

COURSE STRUCTURE AT A GLANCE

**B.Sc. Biotechnology-Semester and Choice Based Credit System
Jamia Millia Islamia, New Delhi-110025**

FIRST YEAR

SEMESTER I					SEMESTER II				
N	Papers	Code	Credit	MM	N	Papers	Code	Credit	MM
1	Biochemistry & Metabolism	BBT-101	4	100	1	Mammalian Physiology	BBT-201	4	100
2	Cell Biology	BBT-102	4	100	2	Plant Anatomy & Physiology	BBT-202	4	100
3	Plant Diversity-I	BBT-103	4	100	3	Animal Diversity-I	BBT-203	4	100
4	Biotechnology & Human Welfare (CBCE)	BBT-104	4	100	4	Bioethics & Biosafety (CBCE)	BBT-204	4	100
5	Lab Course-I	BBT-105	4	100	5	Lab Course-II	BBT-205	4	100

SECOND YEAR

SEMESTER III					SEMESTER IV				
N	Papers	Code	Credit	MM	N	Papers	Code	Credit	MM
1	Genetics	BBT-301	4	100	1	Gen Microbiol.	BBT-401	4	100
2	Mol. Biology	BBT-302	4	100	2	Immunology	BBT-402	4	100
3	Chemistry-I	BBT-303	4	100	3	Chemistry-II	BBT-403	4	100
4	Plant Div-II	BBT-304	4	100	4	Animal Div-II	BBT-404	4	100
5	Med. Biotech (AECC)	BBT-305	4	100	5	Dev. Biology (CBCE)	BBT-405	4	100
6	Lab Course-III	BBT-306	4	100	6	Lab Course-IV	BBT-406	4	100

THIRD YEAR

SEMESTER V					SEMESTER VI				
N	Papers	Code	Credit	MM	N	Papers	Code	Credit	MM
1	Bioprocess Tech	BBT-501	4	100	1	Bioanalytical Tools	BBT-601	4	100
2	rDNA Tech. (CBCE)	BBT-502	4	100	2	Animal Biotech	BBT-602	4	100
3	Plant Biotech	BBT-503	4	100	3	Env. Biotech	BBT-603	4	100
4	Bioinformatics	BBT-504	4	100	4	Biostatistics	BBT-604	4	100
5	Essential Maths	BBT-505	4	100	5	Enzymology (SEC)	BBT-605	4	100
6	Lab Course-V	BBT-506	4	100	6	Lab Course-VI	BBT-606	4	100

Total Duration of Course	3 Yrs		Total Credits	136
Total Semesters	06		Total Marks	3400

SEMESTER - I

BIOCHEMISTRY AND METABOLISM (Code: BBT-101)

Credits: 4 MM: 100

UNIT I: Introduction to Biochemistry (10 Periods)

A historical perspective:

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

UNIT II (10 Periods)

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, . Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

UNIT III (20 Periods)

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD⁺, NADP⁺, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

UNIT IV (20 Periods)

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. β -oxidation of fatty acids.

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

CELL BIOLOGY (Code: BBT-102)

Credits: 4 MM: 100

UNIT I (10 Periods)

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

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

UNIT II (15 Periods)

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

Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III (20 Periods)

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 Periods)

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

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

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.

PLANT DIVERSITY-I (Code: BBT-103)

Credits: 4 MM: 100

UNIT I

Algae: (20 Periods)

General character, classification and economic importance. Life histories of algae belonging to various classes:

Chlorophyceae – *Volvox*, *Oedogonium*

Xanthophyceae – *Vaucheria* Phaeophyceae – *Ectocarpus* Rhodophyceae – *Polysiphonia*

UNIT II

Fungi: (20 Periods)

General characters, classification & economic importance. Life histories of Fungi:

Mastigomycotina- *Phytophthora* Zygomycotina-*Mucor* Ascomycotina-

Saccharomyces Basidiomycotina-*Agaricus* Deutromycotina-*Colletotrichum*

UNIT III

Lichens : (10 Periods)

Classification, general structure, reproduction and economic importance. Plant diseases:

Casual organism, symptoms and control of following plant diseases. Rust & Smut of Wheat.

White rust of Crucifers. Late blight of Potato. Red rot of Sugarcane. Citrus Canker.

UNIT IV

Bryophytes: (10 Periods)

General characters, classification & economic importance. Life histories of following:

Marchantia.

Funaria.

SUGGESTED READING

1. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4th edition, John Wiley and Sons (Asia) Singapore.
3. Bold, H.C. & Wayne, M.J. 1996 (2nd Ed.) Introduction to Algae.
4. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.

8. Van den Hoek, C.; Mann, D.J. & Jahns, H.M. 1995. *Algae: An introduction to Phycology*. Cambridge Univ. Press.
9. Vander-Poorteri 2009 *Introduction to Bryophytes*. COP.
10. Webster, J. and Weber, R. 2007 *Introduction to Fungi*. 3rd edition, Cambridge University Press, Cambridge.
11. Wickens, G.E. 2004 *Economic Botany: Principles and Practices*, Springer. Kuwer Publishers, Dordrecht, The Netherlands

BIOTECHNOLOGY AND HUMAN WELFARE (Code: BBT-104)

Credits: 4 MM: 100

UNIT I (10 Periods)

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II (10 Periods)

Agriculture: N₂ fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III (15 Periods)

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT IV (12 Periods)

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V (13 Periods)

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E. coli*, human genome project.

SUGGESTED READING

1. Sateesh MK (2010) *Bioethics and Biosafety*, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) *Bioethics and Biosafety in Biotechnology*, New age international publishers.

SEMESTER - II

MAMMALIAN PHYSIOLOGY (Code: BBT-201)

Credits: 4 MM:100

UNIT I: Digestion and Respiration (15 Periods)

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

Respiration: Exchange of gases, Transport of O₂ and CO₂, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation (15 Periods)

Composition of blood, Plasma proteins & their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood.

Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT III: Muscle physiology and osmoregulation (15 Periods)

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

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

UNIT IV: Nervous and endocrine coordination (15 Periods)

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

Mechanism of action of hormones (insulin and steroids)

Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Herculat Asia PTE Ltd. /W.B. Saunders Company.

2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI

PLANT ANATOMY & PHYSIOLOGY (Code: BBT-202)

Credits: 4 MM:100

UNIT I: Anatomy (10 Periods)

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

UNIT II: Plant water relations and micro & macro nutrients (12 Periods)

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT III: Carbon and nitrogen metabolism (20 Periods)

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT IV: Growth and development (18 Periods)

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberellins, cytokinins, abscisic acid, ethylene)

Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

SUGGESTED READING

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. J. Wiley & Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjamin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th ed. Sinauer Associates Inc .MA, USA

ANIMAL DIVERSITY-I (Code: BBT-203)

Credits: 4 MM:100

UNIT I (15 Periods)

- a).Outline of classification of Non-Chordates up to subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes.
- b).Protozoa: Locomotion, Reproduction, evolution of Sex, General features of *Paramoecium* and *Plasmodium*. Pathogenic protozoans
- c).Porifera: General characters, outline of Classification; skeleton, Canal System

UNIT II (15 Periods)

- a).Coelenterata: General Characters, Outline of classifications, Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation.
- b).Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations.
- c).Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT III (15 Periods)

- a).Annelida: - General features, Outline of classification, Coelom: Metameric segmentation, General features of Earthworm, Vermicomposting.
- b).Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.

UNIT IV (15 Periods)

- a).Mollusca : general features, Outline of classification, Shell Diversity; Torsion in gastropoda,
- b).Echinodermata: General features, Outline of Classification Larval forms
- c).Hemichordata: Phylogeny: Affinities of *Balanoglossus*

SUGGESTED READING

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
5. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-HillCompanies.

BIOETHICS AND BIOSAFETY (Code: BBT-204)

Credits: 4 MM:100

UNIT-I (15 Periods)

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 Periods)

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 Periods)

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

UNIT IV (15 Periods)

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).

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

SEMESTER - III

GENETICS (Code: BBT-301)

Credits: 4 MM:100

UNIT I (12 Periods)

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 Periods)

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 Periods)

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, 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, abnormalities—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 Periods)

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.

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 Inc.

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.

MOLECULAR BIOLOGY (Code; BBT-302)

Credits: 4 MM:100

UNIT I: DNA structure and replication (15 Periods)

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, 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: DNA damage, repair and homologous recombination (10 Periods)

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: Transcription and RNA processing (17 Periods)

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and 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.

UNIT IV: Regulation of gene expression and translation (18 Periods)

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Posttranslational modifications of proteins.

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

CHEMISTRY-I (Code: BBT-303)

Credits: 4 MM:100

Unit I: Alcohols

Classification and Nomenclature

Dihydric alcohols- Nomenclature, methods of preparation, chemical reactions of vicinal glycols, eg: Oxidative cleavage using $(\text{Pb}(\text{OAc})_4)$ & HIO_4 and pinacol-pinacolone rearrangement.

Trihydric alcohols- Nomenclature and methods of preparation, chemical reactions of glycol.

Unit II: Phenols

Nomenclature, structure and bonding of phenols, Physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenol. Electrophilic aromatic substitution, acylation and carboxylation, mechanism of Fries rearrangement, Claisen rearrangement, Reimer-Tiemann reaction.

Unit III: Ethers and Epoxides

A. Nomenclature of ethers and methods of their preparation, Physical properties. Chemical reactions- Cleavage and autoxidation, Ziesel's method.

B. Synthesis of epoxides, Acid and base catalysed ring opening, reaction of Grignards and organolithium reagents with epoxides.

Unit IV: Aldehydes and Ketones

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes from acid chlorides, synthesis of ketones from nitriles and from carboxylic acids. Physical properties, Mechanism of nucleophilic addition to Carbonyl compounds. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction.

SUGGESTED READING

1. Organic Chemistry by P.Y. Bruice
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi .
3. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi.

PLANT DIVERSITY II (Code: BBT-304)

Credits: 4 MM:100

UNIT I: Pteridophytes

General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – *Rhynia*. (10 Periods)

UNIT II: Pteridophytes: Type studies

Life histories of *Selaginella*- (Heterospory and seed habit), *Equisetum*, *Pteris*, *Lycopodium*. (20 Periods)

UNIT III: Gymnosperms

General characters, classification, geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms- *Williamsonia* & *Glossopteris*, telome and stele concept. (20 Periods)

UNIT IV: Gymnosperms: Type studies

Life histories of *Cycas* & *Pinus*, economic importance of gymnosperms. (10 Periods)

SUGGESTED READING

1. Bhatnager, S.P. and Moitra, A. 1996 Gymnosperms. New Age International (P) Ltd. Publishers, New Delhi.
2. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
3. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
4. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

Medical Biotechnology (BBT-305)

Credits: 4 MM:100

UNIT I

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*, *C.tetani*, *C.botulinum*, *C.diphtheriae*, *M.tuberculosis*, *M. Leprae*) and gram negative bacteria: (*E.coli*, *N. gonorrhoea*, *P. aeruginosa*, *S. typhi*, *Y. pestis*, *V. cholerae*, *T. Pallidum*, *Rickettsiaceae*, *Chlamydiae*)

Resistance to antimicrobials: Biochemical mechanisms of resistance, Genetics of resistance; Laboratory safety regulations.

UNIT II

Viral disease and diagnosis- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses. Antiretrovirals.

UNIT III

Enzyme Immunoassays:

Enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Immuno florescence.

UNIT IV

Molecular Diagnostics:

Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing of bacterial pathogens. flowcytometry and cell sorting.

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.
4. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
5. Bioinstrumentation, Webster
6. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
7. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.

SEMESTER – IV

GENERAL MICROBIOLOGY (Code: BBT-401)

Credits: 4 MM:100

UNIT I (10 Periods)

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 eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II (10 Periods)

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

UNIT III (20 Periods)

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV (20 Periods)

Control of Microorganisms: By physical, chemical 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 born infections and intoxications, Preservation of various types of foods. Fermented Foods.

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*. 7th edition, 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. 9th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education

IMMUNOLOGY (Code: BBT-402)

Credits: 4 MM:100

UNIT I (20 Periods)

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or 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 Periods)

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 (13 Periods)

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT IV (12 Periods)

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

SUGGESTED READING

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th 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 Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinburgh.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

CHEMISTRY-II (Code: BBT-403)

Credits: 4 MM:100

Unit –I: Arenes and Aromaticity

Structure of benzene-molecular formula and Kekule structure, Stability and carbon-carbon bond lengths in benzene, Aromaticity-the Huckel rule, Aromatic electrophile substitution –general pattern of the mechanism, effect of substituent groups. Mechanism of nitration, halogenation, sulphonation, Friedal-Crafts alkylation, Friedal-Crafts acylation.

Unit -II: Haloalkanes and Haloarenes

Nomenclature and classes of alkyl halides, methods of preparation, Nucleophilic substitution in haloalkanes. Mechanisms of nucleophilic Substitution (S_N2 and S_N1) reactions, β -Elimination, mechanisms of β -elimination.

Methods of formation of Haloarenes, Nucleophilic aromatic substitution Through addition elimination and the elimination addition mechanisms(Benzyne mechanisms)

Unit- III: Amines

Structure and nomenclature of amines, stereochemistry of amines, separation of a mixture of primary, Secondary and tertiary amines structural features effecting basicity of amines preparation of alkyl and arylamines by reduction of nitro compounds and nitriles, reductive amination of aldehydes and ketones compounds, Gabriel phthalimide reaction, Hofmann bromamide reaction.

Reaction of amines, electrophilic aromatic substitution in aryl amines. Reactions of amines with nitrous acid, synthetic transformations of aryl diazonium salts, azo coupling.

Unit- IV: Heterocyclic Compounds

General introduction to heterocyclic systems, Five-membered rings-Structure of pyrrole, furan and thiophene, electrophilic substitution in pyrrole, furan and thiophene, Six-membered rings-Structure of pyridine, basicity of pyridine. electrophilic and nucleophilic substitution in pyridine.

Books suggested:

1. Organic Chemistry by P.Y. Bruice
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi .
3. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi.

ANIMAL DIVERSITY II (Code: BBT-404)

Credits: 4 MM:100

UNIT I: Proto-chordates, Pisces and Ambhibia (15 Periods)

Proto-chordates: Outline of classification, General features and important characters of *Herdmania*, *Branchiostoma*

Origin of Chordates

Pisces: Migration in Pisces, Outline of classification Amphibia: Classification, Origin, Parental care, Paedogenesis

UNIT II: Reptilia, Aves and Mammalia (15 Periods)

Reptelia: Classification, Origin

Aves: Classification, Origin, flight- adaptations, migration

Mammalia: Classification, Origin, dentition

UNIT III: Comparative anatomy of vertebrates I (15 Periods)

Comparative anatomy of various systems of vertebrates: Integumentary, digestive respiratory systems.

UNIT IV: Comparative anatomy of vertebrates II (15 Periods)

Comparative Anatomy of vertebrates – Heart, Aortic arches, Kidney & urinogenital system, Brain, Eye, Ear.

Autonomic Nervous system in Mammals

SUGGESTED READING

- 1.Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
- 2.Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Function and evolution. IV Edition.McGraw-Hill Higher Education.
- 3.Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. TheMcGraw-HillCompanies.
- 4.Weichert, C.K. (1970). Anatomy of Chordate. McGraw Hill.
- 5.Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.

DEVELOPMENTAL BIOLOGY (Code: BBT-405)

Credits: 4 MM:100

UNIT I: Gametogenesis and Fertilization (10 Periods)

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: Early embryonic development (20 Periods)

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III: Embryonic Differentiation (20 Periods)

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV: Organogenesis (10 Periods)

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

SUGGESTED READING

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

SEMESTER - V

Bioprocess Technology (Code: BBC-501)

Credits: 4 MM:100

UNIT I

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 Periods)

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 Periods)

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 Periods)

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

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.

RECOMBINANT DNA TECHNOLOGY (Code: BBT-502)

Credits: 4 MM:100

UNIT I (15 Periods)

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors(Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT II (20 Periods)

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering 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 III (10 Periods)

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 IV (15 Periods)

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.

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-Appling 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.

PLANT BIOTECHNOLOGY (Code: BBT-503)

Credits: 4 MM:100

UNIT I

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. **(15 Periods)**

UNIT- II

In vitro haploid production Androgenic methods: Anther culture, Microspore culture androgenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals. **(20 Periods)**

UNIT - III

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

Plant Growth Promoting bacteria.

Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation,

Biocontrol of pathogens, Growth promotion by free-living bacteria.

(10 Periods)

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.

BIOINFORMATICS (Code: BBT-504)

Credits: 4 MM:100

UNIT I (10 Periods)

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II (20 Periods)

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT III (20 Periods)

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT IV (10 Periods)

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission.
Genome Annotation: Pattern and repeat finding, Gene identification tools.

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.

ESSENTIAL MATHEMATICS (Code: BBT-505)

Credits: 4 MM:100

Unit-I:

Definition and examples of matrices, types of matrices, basic operations, equality of matrices, addition and scalar multiplication of matrices, properties of addition and scalar multiplication, transpose of a matrix, symmetric and skew symmetric matrices and their properties, matrix multiplication in general and its properties. Definition of Determinant, minors and cofactors of an element of a determinant, singular and non-singular matrices, multiplicative inverse of a matrix and its properties, Applications. Set and their representations, finite and infinite sets, subsets, type of sets, operations on sets and their algebraic properties, Venn diagram, ordered pair, Cartesian product & relation.

Unit-II:

Concept of functions and Relation in biological terminology, its domain and range, Types and classification of function, graphs of some well known functions, even and odd functions, periodic functions, algebra of functions, composite functions, inverse of a function. Limits, left hand and right hand limits, algebra of limits, continuity of a function at a point, over an open/closed interval, differentiability of a function at a point, left hand and right hand differentiability, relation between continuity and differentiability, Derivative of a function, its geometrical and physical significance, Applications.

Unit-III:

Introduction of indefinite integral, anti-derivative or primitive function, standard formulae, and fundamental laws of integrations, methods of integration: by substitution, by parts, by long division, by partial fractions, by successive reduction, Integration of some well known forms. Definition of definite integral as the limit of sum, The fundamental theorem of calculus (without proof), evaluation of definite integral, transformation of definite integral by substitution, by parts. Properties of definite integral and problems based on these properties, Applications.

Unit-IV:

Differential equation, order and degree of a differential equation, solution of a (first order and first degree) differential equation by the method of variable separable, Homogeneous differential equation and their solution, solution of the linear differential equation of the first order of type: $dy/dx+P(x).y=Q(x)$.

Suggested Books:

1. Seymour Lipschutz, 1981, Set Theory, (Schaum's Outline Series) McGraw Hill Book co.
2. Frank Ayres, J.R.,1974, Matrices, (Schaum's Outline Series) McGraw Hill Inc.
3. Shanti Narayan, 1999, Differential and Integral Calculus, S. Chand and Co. Ltd.
4. Frank Ayres, J.R.,1992, Theory and Problems of Differential Equations, (Schaum's Outline Series) McGraw Hill Inc.
5. Pishkunov, N.,1981, Differential and Integral Calculus, CBS Publishers and distributors.
6. Shanti Narayan, 1999, Differential and Integral Calculus, S. Chand and Co. Ltd.

7. Frank Ayres, J.R., 1992, Theory and Problems of Differential Equations, (Schaum's Outline Series) McGraw Hill Inc.
8. Pishkunov, N., 1981, Differential and Integral Calculus, CBS Publishers and distributors.
9. Khalil Ahmad, 2013, Text Book of Differential Equations, Real World Education Publishers, New Delhi.
10. Khalil Ahmad, 2013, Text Book of Calculus, Real World Education Publishers, New Delhi.

SEMESTER – VI

BIO-ANALYTICAL TOOLS (Code: BBT-601)

Credits: 4 MM:100

UNIT I (10 Periods)

Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II (15 Periods)

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra-red), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III (15 Periods)

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV (20 Periods)

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.

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.

ANIMAL BIOTECHNOLOGY (Code: BBT-602)

Credits: 4 MM:100

UNIT I (10 Periods)

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

UNIT II (10 Periods)

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 Periods)

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

UNIT IV (20 Periods)

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

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.

ENVIRONMENTAL BIOTECHNOLOGY (Code: BBT-603)

Credits: 4 MM:100

UNIT I (18 Periods)

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 Periods)

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 chlorinated hydrocarbons and petroleum products.

UNIT III

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 Periods)

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium).
Environmental significance of genetically modified microbes, plants and animals.

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

BIostatISTICS (Code: BBT-604)

Credits: 4 MM:100

UNIT I (12 Periods)

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT II (18 Periods)

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

UNIT III (18 Periods)

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 Periods)

Correlation and Regression. Emphasis on examples from Biological Sciences.

SUGGESTED READING

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield™ 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.

ENZYMولوجY (Code: BBT-605)

Credits: 4 MM:100

UNIT - I (20 Periods)

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation,

Different plots for the determination of K_m and V_{max} and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT – II (15 Periods)

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of K_i , suicide inhibitor.

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples:-chymotrypsin, Lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.

Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

(12 Periods)

UNIT – III (13 Periods)

Allosteric enzymes with special reference to aspartate transcarbamylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT – IV

Enzyme Technology: Methods for large scale production of enzymes.

Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes.

Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution.

Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *invitro* & *invivo*.

SUGGESTED READING

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.
4. Biochemistry by Mary K. Campbell & Shawn O. Farrell, 5th Edition, Cengage Learning, 2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley-VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

Lab Courses B.Sc. Biotechnology

(6 Semester UG Degree Course)

(Choice Based Credit System)

Department of Biotechnology

Jamia Millia Islamia, New Delhi

SEMESTER - I

Lab Course-I (BBT 105)

1. To study the principle and working of compound microscope
2. To study the plasmolysis and de-plasmolysis in the given plant part
3. To study the structures of Prokaryotic and Eukaryotic cell.
4. To observe the mammalian cell line and *Leishmania* under the inverted microscope
5. Staining of *Leishmania* infected macrophages through Giemsa stain
6. To Study various stages of mitosis and meiosis in onion root tip.
7. To study the barr-body detection and its significance.
8. Identification of algal species by studying their permanent slides.
9. Study of thallus and reproductive structures by slide preparation and staining of the following algal species.
 - a. *Volvox*, *Oedogonium*, *Vaucheria*, *Ectocarpus*, *Polysiphonia*
10. Identification of different plant diseases by studying the permanent slides.
11. Study of plant disease by slide preparation and staining for the following diseases.
Rust of wheat, Black smut of wheat, citrus canker, late blight of potato, white rust of crucifers, red rot of sugarcane
12. Preparation of solutions and buffers
13. Qualitative tests for biomolecules (protein, lipids, carbohydrates, nucleic acid)
14. Estimation of protein in given sample by Lowry method
15. Measuring the enzyme activity under different conditions
16. To study Beer Lambert law using proteins: Absorbance vs concentration
17. Determination of concentration of protein using Absorption Coefficient
18. Comparative study of thallus and reproductive organs of various algae mentioned in theory.
19. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
20. Section cutting and lectophenol mount of plant disease materials
21. To study the various types of lichens.
22. Study of external features & anatomy of vegetative and reproductive parts of Marchantia and Funaria.
23. Collection of algae, fungi, plant diseased materials and bryophytes available locally.

SEMESTER - II

Lab Course II (BBT 205)

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin
7. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
8. Demonstration of plasmolysis by *Tradescantia* leaf peel.
9. Demonstration of opening & closing of stomata
10. Demonstration of guttation on leaf tips of grass and garden nasturtium.
11. Separation of photosynthetic pigments by paper chromatography.
12. Demonstration of aerobic respiration.
13. Preparation of root nodules from a leguminous plant.
14. Proxy filing of Indian Product patent
15. Proxy filing of Indian Process patent
16. Planning of establishing a hypothetical biotechnology industry in India
17. A case study on clinical trials of drugs in India with emphasis on ethical issues.
18. Case study on women health ethics.
19. Case study on medical errors and negligence.
20. Case study on handling and disposal of radioactive waste
21. Identification and Classification of Any three of the following –
Porifera: Scypha, Leucosolenia, Euspongia, Hylonema, Euplectella
Cnidaria: Medusozoa, Millepora, Physalia, Porpita, Valella, Aurelia, Metridium
Platyhelminthes: Taenia, Fasciola, Aschelminthes: Ascaris, Ancylostoma, Enterobius
Annelida: Pheretima, Hirudinaria, Chaetopterus, Nereis, Aphrodite
Arthropoda: Julus, Scolopendra, Peripatus, Carcinus, Limulus, Lepisma, Dragonfly, Musca, Acheta
Mollusca: Pila, Unio, Mytilus, Loligo, Sepia, Octopus, Solen
Echinodermata: Asterias, Ophiothrix, Echinus, Holothuria, Astrophyton
Hemichordata: Balanoglossus
22. Identification of slides with two points of identification.
Amoeba, Paramecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules of sponges, L.S. Hydra, Obelia, Bougainvillia, Larvae of Fasciola, Seta of Earthworm, Radula

SEMESTER - III

Lab Course III (BBT 306)

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples

6. Examination of morphology and anatomy of vegetative and reproductive parts of Selaginella, Equisetum & Pteris.
7. Examination of morphology and anatomy of vegetative and reproductive parts of –Cycas & Pinus.
8. Collection of pteridophytes & gymnosperms
9. Permanent and temporary mount of mitosis.
10. Permanent and temporary mount of meiosis.
11. Mendelian deviations in dihybrid crosses
12. Demonstration of – Barr Body _ Rhoeo translocation.
13. Karyotyping with the help of photographs
14. Pedigree charts of some common characters like blood group, colorblindness and PTC tasting.
15. Study of polyploidy in onion root tip by colchicines treatment.

16. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
17. To study the different staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.
18. Perform/demonstrate RFLP and its analysis
19. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
20. A kit-basd detection of a microbial infection (Widal test)
21. To perform any one immuno diagnostic test

SEMESTER - IV

Lab Course IV (BBT 406)

1. To study the permanent slides of different developmental stages of Frog.
2. Staining and mounting of blastoderm of chicken embryo.
3. Study of chick embryo using permanent slides. 1. To recognize bacterial strain by using Gram Staining Technique.
4. To perform Sterilization Techniques for Microbiology experiments.
5. To perform Acid Fast staining technique by using ZiehlNesselson s staining method.
6. To identify various strains of bacteria using light microscopy.
7. To prepare culture Media for the various bacterial cultures.
8. To inoculate bacterial culture using streaking technique in sterilized experimental conditions.
9. To prepare the Blood smears of Man and identification of Leucocytes by Giemsa staining.
10. To perform calculation of differential count of Leucocytes in Human blood.
11. Separation of Serum from Blood
12. Determination of blood groups (ABO and Rh type) in human.
13. Dot blot or immunoblotting
14. Demonstration of ELISA
15. Identification & Classification upto order of the Following:
 - Proto –chordate : Salpa, Doliolum, Herdmania, Branchiostoma
 - Cyclostomata : Myxine, Petromyzon
 - Chondrichthyes : Scoliodon, Zygnema, Pristis, Trygon, Raja , Chimaera
 - Ostiechthyes : Labeo, Mystus, Catla, Hippocampus, Anabas, Echeneis, Lophius
 - Polypeterus Amphibia : Rana, Hyla, Amblystoma, Necturus, Proteus,
 - Reptiles : Hemidactylus, Calotes, Draco, Phrynosoma, Naja Vipera,
 - Bungarus Aves : Columba, Alcedo, Passer
 - Mammalia : Ornithorhynchus, Macropus, Didelphes, Dasyopus.
16. An Ecological Note on any one of the specimens mentioned above.
17. Identification of the following slides
 - Mammalian Histology : Liver, Lung Intestine, Kidney, Ovary, Testes Slides of Salpa, Doliolum, Spicules of Herdmania, Tadpole of Frog
18. Preparation of a permanent mount of Salpa, Placoid scales, spicules of Herdmania, Pharynx of Amphioxus, Tadpole Larva of frog.
19. Identification of endoskeletons (Axial & Appendicular skeletons) of frog and rabbit.

SEMESTER - V

Lab Course V (BBT 506)

1. Isolation of amylase producing bacteria from soil by serial dilution using starch as a carbon source.
2. Growth curve analysis of *E. coli* using Luria Bertini broth.
3. Isolation of protease producing micro-organisms from garden soil by serial dilution using casein as a carbon source.
4. Isolation of lactic acid bacteria from yogurt and fermentation of lactic acid using different carbon sources.
5. To study the alcohol fermentation by *Sacharomyces cerevesiae* using different simple and complex carbon sources.
6. To have on site overview of lab safety, troubleshooting and good laboratory practices.
7. Preparation of modified MS Media for Plant Tissue Culture.
8. *In vitro* induction, culturing and sub-culturing of callus induced from plant explants.
9. Preparation of artificial seeds.
10. Extraction, purification and quantification of plant genomic DNA
11. Electrophoresis of plant genomic DNA
12. Isolation of DNA from plant tissue and its qualitative and quantitative analysis .
13. To perform the restriction digestion of DNA.
14. Plasmid DNA isolation.
15. Demonstration of PCR
16. To introduce Entrez as a biological data retrieval system and to learn how to use Entrez search engine to retrieve nucleotide/protein sequence data.
17. Understanding the use of various web resources: EMBL, Genbank and Protein Information Resources (PIR).
18. To introduce PubMed database and its features and to learn how to retrieve articles from PubMed of NCBI.
19. To introduce PDB, SwissProt and TREMBL databases.
20. To learn how to retrieve structural data of a protein using PDB database.
21. To study the pairwise sequence similarity search using BLAST algorithm and interpret its results.
22. To design (or find) PCR primers from a given nucleotide sequence using a bioinformatics tool.
23. To learn how ORF Finder searches for open reading frames in a DNA sequence using the standard or alternative genetic codes.
24. To identify all the possible open reading frames in a nucleotide sequence
25. To perform multiple sequence alignment using Clustal W.

SEMESTER - VI

Lab Course VI (BBT 606)

1. To learn the sterilization techniques: Glassware sterilization, media sterilization.
2. Isolation of lymphocytes from blood and culturing in complete RPMI media.
3. Culturing of adherent cell lines in complete DMEM medium.

4. Culture of suspension cell lines in complete RPMI medium.
5. Transfection of GFP plasmid in adherent cell lines and its visualization by fluorescent microscopy.
6. Isolation of DNA from animal tissue, its quantification and analysis on agarose gel.
7. To estimate dissolved oxygen (DO) in the given water sample by Winkler's method.
8. Analysis of Biological oxygen Demand (BOD) in the given water samples.
9. To compare bacterial load in different water samples
10. Bacterial examination of water by MPN method
11. To study the Principle of measuring chemical oxygen demand (COD) in water samples.
12. Demonstration of SDS-polyacrylamide gel electrophoresis of proteins under reducing conditions.
13. To perform the Western blotting of SDS-PAGE separated proteins.
14. Separation of amino acids by Thin-Layer Chromatography (TLC).
15. To learn the gel filtration chromatography
16. To verify the validity of Beer's law and determination of the molar extinction coefficient of various biomolecules.
17. To study the effect of temperature and pH change of a protein solution on its absorption spectra, using UV-Visible Spectrophotometer.
18. Preparation of protoplasts from leaves.