production of alcohol or wine using different substrates.
5. Estimation of alcohol by titrimetry.
6. Estimation of alcohol by colorimetric method.
7. Production of citric acid.
8. Citric acid production by submerged fermentation.
9. Estimation of citric acid by titrimetry.

SEMESTER - V

COURSE 12 A: MEDICAL BIOTECHNOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To provide knowledge of genetic, microbial, and neurological diseases with molecular mechanisms of pathogenesis.
2. To understand principles of infectious disease transmission, epidemiology, and prevention.
3. To introduce therapeutic approaches for fungal, viral, protozoan, and sexually transmitted diseases.
4. To explain the concepts and strategies of gene therapy, stem cell therapy, and vector systems.
5. To familiarize students with drug discovery, clinical trial design, and molecular disease diagnostics.

Learning Outcomes:

After completing this course, students will be able to:

1. Explain the genetic and microbial basis of diseases and the role of biotechnology in healthcare.
2. Describe the mechanisms of infectious disease transmission and apply epidemiological concepts in disease control.
3. Discuss fungal, viral, protozoan, and sexually transmitted diseases and their therapeutic interventions.
4. Demonstrate understanding of gene therapy, stem cell therapy, and vectors used in therapeutic applications.
5. Evaluate novel drug development processes, clinical trial phases, and molecular diagnostic strategies for disease detection.

Syllabus

UNIT-I

Scope of Biotechnology in Health. Genetic Diseases: Chromosomal aberrations (numerical and structural), Autoimmune and X-linked disorders. Neurological disorders-Parkinson's diseases, Alzheimer's disease. Disease caused by microbial sources. Mechanism and molecular basis of pathogenicity and diseases. Antimicrobial compounds and their mode of action

Unit-II

Characteristics of infectious diseases, herd immunity. Disease cycle (source of disease, reservoir, carries), transmission of pathogens (airborne, contact transmission, and vector transmission). Bacterial diseases – epidemiology, pathogenicity, laboratory, diagnosis, prevention and control of the following diseases – tuberculosis, typhoid.

Unit-III
General account of fungal diseases: mycosis (one from subcutaneous and one from deep). General account of viral and protozoan diseases- SARS, AIDS, malaria and their therapeutics. Brief account of sexually transmitted diseases.

Unit-IV
Gene therapy– *Ex-vivo,In-vivo, In-situ* gene therapy. Strategies of gene and Stem cell therapy. Vectors used in gene therapy, biological vectors–retrovirus, adenovirus, herpes. Synthetic vectors- liposomes, receptor medicate gene transfer

Unit-V
Introduction to drug discovery. Novel Drug Development and its toxicology studies. Clinical Trials: Types of clinical trials Phase-I, Phase-II and Phase-III. Disease Diagnosis: DNA/RNA based diagnosis and strategies.

Reference books:

1. Glick, B.R. & Pasternak, J.J. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 4th Edition, ASM Press.
2. Primrose, S.B. & Twyman, R. (2006). *Principles of Gene Manipulation and Genomics*. 7th Edition, Blackwell Publishing.
3. Bernard R. Glick, Cheryl L. Patten, Terry L. Delovitch & Cheryl L. Patten (2014). *Medical Biotechnology*. ASM Press.
4. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. & Losick, R. (2013). *Molecular Biology of the Gene*. 7th Edition, Pearson.
5. Rang, H.P., Dale, M.M., Ritter, J.M. & Flower, R.J. (2012). *Rang and Dale's Pharmacology*. 7th Edition, Churchill Livingstone.
6. Lippincott Williams & Wilkins (2013). *Medical Microbiology*. 27th Edition, McGraw Hill.
7. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. & Walter, P. (2015). *Molecular Biology of the Cell*. 6th Edition, Garland Science.

SEMESTER - V

COURSE 12 A: MEDICAL BIOTECHNOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Laboratory Safety Regulations
2. Culture media & isolation of pure culture
3. Smear Preparation & Simple stain
4. Gram stain
5. Culture of bacteria and its cultural characteristics
6. C Reactive protein test
7. Widal test
8. Serological diagnosis of tuberculosis
9. Serological diagnosis of HIV

SEMESTER - V

COURSE 12 B: MARINE BIOTECHNOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. A comprehensive understanding of marine ecosystems and their unique biodiversity.
2. Knowledge of marine microbes, bioactive compounds, and their industrial and pharmaceutical applications.
3. Skills in aquaculture techniques, including pathogen identification and use of probiotics.
4. Insights into genetic manipulation, transgenics, and cryopreservation in aquaculture.
5. Awareness of marine environmental issues such as biofouling, ballast water management, red tides, and oil spill bioremediation.

Learning Outcomes:

On completion of this course, students will be able to:

1. Explain the diversity and functional aspects of marine ecosystems and microbes.
2. Analyze the applications of bioactive compounds, marine enzymes, and pharmaceuticals in biotechnology and healthcare.
3. Demonstrate knowledge of aquaculture practices, live feed culture, and disease management strategies.
4. Apply concepts of genetic manipulation and transgenesis in fish breeding and aquaculture improvement.
5. Evaluate and propose biotechnological strategies to address marine environmental challenges such as biofouling, red tides, and oil spills.

Syllabus

UNIT I

The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal & deep sea ecosystems. Hydrothermal vents- biodiversity of organisms. Marine microbes - unculturable bacteria, occurrence, characteristics and exploitation, Barophilic organisms and their potential gene application for Marine Biotechnology Industry.

UNIT II

Bioactive compounds from marine organisms, GFP, RFP characteristics and their applications, Green mussel adhesive protein, Marine hydrocolloids- Agar, Agarose, Chitosan, Chitin, Alginate, Carrageen and its applications, Marine enzymes and their applications in food processing, Marine Pharmaceuticals – Zinconotide, Dolostain, Bryostain.

UNIT III

Aquaculture - Culturing of shrimp, edible mollusks, oysters, pearl oysters, sea cucumbers. Culture of live feed organisms - brine shrimp, rotifers, marine algae. Techniques for identification of bacterial & viral pathogens in aquaculture, Probiotic bacteria and their importance in aquaculture.

UNIT IV

Chromosome manipulation in aquaculture – hybridization; Ploidy induction; Gynogenesis, Androgenesis and sex reversal in commercially important fishes; Cryopreservation of fish gametes and embryo; Transgenic fishes - Antifreeze and metallothionine gene.

UNIT V

Biofouling, biofilms, corrosion and antifouling treatment. Ballast water: consequences & management. Red tides: causative organisms and control. Control of oil spills and bioremediation.

Reference books:

1. Kim, Se-Kwon. *Handbook of Marine Biotechnology*. Springer, 2015.
2. Fingerman, Milton, and Rachakonda Nagabhushanam. *Marine Biotechnology*. CRC Press, 2003.
3. Dhar, Arup K., and Sudha S. Reddy. *Advances in Marine and Brackishwater Aquaculture*. Springer, 2015.
4. Imhoff, Johannes F. *Marine Biotechnology I: Marine Microorganisms*. Springer, 2005.
5. Proksch, Peter, and Wolfgang E.G. Müller. *Frontiers in Marine Biotechnology*. Horizon Bioscience, 2006.
6. Kim, Se-Kwon. *Marine Enzymes for Biocatalysis: Sources, Biocatalytic Characteristics and Bioprocesses of Marine Enzymes*. Woodhead Publishing, 2013.
7. Payne, Chris, and Andrew J. Wheeler. *Marine Biotechnology: Environmental and Aquaculture Applications*. Springer, 2020.

SEMESTER - V

COURSE 12 B: MARINE BIOTECHNOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Isolation and Culturing of Marine Microorganisms
2. Mass Cultivation of Microalgae and Biomass Estimation
3. Monitoring Water Quality Parameters in Aquaculture Systems
4. Extraction and Characterization of Bioactive Compounds from Marine Organisms
5. Mass Cultivation of Microalgae and Biomass Estimation
6. Mass Cultivation of Microalgae and Biomass Estimation

SEMESTER - V

COURSE 13 A: NANOBIOTECHNOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

- To introduce the fundamentals and scope of nanobiotechnology and its interdisciplinary applications.
- To provide an understanding of nanoparticle synthesis, characterization techniques, and delivery systems.
- To explore the applications of nanobiotechnology in medicine, agriculture, food, and environment.
- To develop knowledge of the safety, toxicity, and ethical concerns related to nanomaterials.
- To prepare students for advanced studies and research in nanoscience, nanomedicine, and nanobiotech industries.

Learning Outcomes:

By the end of this course, students will be able to:

1. Define the fundamentals and scope of nanobiotechnology, and explain nanoscale dimensions and properties of nanomaterials.
2. Differentiate between various physical, chemical, and biological methods of nanoparticle synthesis.
3. Describe delivery methods of nanoparticles and their relevance in biomedicine.
4. Demonstrate understanding of nanomaterial characterization techniques (TEM, SEM, AFM, XRD, spectroscopy).
5. Evaluate the applications of nanobiotechnology in medicine, agriculture, food safety, and environmental protection.

Syllabus

Unit I – Fundamentals of Nanobiotechnology
Definition, scope, and historical milestones of nanobiology and nanotechnology. Nanoscale and significance: comparison of macro, micro, and nano dimensions. Nanostructures in biological systems – proteins, DNA, biomimetic nanostructures. Properties of nanomaterials – physical, chemical, optical, mechanical, and quantum effects.

Unit II –Nanoparticle Synthesis and Delivery Methods
Bio-nanoparticles – nano starch, nanocomposites, dendrimers, biodegradable polymers. Methods of Nanoparticle Synthesis – Physical Methods (top-down and bottom-up; sol-gel), Chemical Method (chemical vapor deposition) and Biological methods (Green synthesis). Delivery of Nanoparticles: Lipid-based nanoparticles – liposomes, cubosomes, hexosomes, liquid nano-dispersions

Unit III – Characterization of Nanomaterials
Microscopy Based (TEM, SEM, AFM, SPM); Spectroscopy Based (UV-Vis, FTIR, Raman spectroscopy); X-ray Based (XRD) methods for characterization ofnanomaterials and nanostructures

Unit IV – Applications of Nanobiotechnology
Medicine – targeted drug delivery, cancer therapy, diagnostic tools, medical imaging, recombinant vaccines. Bio-nanoelectronics – nanosensors, nanotransistors, quantum dots, DNA sequencing, protein analysis. Agriculture & environment – Nanofertilizers (Nano Zinc and Nano Urea), Nanotechnology in crop protection. Food safety, water purification, environmental biosensors

Unit V – Nanobiotechnology Safety and Ethical Aspects
Safety concerns – toxicity of nanomaterials, environmental and health impacts. Regulatory frameworks – guidelines and policies for safe use and disposal of nanomaterials. Future prospects in nanotechnology and nanobiotechnology

Reference books:

1. Goodsell, D. S. (2004). *Bionanotechnology: Lessons from Nature*. Wiley-Liss.
2. Sahoo, S. K. & Labhasetwar, V. (2003). *Nanotech Approaches to Drug Delivery and Imaging*. CRC Press.
3. Elliott, B. & Chen, H. (2012). *Introduction to Nanoscience and Nanotechnology*. World Scientific.
4. Chaudhery Mustansar Hussain (2018). *Handbook of Nanomaterials for Industrial Applications*. Elsevier.
5. Cao, G. & Wang, Y. (2011). *Nanostructures and Nanomaterials: Synthesis, Properties, and Applications*. Springer.
6. Hari Singh Nalwa (2005). *Encyclopedia of Nanoscience and Nanotechnology*. American Scientific Publishers.
7. Rizzello, L. & Pompa, P. P. (2014). "Nanosilver-based antibacterial drugs and devices: Mechanisms, methodological drawbacks, and guidelines." *Chemical Society Reviews*.

SEMESTER - V

COURSE 13 A: NANOBIOTECHNOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Antimicrobial Activity of Nanoparticles
2. Demonstration of Synthesis of Metal Nanoparticles using Biological Methods (e.g., Plant Extracts)
3. Demonstration using available videos on Characterization of Nanoparticles using UV-Vis Spectrophotometry
4. Demonstration of Cytotoxicity Testing of Nanoparticles (MTT Assay)
5. Demonstration of Applications of Nanomaterials in Biosensors (Demo/Design)

SEMESTER - V

COURSE 13 B: BIOFERTILIZERS AND BIOPESTICIDES PRODUCTION

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce the concept, scope, and significance of biofertilizers and biopesticides in agriculture.
2. To study the types of microorganisms used in biofertilizers and their role in nutrient cycling.
3. To understand mycorrhizal associations and their importance in phosphorus solubilization.
4. To learn about different classes of biopesticides and their mechanisms of action.
5. To provide knowledge of laboratory techniques, mass production, formulation, and field application methods.

Learning Outcomes:

After completing the course, students will be able to:

1. Explain the history, classification, and scope of biofertilizers and biopesticides.
2. Differentiate between bacterial, fungal, algal biofertilizers and describe their agricultural benefits.
3. Describe the role of mycorrhizae in nutrient uptake and crop improvement.
4. Evaluate the application of biopesticides in plant disease and pest management.
5. Demonstrate skills in isolation, mass production, and application of microbial inoculants.

Syllabus

UNIT -1- Bio fertilizers
Introduction, history, concept, scope of bio fertilizers in India. Classification, microorganisms used as bio fertilizers. Bacterial, fungal and algal bio fertilizers. Symbiotic and asymbiotic microorganisms. Mechanism of nodulation and nitrogen fixation.

UNIT – 2- Mycorrhizal bio fertilizers
Importance, types, characteristic features of ecto and endo mycorrhiza. Mechanism of phosphorus solubilization. Uptake of phosphates by the roots. Consortium based inoculums and significance.

UNIT-3 - Bio pesticides
Definition, concept, history, scope and importance of bio pesticides. Classification - botanicals, bacterial, fungal and viral based bio pesticides. Mechanism of action of *Bacillus thuringiensis* and *Trichoderma viridae* as bio control agents.

UNIT -4 - Mass production techniques
Media, types, preparation. Methods of isolation, streak plate, spread plate and pour plate techniques, purification and identification of microorganisms used as bio fertilizers and bio pesticides. Mass production and packing techniques.

UNIT- 5 - Field application methods
Preparation of carrier-based inoculum. Sphagnum, peat, vermiculite as inoculums carriers. Dosage standardization. Seed treatment, foliar application, root dressing and soil application techniques. Storage and maintenance of inoculum.

Reference books:

1. **Subba Rao, N. S.** (2000). *Soil Microorganisms and Plant Growth*. Oxford & IBH Publishing.
2. **Vessey, J. K.** (2003). "Plant growth promoting rhizobacteria as biofertilizers." *Plant and Soil*, 255: 571–586.
3. **Kannaiyan, S.** (2002). *Biofertilizers for Sustainable Crop Production*. Scientific Publishers.
4. **Reddy, S. R.** (2014). *Principles of Agronomy*. Kalyani Publishers.
5. **Kerry, B. R. & Hominick, W. M.** (2002). *Biological Control of Plant Pests and Diseases*. CABI Publishing.
6. **Choudhary, D. K., Varma, A. & Tuteja, N.** (2016). *Plant-Microbe Interaction: An Approach to Sustainable Agriculture*. Springer.
7. **Dubey, R. C.** (2014). *A Textbook of Biotechnology*. S. Chand Publishing.
8. **Glick, B. R.** (2012). *Plant Growth-Promoting Bacteria: Mechanisms and Applications*. Horizon Scientific Press.

SEMESTER - V

COURSE 13 B: BIOFERTILIZERS AND BIOPESTICIDES PRODUCTION

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Preparation of Nutrient agar, YEMA, and PDA media
2. Isolation of *Rhizobium* from root nodules
3. Isolation of *Azatobacter* from soil samples
4. Isolation of *Trichoderma*
5. Gram staining of bacteria
6. VAM root staining
7. Raising of legume seedlings with *Rhizobium* treatment
8. Visit to commercial biocontrol units and Krishi seva Kendra

SEMESTER - VI

COURSE 14 A: PHARMACEUTICAL BIOTECHNOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce the scope, history, and principles of pharmaceutical biotechnology and pharmacology.
2. To provide knowledge on natural products, phytopharmaceuticals, and their role in drug discovery.
3. To study antibiotics, antimicrobial agents, and pharmacological assays.
4. To understand the process of drug discovery, development, and regulatory guidelines.
5. To explore modern applications such as vaccines, recombinant proteins, nanodrugs, tissue engineering, and nutraceuticals.

Learning Outcomes:

After completing this course, students will be able to:

1. Explain the principles of pharmacokinetics, pharmacodynamics, and drug administration routes.
2. Analyze phytopharmaceuticals and apply techniques like TLC, HPTLC, HPLC, NMR, and MS in drug screening.
3. Describe antibiotics, antimicrobial resistance, and evaluate pharmacological assays (in vitro & in vivo).
4. Demonstrate knowledge of the drug discovery pipeline, preclinical/clinical trials, and regulatory frameworks.
5. Assess modern trends including recombinant proteins, nanodrugs, vaccines, tissue engineering, and nutraceuticals.

Syllabus

Unit I – Introduction to Pharmaceutical Biotechnology
Definition, scope, and history of pharmaceutical biotechnology. Sources of drugs, classification of pharmacological agents (chemistry, mode of action, dosage forms). Routes of drug administration, absorption, distribution, bioavailability, metabolism, and excretion. Principles of pharmacology – pharmacokinetics and pharmacodynamics.

Unit II – Natural Products and Phytopharmaceuticals
General classes and properties of phytopharmaceuticals. Extraction and phytochemical screening of medicinal plants. Bioassay-guided fractionation (TLC, HPTLC, GC, HPLC). Role of advanced tools (NMR, Mass spectrometry) in drug discovery.

Unit III – Antimicrobial Agents and Pharmacological Assays
Antibiotics – sources, classification, and mode of action. Antimicrobial resistance; antimicrobial activity studies (antibacterial, antiviral, antifungal, antiparasitic). Chemotherapeutic drugs – protein synthesis inhibitors, anti-inflammatory, anticancer, anti-helminthic agents. Pharmacological assays – in vitro (chemical, biological, immunological), in vivo assays.

Unit IV – Drug Discovery and Development
Steps in drug discovery: target identification, assay development, lead optimization. Preclinical and clinical trials, regulatory approvals, Phase IV trials. High throughput screening, CCSEA and ICMR guidelines for drug testing. Measurement of drug action; case studies of approved drugs.

Unit V – Modern Trends and Applications
Vaccines – inactivated, attenuated, toxoid, recombinant, peptide, DNA, edible vaccines, nanodrugs. Recombinant proteins and approved rDNA drugs (insulin, HGH, erythropoietin, interferons, clotting factors). Synthetic therapy – synthetic DNA, ribozymes, synthetic drugs. Tissue engineering (skin, liver, pancreas), probiotics, nutraceuticals, economic and legal considerations.

Reference books:

1. Satinder Ahuja & Michael W. Dong – *Handbook of Pharmaceutical Analysis by HPLC* (Academic Press).
2. Gary Walsh – *Pharmaceutical Biotechnology: Concepts and Applications* (Wiley).
3. Crommelin, Sindelar & Meibohm – *Pharmaceutical Biotechnology* (Springer).
4. Patrick J. Sinko – *Martin's Physical Pharmacy and Pharmaceutical Sciences*.
5. Rang, Ritter, Flower & Henderson – *Rang and Dale's Pharmacology* (Elsevier).
6. Jay P. Reddy – *Textbook of Pharmaceutical Biotechnology*.
7. Leon Shargel – *Applied Biopharmaceutics & Pharmacokinetics*.

SEMESTER - VI

COURSE 14 A: PHARMACEUTICAL BIOTECHNOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Estimation of penicillin/streptomycin by biological assay.
2. Estimation of penicillin/streptomycin by chemical assay.
3. Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin
4. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
5. Determination of shelf life of antibiotics (Expired drugs)
6. Sterility testing of commercial pharmaceuticals.
7. Study of microbial spoilage of pharmaceuticals.
8. Sterility testing of injectable as per IP.
9. Effect of chemical disinfectant on growth of bacteria

SEMESTER - VI

COURSE 14 B: FOOD&NUTRITIONAL BIOTECHNOLOGY

Theory	**Credits: 3**	**3 hrs/week**

Course Objectives:

1. To provide an understanding of the principles of food preservation and the role of microorganisms in food spoilage.
2. To impart knowledge on methods of cooking, food packaging, food additives, and preservation techniques.
3. To study the importance, nutritional values, and preservation of animal and sea foods along with milk and milk products.
4. To understand the role of carbohydrates, proteins, fats, vitamins, and minerals in human nutrition and their related deficiency disorders.
5. To develop awareness of energy requirements, BMR, BMI, dietary allowances, and nutrition during special physiological conditions.

Learning Outcomes:

On successful completion of this course, students will be able to:

1. Explain the concepts of food preservation, shelf-life, and microbial association with foods.
2. Compare different cooking methods and analyze their effects on food quality and safety.
3. Describe preservation methods for animal, sea foods, and dairy products, along with their microbiology.
4. Assess the nutritional importance of macronutrients, vitamins, and minerals, and identify deficiency disorders.
5. Evaluate dietary needs, calorific values, and nutrition for special groups such as pregnant and lactating women, infants, and people with health disorders.

Syllabus

Unit I
Principles of food preservation. Microorganisms associated with foods. Infection, food intoxication, definition of self-life, perishable foods. Food preservation by freezing, refrigeration. Storage at high temperature: sterilization, pasteurization, blanching, drying, dehydration, evaporation and irradiation.

Unit II
Food packing, methods of cooking – dry, moist, frying and microwave cooking. Advantages, disadvantages and effects of various cooking methods of food. Canning, fermentations, pasteurization and adulteration. Food additives.

Unit III
Animal and sea foods – their importance, nutritional values, and preservation methods. Microbiology of milk, milk products – cheese, yoghurt, butter, ice–cream, milk powder and their preparation. Food preservation by salting, smoking, curing and crystallization.

Unit IV
Components of food: Carbohydrates, Fats, Proteins and their importance in daily diet. Deficiency disorders: Protein deficiency disorders, Calorie maintenance diet, Malnutrition, Kwashiorkor, Marasmus, Starvation. Vitamins: types of vitamins, sources of various vitamins. Essential vitamins and their biological role in metabolisms. Vitamin deficiency disorders.

Unit V
Basal Metabolic Rate (BMR) and its determination. Calorific values of foods, Atherosclerosis and obesity. Body Mass Index (BMI). Recommended dietary allowances, Food allergy and its importance in health, Controlling measures. Essential minerals: Ca, Mg, Fe, I, Co, Mo, Zn, Se & F. Their role and deficiency disorders. Nutrition for pregnant, lactating women and for infants.

Reference books:

1. Fellows, P.J. – *Food Processing Technology: Principles and Practice*. Woodhead Publishing.
2. Potter, N.N. & Hotchkiss, J.H**.** – *Food Science*. Springer.
3. Desrosier, N.W. & Desrosier, J.N. **–** *The Technology of Food Preservation*. CBS Publishers.
4. Frazier, W.C. & Westhoff, D.C. – *Food Microbiology*. McGraw Hill.
5. Jay, J.M. – *Modern Food Microbiology*. Springer.
6. Manay, S. & Shadaksharaswamy, M. – *Foods: Facts and Principles*. New Age International.
7. Srilakshmi, B. – *Food Science*. New Age International.
8. Srilakshmi, B. **–** *Dietetics*. New Age International.
9. Swaminathan, M. – *Handbook of Food and Nutrition*. BAPPCO.
10. Gopalan, C., Ramasastri, B.V. & Balasubramanian, S.C. – *Nutritive Value of Indian Foods*. NIN, ICMR.

SEMESTER - VI

COURSE 14 B: FOOD & NUTRITIONAL BIOTECHNOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Quantitative analysis of food for a) Moisture b) ash c) Iron d) Calcium
2. Isolation of Glycogen from sheep liver
3. Preparation of chloroplast from green leaves/carotenes from carrots.
4. Determination of pH of different foods using pH meter.
5. Study of food preservation methods
6. Nutritional labelling of food
7. Preparation of yoghurt
8. Isolation and identification food spoiling microorganisms.

SEMESTER - VI

COURSE 15 A: GENOMICS & PROTEOMICS

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce the fundamental concepts of genomics, genetic mapping, and physical mapping techniques.
2. To familiarize students with model organisms and whole genome sequencing strategies and projects.
3. To understand genome annotation methods such as ORF scanning, codon bias, exon-intron prediction, and transcriptome studies.
4. To impart knowledge on proteomic techniques including SDS-PAGE, 2D-PAGE, protein staining, and affinity purification.
5. To provide insights into modern mass spectrometry tools such as MALDI-TOF, ESI, and tandem MS/MS for protein identification and sequencing.

Learning Outcomes:

1. Students will gain an understanding of the principles and applications of genetic and physical mapping in genomics.
2. Students will be able to explain the importance of model organisms and evaluate different genome sequencing strategies.
3. Students will learn to analyze gene structures, expression profiles, and transcriptome data using various molecular techniques.
4. Students will acquire skills in proteomic separation, detection, quantitation, and purification of proteins.
5. Students will understand mass spectrometry-based approaches for proteomics and apply them for protein identification and functional studies.

Syllabus

Unit-I
Introduction of Genomics, Studying the Genome, DNA databases. Genetic Mapping-Markers for Genetic Mapping; RFLP, SSLP -VNTR's, STR's, SNP's; Physical Mapping- In situ hybridization, Sequence Tagged Sites Mapping.

UNITII
Introduction to Model Organisms for Genomics (Arabidopsis, Zebra fish, and Human). Whole Genome Sequencing Strategies: Clone by Clone Sequencing, contig and shotgun method. Whole Genome Sequencing Projects: Human Genome Project (HGP) and its applications.

UNITIII
ORF scanning– Codon bias, Exon-Intron boundaries -Exon trapping, CpG island. Copy number variation and Gene location– Southern Blot mediated. Studying a transcriptome– Northern blotting hybridization, Micro array analysis and SAGE.

UNITIV
Proteomics-1D–SDS-PAGE, 2D-PAGE. Detection and quantitation of proteins in gels. Protein staining techniques. Affinity purification of proteins.

UNITV
Basics of Mass Spectroscopy- MALDI-TOF. ESI and their applications in proteomics. Tandem MS / MS spectrometry, Denovo sequencing using mass spectrometric data.

Reference books:

1. T.A. Brown – *Genomes 4* (Garland Science, 2018).
2. Primrose & Twyman – *Principles of Genome Analysis and Genomics* (Wiley-Blackwell).
3. David Mount – *Bioinformatics: Sequence and Genome Analysis* (Cold Spring Harbor Laboratory Press).
4. Richard Twyman – *Principles of Proteomics* (Garland Science, 2014).
5. Andreas D. Baxevanis & B.F. Francis Ouellette – *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (Wiley-Interscience).
6. Arthur Lesk – *Introduction to Genomics* (Oxford University Press, 2nd/3rd edition).
7. Daniel C. Liebler – *Introduction to Proteomics: Tools for the New Biology* (Humana Press).
8. S. Baluja & P.K. Gupta – *Genomics and Proteomics: Principles, Techniques and Applications*.
9. M. Hanes & M. Griffiths – *Genomics and Proteomics for Beginners*.
10. Robert F. Weaver – *Molecular Biology* (McGraw Hill).

SEMESTER - VI

COURSE 15 A: GENOMICS & PROTEOMICS

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Genome Viewers, SNP Analysis
2. Microarray Analysis
3. Protein Structure Prediction
4. Proteome Analysis
5. Network & Pathway Analysis
6. Calculation of phi and psi angles in proteins.
7. Structure validation and Protein Data Bank
8. Structural and functional motifs in proteins

SEMESTER - VI

COURSE 15 B: ENVIRONMENTAL BIOTECHNOLOGY

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To provide knowledge on ecological principles, ecosystems, and microbial roles in biogeochemical cycles.
2. To understand various environmental pollutants, their detection, monitoring, and control measures.
3. To study the effects of biocides and explore eco-friendly alternatives for environmental safety.
4. To learn different waste management strategies including wastewater and solid waste treatment methods.
5. To introduce concepts of bioremediation and the application of genetically modified organisms in environmental management.

Learning Outcomes:

1. Students will be able to explain ecological principles and the significance of microbes in nutrient cycling.
2. Students will gain knowledge of major environmental pollutants and methods for monitoring and controlling pollution.
3. Students will understand the environmental impact of biocides and adopt sustainable alternatives for waste disposal.
4. Students will acquire practical knowledge of wastewater treatment and solid waste management techniques.
5. Students will develop insights into advanced concepts like bioremediation, biodegradation, and the role of GMOs in environmental sustainability.

Syllabus

Unit I
Principles of Ecology, Water and terrestrial ecosystems, Bio-geo chemical cycles - Carbon, Nitrogen cycles. Role of microbes in bio-geochemical cycles.

Unit II
Inorganic and Organic pollutants of air, land and water; maintenance of standards, Environmental monitoring. Detection, treatment and prevention of pollution. Biological indicators

Unit III
Biocides, Four stage alternatives, Refuse disposal - Treatment methods, effluent from pharmaceuticals, fertilizers, pulp and paper industry.

Unit IV

Waste water management - Aerobic and anaerobic treatment, primary, secondary and tertiary treatment of municipal wastes, Solid waste management.

Unit V

Bioremediation, Biodegradation of recalcitrant compounds and the role of genetically engineered microbes and genetically modified organisms in the environmental management.

Reference books:

1. **R.M. Atlas & R. Bartha** – *Microbial Ecology: Fundamentals and Applications*.
2. **G. Subramanian** – *Environmental Biotechnology*.
3. **Pradipta Kumar Mohapatra** – *Textbook of Environmental Biotechnology*.
4. **A.K. De** – *Environmental Chemistry*.
5. **Metcalf & Eddy** – *Wastewater Engineering: Treatment and Resource Recovery*.
6. **C.N. Sawyer, P.L. McCarty & G.F. Parkin** – *Chemistry for Environmental Engineering and Science*.
7. **V.S. Rana** – *Essentials of Ecology and Environmental Science*.
8. **S.N. Jogdand** – *Environmental Biotechnology*.
9. **G. Bitton** – *Wastewater Microbiology*.
10. **P. Chatterji** – *Environmental Biotechnology: Concepts and Applications*.

SEMESTER - VI

COURSE 15 B: ENVIRONMENTAL BIOTECHNOLOGY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Isolation of microorganisms from soil, water, and air.
2. Determination of microbial population in soil/water (standard plate count, MPN method).
3. Estimation of coliforms in water samples (MPN test).
4. Detection of fecal contamination in water (E. coli test).
5. Antibiotic sensitivity/resistance testing of environmental isolates.
6. Determination of pH, conductivity, turbidity, and TDS in water samples.
7. Estimation of Biological Oxygen Demand (BOD) in polluted vs. unpolluted water.
8. Estimation of Chemical Oxygen Demand (COD**)** in water samples.