West Bengal State University

DRAFT SYLLABUS FOR THREE-YEAR
HONOURS DEGREE COURSE IN

MOLECULAR BIOLOGY AND BIOTECHNOLOGY

UNDER CHOICE BASED

CREDIT SYSTEM (CBCS)

(With effect from the session 2019-2020)

Course Details of B. Sc. Honours in Molecular Biology and Biotechnology Under CBCS System

Core Course (6 credits each)

MBBACOR01T/P: **BIOCHEMISTRY**
MBBACOR02T/P: **CELL BIOLOGY**
MBBACOR03T/P: **HUMAN PHYSIOLOGY AND METABOLISM**
MBBACOR04T/P: **GENERAL MICROBIOLOGY**
MBBACOR05T/P: **GENETICS**
MBBACOR06T/P: **VIROLOGY**
MBBACOR07T/P: **BIOPHYSICAL PRINCIPLES**
MBBACOR08T/P: **MOLECULAR BIOLOGY**
MBBACOR09T/P: **IMMUNOLOGY**
MBBACOR10T/P: **COMPUTER APPLICATION AND BIOINFORMATICS**
MBBACOR11T/P: **BIOPROCESS TECHNOLOGY**
MBBACOR12T/P: **RECOMBINANT DNA TECHNOLOGY**
MBBACOR13T/P: **BIO-ANALYTICAL TOOLS**
MBBACOR14T/P: **GENOMICS & PROTEOMICS**

Discipline Specific Elective (6 credits each)

MBBADSE01T/P: **ANIMAL BIOTECHNOLOGY**
OR
MBBADSE02T/P: **MICROBIAL BIOTECHNOLOGY**

MBBADSE03T/P: **PLANT BIOTECHNOLOGY**
OR
MBBADSE04T/P: **MEDICAL MICROBIOLOGY**

MBBADSE05T/P: **I.P.R. ENTREPRENEURSHIP BIOETIHCS & BIOSAFETY**
OR
MBBADSE06T/P: **BIOSTATISTICS**

MBBADSE07T/P: **EVOLUTIONARY BIOLOGY**
OR
MBBADSE08T/P: **ENVIRONMENTAL BIOTECHNOLOGY**

Skill Enhancement Elective Courses (Any Two) (2 credits each)

MBBSSEC001: **FERMENTATION BIOLOGY AND BIOPROCESS TECHNIQUES**
MBBSSEC002: **BIOTECHNOLOGY IN SUSTAINABLE DEVELOPMENT**

Molecular Biology and Biotechnology (Hons.) Semester I

Course Code	Course Title	Credit	Marks	
			Internal Assessment	End Sem Examination
MBBACOR01T	BIOCHEMISTRY (Theory)	4	10	40
MBBACOR01P	BIOCHEMISTRY (Practical)	2	15	10
MBBACOR02T	CELL BIOLOGY (Theory)	4	10	40
MBBACOR02P	CELL BIOLOGY (Practical)	2	15	10
Total in semester I		**12**	**150**	

Besides this, a student has to complete **one Generic Elective course (6 credits/ 75 marks)** from the Departments other than **Molecular Biology and Biotechnology** and **one Ability enhancement Compulsory Course (2 credit/25 marks)**

- **Therefore, a student covers a total of 20 credits (12+6+2) in Semester I**

Molecular Biology and Biotechnology (Hons.) Semester II

Course Code	Course Title	Credit	Marks	
			Internal Assessment	End Sem Examination
MBBACOR03T	HUMAN PHYSIOLOGY AND METABOLISM (Theory)	4	10	40
MBBACOR03P	HUMAN PHYSIOLOGY AND METABOLISM (Practical)	2	15	10
MBBACOR04T	GENERAL MICROBIOLOGY (Theory)	4	10	40
MBBACOR04P	GENERAL MICROBIOLOGY (Practical)	2	15	10
Total in semester II		**12**	**150**	

Besides this, a student has to complete **one Generic Elective course (6 credits/75 marks)** from the Departments other than Molecular Biology and Biotechnology and **one Ability enhancement Compulsory Course (2 credit/25 marks)**

- **Therefore, a student covers a total of 20 credits (12+6+2) in Semester II**

Molecular Biology and Biotechnology (Hons.) Semester III

Course Code	Course Title	Credit	Marks	
			Internal Assessment	End Sem Examination
MBBACOR05T	GENETICS (Theory)	4	10	40
MBBACOR05P	GENETICS (Practical)	2	15	10
MBBACOR06T	VIROLOGY (Theory)	4	10	40
MBBACOR06P	VIROLOGY (Practical)	2	15	10
MBBACOR07T	BIOPHYSICAL PRINCIPLES (Theory)	4	10	40
MBBACOR07P	BIOPHYSICAL PRINCIPLES (Practical)	2	15	10
MBBSSEC001	FERMENTATION BIOLOGY AND BIOPROCESS TECHNIQUES	2	05	20
Total in semester III		**20**	**250**	

Besides this, a student has to complete **one Generic Elective course (6 credits/75 marks)** from the Departments other than **Molecular Biology and Biotechnology**.

- **Therefore, a student covers a total of 26 credits (20+6) in Semester III**

Molecular Biology and Biotechnology (Hons.) Semester IV

Course Code	Course Title	Credit	Marks	
			Internal Assessment	End Sem Examination
MBBACOR08T	MOLECULAR BIOLOGY (Theory)	4	10	40
MBBACOR08P	MOLECULAR BIOLOGY (Practical)	2	15	10
MBBACOR09T	IMMUNOLOGY (Theory)	4	10	40
MBBACOR09P	IMMUNOLOGY (Practical)	2	15	10
MBBACOR10T	COMPUTER APPLICATION AND BIOINFORMATICS (Theory)	4	10	40
MBBACOR10P	COMPUTER APPLICATION AND BIOINFORMATICS (Practical)	2	15	10
MCBSSEC002	BIOTECHNOLOGY IN SUSTAINABLE DEVELOPMENT	2	05	20
Total in semester IV		**20**	**250**	

Besides this, a student has to complete **one Generic Elective course (6 credits/75 marks)** from the Departments other than **Molecular Biology and Biotechnology**.

Therefore, a student covers a total of 26 credits (20+6) in Semester IV

Molecular Biology and Biotechnology (Hons.) Semester V

Course Code	Course Title	Credit	Marks	
			Internal Assessment	Examination
MBBACOR11T	BIOPROCESS TECHNOLOGY (Theory)	4	10	40
MBBACOR11P	BIOPROCESS TECHNOLOGY (Practical)	2	15	10
MBBACOR12T	RECOMBINANT DNA TECHNOLOGY (Theory)	4	10	40
MBBACOR12P	RECOMBINANT DNA TECHNOLOGY (Practical)	2	15	10
MBBADSE01T/ MBBADSE02T	ANIMAL BIOTECHNOLOGY OR MICROBIAL BIOTECHNOLOGY (Theory)	4	10	40
MBBADSE01P/ MBBADSE02P/	ANIMAL BIOTECHNOLOGY OR MICROBIAL BIOTECHNOLOGY (Practical)	2	15	10
MBBADSE03T/ MBBADSE04T	PLANT BIOTECHNOLOGY OR MEDICAL MICROBIOLOGY (Theory)	4	10	40
MBBADSE03P/ MBBADSE04P	PLANT BIOTECHNOLOGY OR MEDICAL MICROBIOLOGY (Practical)	2	15	10
Total in semester V		**24**	**300**	

Molecular Biology and Biotechnology (Hons.) Semester VI

Course Code	Course Title	Credit	Marks	
			Internal Assessment	Examination
MBBACOR13T	BIO-ANALYTICAL TOOLS (Theory)	4	10	40
MBBACOR13P	BIO-ANALYTICAL TOOLS (Practical)	2	15	10
MBBACOR14T	GENOMICS & PROTEOMICS (Theory)	4	10	40
MBBACOR14P	GENOMICS & PROTEOMICS (Practical)	2	15	10
MBBADSE05T/ MBBADSE06T/	I.P.R. ENTREPRENEURSHIP BIOETIHCS & BIOSAFETY OR BIOSTATISTICS (Theory)	4	10	40
MBBADSE05P/ MBBADSE06P/	I.P.R. ENTREPRENEURSHIP BIOETIHCS & BIOSAFETY OR BIOSTATISTICS (Practical)	2	15	10
MBBADSE07T/ MBBADSE08T	EVOLUTIONARY BIOLOGY OR ENVIRONMENTAL BIOTECHNOLOGY (Theory)	4	10	40
MBBADSE07P/ MBBADSE08P	EVOLUTIONARY BIOLOGY OR ENVIRONMENTAL BIOTECHNOLOGY (Practical)	2	15	10
Total in semester V		**24**	**300**	

TOTAL CREDIT = 140

TOTAL MARKS = 1750

B.Sc (HONOURS) MOLECULAR BIOLOGY AND BIOTECHNOLOGY

(CBCS STRUCTURE)

Core Course (6 credits each)

SEMESTER –I

MBBACOR01T: BIOCHEMISTRY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (5 hrs)

Stereochemistry: Plane of symmetry, centre and axis of symmetry; Concepts of chirality; optical isomerism; geometrical isomerism; DL, RS nomenclature; Projection formula (Fischer & Haworth); Isomers: Enantiomers, Diastereoisomers, Anomers and Epimers. Optical activity and Specific rotation.

UNIT II (10 hrs)

Amino Acids and Proteins: General structure and classification of Amino Acids. Essential and non-essential amino acids. Zwitterionic structure, Acid-Base properties, Biphasic Titration Curve and Isoelectric point. Reactions of carboxyl and amino groups, formation of Peptide bond. Structural organization of proteins (primary, secondary, tertiary & quaternary), Covalent and Non-covalent interactions that stabilize the three-dimensional structures of proteins. Fibrous and globular proteins. Native structure of Proteins. Domains and motifs. Denaturation.

UNIT III (10 hrs)

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo and Hetero polysaccharides, Polysaccharides: Storage polysaccharides (starch and glycogen). Structural Polysaccharides (cellulose and chitin). Mucopolysaccharides,Bacterial cell wall polysaccharides, Glycoproteins and their biological functions.

UNIT IV (7 hrs)

Lipids: Classification of lipids, Nomenclature and structure of Saturated and Unsaturated Fatty acids, delta and omega-system; Essential fatty acids. Saponification number, Iodine number, Acetyl number of fats. Structure and Biological importance of triglycerides, phospholipids,
sphingolipids, glycolipids, cerebrosides, gangliosides, prostaglandins and steroids (cholesterol).

UNIT V (8 hrs)

Nucleic acids: Structure of Nucleotides, Nucleotides as source of energy, component of coenzymes, second messengers. DNA structure – Watson-Crick model. A, B & Z forms of DNA, Supercoiled and relaxed DNA, quardruplex DNA, denaturation and renaturation of DNA, melting temperature (Tm), UV absorption and hyperchromic effect. Nucleosome structure and Genome organization. Structure of major types of RNA.

UNIT VI (20 hrs) Enzymes:

IUB classification, active site, cofactors, coenzymes and prosthetic groups, activation energy and transition state, catalytic efficiency, activity, specific activity and turnover no. enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Principles of Enzyme kinetics: Michaelis-Menten Equation, Significance of K_m and V_{max}, Determination of Km and V_{max}, Double reciprocal Plot, Effect of temperature, pH and Inhibitors (Reversible Inhibition: competitive, un-competitive and non-competitive and Irreversible Inhibition), Allosteric Enzymes and Feedback Inhibition, Isozymes and Abzymes.

MBBACOR01P: BIOCHEMISTRY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH on the activity of alkaline phosphatase or amylase enzyme. Determination of optimum pH.
3. To study the effect of temperature on the activity of alkaline phosphatase or amylase enzyme. Determination of optimum temperature.
4. Study of enzyme kinetics (alkaline phosphatase or amylase): Determination of Km and Vmax by Lineweaver Burk Plot. Calculation of specific activity.
5. Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
6. Estimation of blood glucose by glucose oxidase method.
7. Principles of Colorimetry**: (i)** Verification of Beer's law, Quantitative Estimation of protein by Biuret and LowryMethod. **(ii)** To study relation between absorbance and % transmission.
8. Determination of Rf value and a) Seperation of amino acids by paper chromatography b) Separation of lipids by TLC.
9. Qualitative tests for carbohydrates: reducing sugars, non- reducing sugars, lipids (cholesterol), amino acids and proteins. Identification of unknown biomolecule.
10. Estimation of RNA in an unknown sample.
11. Estimation of DNA in an unknown sample.
12. Titration of amino acid glycine and Formol titration.

SUGGESTED READING

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

MBBACOR02T: CELL BIOLOGY (THEORY)
(Total hours: 60, Credits: 4)

UNIT I (10 hrs)

Cell: Cells as basic functional unit of life. **I**ntroduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes: phospholipids, glycolipids, cholesterol, membrane proteins; organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II (15 hrs)

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure and function. Role of ER in protein segregation. Targeting proteins to rough ER and smooth ER. Export of proteins from ER.

Golgi complex: Organization, biogenesis and functions including role in protein glycosylation, protein sorting and protein secretion.

UNIT III (20 hrs)

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

UNIT IV (15 hrs)

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction: signaling via G-protein-linked cell surface receptors; signaling via Enzyme-linked cell surface.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

MBBACOR02P: CELL BIOLOGY PRACTICAL
(Total hours: 60, Credits: 2)

1. To study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Observation of any plant tissue and animal tissue (squamous epithelium) by microscopy.
5. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
6. Cell division in onion root tip/ insect gonads.
7. Preparation of Nuclear, Mitochondrial, lysosome & cytoplasmic fractions. to identify by marker enzyme

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

SEMESTER-II MBBACOR03T: HUMAN PHYSIOLOGY AND METABOLISM (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (15 hrs)

Digestion and Respiration: Digestion: Mechanism of digestion and absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice.

Respiration: Exchange of gases, Transport of O_2 and CO_2 , Oxygen dissociation curve, Chloride shift.

UNIT II (15 hrs)

Blood and circulation:- Composition of blood, Plasma proteins & their role, Blood corpuscles, haemopoiesis, plasma function, blood groups, haemoglobin, Mechanism of coagulation of blood. **Cardiovascular System:** Mechanism of working of heart:

Cardiac output, cardiac cycle, Origin & conduction of heart beat. ECG – its principle and significance.

UNIT III (10 hrs)

Nervous system: - Neurons, action potential, neurotransmitters.

Osmoregulation: Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV: (15 hrs)

Carbohydrate Metabolism: Catabolism and Anabolism, Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. TCA cycle. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis.

UNIT V (5 hrs)

Catabolism of fatty acids: Transport of fatty acids into Mitochondria, β-oxidation of saturated fatty acids (Reactions and Energetics), Ketogenesis.

MBBACOR03P: HUMAN PHYSIOLOGY AND METABOLISM (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Study of respiration in yeast.
2. Determination of heart rate of a human being from the ECG records.
3. Interpretation of ECG.
4. Determination of blood pressure.
5. Finding the coagulation time of blood.
6. Determination of blood groups.
7. Counting of human RBCs.
8. Determination of TLC and DLC.
9. Demonstration of action of an enzyme.
10. Determination of Haemoglobin.

MBBACOR04T: GENERAL MICROBIOLOGY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (10 hrs)

Fundamentals, History and Evolution of Microbiology

Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms e.g. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II (10 hrs)

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT III (20 hrs)

Bacterial growth and its dependence on environment: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria (temperature, oxygen, and pH). Endospores and sporulation in bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways. **Mechanisms of Genetic Exchange:** Mechanism of bacterial transformation, conjugation (Discovery, F factor, *Hfr* and $F^{/}$ strains) and transduction (Generalized transduction and specialized transduction).

UNIT IV (20 hrs)

Control of Microorganisms: By physical (high and low temperature, radiation, filtration) and chemical agents (phenol and phenolic compounds, alcohol) and Chemotherapeutic agents. **Water Microbiology:** Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food borne infections and intoxications, Preservation of various types of foods. Fermented Foods.

MBBACOR04P: GENERAL MICROBIOLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Isolation of bacteria [Streak plate, spread plate, pour plate, serial dilution] and their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media and sterilization methods.
4. Methods of Isolation of bacteria from different sources [air, soil and water].
5. Determination of bacterial cell size by micrometry.
6. Enumeration of microorganisms - total and viable count.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology* . 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.

4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

SEMESTER-III

MBBACOR05T: GENETICS (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (12 hrs)

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.

Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

UNIT II (18 hrs)

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA. Genetic organization of prokaryotic and viral genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT III (15 hrs)

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Gain of function and Loss of function mutation, Forward and Reverse mutation, Point mutation (Transitions, transversions, Missense mutation, Nonsense mutation, silent mutation, Frame shift mutation), Spontaneous mutation, Luria-Delbruck fluctuation test, Induced mutation, Mutagen – physical (Ionizing radiation, UV radiation), chemical (Base analogs, Nitrous acid, Acridine dyes, Alkylating agents).

Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X- syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT IV (15 hrs)

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.

Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

MBBACOR05P: GENETICS (PRACTICAL)

(Total hours: 60. Credits: 2)

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr Body -*Rhoeo* translocation.
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC testing.
7. Study of polyploidy in onion root tip by colchicine treatment.

SUGGESTED READING

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

MBBACOR06T: VIROLOGY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (12 hrs)

Nature and Properties of Viruses: Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin.

Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of viruses.

Viral taxonomy: Classification and nomenclature of different groups of viruses.

UNIT III (10 hrs)

Bacteriophages: Diversity of bacteriophages and their classification. One step multiplication curve, lytic (T4 phage) and lysogenic phages (lambda phage), concept of early and late proteins, regulation of transcription in lambda phage.

UNIT III (20 hrs)

Viral Transmission, Salient features of viral nucleic acids and Replication: Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV). Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174,

Retroviridae, Vaccinia, Picorna), assembly, maturation and release of virions. **UNIT IV (6 hrs)**

Viruses and Cancer: Introduction to oncogenic viruses. Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes. **UNIT V (8 hrs)**

Prevention & control of viral diseases: Antiviral compounds and their mode of action. Interferons and their mode of action. General principles of viral vaccination.

UNIT VI (4 hrs) Applications of Virology

Use of viral vectors in cloning and expression, Gene therapy and Phage display.

MBBACOR06P: VIROLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs.
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs.
3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.
5. Studying isolation and propagation of animal viruses by chick embryo technique.
6. Study of cytopathic effects of viruses using photographs.
7. Perform local lesion technique for assaying plant viruses.

SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.

6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

MBBACOR07T: BIOPHYSICAL PRINCIPLES (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (10 hrs)

Forces stabilizing atomic and molecular interactions: Formation, properties and biological significance of Van der Waals force, hydrogen bond, ionic bond, covalent bond and hydrophobic interaction.

pH and buffer: Ionization of water, Lowry Bronsted theory of acids and bases, pH and buffers, Henderson Hasselbalch Equation, Biological buffers, Importance of buffers in living system.

UNIT II (15 hrs)

Thermodynamics, reaction kinetics and energy transduction: Isolated, closed and open systems; First and second laws of thermodynamics and their biological significance; Activation energy and transition-state theory; Different orders of chemical reactions, free energy and chemical reaction; Energy-rich molecules, Mitochondrial Electron Transport Chain (ETC), Idea of Redox Potential, Chemiosmotic Hypothesis and Oxidative Phosphorylation, Inhibitors and Uncouplers.

UNIT III (10 hrs)

Viscosity: Definition, Laminar and turbulent flow, Concept of Reynolds number, Newton's law of viscosity, Newtonian and non- Newtonian fluids, Coefficient of viscosity, Relative viscosity and fluidity. Measurement by Ostwald's viscometer. Dependence of viscosity on temperature and other factors e.g. size and shape of solutes (general idea), Viscosity of human blood
(general idea).

UNIT IV (5 hrs)

Radioactivity: Radioactivity, decay law, Radioactive labeling, Detection and measurement of radioactive dose by GM counter, scintillation counter, autoradiography.

UNIT V (20 hrs)

Spectroscopic Techniques: Electromagnetic spectrum, Introduction to concepts of absorption and emission spectroscopy, Absorption of light, Transmittance, Absorbance (Optical density), Lambert-Beer's law and its limitations, Concept of

Molar extinction co-efficient, Colorimetry, Study of absorption spectra of Proteins and Nucleic Acids, Analysis of Proteins and Nucleic Acids using UV-Visible spectroscopy, Fluorescence and phosphorescence, Spectroflourimetry.

MBBACOR07P: BIOPHYSICAL PRINCIPLES PRACTICAL

(Total hours: 60, Credits: 2)

1. Preparation of sodium acetate-acetic acid, Citrate, Tris-HCl and Phosphate buffer solutions and measurement of their pH.
2. Use of pH meter.
3. Titration of amino acid (Glycine) for determination of pKa.
4. Verification of Beer's Law for potassium dichromate/ potassium permanganate solution.
5. Quantitative Estimation of protein (Bi-Uret Method / Bradford Method).
6. Study of absorption spectra of DNA and protein using UV-Visible spectrophotometer.
7. Determination of Purity of DNA using UV-Visible spectrophotometer (A260/ A280 measurement).

SUGGESTED READINGS

1. Freifelder D. (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W. H. Freeman.
2. Wilson K and Walker J. (2010).Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
3. Nelson DL and Cox MM. (2008) Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
4. Hallett FR, Speiglet PA and Stinson RH. (1982) Physics for the biological sciences. Chapman and Hall.

SEMESTER-IV

MBBACOR08T: MOLECULAR BIOLOGY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (15 hrs)

DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication (Messelson and Stahl's experiment), Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins,

primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II (10 hrs)

DNA damage, repair and homologous recombination: DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism. **UNIT III (17 hrs)**

Transcription and RNA processing: RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and rho dependent and independent termination of RNA chains.

Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5′cap formation, polyadenylation, splicing, rRNA and tRNA splicing, RNA editing. Inhibitors of transcription Actinomycin D and α- Amanitin.

UNIT IV (18 hrs) Regulation of gene expression and translation

Regulation of gene expression in prokaryotes: Operon concept, *lac* , *ara* and *trp* operons (inducible and repressible system).

Genetic code and its characteristics, Wobble hypothesis, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of t-RNA, aminoacyl t-RNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Action of antibiotics that act as protein synthesis inhibitors - Streptomycin, Tetracyclin, Kanamycin, Chloramphenicol and Puromycin. Post-translational modifications of proteins.

MBBACOR08P: MOLECULAR BIOLOGY (PRACTICAL)

(Total hours: 60. Credits: 2)

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
4. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).
5. Quantitative estimation of DNA by diphenylamine reaction using colorimeter.
6. Quantitative estimation of RNA by orcinol method using colorimeter.

7. Study of different types of DNA and RNA using micrographs and model / schematic representations
8. Study of semi-conservative replication of DNA through micrographs / schematic representations.

SUGGESTED READING

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

MBBACOR09T: IMMUNOLOGY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (20 hrs)

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Antigenic determinants on antibodies
(Isotypic, allotypic, idiotypic), Monoclonal and Chimeric antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT II (15 hrs)

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT III (12 hrs)

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing and presentation (Cytosolic and Endocytic pathways)

Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS. **UNIT IV (13 hrs)**
Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization.
Immunological Techniques:
Principles of Precipitation, Agglutination, Immunodiffusion. Introduction to immunodiagnostics – RIA, ELISA.

MBBACOR09P: IMMUNOLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Differential leucocytes count.
2. Total leucocytes count.
3. Total RBC count.
4. Haemagglutination assay.
5. Haemagglutination inhibition assay.
6. Separation of serum from blood.
7. Antigen-Antibody reactions – Agglutination (Blood group testing).
8. Ouchterlony Double immunodiffusion test using specific antibody and antigen.
9. Immuno-electrophoresis, Rocket immuno-electrophoresis.
10. ELISA

SUGGESTED READING

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garlad Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

MBBACOR10T: COMPUTER APPLICATION AND BIOINFORMATICS (THEORY)

(TOTAL HOURS: 60, CREDITS: 4)

UNIT I (10 hrs)

Computer Application: Basic idea to work on Linux platform – basic concept of OS. Simple shell commands.

UNIT II (10 hrs)

Idea of Computational Biology and it's need in biological study. Concept of databases, characteristics and classification of databases. Sequence information sources, EMBL, GENBANK, Entrez, Unigene.

UNIT III (15 hrs)

Nucleic acid and protein sequence database and information retrieval; sequence file formats - FASTA & GENBANK.

Sequence alignment - pairwise and multiple sequence alignment. Pairwise alignment tool - BLAST and multiple sequence alignment tool - Crustal W/ Clustal omega.

UNIT IV (15 hrs)

Protein and nucleic acid structure database: Protein information Sources, PDB, SWISSPROT, TREMBL. The Protein Database (PDB); information retrieval from structural database.

UNIT V (10 hrs)

Introduction to phylogenetic study; phylogenetic tree nomenclature and structure; tree evaluation method - bootstrapping.

MBBACOR10P: COMPUTER APPLICATION AND BIOINFORMATICS (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Downloading nucleic acid and protein sequences In FASTA and GenBank format from sequence database - NCBI, EMBL etc.
2. Using various BLAST and interpretation of results.
3. Retrieval of information from nucleotide databases.
4. Performing local alignment using BLAST and explaining the concept of E-value and gap score calculation. (Only BLASTn and BLASTp).
5. Preparing Multiple sequence text files and Performing Multiple sequence alignment using Clustal omega.

6. Viewing protein structure database and demonstrating the basics of the PDB files, Swissprot, TREMBL.
7. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR).
8.

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
4. Mariappan P. (2010) Biostatistics. Pearson.
5. Banerjee PK. Introduction to Biostatistics. S. Chand.
6. Rashidi H, Buehler KL. (2005) Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press/Taylor & Francis Group.
7. Lesk MA. (2002) Introduction to Bioinformatics. Oxford University Press.

SEMESTER-V

MBBACOR11T: BIOPROCESS TECHNOLOGY (THEORY)

(Total hours: 60. Credits: 4)

UNIT I (10 hrs)

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT II (20 hrs)

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT III (15 hrs)

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV (15 hrs)

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

MBBACOR11P: BIOPROCESS TECHNOLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

MBBACOR12T: RECOMBINANT DNA TECHNOLOGY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (25 hrs)

Introduction to Molecular Cloning:

Vectors:

Characteristics of cloning vectors, Plasmids (pSC101, pBR322, pUC18/I9), Bacteriophage lambda insertion and replacement vectors, M13 based vectors, Cosmids, Ti plasmid and artificial chromosomes (YACs, BACs and PACs). Shuttle vectors and Expression vectors: *E.coli lac* and T7 promoter-based vectors.

Enzymes used in Molecular Cloning:

Restriction enzymes. Types I, II and III, nomenclature, use of Type II restriction enzymes in cloning, Isoschizomers and Neoschizomers, Restriction Mapping, Restriction Fragment Length Polymorphism (RFLP), Modification Enzymes.
DNA ligases, Terminal deoxynucleotidyl transferase, Polynucleotide Kinase, Phosphatases and Reverse Transcriptase.

Methods used in Molecular Cloning:

Agarose gel electrophoresis of DNA, Southern, Northern and Western blotting, Reverse transcription.

Cloning strategies:
Construction of recombinant DNA: Joining of cohesive ends and blunt ends, c-DNA synthesis and cloning. Transformation of *E.coli* host by Calcium chloride method and electroporation. Gene transfer by Microinjection. Preparation and comparison of Genomic and cDNA library, screening of recombinants.

UNIT II (5 hrs)
PCR Techniques: Principle of Polymerase Chain Reaction, RT (Reverse transcription) -PCR, Real-Time PCR and their applications.
UNIT III (10 hrs) Applications of Genetic Engineering: Genome mapping, DNA fingerprinting. **Genetic engineering in animals:** Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).
UNIT IV (10 hrs)
Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).
UNIT V (10 hrs)
Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

MBBACOR12P: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Isolation of plasmid DNA.
2. Agarose Gel Electrophoresis of plasmid DNA.
3. Preparation of competent cells for transformation by calcium chloride method.
4. Transformation of *E.coli* host cell with plasmid DNA.
5. Digestion of plasmid DNA using restriction enzymes and analysis by agarose gel electrophoresis.
6. Isolation of chromosomal DNA from plant cells.
7. Isolation of chromosomal DNA from *E.coli.*
8. Qualitative and quantitative analysis of DNA using spectrophotometer.
9. Demonstration of PCR.

SUGGESTED READING

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual.
   3rd edition. Cold Spring Harbor Laboratory Press.

SEMESTER-VI MBBACOR13T: BIO-ANALYTICAL TOOLS (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (15 hrs)

Microscopy: Optical microscopy: the nature of light—its particle and wave character.

Ray diagrams and image formation.

Simple and compound microscopes, Applications of optical microscopes, Numerical Aperture (NA), Resolution, Contrast, magnification, Spherical aberration, Chromatic aberration of optical system (definitions only). Mathematical expression for limit of resolution in terms of Rayleigh criteria. Empty magnification. Basic principles of oil immersion microscope. Limitations of optical microscopes.
Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal Microscope.
Electron microscopy---Basic working principle of TEM and SEM. Advantages of electron microscope over optical microscope, Electrostatics and magnetostatics electron microscopes, Relation between the applied voltage and wavelength of electrons.

UNIT II (10 hrs)

Centrifugation: Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge (Preparative, Analytical), Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient, Centrifugation of associating systems, Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation, Relative centrifugal force

(RCF), Isopycnic (equilibrium) sedimentation (discussion with example e.g. Meselson and Stahl Experiment), cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III (15 hrs)

Chromatography: Introduction to the principle of chromatography, Partition co-efficient, Paper chromatography and its applications (including 2-D), thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV (20 hrs)

Electrophoresis: Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications**.**

MBBACOR13P: BIO-ANALYTICAL TOOLS (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Native gel electrophoresis of proteins.
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Freifelder D. (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W. H. Freeman.
6. Wilson K and Walker J. (2010).Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.

MBBACOR14T: GENOMICS & PROTEOMICS (THEORY)

(Total hours: 60. Credits: 4)

UNIT I (15 hrs)

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sanger method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II (10 hrs)

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III (20 hrs)

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der wall interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE.

UNIT IV (15 hrs)

Introduction to Proteomics, Analysis of proteomes. 2 D-PAGE. Sample preparation, solubilisation, reduction, resolution.

Reproducibility of 2D-PAGE. Mass spectrometry: MALDI-TOF, ESI-MS, Methods for protein identification using Mass Spectrometry. *De novo* sequencing using mass spectrometric data.

MBBACOR14P: GENOMICS & PROTEOMICS (PRACTICAL)

(Total hours: 60. Credits: 2)

1. Use of SNP databases at NCBI and other sites.
2. Use of OMIM database.
3. Detection of Open Reading Frames using ORF Finder.
4. Proteomics 2D PAGE database.
5. Softwares for Protein localization.
6. Hydropathy plots.

SUGGESTED READING

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition,

4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
8. Russell, P. J. (2009). *i*Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
9. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
10. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

Discipline Specific Elective (6 credits each)

SEMESTER V

MBBADSE01T: ANIMAL BIOTECHNOLOGY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (10 hrs)

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer,

Retrovirus & Gene transfer.

UNIT II (10 hrs)

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect.

Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT III (20 hrs)

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV (20 hrs)

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

MBBADSE01P: ANIMAL BIOTECHNOLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing 6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

SUGGESTED READING

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

MBBADSE02T: MICROBIAL BIOTECHNOLOGY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (10 hrs)

Microbial Biotechnology and its Applications: Microbial biotechnology: Scopeand its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology.

Use of prokaryotic and eukaryotic microorganisms in biotechnological applications. Genetically engineered microbes for industrial application: Bacteria and yeast.

UNIT II (10 hrs)

Therapeutic and Industrial Biotechnology: Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine).

Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, Bioplastics, Microbial biosensors.

UNIT III (8 hrs)

Applications of Microbes in bio-transformations: Microbial based transformation of steroids and sterols.

Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

UNIT IV (10 hrs)

Microbial Products and their Recovery:

Microbial product purification: filtration, ion exchange & affinity chromatography techniques. **Immobilization methods and their application:** Whole cell immobilization.

UNIT V (12 hrs)

Microbes for Bio-energy and Environment: Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture.

Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents

UNIT VI (6 hrs)

RNAi: RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions.

UNIT VI (4 hrs)

Intellectual Property Rights: Patents, Copyrights, Trademarks.

MBBADSE02P: MICROBIAL BIOTECHNOLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*)
4. Isolation of xylanase or lipase producing bacteria
5. Study of algal Single Cell Proteins

SUGGESTED READING

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.

2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

MBBADSE03T: PLANT BIOTECHNOLOGY (THEORY)

(Total hours: 60. Credits: 4)

UNIT I (15 hrs)

Introduction, Cryo and organogenic differentiation, Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT- II (20 hrs)

In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors affecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT – III (15 hrs)

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations.

Somaclonal variation: Nomenclature, methods, applications basis and disadvantages.

UNIT – IV (10 hrs)

Plant Growth Promoting bacteria.

Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

MBBADSE03P: PLANT BIOTECHNOLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium) 3. To selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.

SUGGESTED READING

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rd edition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

MBBADSE04T: MEDICAL MICROBIOLOGY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (18 hrs)

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S. aureus, S. pyogenes, B. anthracis, C. perferinges, C. tetani, C. botulinum, C. diphtheriae M. tuberculosis, M. leprae.*

UNIT II (15 hrs)

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E. coli, N. gonorrhoea, N.*

meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum M. pneumoniae, Rickettsiaceae, Chlamydiae.

UNIT III (12 hrs)

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT IV (15 hrs)

Fungal and Protozoan infections. Dermatophytoses (*Trichophyton, Microsporun and Epidermophyton*) Subcutaneous infection (*Sporothrix, Cryptococcus*), systemic infection (*Histoplasma, Coccidoides)* and opportunistic fungal infections (*Candidiasis, Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

MBBADSE04P: MEDICAL MICROBIOLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
2. Growth curve of a bacterium.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of Aspergillus and Candida by appropriate staining.
5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

SUGGESTED READINGS

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

SEMESTER VI

MBBADSE05T: I.P.R. ENTREPRENEURSHIP BIOETIHCS & BIOSAFETY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (15 hrs)

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT II (20 hrs)

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

UNIT III (10 hrs)

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

UNIT IV (15 hrs)

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

MBBADSE05P: I.P.R. ENTREPRENEURSHIP BIOETIHCS & BIOSAFETY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India 4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste.

SUGGESTED READING

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship : Jack M. Kaplan

3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers.

MBBADSE06T: BIOSTATISTICS (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (12 hrs)

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical data. Measures of central tendency and Dispersion. Measures of representation of Statistical Skewness and Kurtosis. **UNIT II (18 hrs)**

Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III (18 hrs)

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV (12 hrs)

Correlation and Regression. Emphasis on examples from Biological Sciences.

MBBADSE06P: BIOSTATISTICS (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

SUGGESTED READING

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield^{TM} Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

MBBADSE07T: EVOLUTIONARY BIOLOGY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (10 hrs)

Chemical theory of the origin of life (Oparin-Haldane theory and Miller's experiment), Concepts and theories of organic evolution, The Lamarckian heritage, From Darwin to Modern Synthesis of the theory of evolution, Evidences in favour of Darwinian evolution, Fossil record, types of fossils, transitional forms.

UNIT II (10 hrs)

Geological Time Scale, The Cambrian Explosion, Systematics and Classification, Molecular Phylogenies and evolution, Trends in evolution of plants and Animals, Evolution of molecular clock.

UNIT III (20 hrs)

Concepts of species and mechanisms of speciation, subspecies and races, Allopatric and Sympatric species, Character displacement, Biological and evolutionary species, "Type" concept of species, Macro and Microevolution, Parallel, convergent and divergent evolution, Anagenesis and Cladogenesis, Extinctions, Background and mass extinctions (causes and effects), detailed example of K-T extinction.

UNIT IV (20 hrs)

Populations, gene frequencies and equilibrium, Hardy Weinberg Principle, Forces of Evolution:
mutation, genetic drift (Founder effect, population bottleneck), gene flow, natural selection, Patterns of natural selection, Polymorphism and selection, Selection in Action: Sickle Cell Anemia vs Malaria, Antibiotic resistance in bacteria, Group selection and Kin selection, r-selection and K-selection, Mimicry and protective colouration, Altruistic behaviour.

MBBADSE07P: EVOLUTIONARY BIOLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies.
3. Construction of phylogenetic trees with the help of bioinformatics tools (eg: Clustal W, Phylip, NJ etc) and its interpretation.
4. Visit to Museum/ excavation sites demarcated by Archaeological Survey of India to get exposed to natural history of plants and animals, techniques of conservation of fossilized specimens and prepare a short report.
5. Mathematical Problem on Hardy Weinberg Equilibrium and Various factors disrupting it.

SUGGESTED READING

1. Strickberger M. W. (2000). Evolution. III Edition. Jones and Bartlett Publishers,
2. Kapoor V.C.Theory and Practice of Animal Taxonomy, IV Edition. Oxford and IBH Publishing Group.
3. Rastogi V.B. Organic Evolution. Rastogi Publications.
4. Alcock J (2013). Animal Behaviour: An Evolutionary Approach. X Edition. Oxford University Press.
5. Evolution by Futuyama.

MBBADSE08T: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)

(Total hours: 60, Credits: 4)

UNIT I (18 hrs)

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.

UNIT II (20 hrs)

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT III (12 hrs)

Treatment of municipal waste and Industrial effluents. Bio-fertilizers.
Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM).

UNIT IV (10 hrs)

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium).
Environmental significance of genetically modified microbes, plants and animals.
B. thuringiensis and its mechanism of action, Bt genes, CRY protein.

MBBADSE08P: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)

(Total hours: 60, Credits: 2)

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.

3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

SUGGESTED READING

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Agricultural Biotechnology, S.S. Purohit
6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy

Skill Enhancement Elective Courses

SEMESTER III

MBBSSEC001: FERMENTATION BIOLOGY AND BIOPROCESS TECHNIQUES

(Total hours: 30, Credits: 2)

UNIT I (10 hours)

Fermentation processes and bio-reactors: Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations.

Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

UNIT II (6 hours)

Down-Stream Processing: Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.

UNIT III (10 hours)

Fermented Foods: Dahi, Yogurt, Cheese, Soy sauce, Bread, Pickels, Saeurkraut: Preparation of inoculums, types of microorganisms and production process.

UNIT IV (4 hours)

Probiotic Foods: Different types of probiotic foods, microorganisms used and health benefits.

SUGGESTED READING

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press.
2. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.
4. Patel A.H. (1996) Industrial Microbiology. 1st edition, Macmillan India Limited
5. Okafor N. (2007) Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA.

SEMESTER IV

MBBSSEC002: BIOTECHNOLOGY IN SUSTAINABLE DEVELOPMENT

(Total hours: 30. Credits: 2)

UNIT I (10 hours)

Biofertilization, Phytosimulation, Bioinsecticides:

Plant growth promoting bacteria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter* , Mycorrhizae, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers.

UNIT II (10 hours)

Secondary Agriculture Biotechnology:

Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters.

UNIT III (10 hours)

GM crops:

Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

SUGGESTED READING

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
3. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
4. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
5. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
6. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.