

**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 the Course	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 $\geq 60\%$	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 & Entrepreneurship

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. 4th 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. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. 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, gibberellins, 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: Shivalal 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, 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.

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, Oesophagus, 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. ASM Press & 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, Paramecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules of sponges, 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. Harcourt 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, aminoacyl 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, coenzyme, 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. Chaihy.

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, 10th 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. 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. 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 androgenesis Significance and use of haploids, Ploidy level and chromosome doubling, diploidization, 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, 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.

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 of Plants, 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 Ingredients 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-Appling 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.
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 Sanger's 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 chlorinated 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 (K_a) 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

BIOTECHNIQUES

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 Pirmal (Dominant 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

Pathogenesis, 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, Coccidioides) 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 appropriate 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, aminoacyl 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-Appling 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 chlorinated 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 (K_a) 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, abnormalities– 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, Oesophagus, 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. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
2. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & 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, aminoacyl 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-Appling 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

BIOTECHNIQUES

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 (Dominant 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.

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 practical classes

Optional SEC II Paper 1
ENZYMOLGY

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 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

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, 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 *in vitro* & *in vivo*.

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 K_m , V_{max} , K_{cat}

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, Cengage 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*, *Pleurotustosreatus* 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.

List of Minimum Instruments required for conducting Practicals

Sl. No.	Subject and Practical	Instrument
1	<p>C-1: MICROBIOLOGY</p> <ol style="list-style-type: none"> 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. <p>C-2: PLANT DIVERSITY AND PHYSIOLOGY</p> <ol style="list-style-type: none"> 1. To study and plot the growth curve of <i>E. coli</i> using turbidometric method and to calculate specific growth rate and generation time. 2. To study and plot the growth curve of <i>Aspergillus niger</i> by radical growth measurement 3. To study the effect of pH on the growth of <i>E. coli</i>. 4. To study the effect of temperature of <i>A. niger</i> by dry weight method & demonstration of the thermal death time and decimal reduction time of <i>E. coli</i>. 5. Separation of photosynthetic pigment by paper chromatography <p>DSE-1: BIOTECHNIQUES</p> <ol style="list-style-type: none"> 1. Separation of amino acids by paper chromatography. 2. To identify lipids in a given sample by TLC. <p>GE-II: RECOMBINANT DNA TECHNOLOGY</p> <ol style="list-style-type: none"> 1. Identification of pathogenic bacteria (any two) based on cultural, morphological 	<ol style="list-style-type: none"> 1. Laminar Air Flow Bench 2. Incubator 3. Autoclave 4. Microscope 5. TL Chromatography Jar 6. Hot air oven

	and biochemical characteristics.	
2	<p>C-3: CELL BIOLOGY AND GENETICS</p> <ol style="list-style-type: none"> 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. <p>DSE-1: BIOTECHNIQUES</p> <ol style="list-style-type: none"> 1. Preparation of the sub-cellular fractions of rat liver cells. 2. Preparation of protoplasts from leaves. 	<ol style="list-style-type: none"> 1. Centrifuge 2. Microtome 3. Compound Microscope
3	<p>C-4: ANIMAL DIVERSITY AND PHYSIOLOGY</p> <ol style="list-style-type: none"> 1. Counting of mammalian RBCs. <p>C-8: IMMUNOLOGY</p> <ol style="list-style-type: none"> 1. Differential leucocytes count. 2. Total leucocytes count. 3. Total RBC count 	<ol style="list-style-type: none"> 1. Haemocytometer 2. Microscope
4	<p>C-5: MOLECULAR BIOLOGY</p> <ol style="list-style-type: none"> 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. <p>GE-II: RECOMBINANT DNA TECHNOLOGY</p> <ol style="list-style-type: none"> 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 	<ol style="list-style-type: none"> 1. Centrifuge 2. Agarose gel casting tray and running Unit with powerpack 3. UV Transilluminator

5	<p>C-6: BIOCHEMISTRY & METABOLISM</p> <ol style="list-style-type: none"> To study activities of any enzyme under optimum conditions. To study the effect of pH, temperature on the activity of salivary amylase enzyme. Determination of pH optima, temperature optima, K_m value, V_{max} value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity. 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. 	<ol style="list-style-type: none"> pH meter Water Bath Spectrophotometer/ Colorimeter Digital balance
6	<p>C-7- BIostatistics AND COMPUTER APPLICATIONS</p> <ol style="list-style-type: none"> DOS commands (Internal & External) Some basic programs in C Programs on Decision making branching Programs Decision making Looping Programs on operators <p>DSE-2: BIOINFORMATICS</p> <ol style="list-style-type: none"> 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. 	<p>Computer with Internet facility</p>
7	<p>C-9,C-10: PLANT AND ANIMAL BIOTECHNOLOGY, C-13: BIO-ETHICS AND BIO-SAFETY</p> <ol style="list-style-type: none"> Primary culture of animal cells: Aseptic techniques, selection and isolation of organs, disaggregation (mechanical/enzymatic), seeding Cell counting and cell viability 	<ol style="list-style-type: none"> Biosafety cabinet CO₂ Incubator Inverted microscope Laminar hood

	<ul style="list-style-type: none"> 3. Preparation of plant tissue culture medium 4. Organ culture, Callus propagation. 	
8	<p>GE-II: RECOMBINANT DNA TECHNOLOGY</p> <ul style="list-style-type: none"> 1. Demonstration of PCR 	<ul style="list-style-type: none"> 1. Polymerase chain reaction (PCR) machine
9	<p>DSE-1: BIOTECHNIQUES</p> <ul style="list-style-type: none"> 1. Native gel electrophoresis of proteins 2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions. <p>C-12: GENOMICS & PROTEOMICS</p> <ul style="list-style-type: none"> 1. Native PAGE 2. SDS-PAGE 	<ul style="list-style-type: none"> 1. Native/ SDS gel casting and running units with powerpack 2. Transilluminator

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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Differential leucocytes count. • Total RBC count. • Haemagglutination assay • Haemagglutination inhibition assay. 	4	6	2
6	Plant Biotechnology	<ul style="list-style-type: none"> • Preparation of complex nutrient medium (Murashige& Skoog's medium) • To demonstrate various steps of Micropropagation 	4	6	2

7	Animal Biotechnology	<ul style="list-style-type: none"> • Cell counting and cell viability • Cell culture techniques 	2	3	1
8	Enzymology	<ul style="list-style-type: none"> • Purification of an enzyme from any natural resource • Perform assay for the purified enzyme. • Calculation of kinetic parameters such as K_m, V_{max}, K_{cat} 	2	3	1
9	Genetic Engineering	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Comparative analysis of design of a batch and continuous fermenter. • Calculation of Mathematical derivation of growth kinetics. 	4	6	2

Model Syllabus of Courses
Ability/Skill Enhancement

**STATE MODEL SYLLABUS FOR UNDER
GRADUATE
COURSE IN
ABILITY/SKILL ENHANCEMENT
(+3 Arts, Science & Commerce Examination)**

**UNDER
CHOICE BASED CREDIT SYSTEM**

ENVIRONMENTAL STUDIES (AECC I)

SEMESTER – I

FOR UNDER GRADUATE ARTS, SCIENCE & COMMERCE – 2019-20

FULL MARKS: 100

TIME: 3 HOURS

TIME: 1 HOUR

END SEMESTER: 80

MID SEMESTER: 20

Unit – I

The Environment: The Atmosphere, Hydrosphere, Lithosphere, Biosphere, Ecology, Ecosystem, Biogeochemical Cycle (Carbon Cycle, Nitrogen Cycle), Environment Pollution: Air Pollution, Water Pollution, Soil Pollution, Radiation Pollution.

Unit – II

Population Ecology: Individuals, Species, Pollution, Community, Control Methods of Population, Urbanization and its effects on Society, Communicable Diseases and its Transmission, Non-Communicable Diseases.

Unit- III

Environmental Movements in India: Grass root Environmental movements in India, Role of women, Environmental Movements in Odisha, State Pollution Control Board, Central Pollution Control Board.

Unit –IV

Natural Resources: Conservation of Natural Resources, Management and Conservation of Wildlife, Soil Erosion and Conservation, Environmental Laws: Water Act, 1974, Air Act, 1981, The Wildlife (Protection) Act, 1972, Environment Protection, 1986, Natural Disasters and their Management.

Books Recommended

1. Dash MC and Mishra PC, Man and Environment, McMillan, London.
2. Mishra PC and Das MC, Environment and Society, McMillan, London.
3. Odeem EP, Fundamentals of Ecology, Natraj Publication.
4. Mishra DD, Fundamental Concept in Environmental Studies, S.Chand, New Delhi.
5. Asthana DK and Asthana Meera, A Testbook of Environmental Studies, S. Chand, New Delhi.

6. Bharucah Erach, Textbook for Environmental Studies, Universities Press India Pvt. Ltd., Hyderabad.

Ability Enhancement Compulsory Course (AECC II)
MIL / Alternative English **

**** The Detailed course is available in the respective language courses. For Example, MIL Odia is available in the Model Syllabus for Odia**

SKILL ENHANCEMENT COURSES (SEC)

As per the CBCS regulation, the student registered under Honours course in any subject has to opt for two SEC courses and a student registered under Pass stream has to opt for four SEC courses. In this context, Some options are provided here. Syllabus of individual subjects also have listed additional skill based papers at the end. In addition, the combined board and Project OHEPEE has also formulated two skill papers in great detail keeping requirements of spoken English and quantitative as well as logical thinking abilities in mind. These two Special SEC papers are available as separate Model Syllabi.

Optional for SEC paper

Total Marks- 100

Skill Enhancement Courses (SEC Option-I)

ENGLISH COMMUNICATION

Introduction: This paper intends to build up the four primary skills in students in the academic as well as in the wider domains of use like public offices. The books recommended only provide guidelines for what to teach, and the list is in no way exhaustive. Teachers must be free and resourceful enough to collect teaching materials on their own, and even use newspaper clippings as teaching materials.

This is an activity-based, goal-oriented, functional course in English Communication, which aims to make the students able and efficient communicators by helping them to be self-reflexive about English. This course has a pre-defined context of being supportive and complementary to the core courses in various disciplines. Therefore, unlike most other courses in English Communication on offer, it does not seek to build facile fluency that passes off as communicative competence. Rather, it intends to equip the students with the relevant skills of presentation and expression needed in the academic as well as in the professional domains of communicative use. While reading skills exercises are meant to promote the acquisition of analytical and comprehension skills, writing skills exercises are centered on sentence construction, paragraph development and précis writing. Teachers must be free and flexible enough in relation to teaching materials, using newspaper clippings, non-conventional and multi-media resources in the classroom. There is ample scope to build the speaking and listening skills of students in the way the course is planned with an emphasis on interactive learning and articulation.

UNIT 1: Introduction

- (i) What is communication?
- (ii) Types of communication (Horizontal, Vertical, Interpersonal, Grapevine),
- (iii) Uses of Communication, Inter-cultural communication, Communication today:
- (iv) Distinct features of Indianisation, alternative texts of language learning, global English and English in the print and electronic media in India.

UNIT 2: The Four Skills and Prospect of new material in language learning

- (i) Listening-Passive and active, Speaking effective, intelligibility and clarity
- (ii) Methods and techniques of reading such as skimming, scanning and searching for information; Reading to understand the literal, metaphorical and suggested meaning of a passage,
- (iii) Identifying the tone (admiring, accusatory, ironical, sympathetic, evasive, indecisive, ambiguous, neutral etc.) of the writer and view-points.
- (iv) Cohesive and Coherent writing

UNIT 3: Grammatical and Composition Skills

- (i) Doing exercises like filling in the blanks, correcting errors, choosing correct forms out of alternative choices, joining clauses, rewriting sentences as directed, and replacing indicated sections with single words / opposites / synonyms, choosing to use correct punctuation marks, getting to understand and use formal and informal styles, learning to understand the usages of officialese, sexism, racism, jargon.
- (ii) Learning to understand information structure of the sentence such as topic-focus relationship; strategies of thematization, postponement, emphasis, structural compression (deletion of redundant parts, nominalization, cleft and pseudo-cleft sentences, elliptical structures etc.), Logical Connectors between sentences, Methods of developing a paragraph, structure of an essay and methods of developing an essay

UNIT 4: Exercises in Written Communication

- (i) Précis writing
- (ii) Note-taking skills
- (iii) Writing reports
- (iv) Guidelines and essentials of official correspondence for making enquiries, complaints and replies
- (v) Making representations; writing letters of application for jobs; writing CV, writing letters to the editor and social appeals in the form of letters/pamphlets.

Reference Books:

- *Ways of Reading: Advanced reading Skills for Students of English Literature.* Martin Montgomery et al. London: Routledge, 2007.

- *Applying Communication Theory for Professional Life: A Practical Introduction.* Dainton and Zelle, <http://tsime.uz.ac.zw/claroline/backends/download.php?url=L0ludHJvX3RvX2NvbW11bmljYXRpb25fVGh3J5LnBkZg%3D%3D&cidReset=true&cidReq=MBA563>
- *Literature and the art of Communication*, Cambridge University Press.
- *Vistas and Visions*. Orient Black Swan (writing and grammar exercises at the end of lessons are recommended) From *Remapping An Anthology for Degree Classes*, ('Writing Skills'), Orient Black Swan.
- *Indian English through Newspapers* (Chapter 4,5 and 6), Concept, New Delhi,2008.
- *Contemporary Communicative English*, S Chand
- *Technical Communication: A Reader Centred Approach*. P.V. Anderson. Wadsworth, Cengage.

SEC Option II
MODERN OFFICE MANAGEMENT

Full marks – 100
Mid Term-20
End Term-80

Unit- I: Office

What is a Business Enterprise? What is an Office? Who are Office Staff? What are the most Common Forms of Business Organization? What are the Advantages of Office Work? What are the Categories of Office Career and Job Classifications under Each Category? What are the Specific Skill Requirements for Office Jobs?

Duties and Responsibilities of Office Staff

Unit-II: Records Management

Objectives of Record Keeping; What is Filing? What are the Different Kinds of Filing System? Steps in Filing; Indexing; Selecting the Appropriate Filing System; How to handle Incoming & Outgoing Mails

Unit –III: Document/Report Writing

Key points to write a document: The 5w-h plan for writing; Steps in writing workplace documents; Important things to remember when editing seven layout mistakes to avoid; Quick tips for report Writing; Basics of Meetings

Unit-IV: Supervisory Skills

What are the Skills of the Supervisor and How to Acquire Them? Functions of Supervisor

Communication

Meaning; Process; Communicating Tools; Types, Barriers

Leadership & Motivation

Meaning and Concept; Importance of Leadership; Qualities of a Leader; Relationship & Differences Leadership and Motivation; Organizational Leadership; Leadership Ethics - Traits of an Ethical Leader; Leadership Styles - Important Leadership Styles- Situational Leadership – Emotional Intelligence of Leader; Which Leadership Style to Follow? Influence of Situational Leadership Styles on Subordinate Development;

References:-

1. Office Management
By Ankita Bhatia
Dr. R. K. Chopra
2. Office Management
By [Dr. P. Rizwan Ahmed](#)
3. Office Management
By R S N Pillai

SEC OPTION III

Leadership and Personality Development

Full Mark:-100 (Mid Sem:-20 End Sem.:80) Credit Point-04 Credit Hour-40

Unit I: Leadership: Definition and meaning, Importance, Leadership and Management, Leader vs Manager, Essential qualities of an effective leader

Unit II: Theories of Leadership: Trait theory, Behavioral theories, Contingency theory

Unit III: Types of Leaders, Leadership styles: Traditional, Transactional, Transformational, Inspirational and servant leadership and Emerging issues in leadership: Emotional Intelligence and leadership, Trust as a factor, Gender and Leadership

Unit IV: Personality: Concept and Definition, Determinants of personality, Personality traits, Personality characteristics in organizations: Self evaluation, Locus of control, Self-efficacy, Self-esteem, Self-monitoring: Positive and negative Impact. Organizational Context of Leadership and Personality, Contemporary Business Leaders.

Book Reference:

1. Organisational Behaviour , M.Parikh and R.Gupta , TataMcGraw Hill Education Private Limited
2. Organisational Behavior, D. Nelson, J.C Quick and P. Khandelwal, Cengage Publication.

SEC OPTION IV

FINANCIAL LITERACY AND BANKING

Full Marks – 100
(Mid Sem-20 + End Sem-80)
Credit Points - 4

Objectives- To make the students aware of the benefits of financial planning

Unit: I – Basics of Savings and Investment: Why are investing and savings important? Savings Vs Investment, Power of Compounding, What should be the investment objectives? Risk and Return, Inflation effects on Investment, Investor's Age and Assets Allocation. **Tax saving Schemes-** Government Schemes-National Saving Certificates, Public Provident Fund, Post Office Schemes, Equity Linked Savings Schemes, Retirement Benefits Schemes- NPS (New Pension System)

Unit:-II- Banking Activities: Deposits and Types of Deposits-Saving Bank Accounts, Fixed Deposit Accounts, Recurring Deposit Account, Special Term Deposit Schemes, Loans and Types of loan advanced by Banks and Other secondary functions of Bank. Banking structure in India and Role of Reserve Bank of India

Unit: III- Financial Markets: Capital Market Vs Money Market, Securities and its types, i.e., Equity, Debentures or Bonds, IPOs and FPOs, Mutual Funds, Types of Mutual Funds, Brokers, sub-brokers, Process for becoming a capital market investor

Unit:IV- Protection Related products: Insurance Policies, Life Insurance, Term Life Insurance, Endowment Policies, Pension Policies, ULIP, Health Insurance and its Plans, Understanding of Ponzi Schemes

Output: It will make a more responsible individual with a disciplined approach to money and helps people from overspending and inculcates a habit of savings and investments.

Books for References:

1. Investment Planning by SEBI
2. Indian financial System, by T. R. Jain and R. L .Sharma, VK Global Publisher
3. Money and Banking by T. R. Jain and R. K. Kaundal, VK Global Publisher

SEC OPTION V

DATA ANALYSIS AND COMPUTER APPLICATION

Course Description: The purpose of this course is to introduce basic computer skills to students at UG level in non technical subjects. After completion of this course, the students are expected to acquire some basic knowledge about computers and to develop some basic skills in using computers for data storage, compilation, analysis and presentation.

Module I:

Introduction to computer and Basic data types Introduction to computer- Characteristics and Basic Applications of Computer, Components of Computer System, Central Processing Unit (CPU), VDU, Keyboard and Mouse, Other input/output Devices, Memory, concepts of Hardware and Software, Classifications of computers; Representation of data/Information concepts of data processing, Basic data types, Storage of data/Information as files, operating system and The User Interface (windows, Linux), Windows Setting- Control Panels, Accessories (windows)

Module II:

Basic Word Processing Introduction to Word Processing, Opening Word Processing Package, Opening and closing documents, Using a Document/Help Wizard, Text Creation and Manipulation, Formatting the Text, Handling Multiple Documents, Table Manipulation, Printing, saving documents in different formats. Basic Presentations Basics- Difference between presentation and document, Using Power Point, Creation of Presentation, Preparation of Slides, Selection of type of Slides, Importing text from word documents, Providing aesthetics- Slide Designs, Slide Manipulation and Slide Show, Presentation of the Slides

Module III:

Spreadsheets and Basic Data Analysis Spread Sheet, Elements of Electronics Spread Sheet, Application/usage of Electronic Spread Sheet, Manipulation of cells, Formulas and functions; Spread

sheets for Small accountings maintaining invoices/budgets, basic practical data analysis works (Maintaining daily and monthly sales reports)

Module IV:

Basic Computer Communication and Internet Basic of Computer networks- LAN and WAN, Internet, Service on Internet; WWW and Web Browsers, Web Browsing software, Surfing the Internet, Chatting on Internet, Email-Basic of electronic mail, Using Emails, Document handling in Email.

Reading List:

1. C.S. French "Data Processing and Information Technology", BPB Publications 1998
2. P.K Sinha, Computer Fundamentals, BPB Publications, 1992
3. Guy Hart-Davis "The ABCs of Microsoft Office 97 Professional edition", BPB Publications, 1998
4. Karl Schwartz, "Microsoft Windows 98 Training Guide", 1998

4. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC.
5. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
6. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
7. Analysis of soil: determination of pH of soil, total soluble salt, estimation of calcium, magnesium, phosphate, nitrate.
8. Separation of metal ions from their binary mixture.
9. Separation of amino acids from organic acids by ion exchange chromatography.
10. Determination of dissolved oxygen in water.
11. Determination of chemical oxygen demand (COD).

Reference Books:

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G. H. Jeffery and others) 5th Ed., The English Language Book Society of Longman.
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed., Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.

GENERIC ELECTIVE (GE)

Generic Elective Paper I (Theory)

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Section A: Inorganic Chemistry-I

Unit-I

Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Quantum numbers and their significance, shapes of s, p and d atomic orbitals, nodal planes.

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbital, Anomalous electronic configurations.

Unit-II

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics, energy considerations. Lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules and its applications.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules (N_2 , O_2) and heteronuclear diatomic molecules (CO, NO). Comparison of VB and MO approaches.

Section B: Organic Chemistry-I

Unit- III

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive effect, Electrometric effect, Resonance and hyperconjugation. Cleavage of bonds: Homolysis and heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Hückel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). D and L; cis-trans nomenclature; CIP Rules: R/ S (for one chiral carbon atoms) and E / Z Nomenclature (for up to two C=C systems).

Unit-IV

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Up to 5 Carbons) *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Up to 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis-alkenes (Partial catalytic hydrogenation) and trans-alkenes (Birch reduction). *Reactions:* cis-addition (alk. KMnO_4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti- Markownikoff's addition), Hydration, Ozonolysis.

Alkynes: (Up to 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO_4 , ozonolysis.

Recommended Text Books:

1. Lee J. D., Concise Inorganic Chemistry, Wiley India, 5thEdn., 2008.

- Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd Ed., 2017.
- Shriver D. E., Atkins P. W., Inorganic Chemistry, Oxford University Press, 5th Edn.
- Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry – Principles of structure and reactivity, Pearson Education, 4th Ed. 2002.
- Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Bhal Arun & Bhal B S , Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism; 8th Edn, New Age International, 2015.

Reference books

- Das Asim K., Fundamentals of Inorganic Chemistry, Vol. II, CBS Publications, 2nd Ed. 2010.
- Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017.
- Mallick, Madan and Tuli, S. Chand Selected Topic in Inorganic Chemistry, 17th Edn. 2010.
- Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications.

Generic Elective Paper I LAB

Section A: Inorganic Chemistry

Volumetric Analysis

- Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
- Estimation of oxalic acid by titrating it with KMnO_4 .
- Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .
- Estimation of Fe(II) ions by titrating it with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator.
- Estimation of Cu(II) ions iodometrically using $\text{Na}_2\text{S}_2\text{O}_3$.

Section B: Organic Chemistry

- Detection of extra elements (N, S, Cl) in organic compounds (containing up to two extra elements)

2. Separation of mixtures by Chromatography: Measure the R_f value in each case (combination of two compounds to be given)
- (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.
- (b) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).

Generic Elective Paper II (Theory)

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY

Section A: Physical Chemistry-I

Unit-I

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchoff's equation.

Statement of Third Law of thermodynamics.

Chemical Equilibrium

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG° , Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases.

Unit- II

Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Section B: Organic Chemistry-II

Unit- III

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Alkyl and Aryl Halides

Alkyl Halides (Up to 5 Carbons) Types of Nucleophilic Substitution (SN_1 , SN_2 and SN_i) reactions.

Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by $-OH$ group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Unit- IV

Alcohols, Phenols and Ethers (Up to 5 Carbons)

Alcohols: Preparation: Preparation of 1° , 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes and ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, Alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Up to 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer Tiemann Reaction, Gattermann -Koch Reaction,

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): Formaldehyde, acetaldehyde, acetone and benzaldehyde

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, NaHSO₃, NH₂-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction.

Recommended Text Books:

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co, 47th Edn., 2017.
3. K. L. Kapoor, Text Book of Physical Chemistry, Mac Grow Hill, 3rdEdn. 2017.
4. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Arun Bahl & B S Bahl, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.

Reference Books:

1. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, Pradeep Publications.
2. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications

Generic Elective Paper II LAB

Section A: Physical Chemistry

Thermochemistry (any three)

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO₃, NH₄Cl).
5. Determination of enthalpy of hydration of copper sulphate.

6. Study of the solubility of benzoic acid in water and determination of ΔH .

Ionic equilibria

pH measurements

- a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
- b) Preparation of buffer solutions:
 - Sodium acetate-acetic acid
 - Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water) and determination of melting.
2. Preparations, recrystallisation, determination of melting point and calculation of quantitative yields of the followings:
 - (a) Bromination of Phenol/Aniline
 - (b) Benzoylation of amines/phenols
 - (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

Reference Books

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).
4. Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).

Generic Elective Paper III (Theory)

CHEMISTRY OF S- AND P-BLOCK ELEMENTS, STATES OF MATTER & CHEMICAL KINETICS

Section A: Inorganic Chemistry-II

Unit-I

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.

Hydrometallurgy, Methods of purification of metals (Al, Pb, Fe, Cu, Ni): electrolytic, oxidative refining, Parting process, van Arkel-de Boer process and Mond's process.

s- and *p*-Block Elements

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling & Mulliken scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Unit-II

Compounds of *s*- and *p*-Block Elements

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of *p*-block elements.

Concept of multicentre bonding (diborane).

Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry.

Hydrides of nitrogen (NH_3 , N_2H_4 , N_3H , NH_2OH); Oxoacids of P, S and Cl; Halides and oxohalides: PCl_3 , PCl_5 , SOCl_2 .

Section B: Physical Chemistry- II

Unit-III

Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.

Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Unit-IV

Solids

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X-Ray diffraction by crystals, Bragg's law. Structures of NaCl, and CsCl (qualitative treatment only). Defects in crystals.

Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Recommended Text Books:

1. Lee J. D., Concise Inorganic Chemistry, Wiley India, 5th Edn., 2008.

2. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017.
3. Shriver D. E., Atkins P. W., Inorganic Chemistry, Oxford University Press, 5th Edn.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co, 47th Edn., 2017.
5. K. L. Kapoor, Text Book of Physical Chemistry, Mac Grow Hill, 3rd Edn. 2017.

Reference Books:

1. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, Pradeep Publications.
2. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017.

Generic Elective Paper -III LAB

Section A: Inorganic Chemistry

Qualitative analysis of inorganic salt mixture using H₂S: not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : NH₄⁺, Pb²⁺, Ag⁺, Bi³⁺, Cu²⁺, Cd²⁺, Sn²⁺, Fe³⁺, Al³⁺, Co²⁺, Cr³⁺, Ni²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, K⁺

Anions: CO₃²⁻, S²⁻, SO₃²⁻, NO₃⁻, Cl⁻, Br⁻, I⁻, NO₃⁻, SO₄²⁻, PO₄³⁻, F⁻

(Spot tests should be carried out wherever feasible)

Section B: Physical Chemistry

Chemical Kinetics

Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
 - a. Acid hydrolysis of methyl acetate with hydrochloric acid.
 - b. Saponification of ethyl acetate.
 - c. Compare the strengths of HCl and H₂SO₄ by studying kinetics of hydrolysis of methyl acetate

Reference Books:

1. Svehla, G, Vogel's Qualitative Inorganic Analysis, 7th Ed, 4th Ed., Pearson Education (2007).

2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).
3. Gulati Shikha , Sharma Gulati JL and Manocha, Shagun, Practical Inorganic Chemistry, 1stEdn., CBS Publishers & Distributors Pvt Ltd., (2017).

Generic Elective Paper- IV (Theory)

ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLYNUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY

Section A: Inorganic Chemistry- III

Unit-I

Chemistry of 3d metals

Oxidation states displayed by Cr, Fe, Co, Ni and Co.

A study of the following compounds (including preparation and important properties);

Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π -acceptor behaviour of carbon monoxide. Synergic effects (VB approach).

Unit-II

Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+ , K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, and structural role (bones).

Section B: Organic Chemistry- III

Unit-III

Polynuclear and heteronuclear aromatic compounds

Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole, Thiophene, and Pyridine.

Active methylene compounds

Preparation: Claisen ester condensation. Keto-enol tautomerism.

Reactions: Synthetic uses of ethylacetoacetate (preparation of non-heteromolecules having up to 6 carbon).

Unit-IV

Application of Spectroscopy (UV-Visible, IR) to Simple Organic Molecules

Electromagnetic radiations, electronic transitions, λ_{\max} & ϵ_{\max} , chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{\max} of conjugated dienes and α , β – unsaturated compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on $>C=O$ stretching absorptions).

Recommended Text Books:

1. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017.
2. Shriver D. E., Atkins P. W., Inorganic Chemistry, Oxford University Press, 5th Edn.
3. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry – Principles of structure and reactivity, , Pearson Education, 4th Ed. 2002.
4. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Arun Bahl & B S Bahl, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.

Reference books

1. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. II, CBS Publications, 2nd Ed. 2010.
2. Das Asim K., Bioinorganic Chemistry, Books & Allied (P) Ltd. 1st ed. 2015.
3. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017.
4. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications

Generic Elective Paper IV LAB

Section A: Inorganic Chemistry

1. Preparation of following compounds (Any two)
 - a. Cuprous oxide (Cu_2O)
 - b. Cuprous chloride, Cu_2Cl_2
 - c. Manganese(III) phosphate, $\text{MnPO}_4 \cdot \text{H}_2\text{O}$
 - d. Lead chromate (PbCrO_4)
2. Separation of mixtures by chromatography: Measure the R_f value in each case. (Combination of two ions to be given)
 - Paper chromatographic separation of Fe^{3+} , Al^{3+} and Cr^{3+} or
 - Paper chromatographic separation of Ni^{2+} , Co^{2+} , Mn^{2+} and Zn^{2+}

Section B: Organic Chemistry

Systematic qualitative organic analysis of organic compounds possessing mono-functional groups (-COOH, phenolic, aldehyde, ketone, amide, nitro, amines) and preparation of one derivative.

Reference Books

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Edn, Pearson, 2009.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
3. Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).
4. Gulati Shikha , Sharma Gulati JL and Manocha, Shagun, Practical Inorganic Chemistry, 1st Edn., CBS Publishers & Distributors Pvt. Ltd., (2017).

8. Study of different modified structures of fishes (Saw of sawfish, Hammer of hammer head fish, tail of sharks etc.)
9. Identification of various types of natural silks.

TEXT BOOKS

1. Sarkar, Kundu and Chaki. (2014) Introduction to Economic Zoology. NCBA Publisher.
2. T.V.R. Pillay (Author), M.N. Kutty (2011) Aquaculture: Principles and Practices, Wiley India Pvt Ltd; Second edition

SUGGESTED READINGS

1. Dhyan Singh Bisht, Apiculture, ICAR Publication.
2. Dunham RA (2004) Aquaculture and Fisheries Biotechnology – Genetic Approaches. CABI publications, U.K.
3. Hafez ESE (1962) Reproduction in Farm Animals. Lea and Fabiger Publishers.
4. Knobil E and Neill JD (2006) The Physiology of Reproduction. Vol.2. Elsevier Publishers, USA.
5. Prost PJ (1962) Apiculture. Oxford and IBH, New Delhi.
6. Singh S. Beekeeping in India, Indian council of Agricultural Research, New Delhi.
7. Srivastava CBL (1999) Fishery Science and Indian Fisheries. Kitab Mahal publications, India.

OR

Project Work

Each student has to undertake a project work under the guidance of a teacher and submit the project report in the form of a thesis. There will be a presentation of the project work before an external examiner.

Generic Elective Paper I

Animal Diversity

Unit 1: Protista, Porifera, Radiata, Aceolomates and Pseudocoelomates

General characters of Protozoa; Life cycle of *Plasmodium*, General characters and canal system in Porifera, General characters of Cnidarians and polymorphism, General characters of Helminthes; Life cycle of *Taenia solium*, General characters of Nemethehelminthes; Parasitic adaptations

Unit 2: Coelomate Protostomes, Arthropoda, Mollusca and Coelomate Deuterostomes

General characters of Annelida, Metamerism, General characters, Social life in insects, General characters of mollusca, torsion in gastropod, pearl formation, General characters of Echinodermata, larval form in Echinodermata.

Unit 3: Protochordata , Pisces, Amphibia

Salient features, Osmoregulation, Migration of Fishes, General characters, Adaptations for terrestrial life, Parental care in Amphibia.

Unit 4: Reptiles, Aves and Mammals

Amniotes, Origin of reptiles, Terrestrial adaptations in reptiles, Origin of birds; Flight adaptations, early evolution of mammals; Primates; Dentition in mammals.

PRACTICAL

1. Study of following specimens:

Non Chordates: *Euglena, Noctiluca, Paramecium, Sycon, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, T. gigas, Limulus, Hermitcrab, Daphnia, Millipede, Centipede, Beetle, Chiton, Dentalium, Octopus, Asterias and Antedon.*

Chordates: *Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Ichthyophis/Uraeotyphlus, Salamander, Rhacophorus Draco, Uromastix, Naja, Viper, model of Archaeopteryx, any three common birds-(Crow, duck, Owl), Squirrel and Bat.*

2. Study of following Permanent Slides:

Cross section of *Sycon*, Sea anemone and *Ascaris* (male and female). T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva

3. Temporary mounts of Septal & pharyngeal nephridia of earthworm.

Unstained mounts of Placoid, cycloid and ctenoid scales.

TEXT BOOKS

1. Kotpal RL. (2016) Modern Textbook of Zoology –Vertebrates; Rastogi Publications – Meerut.
2. Kotpal RL.(2016) Modern Textbook of Zoology –Invertebrates; Rastogi Publications – Meerut.

SUGGESTED READINGS

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
3. Raven, P.H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications, New Delhi.
4. Kardong, K.V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.

OR

Insect Vectors and Diseases

Unit 1: Insects, Concept of Vectors, Insects as Vectors

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts with reference to. feeding habits, Brief introduction of Carrier and Vectors (mechanical and biological vector),Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity, Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

Unit 2: Dipteran as Disease Vectors

Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly, Study of house fly as important mechanical vector, Myiasis, Control of house fly

Unit 3: Siphonaptera and Siphunculata as Disease Vectors

Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas, Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond's disease, Phthiriasis; Control of human louse

Unit 4: Hemiptera as Disease Vectors

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

PRACTICAL

1. Study of different kinds of mouth parts of insects
2. Study of following insect vectors through permanent slides/ photographs: *Aedes*, *Culex*, *Anopheles*, *Pediculus humanus corporis*, *Phthirus pubis*, *Xenopsylla cheopis*, *Cimex lectularius*, *Phlebotomus argentipes*, *Musca domestica* through permanent slides/ photographs
3. Study of different diseases transmitted by above insect vectors.
4. Submission of a project report on any one of the insect vectors and disease transmitted.

TEXT BOOKS

1. Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell
2. Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK

SUGGESTED READINGS

1. Mike Service (2012) Medical Entomology for Students Cambridge University Press; 5th edition.
2. Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication

5

Generic Elective Paper II

Aquatic Biology

UNIT 1: Aquatic Biomes

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, Streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs

UNIT 2: Freshwater Biology

Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous

Streams: Different stages of stream development, Physico-chemical, environment, Adaptation of hill-stream fishes.

UNIT 3: Marine Biology

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

UNIT 4: Management of Aquatic Resources

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment-BOD and COD.

015

PRACTICAL

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free, Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from nearby lake/ water body.
4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
5. A Project Report on a visit to a Sewage treatment plant/Marine bioreserve/ Fisheries Institutes.

TEXT BOOKS

1. Wetzel RG (2001)Limnology: Lake and River Ecosystems, Academic Press; 3rd edition

SUGGESTED READINGS

1. Anathakrishnan : Bioresources Ecology 3rd Edition
2. Odum and Barrett : Fundamentals of Ecology, 5th Edition
3. Pawlowski: Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
4. Trivedi and Goyal : Chemical and biological methods for water pollution studies
5. Welch : Limnology Vols. I-II

OR

Food, Nutrition And Health

Unit 1: Basic concept of food and nutrition

Food Components and food-nutrients, Concept of a balanced diet, nutrient needs and dietary pattern for various groups, adults, pregnant and nursing mothers, infants, school children, adolescents and elderly

Unit 2: Nutritional Biochemistry:

Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role
Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance
Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions

Unit 3: Health

Introduction to health- Definition and concept of health, Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any. Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications, Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention, Common ailments- cold, cough, and fevers, their causes and treatment

Unit 4: Food hygiene:

Potable water- sources and methods of purification at domestic level Food and Water borne infections: **Bacterial infection:** Cholera, typhoid fever, dysentery; **Viral infection:** Hepatitis, Poliomyelitis, **Protozoan infection:** amoebiasis, giardiasis; **Parasitic infection:** taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention. Brief account of food spoilage: Causes of food spoilage and their preventive measures

01

PRACTICAL

1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric
3. Estimation of Lactose in milk
4. Ascorbic acid estimation in food by titrimetry
5. Estimation of Calcium in foods by titrimetry
6. Study of the stored grain pests from slides/ photograph (*Sitophilus oryzae*, *Trogoderma granarium*, *Callosobruchus chinensis* and *Tribolium castaneum*): their identification, habitat and food sources, damage caused and control. Preparation of temporary mounts of the above stored grain pests.
7. Project- Undertake computer aided diet analysis and nutrition counseling for different age groups. OR Identify nutrient rich sources of foods (**fruits and vegetables**), their seasonal availability and price OR Study of nutrition labeling on selected foods

TEXT BOOKS

1. Mudambi, SR and Rajagopal, MV (2018). Fundamentals of Foods, Nutrition and Diet Therapy; Sixth Ed; New Age International Publishers.
2. Bamji MS, Rao NP, and Reddy V.(2017) Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd., 4th edition

SUGGESTED READINGS

1. Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.
2. Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.
3. Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO

Generic Elective Paper III

Human Physiology

Unit 1: Digestion and Respiratory Physiology

Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and hormonal control of digestion (in brief), Ventilation, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.

Unit 2: Functioning of Excitable Tissue (Nerve and Muscle)

Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fiber); Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction

Unit 3: Renal Physiology and Cardiovascular Physiology

Functional anatomy of kidney, Mechanism and regulation of urine formation, Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG

Unit 4: Endocrine and Reproductive Physiology

Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis, Menstrual cycle.

PRACTICAL

1. Preparation of temporary mounts: Neurons and Blood film.
2. Preparation of haemin and haemochromogen crystals.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Examination of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary.

TEXT BOOKS

1. Marieb EN and Hoehn K, (2015) Human Physiology, 10th global edition, Pearson Education, USA.
2. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.

SUGGESTED READINGS

1. Widmaier, E.P., Raff, H. and Strang, K.T. (2008). Vander's Human Physiology, XI Edition, McGraw Hill.
2. Kesar, S. and Vashisht, N. (2007). Experimental Physiology, Heritage Publishers.
3. Prakash, G. (2012). Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Company Ltd.
4. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley and Sons, Inc.

OR

Environment and Public Health

UNIT 1: Environmental hazards

Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.

UNIT 2: Pollution

Air, water, noise pollution sources and effects, Pollution control; Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health

Unit 3: Waste Management Technologies

Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, biomedical waste handling and disposal, nuclear waste handling and disposal, Waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath

Unit 4 Diseases

Causes, symptoms and control of: Tuberculosis, Asthma, Cholera, Typhoid, Malaria and AIDS

PRACTICAL (Credits 2)

1. To determine pH, Cl, SO₄, NO₃ in soil and water samples from different locations.

TEXT BOOKS

1. Cutter, S.L. (1999) Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Park K (2017) Parks Text Book Of Preventive & Social Medicine, Banarsidas Bhanot Publishers

SUGGESTED BOOKS

1. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff 1996. "Risk Assessment and Management Handbook", McGraw Hill Inc., New York.
2. Kofi Asante Duah 1998 "Risk Assessment in Environmental management", John Wiley and sons, Singapore.
3. Kasperson, J.X. and Kasperson, R.E. and Kasperson,R.E., 2003. Global Environmental Risks, V.N.University Press, New York,
4. Joseph F Louvar and B Diane Louver 1997 Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey.
5. Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.
6. Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
7. Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International (P) Ltd.

Generic Elective Paper IV

Animal Biotechnology

UNIT 1: Introduction and Techniques in Gene manipulation

Concept and Scope of Biotechnology, Outline process of genetic engineering and recombinant DNA technology, Isolation of genes, Concept of restriction and modification: Restriction endonucleases, DNA modifying enzymes, Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, HAC. Shuttle and Expression Vectors, Construction of Genomic libraries and cDNA libraries, Transformation techniques: microbial, plants and animals: Cloning in mammalian cells, Integration of DNA into mammalian genome- Electroporation and Calcium, Phosphate Precipitation method.

UNIT2: Animal cell Culture

Basic techniques in animal cell culture and organ culture, Primary Culture and Cell lines, Culture media- Natural and Synthetic, Stem cells, Cryopreservation of cultures. Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, DNA sequencing: Sanger method, Polymerase chain reaction, DNA Fingerprinting and DNA microarrays

UNIT 3: Fermentation

Different types of Fermentation: Submerged & Solid state; batch, Fed batch & Continuous; Stirred tank, Air Lift, Fixed Bed and Fluidized, Downstream Processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization

UNIT 4: Transgenic Animal Technology and Application in Health

Production of transgenic animals: nuclear transplantation, retroviral method, DNA microinjection method, Dolly and Polly, Development of recombinant Vaccines, Hybridoma technology, Gene Therapy, Production of recombinant Proteins: Insulin and growth hormones.

PRACTICAL

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of culture media.
3. Preparation of genomic DNA from *E. coli*/animals/ human.
4. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).
5. Restriction digestion of lambda (λ) DNA using EcoR1 and Hind III.
6. Preparation of competent cells and Transformation of *E. coli* with plasmid DNA using CaCl₂, Selection of transformants on X-gal and IPTG (Optional).
7. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, DNA Microarrays.

TEXTBOOKS

1. BD Singh, (2014) Biotechnology: Expanding Horizons, Kalyani Publishers
2. U.Satyanarayan and U Chakrapani, (2014) Biotechnology, Books & Allied Ltd

SUGGESTED READINGS

1. T.A. Brown (2008): Gene cloning and DNA analysis: An Introduction, Blackwell Science.
2. Animal Cell Culture Methods Academic Press
3. P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2017).

4. B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001).
5. 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
6. Verma S A, Das S and Singh (2014) A. Laboratory Manual for Biotechnology. S Chand Publication.

OR

Cell and Molecular Biology

Unit 1: Cells and Plasma Membrane

Prokaryotic and Eukaryotic cells, Various models of plasma membrane; Transport across membranes, The Endoplasmic Reticulum; Golgi apparatus; Lysosomes; Structure and function of mitochondria

Unit 2: Nucleus, cell division

Ultra structure of nucleus; Mitosis, Meiosis, Cell cycle and its regulation

Unit 3: Nucleic Acids and DNA Replication

Salient features of DNA double helix; Watson and Crick model of DNA, Structure of RNA, tRNA, DNA Replication in prokaryotes and eukaryotes; Mechanism of DNA replication

Unit 4: Transcription and Translation

Mechanism of transcription in prokaryotes and Eukaryotes, Process of protein synthesis in prokaryotes and translation

PRACTICAL

1. Study of prokaryotic and eukaryotic cell types through permanent slides.
2. Study of mitosis and meiosis through squashing in Grasshopper.
3. Demonstration of transport through cell membrane.
4. Preparation of DNA and RNA models.
5. Demonstration of protein synthesis through models.

TEXT BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and 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.

SUGGESTED READINGS

1. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008) Molecular Biology of the Cell. 5th Edition. Garland publishing Inc., New York.
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni G P (2009) The World of the Cell. 7th Edition. Pearson Benjamin Cummings Publishing, San Francisco.
3. Cooper GM and Hausman RE (2009) The Cell: A Molecular Approach. 5th Edition. ASM Press, Washington D.C.
4. S Harisha (2007) Biotechnology procedures and experiments handbook., Infinity Science Press, Hingham