STATE MODEL SYLLABUS FOR UNDER GRADUATE COURSE IN BIOTECHNOLOGY (Bachelor of Science Examination)

UNDER

CHOICE BASED CREDIT SYSTEM

BIOTECHNOLOGY

Framework of CBCS Syllabus for BIOTECHNOLOGY (Honours) from 2019-20

Semester – I

Sl No	Name of the Course	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C1: Microbiology	6	60	100
2	Core	C2 : Plant Diversity & Physiology	6	60	100
3	GE-A	GE 1A: Paper I from either subjects [Zoology / Botany / Chemistry]	6	60	100
4	AECC – I	Environmental Science	4	40	100
Total Paper		4	22	220	400

Semester – II

Sl No	Name of theCourse	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C3: Cell Biology and Genetics	6	60	100
2	Core	C4: Animal Diversity & Physiology	6	60	100
3	GE-B	GE 2B: Paper from remaining 02 subjects other than that opted in first semester [Zoology / Botany / Chemistry]	6	60	100
4	AECC - II	MIL Communication (Odia/ Alt English)	4	40	100
Total Paper		4	22	220	400

Semester – III

Sl No	Name of the Course	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C5: Molecular Biology	6	60	100
2	Core	C6: Biochemistry and Metabolism	6	60	100
3	Core	C7: Biostatistics and Computer Applications	6	60	100
4	GE-A	GE 3A: Paper II of the subject opted in first semester [Zoology / Botany / Chemistry]	6	60	100
5	SEC- 1	SEC–1: Communicative English	4	40	100
Total Paper		5	28	280	500

Semester – IV

Sl No	Name of the Course	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C8: Immunology	6	60	100
2	Core	C9: Plant Biotechnology	6	60	100
3	Core	C10: Animal Biotechnology	6	60	100
4	GE-B	GE 4B, Paper II of the subject opted in second semester Zoology / Botany / Chemistry	6	60	100
5	SEC – 2	SEC–2: Enzymology / Basics of Forensic Science / Mushroom culture/ Sericulture	4	40	100
Total Paper		5	28	280	500

Semester – V

Sl No	Name of the Course	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C 11: Genetic Engineering	6	60	100
2	Core	C 12: Genomics and Proteomics	6	60	100
3	DSE 1	DSE 1: Biotechniques	6	60	100
4	DSE 2	DSE 2: Bioinformatics	6	60	100
Total Paper		4	24	240	400

Semester – VI

Sl No	Name of the Course	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C 13: Bioethics and Biosafety	6	60	100
2	Core	C 14: Bioprocess Engineering and Technology	6	60	100
3	DSE 3	DSE 3: Bioenterpreurship	6	60	100
4	DSE 4	DSE 4: Medical Microbiology (to be opted by students securing below 60%) / Project Report & Seminar* *- for students securing ≥ 60%	6	NA	100
Total Paper		4	24	180	400
Grand Total		26	148	1480	2600

(Project 80 + 20 Viva)

** AECC – Ability Enhancement Compulsory Course * SEC – Skill Enhancement Course*

** DSE – Discipline Specific Elective * GE – Generic Elective*

*Hons students has to opt two Generic Elective Subjects. *SubjectsA& B (containing 2 Papers) from subjects available other than Core (Hons.) Subject. Subject - **A** for Semester 1 & 3 another subject **B** for Semester 2 & 4.

*** GE – Generic Elective [To be opted by +3, Biotechnology (Hons.)]**

Two subjects among three subjects viz., Zoology / Botany / Chemistry to be chosen(02 papers/ Subject i.e. Total 04 papers/ 02 subjects) other than Core as **Generic Elective**.

Subject	**Generic Elective Papers**	
	GE Paper-I	**GE Paper-II**
Zoology	Animal Diversity (Non-Chordate), Physiology and Endocrinology	Animal Diversity (Protochordata and Chordata), Developmental Biology and Immunology
Botany	Industrial and Environmental Microbiology	Botany and Plant Biotechnology
Chemistry	Atomic Structure Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	Chemical Energetic & Equilibria and Functional Organic Chemistry
Any two subjects among three subjects and each Subject contains two papers (**Subject-A with two papers** at Semester I & III [GE-1A & GE-3A] and another **Subject B with two papers** for Semester II & IV [GE-2B & GE-4B] is to be opted.		

*** GE – Generic Elective [To be opted by +3, Science (Hons.) other than Biotechnology]**

Subject	**Generic Elective Papers**	
	Paper-I	**Paper-II**
Biotechnology	Biochemistry and Molecular Biology	Recombinant DNA Technology
	Paper-III	**Paper-IV**
	Environmental Biotechnology and Bioethics	Bioprocess Technology &Enterpreneurship

BIOTECHNOLOGY Papers for HONOURS Students

Core course – 14 papers, Discipline Specific Elective – 4 papers
Generic Elective for non Biotechnology students – 4 papers. In case University offers 2 subjects as GE, then papers 1 and 2 will be the GE paper.

Marks per paper - Midterm: 15 marks, Practical: 25 marks, End term: 60 marks, Total: 100 marks, Credit per paper – 6: Theory-4, Practical-2, Teaching hours per paper – 40 hours theory classes+ 20 hours practical classes

C 1: MICROBIOLOGY

Unit-I

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used, including molecular approaches, Microbial phylogeny, Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms e.g. Bacteria, Algae, Fungi, Protozoa, Archea (Halophyles, Methanogens, Thermophyles), Virus (structure of viruses, Bacterial, plant, animal and tumor viruses, DNA- and RNA- viruses.

Unit-II

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation. Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Unit-III

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. Nutritional Classification of Microorganisms.

Unit-IV

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: molds, Yeasts, bacteria.

Practical:

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

Text Books:

1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill BookCompany.
2. Prescott/Harley/Klein's Microbiology, by Joanne Willey (Author), Linda Sherwood (Author), Chris Woolverton (Author), McGraw Hill Education; 7 edition

Suggested Readings

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 thedition.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. 12thedition. Pearson/Benjamin Cummings.
5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5thedition. McMillan.

C 2: PLANT DIVERSITY AND PLANT PHYSIOLOGY

Unit-I

Algae: General character, classification& economic importance.
Fungi: General characters, classification& economic importance.
Lichens: Classification, general structure, reproduction and economic importance.
Bryophytes: General characters, classification& economic importance.

Unit-II

General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance.

Gymnosperms: General characters, classification, geological time scale, theories of fossil formation, types of fossils.

Life histories of Cycas & Pinus, economic importance of gymnosperms.

Unit-III

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.

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

Unit-IV

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

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.

Practical:

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory.
2. Separation of photosynthetic pigments by paper chromatography.
3. Study of various types of lichens.
4. Demonstration of aerobic respiration.
5. Preparation of root nodules from a leguminous plant.
6. Demonstration of plasmolysis by *Tradescantia* leaf peel.

Text Books:

1. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA
2. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK, International Publishers.

Suggested Reading:

1. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.
2. Van den Hoek, C.; Mann, D.J. &Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
3. A Test Book of Plant Physiology, Biochemistry & Biotechnology, Author: Verma & Verma, Pub: S. Chand
4. Plant Physiology, Author: Salisbury & Ross, Pub: WADSWORTH C engage learning
5. Unified Botany, Author: Agrawal S.B, Pub: Shivlal Agrawal A Textbook of Botany by Singh, Pande, Jain.

C-3: CELL BIOLOGY & GENETICS

Unit-I

Cell: Introduction and structural organization of prokaryotic and Eukaryotic cells, compartmentalization of eukaryotic cells, cell fractionation. Cell membrane and Permeability: Chemical components of biological membranes and its organization, Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

Cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure & function, Golgi complex: Structure, biogenesis and function.

Unit-II

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

Structure and functions; Lysosomes, Vacuoles and micro bodies, Ribosomes, Mitochondria, Chloroplasts, Nucleus: Chromosomes and their structure.

Unit-III

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, mono, di- and tri hybrid crosses, Law of segregation & Principle of independent assortment. Chromosomal theory of inheritance.
Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Unit-IV

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, concept of cistron, exons, introns, genetic code, gene function.

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, 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.

Practical:

1. Study of plasmolysis and de-plasmolysis.
2. Study of structure of any prokaryotic Eukaryotic cell.

3. Microtomy: Fixation, Block making, Section cutting, Double staining of animal tissues like liver, Oesphagus, Stomach, pancreas, Intestine, Kidney, Ovary, testes.
4. Cell division in onion root tip/insect gonads.
5. Preparation of Nuclear, mitochondria & cytoplasmic fractions.
6. Study of polyploidy in onion root tip by colchicine treatment.
7. Karyotyping with the help of photographs.

Text Books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

Suggested Readings

1. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8thedition.Lippincott Williams and Wilkins, Philadelphia.
2. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress& Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. 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.
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.

C 4: ANIMAL DIVERSITY AND PHYSIOLOGY

Unit-I

Proto-chordates: Outline of classification, General features.

Outline of classification of Non-Chordates upto subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes.

General characters, outline of Classification of Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Hemichordata.

Unit-II

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.

Reptilia: Classification, Origin.

Aves: Classification, Origin, flight- adaptations, migration.

Mammalia: Classification, Origin, dentition.

Unit-III

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

Unit-IV

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

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

Unit-V

Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions, Mechanism of action of hormones (insulin and steroids).

Practical:

1. Identification of slides with two points of identification. Amoeba, Paramoecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules ofsponges, L.S. Hydra, Obelia, Bougainvillia, Larvae of Fasciola, Seta of Earthworm, Radul.
2. Identification & Classification upto order of the following: Proto-chordata: Salpa, Doliolum, Herdmania, Branchiostoma.
3. Finding the coagulation time of blood.
4. Determination of blood groups.
5. Determination of Haemoglobin.
6. Counting of mammalian RBCs.
7. Determination of TLC and DLC.

Text Books:

1. Modern text book of zoology: invertebrates, R.L. Kotpal, Rastogi Publications,Meerut
2. Modern text book of zoology: vertebrates, R.L Kotpal, Rastogi Publications, Meerut
3. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John Wiley & Sons,Inc

Suggested Reading:

1. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
2. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
3. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.
4. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.

C5: MOLECULAR BIOLOGY

Unit-I

DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Nucleosome, Packaging of DNA molecule into chromosomes, 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: DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Homologous recombination: models and mechanism.

Unit-III

Transcription and RNA processing: 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

Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoa acyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Post translational modifications of proteins

Regulation of gene expression and translation: Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics.

Practical:

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from animal/bacterial cells.
3. Agarose gel electrophoresis of genomic DNA.
4. Quantitation of DNA by Spectrophotometry.
5. Extraction of protein
6. SDS PAGE and Native PAGE

Text Book:

1. Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner (Pearson Education)

Suggested Readings

1. Cell and Molecular Biology - By Robertis&Robertis, Publ: Waverly
2. Genes - By B. Lewin - Oxford Univ. Press
3. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Fundamentals of Molecular Biology. Jayant K Pal and SS Ghaskadbi, Oxford University Press.

C6: BIO-CHEMISTRY AND METABOLISM

Unit-I

pH and buffers, Preparation and significance of buffers in biological system. .Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero polysaccharides, Muco-polysaccharides, Bacterial cell wall polysaccharides, Glycoproteins and their biological functions.

Carbohydrates Metabolism: Reactions, energetic and regulation. Glycolysis: Fate of pyruvate under aerobic and anerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis,Glycogenolysis and glycogen synthesis. TCA cycle, Electron transport chain, Oxidative phosphorylation,

Unit-II

Amino acid & Proteins: Structure and properties of Amino acids, Types of Proteins and their Classification, Different levels of structural organization of proteins, Fibrous and globular proteins.

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenezyme, prosthetic groups, Enzyme activity, Specific activity,

Unit-III

Lipids: Structure and functions Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, Sphingolipids, Glycolipids, Cerebrosides, Gangliosides, Prostaglandins, Cholesterol**.** Beta-oxidation of fatty acids.

Unit-IV

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.

Practical:

1. To study activities of any enzyme under optimum conditions.
2. Preparation of buffers.
3. Separation of Amino acids by paper chromatography.
4. Qualitative and quantitative tests for Carbohydrates and lipids.
5. Qualitative and quantitative estimation of proteins.

Text Book:

1. Nelson, D.L., Cox, M.M. (2004), Lehninger Principles of Biochemistry, 7th Edition, WH Freeman and Company, New York, USA.

Suggested Readings:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Harper's Illustrated Biochemistry (Harper's Biochemistry) by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell.

3. Fundamentals of Biochemistry. Life at the molecular level (Fourth Edition) by Donald Voet, Judith G. Voet and Charlotte. W. Pratt. Willey 2010.
4. Biophysical Chemistry, Principles & Techniques – Upadhyay, Upadhyay&Nath – Himalaya Publ.
5. Biochemistry, 4th edition by U Satyanarayana and U Chakrapani, Elsevier India
6. Biochemistry Concepts and Connections, DR Appling, SpEncer J. Anthony-Cahill,& Christopher K.Mathews, Pearson

C7: BIOSTATISTICS AND COMPUTER APPLICATIONS

Unit-I

Statistical methods and Developmental models: Graphical representation of statistical data, Mean, Poisson and Binomial, Distribution, Arithmetic, Geometric and Harmonic means, Median, Mode; Design of experiments,

Unit II

Analysis of Variance, Standard Deviation, Standard error of mean, Correlation and regression of two variables, Test of significance, Probability, sampling, measurement and distribution of attributes, t-test, chi-square test, F-test. Collection, Classification and Tabulation of data.

Unit III

Basic concept of computer: - Introduction, different components of computer, basic design of computer. Introduction to operating system, different management (processor, memory, device, file), Processor management-Process concept ,Threads ,CPU Scheduling Process scheduling, Deadlocks ,Process synchronization. Memory management – Memory allocation rule, Swapping, Overlay, Paging, Demand paging, segmentation, virtual memory. Device management, File management.

Unit IV

Computer application, DOS command, MS-Office, MS-Access, MS-Excel, MS-Power point, Assessing Internet. Services: Browsing, Downloading, e-correspondence.

Introduction C programming: Structure of C Program, Execution of C Program, Constants, Variable, Datatypes, Operator and Expression, Decision making Branching and Decision making looping, Array.

Practical:

1. Calculation of mean, median & mode taking biological samples.
2. Calculation of standard error of mean.
3. Chi-square test using biological samples.
4. DOS commands (Internal & External).
5. Some basic programs in C.
6. Programs on Decision making branching.
7. Programs Decision making Looping.
8. Programs on operators.

Text Books:

1. C in Depth by Shrivastava SK, Shrivastava D, BPB Publication, 2nd revised edition.
2. Biostatistics Theory and Applications by G. Mishra & P.K. Mohanty G.B.N. Chainy.

Suggested Readings:

1. Taxmann's Information Technology by Dr.Sushila Madan.
2. Let Us C by Yashwant Kanetkar 11th Edition.
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.
5. S.C. Gupta, V.K. Kapoor Fundamentals of Mathematical Statistics, A Modern Approach, 10^{th} edition, S Chand & Sons.

C8: IMMUNOLOGY

Unit-I

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

Regulation of immunoglobulin gene expression clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory.

Unit-III

Major Histocompatibility complexes class I & class II MHC antigens, antigen processing and presentation.

Immunity to infection- immunity to different organisms, pathogen defence strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency diseases, AIDS.

Unit-IV

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.

Practical:

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.

Text Book:

1. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W. H. Freeman and Company, New York.

Suggested Readings

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 thedition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11thedition Wiley-Blackwell Scientific Publication, Oxford.
3. Essentials of immunology by Roitt(Blackwell scientific publication)
4. Immunology and immunotechnology by Ashim k. Chakravarty (Oxford university Press).

C9: PLANT BIOTECHNOLOGY

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.

Unit- II

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 effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

Unit - III

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

Practical:

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

Text Book:

1. Introduction to Plant Biotechnology, H.S. Chawla,Science Publishers, 2002

Suggested Readings:

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice.Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
4. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.

5. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication
6. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation ofPlants, Oxford University Press.

C 10: ANIMAL BIOTECHNOLOGY

Unit I

Equipments and materials for animal cell culture: Design and layout of culture room, Basic equipments used in cell culture, Sterilization and aseptic techniques.

Culture media: General considerations in media design, Natural media, synthetic media. Primary culture and its maintenance.

Unit II

Various methods of cell separation, Cell cloning: Dilution cloning and isolation cloning, Transformation of cells, Organ culture, In vitro Fertilization, Embryo culture. Three dimensional culture.

Unit III

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.
Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo
transfer techniques. Introduction to Stem Cell Technology and its applications.

Unit IV

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

Practical:

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Cell counting and cell viability
4. Preparation of Hanks Balanced salt solution
5. Preparation of Minimal Essential Growth medium

Text Book:

1. Animal cell culture techniques, Ian Freshney, Wiley-Leiss

Suggested Readings:

1. Tissue Culture – Methods and Applications by Paul F. Kruse Jr. and M. K. Patterson, Jr.
2. Cell Culture LabFAx, M. Butler and M. Dawson, Bios scientific Publications Ltd
3. Cell and Tissue Culture: Laboratory Procedures in Biotechnology, A. Doyle and B.Griffith, Wiley publications.
4. Plant cell and Tissue Culture for the production of Food Ingradients by Fu, Singh and Curtis
5. Handbook of plant tissue culture, ICAR, publications & information division, New Delhi.
6. Animal Cell Culture - John R. W. Masters - Oxford University Press.

7. Introduction to Plant Biotechnology 2017 by H S Chawla - CRC Press.

C 11: GENETIC ENGINEERING

Unit- I

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, lectroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

Unit-II

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

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

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.

Practical:

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Demonstration of PCR

Text Book:

1. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

Suggested Readings:

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
3. Revolution.Elsevier Academic Press, USA.
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.
6. Biotechnology by B.D.Singh (Kalyani Publishers).

C 12: GENOMICS & PROTEOMICS

Unit-I

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

Unit-II

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

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions.

Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures Edman degradation.

Unit-IV

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilisation, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

Practical:

1. Use of SNP databases at NCBI and other sites
2. Detection of Open Reading Frames using ORF Finder
3. Proteomics 2D PAGE database
4. Software for Protein localization.
5. Native PAGE
6. SDS-PAGE

Text Books:

1. Charles Malkoff, 2016. Exploring Genomics, Proteomics and Bioinformatics, Syrawood Publishing House.
2. A. Malcolm Campbell Discovering Genomics, Proteomics and Bioinformatics,Pearson Education India; 2 edition

Suggested Readings:

1. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific.
2. Graur, D and W H Li, 2000. Fundamentals of molecular evolution. Sinauer Associates.
3. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres.2004. Genetics from Genes to Genomes. McGraw Hill.
4. The Human Genome 2001, Nature Vol. 409.
5. The Drosophila Genome. 2000, Science Vol. 267.
6. The Caenorhabditis elegans genome 1998. Science Vol. 282.

7. The Arabidopsis Genome 2000 Nature vol. 408.

C 13: ENVIRONMENTAL BIOTECHNOLOGY & BIOETHICS

Unit-I

Environment: Basic concepts and issues, Environmental modeling, Systems ecology, Ecosystem, Global Environmental Problems; Ozone depletion, Influence on Biodiversity of aquatic and terrestrial environment, Biodiversity of oceans, Estuaries and Lagoons.

Acid rain, Arid and semi-arid plant biotechnology, Green house technology, Environmental pollution and measures; Air, Water, Soil, Radioactive pollutions.

Unit-II

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

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

Unit-IV

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

Introduction to intellectual property: Types of IP (Trademarks, Copyright & Related rights, Industrial design, Traditional knowledge, Geographical indications, Protection of GMOs).

Basics of patents (Types of patent application and Specifications), concept of Prior Art and patent filing procedures

Practical:

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. 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.

Text Book:

1. P. K. Mohapatra, Textbook of Environmental Biotechnology, I.K. International Publishing House; 1st Ed. edition.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Suggested Readings:

1. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
2. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
3. Agricultural Biotechnology, S.S. Purohit
4. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
5. Introduction to Environmental Biotechnology, Milton Wainwright
6. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.

C 14: BIOPROCESS ENGINEERING & TECHNOLOGY

Unit-I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2- 3 butanediol, gluconic acid, itaconic acid. Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, Microbial electricity, starch conversion processes.

Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti-cancer agents, amino acids.

Unit-II

Production of microbial metabolite, Secondary metabolism its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

Unit-III

Purification & characterization of proteins, Upstream and downstream processing. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

Unit-IV

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

Practical:

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)
5. Production and analysis of Amylase.

Text Book:

1. Prescott & Dunn's Industrial Microbiology Paperback, 2004 by G. Reed (Author), CBS Publication

Suggested Readings

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

Discipline Specific Elective 1

BIOTECHINIQUES

Unit-I

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

Unit-II

Principle and law of absorption fluorimetry, Colorimetry, Spectrophotometry (visible, UV, infrared), Centrifugation, Cell Fractionation Techniques, Isolation of sub-cellular organelles and particles.

Unit-III

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

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

Practical:

1. Native gel electrophoresis of proteins
2. Determination of absorption maxima of given chemicals.
3. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
4. Separation of amino acids by paper chromatography.
5. To identify lipids in a given sample by TLC.
6. To verify the validity of Beers law and determine the molar extinction coefficient of NADH.

Text Books:

1. Principle and Techniques of Biochemistry and Molecular biology, 7th ed By Keith Wilson and Jhon Walker, Cambridge Press
2. Rodney Boyer, Modern Experimental Biochemistry, Pearson Education; 3 Edition.

Suggested Readings:

1. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III,
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7thedition. Pearson Benjamin Cummings Publishing, San Francisco.
3. An introduction to Practical Biochemistry - T. Plummer
4. Experimental Biochemistry- V. Deshpande and B. Sasidhar Rao (A Student Companion)
5. Biophysics – Vastala Piramal (Dominent Publishers)
6. Introductory Practical Biochemistry - S.K. Sawhney, Randhir Singh, Narosa Publishing.

Discipline Specific Elective 2

BIOINFORMATICS

Unit I

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

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, Mass Spectrometry.

Unit-III

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

Unit-IV

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

Practical:

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

Text Book:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

Suggested Readings:

1. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
2. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

Discipline Specific Elective 3

BIOENTERPRENEURSHIP

Unit I:Introduction
Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

Unit II: Establishing an Enterprise
Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

Unit III: Financing the Enterprise
Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

Unit IV: Marketing Management
Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.
Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

Text Book:
1. Gupta CB, Khanka SS. Entrepreneurship and small Business Management, Sultan Chand and Sons

Suggested Readings:
1. Holt DH Entrepreneurship: New Venture Creation.
2. Kalpan JM Patterns of Entrepreneurship

Discipline Specific Elective 4

MEDICAL MICROBIOLOGY

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, B. anthracis, C. tetani C. diphtheriae M. tuberculosis, M. leprae.*

Unit II
Pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli, N. gonorrhoea, N. meningitidis, S. typhi, S. dysenteriae, H. influenzae, V. cholerae, M. pneumoniae, Rickettsiaceae, Chlamydiae.*

Unit III
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
Fungal and Protozoan infections. Dermatophytoses (Trichophyton 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).

Practical:
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 apprpriate staining.
5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

Text Book:
1. Ananthnarayan ,Paniker, Arti Kapil Ananthanarayan and Paniker's Textbook of Microbiology, Universities Press (India) Private Limited

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.

DISCIPLINE SPECIFIC ELECTIVE 4: Project Reports& Seminar

Credits-6, Project Report: 60 marks, Seminar: 20 marks, Viva: 20 marks&Total: 100 Marks

- A selected Biotechnology based product
- Review articles
- Latest techniques and products of societal impact
- Contribution/discovery of Scientists in the field of Biotechnology
- Instrumentation and applications
- Scale up/ Down stream processing
- Models
- Bioinformatics tools

Generic Elective Paper-I

BIOCHEMISTRY AND MOLECULAR BIOLOGY

Unit-I

pH and buffers, Preparation and significance of buffers in biological system.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero polysaccharides, Glycoproteins and their biological functions.

Amino acid & Proteins: Structure and properties of Amino acids, Types of Proteins and their Classification, Different levels of structural organization of proteins.

Unit-II

Lipids: Structure and functions Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, Sphingolipids, Glycolipids, Cerebrosides, Gangliosides, 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.

Unit-III

DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Nucleosome, Replication of DNA in prokaryotes and eukaryotes: semiconservative nature of DNA replication.

Transcription and RNA processing: RNA structure and types of RNA, Transcription in prokaryotes and Eukaryotes, RNA splicing and processing: processing of pre-mRNA: 5 cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

Unit-IV

Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoa acyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Post translational modifications of proteins.

Practical:

1. Preparation of buffers.
2. Separation of Amino acids by paper chromatography
3. Qualitative and quantitative estimation of proteins.
4. Isolation of chromosomal DNA from bacterial cells.
5. Agarose gel electrophoresis of genomic DNA.
6. Quantification of DNA by Spectrophotometry.

Text Books:

1. Nelson, D.L., Cox, M.M. (2004), Lehninger Principles of Biochemistry, 7th Edition, WH Freeman and Company, New York, USA.

2. Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner (Pearson Education)

Suggested Readings

1. Biochemistry, 4th edition by U Satyanarayana and U Chakrapani, Elsevier India
2. Harper's Illustrated Biochemistry (Harper's Biochemistry) by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell.
3. Fundamentals of Biochemistry. Life at the molecular level (Fourth Edition) by Donald Voet, Judith G. Voet and Charlotte. W. Pratt. Willey 2010.
4. Biophysical Chemistry, Principles & Techniques – Upadhyay, Upadhyay&Nath – Himalaya Publ.
5. Genes - By B. Lewin - Oxford Univ. Press
6. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
7. Fundamentals of Molecular Biology. Jayant K Pal and SS Ghaskadbi, Oxford University Press

Generic Elective Paper-II

RECOMBINANT DNA TECHNOLOGY

Unit I

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),
Principle and applications of Polymerase chain reaction (PCR), primer-design, and Types of PCR.

Unit II

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 Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

Unit III

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

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.

Practical:

1. Isolation of chromosomal DNA from *E.coli*
2. Qualitative and quantitative analysis of DNA using spectrophotometer
3. Plasmid DNA isolation
4. Restriction digestion of DNA
5. Demonstration of PCR

Text Book:

1. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

Suggested Readings:

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. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
5. Biotechnology by B.D.Singh (Kalyani Publishers).

Generic Elective Paper-III

ENVIRONMENTAL BIOTECHNOLOGY AND BIOETHICS

Unit-I

Environment: Basic concepts and issues, Environmental modeling, Systems ecology, Ecosystem, Global Environmental Problems; Ozone depletion, Influence on Biodiversity of aquatic and terrestrial environment, Biodiversity of oceans, Estuaries and Lagoons.

Acid rain, Arid and semi-arid plant biotechnology, Green house technology, Environmental pollution and measures; Air, Water, Soil, Radioactive pollutions.

Unit-II

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

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

Unit-IV

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

Introduction to intellectual property: Types of IP (Trademarks, Copyright & Related rights, Industrial design, Traditional knowledge, Geographical indications, Protection of GMOs).

Basics of patents (Types of patent application and Specifications), concept of Prior Art and patent filing procedures

Practical:

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. 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

Text Book:

1. P. K. Mohapatra, Textbook of Environmental Biotechnology, I.K. International Publishing House; 1st Ed. edition.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Suggested Reading:

1. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
2. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
3. Agricultural Biotechnology, S.S. Purohit
4. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
5. Introduction to Environmental Biotechnology, Milton Wainwright
6. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.

Generic Elective Paper-IV

BIOPROCESS ENGINEERING & TECHNOLOGY

Unit-I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2 - 3 butanediol, gluconic acid, Biofuels: Biogas, Ethanol, butanol, biodiesel, Microbial electricity.

Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti-cancer agents, amino acids.

Unit-II

Production of microbial metabolite, Secondary metabolism its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell

immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, enzymes in food technology/organic synthesis.

Unit-III

Purification & characterization of proteins, Upstream and downstream processing. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

Unit-IV

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

Practical:

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)
5. Production and analysis of Amylase.

Text Book:

1. Prescott & Dunn's Industrial Microbiology Paperback, 2004 by G. Reed (Author), CBS Publication

Suggested Readings:

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

Framework of Biotechnology Syllabus for Pass Students

Sl No	Name of the Course	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	DSC 1	Cell Biology and Genetics	6	60	100
2	DSC 2	Molecular Biology	6	60	100
3	DSC 3	Biochemistry and Metabolism	6	60	100
4	DSC 4	Genetic Engineering	6	60	100
Total Paper		4	24	240	400

Sl No	Name of the Course	Paper	CP (Credit Point)	CH (Credit Hour)	MARKS
1	DSE 1	Bio-techniques	6	60	100
2	DSE 2	Bioinformatics	6	60	100
Total Paper		2	12	120	200

BIOTECHNOLOGY Papers for PASS Students

Discipline Specific Core – 4 papers&Discipline Specific Elective – 2 papers

Marks per paper - Midterm: 15 marks, Practical: 25 marks, End term: 60 marks, Total: 100 marks, Credit per paper – 6: Theory-4, Practical-2, Teaching hours per paper – 40 hours theory classes + 20 hours practical classes

Discipline Specific Core Paper I

CELL BIOLOGY & GENETICS

Unit-I

Cell: Introduction and structural organization of prokaryotic and Eukaryotic cells, compartmentalization of eukaryotic cells, cell fractionation. Cell membrane and Permeability: Chemical components of biological membranes and its organization, Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport. Cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure & function, Golgi complex.

Unit-II

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

Structure and functions; Lysosomes, Vacuoles and micro bodies, Ribosomes, Mitochondria, Chloroplasts, Nucleus: Chromosomes and their structure.

Unit-III

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, mono, di- and tri hybrid crosses, Law of segregation & Principle of independent assortment. Chromosomal theory of inheritance. Non allelic interactions

Unit-IV

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, concept of cistron, exons, introns, genetic code, gene function. Chromosome and gene mutations: Definition and types of mutations, causes of mutations, position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy. Sex determination and sex linkage: Mechanisms of sex determination.

Practical:

1. Study of plasmolysis and de-plasmolysis.
2. Study of structure of any prokaryotic Eukaryotic cell.
3. Microtomy: Fixation, Block making, Section cutting, Double staining of animal tissues like liver, Oesphagus, Stomach, pancreas, Intestine, Kidney, Ovary, testes.
4. Cell division in onion root tip/insect gonads.
5. Preparation of Nuclear, mitochondria & cytoplasmic fractions.
6. Study of polyploidy in onion root tip by colchicine treatment.
7. Karyotyping with the help of photographs.

Text Books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

Suggested Readings

1. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8thedition.Lippincott Williams and Wilkins, Philadelphia.
2. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress& Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. 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.
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.

Discipline Specific Core Paper 2

MOLECULAR BIOLOGY

Unit-I
DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Nucleosome, Packaging of DNA molecule into chromosomes, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, The replication complex: Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

Unit-II
DNA damage, repair and homologous recombination: DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Homologous recombination: models and mechanism.

Unit-III
Transcription and RNA processing: 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, mechanism of transcription initiation, RNA splicing and processing.

Unit-IV
Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoa acyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Post translational modifications of proteins, Regulation of gene expression and translation: Regulation of gene expression in prokaryotes: Operon concept

Practical:
1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from animal/bacterial cells.
3. Agarose gel electrophoresis of genomic DNA.
4. Quantitation of DNA by Spectrophotometry.
5. Extraction of protein.
6. SDS PAGE and Native PAGE.

Text Book:
1. Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner (Pearson Education)

Suggested Readings:
1. Cell and Molecular Biology - By Robertis&Robertis, Publ: Waverly
2. Genes - By B. Lewin - Oxford Univ. Press
3. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Fundamentals of Molecular Biology. Jayant K Pal and SS Ghaskadbi, Oxford University Press.

Discipline Specific Core Paper 3

BIO-CHEMISTRY AND METABOLISM

Unit-I

pH and buffers, Preparation and significance of buffers in biological system. . Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Carbohydrates Metabolism: Reactions, energetic and regulation. Glycolysis: Fate of pyruvate under aerobic and anerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis.

Unit-II

Amino acid & Proteins: Structure and properties of Amino acids, Types of Proteins and their Classification, Different levels of structural organization of proteins, Fibrous and globular proteins. Enzymes: Nomenclature and classification of Enzymes.

Unit-III

Lipids: Structure and functions Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, Sphingolipids, Glycolipids, Cerebrosides, Gangliosides, Prostaglandins, Cholesterol**.** Beta-oxidation of fatty acids.

Unit-IV

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.

Practical:

1. To study activities of any enzyme under optimum conditions.
2. Preparation of buffers.
3. Separation of Amino acids by paper chromatography.
4. Qualitative and quantitative tests for Carbohydrates and lipids.
5. Qualitative and quantitative estimation of proteins.

Text Book:

1. Nelson, D.L., Cox, M.M. (2004), Lehninger Principles of Biochemistry, 7th Edition, WH Freeman and Company, New York, USA.

Suggested Readings:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Harper's Illustrated Biochemistry (Harper's Biochemistry) by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell.
3. Fundamentals of Biochemistry. Life at the molecular level (Fourth Edition) by Donald Voet, Judith G. Voet and Charlotte. W. Pratt. Willey 2010.
4. Biophysical Chemistry, Principles & Techniques – Upadhyay, Upadhyay&Nath – Himalaya Publ.
5. Biochemistry, 4th edition by U Satyanarayana and U Chakrapani, Elsevier India
6. Biochemistry Concepts and Connections, DR Appling, SpEncer J. Anthony-Cahill,& Christopher K.Mathews, Pearson

Discipline Specific Core Paper 4

GENETIC ENGINEERING

Unit-I

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, PCR, primer-design, Reverse transcription PCR.

Unit-II

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.

Unit-III

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

Unit-IV

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.

Practical:

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Demonstration of PCR

Text Book:

1. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

Suggested Readings:

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. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
5. Biotechnology by B.D.Singh (Kalyani Publishers).

Discipline Specific Elective Paper I

BIOTECHINIQUES

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

Unit-II
Principle and law of absorption fluorimetry, Colorimetry, Spectrophotometry (visible, UV, infrared), Centrifugation, Cell Fractionation Techniques, isolation of sub-cellular organelles.

Unit-III
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
Introduction to electrophoresis, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting.

Practical:
1. Native gel electrophoresis of proteins.
2. Determination of absorption maxima of given chemicals.
3. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
4. Separation of amino acids by paper chromatography.
5. To identify lipids in a given sample by TLC.
6. To verify the validity of Beers law and determine the molar extinction coefficient of NADH.

Text Book:
1. Principle and Techniques of Biochemistry and Molecular biology, 7th ed By Keith Wilson and Jhon Walker, Cambridge Press
2. Rodney Boyer, Modern Experimental Biochemistry, Pearson Education; 3 Edition.

Suggested Readings:

1. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III,
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7thedition. Pearson Benjamin Cummings Publishing, San Francisco.
3. An introduction to Practical Biochemistry - T. Plummer
4. Experimental Biochemistry- V. Deshpande and B. Sasidhar Rao (A Student Companion)
5. Biophysics – Vastala Piramal (Dominent Publishers)
6. Introductory Practical Biochemistry - S.K. Sawhney, Randhir Singh, Narosa Publishing.

Discipline Specific Elective Paper I

BIOINFORMATICS

Unit I

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

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

Unit-III

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

Unit-IV

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

Practical:

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

Text Book:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

Suggested Readings:

1. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
2. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

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Four Optional SEC II Papers on BIOTECHNOLOGY:
Enzymology/ Basics of Forensic Science/ Mushroom culture/ Sericulture

Marks per paper - Midterm: 15 marks, Practical: 25 marks, End term: 60 marks, Total: 100 marks, Credit per paper – 6, Theory: 4 credits, Practical: 2 credits, Teaching hours per paper – 40 hours theory classes + 20 hours practicalclasses

Optional SEC II Paper 1
ENZYMOLOGY

Unit - I

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 Km and Vmax 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

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, 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, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feedback control, covalent modification.

Unit – III

Allosteric enzymes with special reference to aspartate transcarbomylase 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-e.g. 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* & i*nvivo*.

Practical:
1. Purification of an enzyme from any natural resource
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Perform assay for the purified enzyme.
4. Calculation of kinetic parameters such as Km, Vmax, Kcat

Suggested Readings:

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen
3. M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition,
4. Mc GrawHill, 2009.
5. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.
6. Biochemistry by Mary K. Campbell& Shawn O. Farrell, 5th Edition, Cenage Learning,2005.
7. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999

Optional SEC II Paper 2

BASICS OF FORENSIC SCIENCE

Unit I
Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit II
Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit III
Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

Unit IV
Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

Practical:
1. Documentation of crime scene by photography, sketching and field notes.
2. a. Simulation of a crime scene for training.
   b. To lift footprints from crime scene.

3. Case studies to depict different types of injuries and death.
4. Separation of nitro compounds (explosives)/ ink samples by thin layer chromatography.
5. Investigate method for developing fingerprints by Iodine crystals.
6. PCR amplification on target DNA and DNA profiling,
7. E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Recovering deleted evidences, Password Cracking

Suggested Readings:

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001). _
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002). _
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005). _
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).

Optional SEC II Paper 3

MUSHROOM CULTURE

Unit I

Introduction, history of mushroom cultivation; biology of mushrooms; Nutritional value: (Proteins, amino acids, mineral elements, carbohydrates, fibers, vitamins); Medicinal value of mushrooms; Poisonous mushrooms and mushroom poisoning; edible mushrooms and cultivation in India and world; Mycorrhizal mushrooms and their role in plant growth

Unit II

Cultivation Technology: Infrastructure, equipments and substrates in mushroom cultivation: Polythene bags, vessels, inoculation hook, inoculation loop, love cost stove, sieves, culture racks, mushroom unit or mushroom house, water sprayer, tray, boilers, driers, pure culture, Spawn: types of spawn, preparation of spawn, mushroom bed preparation and factors affecting mushroom bed preparation; Compost: materials used for compost preparation, compost technology in mushroom production

Unit III

Casing; raw material used for casing, preparation of casing material; important sanitation during various stages of mushroom cultivation, Cultivation of important mushrooms: General process for the cultivation of *Agaricusbisporus*, *Pleurotusostreatus* and *Volvariellavolvaceae* Pests and Pathogens of mushrooms and their management with reference to *Agaricusbisporus.*

Unit IV

Storage and food preparation from mushrooms: Methods of storage of mushroom cultivation, Long term and short term storage of mushrooms Foods/recipes from mushrooms; Mushroom research centers/farms: National level and regional level, Marketing of mushrooms in India and world.

Reference Books:

1. Mushroom Cultivation, Tripathi, D.P.(2005) Oxford & IBH Publishing Co. PVT.LTD, New Delhi.
2. Mushroom Production and Processing Technology, Pathak Yadav Gour (2010) Published by Agrobios (India).
3. A hand book of edible mushroom, S. Kannaiyan & K.Ramasamy (1980). Today & Tomorrows printers & publishers, New Delhi
4. Handbook on Mushrooms, Nita Bahl, Oxford & IBH Publishing Co.

Optional SEC II Paper 4

SERICULTURE

Unit- I:

History and scope of Sericulture: General account of global production of mulberry and non-mulberry silk, silk route, Geographical distribution of mulberry and non-mulberry sericulture, scope of sericulture in India; Types of silkworms: Life history of mulberry silkworm, growth stages of mulberry silkworm, classification of silkworm, non-mulberry silkworm's insects.

Unit-II:

Selection of silkworm breeds for rearing, estimation of mulberry leaf yield and assessment of leaf quality, estimation of brushing capacity requirements of rearing, disinfecting silkworm rearing house and appliances, silkworm rearing house, characteristics of rearing house, selection of site, Egg handling, Incubation & Chawki rearing; Pre-incubation care of silkworm eggs, incubation, black boxing, hatching, brushing of larvae, Late age silkworm rearing; Characteristics of late age silkworms, rearing methods, tray rearing, shelf rearing, floor rearing, advantages and disadvantages of shoot feeding and floor rearing, environmental conditions for silkworm rearing, leaf harvest, transportation and preservation, leaf quality and quantity, late age rearing, mechanization in silkworm rearing; Non- mulberry silkworm rearing; Tasar Silkworm Rearing, Oak Tasar Silkworm Rearing, Eri Silkworm Rearing, Muga Silkworm Rearing

Unit-III:

Silkworm seed technology : Silkworm egg production, embryonic development, diapause and non-diapause eggs, acid treatment, incubation of eggs in grainages through incubation chambers and related aspects; Silk Technology: Textile fibers: brief introduction to natural and synthetic fibers silk industry: general silk industry in various states of India cocoons: assessment of cocoon properties, silk reeling, cocoon stifling storage & preservation of cocoons in silk reeling units, cocoon cooking, silk reeling and re-reeling, raw silk testing, spun silk yarn, silk weaving;

Unit-IV:

Mulberry and Non-Mulberry food plants diseases and their management: Types of mulberry diseases, foliar diseases of mulberry and their management, leaf spot disease, powdery mildew disease, leaf rust disease, leaf blight disease, preparation of the spray solution, fungicides and their toxicity, equipments used for spraying the fungicides,precautions to be taken while spraying the fungicides, soil-borne diseases of mulberry,nursery diseases, root knot disease, root rot disease, types of diseases of non-mulberry silkworm host plants,

diseases of tropical tasar silkworm host plants, diseases of oak tasar silkworm host plants, diseases of muga silkworm host plants, diseases of eri silkworm host plants, tips on fungicides, Integrated disease management (IDM).

References Books:

1. Anonymous (1972): FAO Manuals on Sericulture Vol. I – IV
2. Hanumappa (1978): Sericulture for Rural Development, Himalaya Publications, Delhi.
3. Gubrajani, M.L. (1986): Silk Dyeing, printing and finishing, IIT, New Delhi.
4. Yokoyama, T. (1959): Silkworm Genetics illustrated: Japan Society for Promotion of Science, Tokyo.
5. Byung, Jo. (1987): Silk Textile Engineering, Moon, Halk Publication Scol. Korea.

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List of Minimum Instruments required for conducting Practicals

Sl. No.	Subject and Practical	Instrument
1	**C-1: MICROBIOLOGY** 1. Isolation of bacteria & their biochemical characterization. 2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop. 3. Preparation of media & sterilization methods, 4. Methods of Isolation of bacteria from different sources. 5. Determination of bacterial cell size by micrometry. 6. Enumeration of microorganism - total & viable count. **C-2: PLANT DIVERSITY AND PHYSIOLOGY** 1. To study and plot the growth curve of *E. coli* using turbidometric method and to calculate specific growth rate and generation time. 2. To study and plot the growth curve of *Aspergillus niger* by radical growth measurement 3. To study the effect of pH on the growth of *E. coli*. 4. To study the effect of temperature of *A. niger* by dry weight method & demonstration of the thermal death time and decimal reduction time of *E. coli*. 5. Separation of photosynthetic pigment by paper chromatography **DSE-1: BIOTECHNIQUES** 1. Separation of amino acids by paper chromatography. 2. To identify lipids in a given sample by TLC. **GE-II: RECOMBINANT DNA TECHNOLOGY** 1. Identification of pathogenic bacteria (any two) based on cultural, morphological	1. Laminar Air Flow Bench 2. Incubator 3. Autoclave 4. Microscope 5. TL Chromatography Jar 6. Hot air oven

	and biochemical characteristics.	
2	**C-3: CELL BIOLOGY AND GENETICS** 1. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source. 2. Preparation of Nuclear, mitochondria & cytoplasmic fractions. 3. Microtomy: Fixation, Block making, Section cutting, Double staining of animal tissues like liver, Oesophagus, Stomach, pancreas, Intestine, Kidney, Ovary, testes. 4. Cell division in onion root tip/insect gonads. **DSE-1: BIOTECHNIQUES** 1. Preparation of the sub-cellular fractions of rat liver cells. 2. Preparation of protoplasts from leaves.	1. Centrifuge 2. Microtome 3. Compound Microscope
3	**C-4: ANIMAL DIVERSITY AND PHYSIOLOGY** 1. Counting of mammalian RBCs. **C-8: IMMUNOLOGY** 1. Differential leucocytes count. 2. Total leucocytes count. 3. Total RBC count	1. Haemocytometer 2. Microscope
4	**C-5: MOLECULAR BIOLOGY** 1. Isolation of chromosomal DNA from bacterial cells. 2. Isolation of Plasmid DNA by alkaline lysis method 3. Agarose gel electrophoresis of genomic DNA & plasmid DNA. **GE-II: RECOMBINANT DNA TECHNOLOGY** 1. Isolation of chromosomal DNA from plant cells 2. Isolation of chromosomal DNA from E.coli 3. Qualitative and quantitative analysis of DNA using spectrophotometer 4. Plasmid DNA isolation 5. Restriction digestion of DNA	1. Centrifuge 2. Agarose gel casting tray and running Unit with powerpack 3. UV Transillumintor

5	**C-6: BIOCHEMISTRY & METABOLISM** 1. To study activities of any enzyme under optimum conditions. 2. To study the effect of pH, temperature on the activity of salivary amylase enzyme. 3. Determination of pH optima, temperature optima, K_m value, V_{max} value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity. 4. Estimation of blood by glucose oxidase method. Item Principles of Colorimetry: (i) Verification of Beers Lambert's law, estimation of protein. (ii) To study relation between absorbance and % transmission.	1. pH meter 2. Water Bath 3. Spectrophotometer/ Colorimeter 4. Digital balance
6	**C-7- BIOSTATISTICS AND COMPUTER APPLICATIONS** 1. DOS commands (Internal & External) 2. Some basic programs in C 3. Programs on Decision making branching 4. Programs Decision making Looping 5. Programs on operators **DSE-2: BIOINFORMATICS** 1. Sequence information resource 2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR) 3. Understanding and using: PDB, Swissprot, TREMBL 4. Using various BLAST and interpretation of results. 5. Retrieval of information from nucleotide databases. 6. Sequence alignment using BLAST. 7. Multiple sequence alignment using Clustal W.	Computer with Internet facility
7	**C-9,C-10: PLANT AND ANIMAL BIOTECHNOLOGY,** **C-13: BIO-ETHICS AND BIO-SAFETY** 1. Primary culture of animal cells: Aspetic techniques, selection and isolation of organs, disaggregation (mechanical/enzymatic), seeding 2. Cell counting and cell viability	1. Biosafety cabinet 2. CO_2 Incubator 3. Inverted microscope 4. Laminar hood

	3. Preparation of plant tissue culture medium 4. Organ culture, Callus propagation.	
8	**GE-II: RECOMBINANT DNA TECHNOLOGY** 1. Demonstration of PCR	1. Polymerase chain reaction (PCR) machine
9	**DSE-1: BIOTECHNIQUES** **1.** Native gel electrophoresis of proteins **2.** SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions. **C-12: GENOMICS & PROTEOMICS** **1.** Native PAGE **2.** SDS-PAGE	1. Native/ SDS gel casting and running units with powerpack 2. Transillumintor

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Faculty Training on Biotechnology Syllabus (21 Days)

[40 (Theory), 60 (Practicals)]

(Theory- 2 hrs, Practicals-3hrs)

Sl. No.	Subjects	Practicals (Hands on training/ Demonstration)	Theory (hrs)	Practicals (hrs)	Numbers of Days
1	Microbiology	• Isolation of bacteria & their biochemical characterization. • Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.	4	6	2
2	Cell Biology and Genetics	• Study of structure of any prokaryotic Eukaryotic cell. • Microtomy: Fixation, Block making, Section cutting, Double staining of animal tissues • Cell division in onion root tip/insect gonads.	4	6	2
3	Molecular Biology	• Isolation of chromosomal DNA from animal/bacterial cells. • Agarose gel electrophoresis of genomic DNA. • Quantitation of DNA by Spectrophotometry. • SDS-PAGE and Native PAGE	4	6	2
4	Biochemistry and Metabolism	• To study activities of any enzyme under optimum conditions. • Separation of Amino acids by paper chromatography. • Qualitative and quantitative tests for Carbohydrates and lipids. • Qualitative and quantitative estimation of proteins.	4	6	2
5	Immunology	• Differential leucocytes count. • Total RBC count. • Haemagglutination assay • Haemagglutination inhibition assay.	4	6	2
6	Plant Biotechnology	• Preparation of complex nutrient medium (Murashige& Skoog's medium) • To demonstrate various steps of Micropropagation	4	6	2

7	Animal Biotechnology	• Cell counting and cell viability • Cell culture techniques	2	3	1
8	Enzymology	• Purification of an enzyme from any natural resource • Perform assay for the purified enzyme. • Calculation of kinetic parameters such as Km, Vmax, Kcat	2	3	1
9	Genetic Engineering	• Isolation of chromosomal DNA • Qualitative and quantitative analysis of DNA • Plasmid DNA isolation • Restriction digestion of DNA • Demonstration of PCR	4	6	2
11	Biotechniques	• Native gel electrophoresis of proteins • Determination of absorption maxima of given chemicals. • To identify lipids in a given sample by TLC.	4	6	2
12	Bioinformatics	• Sequence information resource • Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR) • Understanding and using: PDB, Swissprot, TREMBL • Using various BLAST and interpretation of results. • Retrieval of information from nucleotide databases. • Sequence alignment using BLAST. • Multiple sequence alignment using Clustal W.	2	3	1
13	Bioprocess Engineering and Technology	• Comparative analysis of design of a batch and continuous fermenter. • Calculation of Mathematical derivation of growth kinetics.	4	6	2

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