M.Sc., - BIOCHEMISTRY

PREAMBLE

- Biochemistry is the study of chemistry and relating to biological organisms.
- Biochemistry is sometimes viewed as a hybrid branch of organic chemistry which specializes in the chemical processes and chemical transformations that take place inside of living organisms.
- Biochemistry incorporates everything in size between a molecule and a cell and all the interactions between them.
- Biochemistry essentially remains the study of the structure and function of cellular components (such as enzymes and cellular organelles) and the processes carried out both on and by organic macromolecules - especially proteins, but also carbohydrates, lipids, nucleic acids and other biomolecules.
- All life forms alive today are generally believed to have descended from a single proto-biotic ancestor, which could explain why all known living things naturally have similar biochemistries.
- Biochemistry is most simply put the chemistry of life.

KARPAGAM ACADEMY OF HIGHER EDUCATION
Coimbatore – 641 021
DEPARTMENT OF BIOCHEMISTRY
FACULTY OF ARTS ,SCIENCE AND HUMANITIES
PG PROGRAM (CBCS)- M.Sc., Biochemistry
(2018–2019 and onwards)

Course code	Name of the course	Objectives and out comes		Instruction hours / week			Credit(s)	Maximum Marks		
		PEOs	POs	L	T	P		CIA	ESE	Total
								40	60	100
SEMESTER - I										
18BCP101	Chemistry of Biopolymers	I	a	4	-	-	4	40	60	100
18BCP102	Enzymes and Microbial Technology	II	d	4	-	-	4	40	60	100
18BCP103	Bioinstrumentation and Good Laboratory Practices	II	d, e	4	-	-	4	40	60	100
18BCP104	Cellular Biochemistry	III	a	4	-	-	4	40	60	100
18BCP105A	Plant Biochemistry	III	a	4	-	-	4	40	60	100
18BCP105B	Ecology and Evolutionary biology	I	c, f							
18BCP105C	Biopharmaceutics	I	d							
18BCP111	Practical – I Quantitative Estimation and Separation Techniques	II	a	-	-	4	2	40	60	100
18BCP112	Practical – II Plant Biochemistry and Microbiology	I, III	a, e	-	-	4	2	40	60	100
	Journal paper analysis and Presentation	I- III	a, e	2	-	-	-	-	-	-
Semester Total				**22**	**-**	**8**	**24**	**280**	**420**	**700**
SEMESTER – II										
18BCP201	Regulation of Metabolic Pathways	II	a	4	-	-	4	40	60	100
18BCP202	Molecular Biology	II	a, b	4	-	-	4	40	60	100
18BCP203	Developmental Genetics	II	a, b	4	-	-	4	40	60	100
18BCP204	Bioinformatics	III	d	4	-	-	4	40	60	100
18BCP205A	Recombinant DNA Technology	I	d	4	-	-	4	40	60	100
18BCP205B	Animal Tissue Culture	III	d, e							
18BCP205C	Genomics and Proteomics	III	d							
18BCP211	Practical – III Molecular Biology and Animal Biotechnology	II	d, g	-	-	4	2	40	60	100
18BCP212	Practical – IV Biological Databases and Analysis	III	d, g	-	-	4	2	40	60	100
	Journal paper analysis and Presentation	I-III	a, e	2	-	-	-	-	-	-
Semester Total				**22**	**-**	**8**	**24**	**280**	**420**	**700**

PROGRAMME OUTCOME(POs)

PG biochemistry graduate will be able to achieve

a. **Critical Thinking and Effective Communication:** The teaching is intended to kindle the critical thinking of the student to address problems (Problem based learning) and equip them to list out their understanding (Activity based learning). The syllabus also includes journal paper presentation and analysis on specific topics of all subjects which will be evaluated by faculty handling the subject.

b. **Future Career:** To prepare students for future careers in the various fields of biochemistry such as academic and research institution.

c. **Societal Contribution and Social Interaction:** The Biochemistry Programme will benefit the society on the whole by adding to the highly skilled scientific workforce, particularly for the biomedical research sectors, in the academic, industry as well as for research laboratories across the country and the globe. Inside the classrooms group discussion is encouraged on topics during the last five minutes of class to improve the understanding and to share the knowledge and view point. Outside the classroom, various outreach programme are conducted on various health initiatives.

d. **Identification and Differential Diagnosis:** To acquire **b**iochemist position in leading hospitals and scientist position in industries.

e. **Ethics:** Students learn about the significance of having right moral features to develop good interpersonal skills.

f. **Environment and Sustainability:** Understand the role of citizen to maintain sustainable environment and encourage Eco-friendly initiatives.

g. **Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of health and disease.

PROGRAMME SPECIFIC OUTCOME (PSOs)

i. To prepare students for future careers in various fields of biochemistry by enhancing analytical and critical-thinking skills in which a core understanding of the chemistry of biological processes is important for the understanding of human health and disease.

j. To equip highly skilled scientific workforce, particularly for the biomedical research sectors, in the academic, industry as well as for research laboratories across the country and the globe.

k. The skills acquired in the programme will help the students in acquiring scientific, academic and industrial positions such as Analyst, Research Scientist at Pharma (R&D) Industries, Academician, Project Associates (JRF, SRF), Doctoral Research positions abroad at India and abroad. Clinical biochemist at renowned hospitals, medical coding, Scientific writers.

PROGRAMME EDUCATIONAL OBJECTIVE (PEOs)

I. The course aims to impart advanced and in depth understanding on all the human physiological and pathological state. To understand the molecular process and their perturbation during disease.

II. The programme covers various aspects of Biomolecule estimation and regulation to ascertain health and disease state. metabolic pathways alterations along with their regulation at the replication, transcriptional, translational, and post-translational levels including by studying DNA, RNA and protein molecules, immunology, endocrinology, advancements in rDNA technologies to circumvent genetic disorders.

III. Further to enrich research understanding various genomic, proteomic and bioinformatics tools are added. Animal cell culture, IPR, Biostatistics, research methodology, clinical research and Plant tissue culture are offered as elective papers to get specialized in a specific area. The final semester is devoted exclusively to enrich the students to address specific research objective.

Mapping of PEOs and POs

POs	a	b	c	d	e	f	g	i	j	k
PEO I	X		X			X				
PEO II	X		X	X	X	X		X	X	X
PEO III	X	X	X	X	X		X		X	X

Semester I

18BCP101 **CHEMISTRY OF BIOPOLYMERS** **4H-4C**

Instruction hours/week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

- To know the structure and role of water in biological system
- To understand the structure and organization of carbohydrate , lipids , proteins and nucleic acids
- To realize the interactions nucleic acid with proteins

Course outcomes (CO's)

1. Able to understand the importance of water in biological system
2. Understand the structure and organization of storage and structural polysaccharides, basics behind the four level organization of proteins
3. Explain the role of lipids in membrane and their associated function as signal molecule
4. structure and organization of DNA, RNA and their properties
5. Exploit the interaction of nucleic acid with proteins and their consequences

UNIT I: Polysaccharides

Brief review of carbohydrates, classification. Occurrence, structure and biological functions of cellulose, chitin, starch and glycogen. Fructans, arabinans and galactans(brief account). Dietary fibre. Occurrence, structure, and biological functions of bacterial cell wall polysaccharides and blood group antigens. Structure and significance of glycoconjucates -Glycosaminoglycans – structure and biological role of hyaluronic acid, chondroitin sulfate and heparin, sialic acid; glycoproteins and glycolipids.

UNIT II: Proteins

Review of structure and classification of aminoacids. Orders of protein structure. Primary structure – determination of amino acid sequence of proteins. The peptide bond – The Ramachandran plot. Secondary structures – α-helix, β-sheet and β-turns. Fibrous proteins- Collagen triple helix-Structure and assembly. Globular proteins-forces involved, folding process and folding patterns. Tertiary structure –Myoglobin organisation. Quarternary structure of proteins- Structure of haemoglobin. Models for haemoglobin allostery. Quintinary structure-basics only. Protein function as enzymes, defensive and transport.

UNIT III: Lipids

Introduction, classification, structure and functions of simple lipid, compound lipids-phospholipids, glycolipids, storage lipids and choesterol. Eicosanoids-porstaglandins, thromboxanes and leucotriens. Properties of lipids-Micelles, bilayers and liposomes. Significance of lipid anchored protein-prenylated, fatty acylated and GPI anchored

proteins. Lipoproteins – classification, composition and biological functions. Lipids as signals, cofactors and pigments (Brief account). Lipid peroxidation and antioxidants.

UNIT IV: Nucleic acids

DNA double helical structure – Watson and Crick model. A, B and Z forms of DNA. Tertiary and quadraplex structures of DNA. DNA supercoiling and linking number. Properties of DNA – DNA bending, buoyant density, viscosity, denaturation and renaturation – The cot curve – Chemical synthesis of DNA.

Major classes of RNA – mRNA, rRNA, tRNA, sn RNA, siRNA, hn RNA – structure and biological functions. Secondary and tertiary structure of tRNA and rRNA.

UNIT V: Nucleic acid interaction with proteins

DNA binding motifs in proteins – the basic helix loop helix (bHLH) motif, zinc finger, the leucine zipper, helix-loop helix and homeo domain. RNA binding motifs in proteins. Molecular aspects of protein-nucleic acid binding – direct interactions. Techniques characterizing nucleic acid-protein complex – chromatin immunoprecipitation assay, DNase I footprinting.

SUGGESTED READINGS

1. Nelson, D., and Cox, M. W.H. (2012) Lehninger Principles of Biochemistry (4th Ed.) New York, Freeman and Company.

2. Murray, R.K., Bender, D.A., Botham, K.M., and Kennelly, P.J., (2012). Harper's illustrated Biochemistry, 29th Edition. McGraw-Hill Medical. London.

3. Zubay, G., (2009). Biochemistry, Wm.C Brown Publishers, Saunders and Company, Philadelphia.

4. Voet, D., Voet, J. G., & Pratt, C. W. (2008). Fundamentals of biochemistry: Life at the molecular level. Hoboken, NJ: Wiley.

5. Nucleic acid structure and recognition. Neidle, Oxford University Press, 2002

6. Nucleic acids in Chemistry and Biology. Blackburn and Gait, IRL Press, 1996

7. Rawn, .J.D.,(2004). Biochemistry, First Indian reprint, Panima Publishing Corporation, New Delhi.

18BCP102 ENZYMES AND MICROBIAL TECHNOLOGY 4H-4C

Instruction hours/week: L: 4 T: 0 P:0 Marks: Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

- To understand the structure of enzymes and their classifications.
- To analyse the active site of enzymes by various experimental approaches.
- To learn the kinetics of enzyme catalysed reactions.
- To learn the importance of enzyme immobilization and its wide applications in medicine and industries.
- To study various fermentor designs and culture systems.
- To understand the application of fermentation process in industry.
- To learn the fermented products preparation, downstream processing and its industrial applications.

Course outcomes (CO's)

After completing this course the students are clear in

1. The mechanism of action of enzymes and their classifications.
2. They could be able to apply the knowledge of enzyme immobilization to produce more products out of it.
3. Clear understanding of microbes implication to derive a product and the role of enzymes in downstream process.
4. Clear in concept of various culture techniques and apply the suitable one for a particular application.

UNIT I: Enzymes

Enzymes Nomenclature and classification of Enzymes with examples; Structure and functions of coenzymes and cofactors. Active site, the investigation of active site structure – The identification of binding sites, catalytic sites-trapping the E-S complex. Use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo oxidation and chemical modification of amino acid side chains . Affinity labeling studies and super reactive amino acid chains. The 3-D structural features of active sites as revealed by X-ray chrystallographic and chemical studies, site directed mutagenesis. catalytic triad. Lock and key model, Induced fit model. Factors affecting enzyme activity. Isolation, purification and characterization of enzymes. Mechanism of enzyme action –Acid base and covalent catalysis (Chymotrypsin, lysozyme), metal activated and metalloenzymes.

UNIT II: Enzyme Kinetics

Derivation of MM equation, LB plot, Eadie Hofstee plot and Hanes plot. Bisubstrate reactions-types of bi-bi reactions, differentiating bi substrate mechanisms-diagnostic plots, isotope exchange. Enzyme inhibition-Types and differentiation of competitive,

uncompetitive and non-competitive inhibition, Allosteric inhibition, feed-back inhibition and regulation. Reversible covalent modification (glycogen phosphorylase); proteolytic cleavage (Zymogen); multi enzyme complex as regulatory enzymes (PDH); isoenzymes (LDH). Mechanism based inhibitors-antibiotics as inhibitors. Mechanism of action of enzymes - chymotrypsin and lysozyme. Enzyme based diagnostic techniques.

UNIT III: Immobilization of enzymes

Methods of immobilization - adsorption, covalent binding, entrapment, membrane confinement. Effect of immobilization on enzyme. Use of enzymes in clinical diagnosis and industries. Enzyme engineering. Artificial enzymes and synzymes, Abzymes, ribozymes, enzymes in organic solvents.

Biosensors – glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors.

UNIT IV: Microbial Growth

Balanced and Unbalanced microbial growth; Measurement of growth; Principles of microbial growth and culture systems- culture, fed culture, semi-continuous culture and continuous culture. Isolation and screening of industrially important microbes. Important strains for better yield. Design of a fermenter. Types of bioreactor-Continuous stirred tank, Bubble column, Airlift, Fluidized bed, Packed bed and Photobioreactor.

Solid substrate fermentation and Media fermentation. Examples of bioprocess for the production of biomass. Microbial metabolic products-primary and secondary metabolites.

UNIT V: Production of fermented products and downstream processing

Production of alcohol and alcoholic beverages. Microbial production of Organic acids: Source, recovery and uses of Citric acid, Lactic acid, Acetic acid and L-ascorbic acid. Production of antibiotics: Penicillin and Tetracyclin. Bioinsecticides: Production of Bacterial and fungal polysaccharides, commercial production of Xanthan gum and pullulan. Production of edible mushroom and SCP.

Biofertilizers *Phosphobcterium* and *Rhizobium sp*.,; Biopesticides, leaching of ores by microbes, microbial treatment of wastewater – aerobic and anaerobic methods.

SUGGESTED READINGS

1. Jain, J.L, (2013). Fundamentals of Biochemistry, S. Chand & Co Ltd, New Delhi.

2. Sathya Narayana U, (2005). Biotechnology, Books and Allied Publishers, Kolkata.

3. Trevor and Palmer, 2004. Enzymes, East West Press Pvt Ltd, New Delhi.

4. Wolf Crueger and Annesie Cruger, 2004. Biotechnology: A Textbook of Industrial Microbiology, 2nd Edition, Panima Publishers, Bangalore.

5. Adams, M.R., and Moss, M. O. (2004). Food Microbiology, New age publishers, New Delhi.

6. Singh, R., and Ghosh, S.K., (2004). Industrial Microbiology, Global Vision publishers, New Delhi.

7. Dixon, M., and Webb, E.C. (1979). Enzymes, 3rd Edition, Longman and company Better World books Ltd. UK

8. Chapline, M.F., and Bucke, C. (1990). Protein Biotechnology. Cambridge University Press, London.

9. Walsh, G (2002), Proteins Biochemistry and Biotechnology, John Wiley & Sons Ltd, New York.

10. Glazer, A.N., Nikaido, H. (2007). Fundamentals of Applied Microbiology. W H. Freeman Company, New York.

11. Price, N.C., and Stevens, L (2012). Fundamentals of Enzymology, 3rd Edition, Oxford Univ. Press, New York.

12. Stanbury, P.F., Whitaker, A and Hall, S.J. (2005). Principles of Fermentation Technology, Elsevier Publishers.

13. Thomas, E., and Creighton, W., (2002). Proteins: Structure and Molecular properties, W.H Freeman and Company, New York.

14. Patel, (2003). Industrial Microbiology, Macmillan India limited, New Delhi.

Semester I

18BCP103 BIOINSTRUMENTATION AND GOOD LABORATORY PRACTICE 4H-4C

Instruction hours/week: L: 4 T: 0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

- To teach students on various techniques used for the assessment of various diseases and research studies.
- To teach the good laboratory practice required to execute the learned techniques.

Course outcomes (CO's)

1. The students learn various techniques and acquire the skills to use appropriate methods.
2. The students acquire the good laboratory practices.

UNIT I: Centrifugation

Types of centrifuges, Principles and applications of analytical and preparative centrifuges, density gradient and ultra centrifugation. Relative molecular mass determination and sedimentation coefficient. Sub cellular fractionation of cellular components. Applications. Separation of cells on the basis of density.

Colorimetry: Beer's law and Lambert's law. Principle of photoelectric colorimeter **Spectroscopy:** Properties of electromagnetic radiations, Instrumentation and applications of UV Visible and mass spectroscopy, FTIR, NIR, reverse spectroscopy. Spectrofluorimetery, atomic spectroscopy, NMR spectroscopy. Advantatages and disadvantages and advancements of spectroscopic methods.

UNIT II: Chromatography

Principles, Types – paper chromatography, thin layer chromatography and HPTLC, Column chromatography - Ion exchange chromatography, affinity chromatography, gel filtration chromatography, Low pressure liquid chromatography (LPLC) and High Performance Liquid Chromatography (HPLC)- Normal and Reverse Phase Gas -liquid chromatography Mass spectroscopy (GC – MS), LC-MS, MALDI-TOF, ICPMS, Application of Chromatography. Separation of phytoconstituents using TLC.

UNIT III: Electrophoresis

Principle, instrumentation and applications of agarose gel electrophoresis, sodium dodecyl sulphate – polyacrylamide gel electrophoresis (SDS-PAGE), native PAGE, isoelectric focusing, immunoelectrophoresis, 2D gel electrophoresis. Pulse field gel electrophoresis, capillary electrophoresis, gel documentation – Applications. Blotting techniques.

UNIT IV: Radioisotopic techniques

Introduction, nature of radio activity, types and rate of radioactive decay, units of radio activity, detection and measurement of radioactivity-Geiger-Muller counter, solid and liquid scintillation counter. Autoradiography, X-ray diffraction and circular dichorism. Non radioactive, fluorescent methods. Applications of radioisotopes in biological sample analysis.

Flowcytometry: Principles and applications**.**
Microscopic Imaging techniques: Atomic Force Microscopy, Confocal fluorescent microscopy, SEM and TEM

UNIT V: Good Laboratory Practices
Quality concepts, personal protective equipment. General safety-biological safety, chemical safety and fire safety. data generation and storage, quality control documents, retention samples, records, audits of quality control facilities. List of Regulations to be followed**.** Laboratory safety procedure- glass ware, equipment safety, hands protection, precaution to be undertaken to prevent accident and contamination. GLP – an overview and basic information, Scope. Principles of GLP: Test Facility Organization and Personnel, Test Systems, Test and Reference Items, Standard Operating Procedures, Performance of the Study, Reporting of Study Result, Storage and Retention of Records and Materials. Responsibilities in GLP. Implementing of GLP in non GLP analytical laboratory.

SUGGESTED READINGS

1. Weinberg, S., (1995). Good Laboratory Practice Regulations, 3rd edition, CRC Press, U.S.A.

2. Harburn, K., (1990). Quality Control of Packing Materials in Pharmaceutical Industry, CRC Press, U.S.A.

3. Chatwal, G.R., and Anand, S.K., (2003). Instrumental Methods of Chemical Analysis. 5th Edition, Himalaya Publishing House, Mumbai.

4. Sharma, B.K., (2004). Instrumental Methods of Chemical Analysis, 24th Edition, Goel Publishing House, Meerut.

5. Richard, A.G., Richard, G., (2009). New Drug Approval Process Drugs and the Pharmaceutical Sciences), 5th edition CRC Press, U.S.A.

6. Wenclawiak, B.W., Koch, M., Hadjicostas, E. (2004). Quality Assurance in Analytical Chemistry: Training and Teaching. 1st edition, springer. U.S.A.

7. Wilson, K., and Walker, J., (2010). Principles and Techniques of Biochemistry and Molecular Biology, 7th Low Price Edition, Cambridge University Press, India.

18BCP104 **CELLULAR BIOCHEMISTRY** **4H-4C**

Instruction hours per week: L: 4 T: 0 P:0 Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course objectives

- To enable the students to understanding the molecules within cells and interactions between cells that allows construction of multi cellular organisms.
- To understand the molecular machinery of living cells.
- To understand the membrane transport mechanisms.

Course outcomes (CO's)

1. Upon successful completion of this course, participants will be able to:
2. Describe the general principles of gene organization and expression in both prokaryotic and eukaryotic organisms.
3. Describe the structure and function of biological membranes including the roles of gradients in energy transduction.
4. Explain the basic pathways and mechanisms in biological energy transduction from oxidation of metabolites to synthesis of ATP.
5. Explain various levels of gene regulation and protein function including signal transduction and cell cycle control.
6. Relate properties of cancerous cells to mutational changes in gene function.

UNIT I: Membrane

Membrane bilayer- models, Membrane lipids- fluidity, asymmetry, phase transition, Liposomes. Langmuir trough, Metamorphic mosaic model, Techniques for determination of membrane protein topology

Membrane proteins – Types, Orientation, Mobility – Experiments, flippases, proteins of RBC membrane, RBC ghosts, Bacteriorhodopsin, Porins – aquaporin.

solubilisation of proteins, lipid anchored proteins, Carbohydrates – cell surface carbohydrates – Lectins and selectins.

UNIT II: Membrane transport

Passive diffusion, facilitated diffusion in erythrocytes, Carriers and ion channels, Ion concentration gradients.

Uniporter Catalyzed transport, active transport systems. Transport process driven by ATP-Ion pumps: Calcium ATP ase; Na^+ K^+ ATPase; Mechanism, Gastric H^+ K^+ ATPase, ABC superfamily – ATPases that transport peptides and drugs (MDR proteins).

Co-transport by Symporters and antiporters, Group translocation.

Osmosis,receptor mediated endocytosis and its significance.

UNIT III: Mitochondria

Mitochondria – Reduction potential, Free energy and entropy**,** electron transport chain – Complexes, Q-cycle, Cyt C oxidase complex, Translocation of protons and the establishment of a proton motive force, machinery for ATP formation and chemi-osmotic mechanism, ATP synthase – Experiments, inhibitors and uncouplers of oxidative phosphorylation.

Microfilaments – Actin – Stuctures, Assembly, Myosin. Microtubules – Organisation and dynamics, kinesin and dynein. Cilia and flagella – Structure and functions, intermediary filaments.
Mitochondrial transport system: ATP/ADP exchange, malate-glycero phosphate shuttle

UNIT IV: Cell – Matrix interaction
Cell – Cell interaction: Extra cellular matrix; Collagen, hyaluronan and proteoglycans, laminin, integrins, Fibrillin, elastin and fibronectins.
Cell – Cell adhesion: Specialised junctions – Desmosomes, Gap junctions, Tight junctions. Adhesion molecules – Cadherins (E and N), Connexins.

Cell – Cell signaling – Role of Signaling molecules and their receptors; functions of cell surface receptors, pathways of intracellular signal transduction, second messengers, G-protein coupled receptors, receptor tyrosine kinases, Ras, MAP kinases in cellular growth and functions.

UNIT V: Cell cycle and cancer
Cell cycle and its control, Cell cycle control in mammalian cells, checkpoints in cell cycle regulation.
Cancer: Properties of tumour cells and genetic basis and onset of cancer.
Tumour viruses – DNA & RNA Viruses as transforming agents – mechanism.
Tumour suppressor genes and functions of their products. Carcinogenic and anticarcinogenic effect of chemicals and radiation. Apoptosis (Programmed cell death) – pathways, regulators and effectors on apoptosis and necrosis.

SUGGESTED READINGS

1. Paul, A., (2009). Text Book of Cell and Molecular Biology,1st edition. Books and Allied (P) Ltd, Kolkata.

2. Cooper, G.M., and Hausman, R.E., (2013).Cell-A Molecular Approach, 6th Edition.. Sinauer Associates. USA.

3. Gerald, K., 2013. Cell and Molecular Biology, 7th edition. John Wiley and Sons, Inc, Hoboken, United States.

4. Nelson, D.L., and Cox, M.M., (2012). Lehninger's Principles of Biochemistry, 6th edition. W.H.Freeman and company, New York.

5. Lodish, H., Berk, A., Kaiser, C.A., and Krieger, M., (2012). Molecular Cell Biology, 7th edition. W.H. Freeman & Company, London.

6. Garrette & Grisham, (2004). Principles of biochemistry, 4th edition. Saunders college publisher, Philadelphia,United States.

7. Alberts, B.,, Johnson, A., Lewis, J., and Raff, M.,. (2007). Molecular Biology of the Cell, 5th edition. Garland Publishing Co.New York.

Semester I

18BCP105A **CORE ELECTIVE -I** **4H-4C**

PLANT BIOCHEMISTRY

Instruction hours/week: L: 4 T: 0 P0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

- Understanding of the plant cell organelles and their functions
- Understanding the functions and regulations of major biosynthetic pathways of plants, plant growth substances
- Obtaining knowledge on tissue culture techniques and metabolic engineering to increase the production of plant secondary metabolites
- To become familiar with the exciting topics in plant biology research.

Course outcomes (CO's)

1. To provide sufficient knowledge about plant cells and its organelles, various metabolic pathways and its applications in plant productivity, Plant growth substances, plant secondary metabolites and its production
2. Technical advantages in plant tissue culture and gene transfer technology to increase production of plant secondary metabolites.

UNIT I: Plant cell

Structure of plant cell – cell wall, vacuoles, plastids, mitochondria, peroxisomes and Golgi complex. Overview of photosynthesis: photosynthetic apparatus, reaction center, photosystems I and II, mechanism of photosynthesis-cyclic and non cyclic photophosphorylation; evidences in support of light and dark reactions.

Solute transport and photo assimilate translocation – Uptake, transport and translocation of water, ions, solutes and macromolecules from soil.

UNIT II: Assimilatory mechanisms in plants

Photorespiration and water consumption, CO_2 assimilation by C3 and C4 plants, CAM plants. Nitrogen assimilation; reduction of nitrate, nitrogen fixation in symbiotic and non-symbiotic plants, nitrogen cycle. Sulphate metabolism in leaf; sulfite reduction and sulphur cycle, glutathione synthesis. Carbon and phosphorus cycles.

UNIT III: Lipid metabolism in plants

Biosynthesis of fatty acids in plastids, synthesis of waxes, triacyl glycerols and glycolipids. Synthesis of chlorophyll. Carotenoid formation. Synthesis of nitrogenous compounds: caffiene synthesis, ureide synthesis in nodulated legumes. Secondary oxidative mechanisms: β- oxidation, ω- oxidation, glyoxylate pathway.

UNIT IV: Plant growth substances

Chemistry, biosynthesis, mode of action and physiological role of auxins, gibberellins, cytokinins, abscisic acid and ethylene. Factors influencing endogenous growth- Biotic and Abiotic factors. Phytochromes: molecule, biological display, functions as light sensor.

Crytochromes and phototropins, stomatal movement, photoperiodism and biological clock. Senescence: biochemical changes, regulation.

UNIT V: Plant secondary metabolites

Synthesis of secondary metabolites- shikimate pathway. Alkaloids, flavonoids, terpenoids, phenols and glycosteroids-Occurrence, distribution & functions, Production of secondary metabolites in plants, stages of secondary metabolite production.

Plant Tissue Culture- Totipotency, meristematic and nodal cultures-Callus induction. Somatic embryogenesis. Metabolic engineering for increased production of secondary metabolites.

Plant Transformation Technology – Ti and Ri plasmid and their transfer mechanisms. Methods of transformation, chloroplast transformation. Agrobacterium mediated transformation.

SUGGESTED READINGS

1. Verma,S.K., and Verma, M., (2010). A Text Book of Plant Physiology, Biochemistry and Biotechnology. 7th edition.S.Chand and Co, New Delhi.

2. Anderson, J.W., and Beardall, J., Molecular Activities of Plant cells-An introduction to Plant Biochemistry. Blackwell Scientific Publications.

3. Goodwin,T.W., and Mercer, E.I., Introduction to Plant Biochemistry, 1st edition, Robert Maxwell.M.C Publisher, New York.

4. Bonner, J., and Varner, J.F., Plant Biochemistry. 3rd edition. Academic Press, New York.

5. Buchannan, B., (2002). Biochemistry and Molecular Biology of Plants, IK. International, New York.

6. Heldt, H.V., (2005). Plant Biochemistry and Molecular Biology, Oxford University Press, England.

7. Wink, M., (2010). Functions and Biotechnology of Plant Secondary Metabolites, Second edition, Blackwell Publishing Ltd, London.

8. Heldt, H.W., Piechulla, B., Heldt, F., (2011). Plant Biochemistry, Fourth Edition, Academic Press Publication, London, UK.

Semester I

18BCP105B **CORE ELECTIVE –I** **4H-4C**

ECOLOGY AND EVOLUTIONARY BIOLOGY

Instruction hours/week: L: 4 T: 0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objective

- The course objective is for students to gain an appreciation for the diversity of life and how organisms interact with each other and their environment.
- After completing this course the student should have gained a basic understanding of how populations function, how communities are structured, and be aware of the central role that evolution plays in biology.

Course outcomes (CO's)

1. The ecology section will emphasize biotic interactions, communities and ecosystems.
2. The evolutionary section will focus on the evidence for evolution and cover the major factors influencing evolutionary change.

UNIT I: Ecology

Population ecology; metapopulation dynamics; growth rates; density independent growth; density dependent growth; niche concept; Species interactions: Plant-animal interactions; mutualism, commensalism, competition and predation; trophic interactions; functional ecology; ecophysiology; behavioural ecology.

UNIT II: Community Ecology

Community assembly, organization and evolution; biodiversity: species richness, evenness and diversity indices; endemism; species-area relationships; Ecosystem structure, function and services; nutrient cycles; biomes; habitat ecology; primary and secondary productivity; invasive species; global and climate change; applied ecology.

UNIT III: Basics of Evolution

Origin, evolution and diversification of life; natural selection; levels of selection. Types of selection (stabilizing, directional etc.); sexual selection; genetic drift; gene flow; adaptation; convergence; species concepts; Life history strategies; adaptive radiation; biogeography and evolutionary ecology.

UNIT IV: Origin of genetic variation

Mendelian genetics; polygenic traits, linkage and recombination; epistasis, gene-environment interaction; heritability; population genetics; Molecular evolution; molecular clocks; systems of classification: cladistics and phenetics; molecular systematics; gene expression and evolution.

UNIT V: Behavioural Ecology

Classical ethology; neuroethology; evolutionary ethology; chemical, acoustic and visual signaling; Mating systems; sexual dimorphism; mate choice; parenting behaviour

Competition; aggression; foraging behaviour; predator–prey interactions; Sociobiology: kin selection, altruism, costs and benefits of group-living.

SUGGESTED READINGS

1. Bergstrom, Carl, T. and Lee Alan Dugatkin., (2016). Evolution. W.W. Norton & Company. ISBN 978-0-393-93793-0.

2. Charles J. Krebs, (2009) Ecology, Benjamin Cummings, 6thEdition , USA.

3. Hall, B.J, (2011) Evolution, Jones and Bartlett Publishers, 1st Edition, USA.

4. McMillan, Victoria E.(2012). Writing Papers in the Biological Sciences, 5th Edition. Bedford/St. Martin's Press, Boston. ISBN- 0-312-64971-1.

Semester I

17BCP105C **CORE ELECTIVE -I** **4H-4C**

BIOPHARMACEUTICS

Instruction hours/week: L:4 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

The students should be able to:

- Explain the relationship among physicochemical and biological factors, dosage forms, routes of administration and therapeutic outcomes;
- Illustrate the principles of pharmaceutics and biopharmaceutics in dosage form design and development;
- Describe production procedures, quality control measurements and stability improvements for tablets and sterile products and different routes of drug administration in principles and applications
- Identify the needs and differences in drug use for various patient groups, and devise appropriate strategies from perspectives of dosage forms.

Course outcomes (CO's)

1. Students be able to explain biopharmaceutical, physiological, biochemical and cell biology-related aspects on the transport and metabolism of drugs in the gastrointestinal tract and in the liver.
2. Students be able to explain mechanisms behind the transport of drug and metabolism and how drugs can interact with other drugs and food and methods to study these - having developed its ability to plan, compile, analyse and report experiment that has importance for biopharmaceutical issues -
3. Students be able to account for regulatory requirements within the biopharmaceutical area
4. Students be able to describe the role of biopharmaceutics in drug development within the pharmaceutical industry

UNIT I: Phytochemistry

Authentication of medicinal palnts, Biosynthesis of primary and secondary metabolites - alkaloids, terpenoids. Phenolic compounds and coumarins.Classification and sources of alkaloids. Major classes in phenolic compounds – carotenoids, flavonoids, tannins and phenolic acids. Classification of terpenoids.

UNIT II: Techniques in plants

General extraction and isolation techniques for compounds from plants. Techniques involved in extraction of phytochemicals – Perculation, Soxhlet extraction, Supercritical Fluid extraction, Pilot scale extraction, reflux and other methods. Factors affecting extraction.

UNIT III: Isolation and purification techniques

Isolation and purification techniques – Thin layer and Column chromatography. Chemical fingerprinting – HPLC, HPTLC, FTIR, NMR and GC-MS.

UNIT IV: Biotechnology of medicinal plants

Production of secondary metabolites from plant culture. Indian Standard Specifications (ISI) laid down for sampling and testing of various drugs in finished form by the Bureau of Indian Standards. Toxicity testing in drugs and Safety.

UNIT V: Bioactive studies

Anticancer, antidiabetic, anti-inflammatory, hepatoprotectives, antimicrobials from medicinal plants. Antioxidants of plant origin – Reactive Oxygen Species (ROS), antioxidant polyphenols.

SUGGESTED READINGS

1. Harborne, J.B., (1998). Phytochemical methods to modern techniques of plant analysis. Chapman & Hall, London.

2. Trease, G.E., Evans, M.C., (1979). Textbook of Pharmacognosy, 12th edition. Balliere-Tindal, London.

3. Khan, I.A., and Khanum, A., (Eds.). (2004). Role of Biotechnology in medicinal and Aromatic plants, Vols. I-X. Ukaaz Publications, Hyderabad.

Semester I

18BCP111 PRACTICAL- I 4H-2C

QUANTITATIVE ESTIMATION AND SEPARATION TECHNIQUES

Instruction hours / week: L:0 T:0 P:4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

- To provide hands on experience on preparation of buffers and determination of pH of solutions
- To estimate the macromolecules quantitatively thro colorimetric procedures
- To understand the principle and estimation of vitamins using fluorimetry
- To know the principle and separate the macromolecules using TLC and column chromatography.
- To perform the secondary metabolite quantification using HPLC.

Course outcomes (CO's)

1. Gain knowledge on preparation of buffers and reagents
2. Able to understand the principle and procedure of quantitative estimation of molecules using colorimetry and fluorimetry.
3. Separate the macro molecules using TLC and column chromatography and quantify the secondary metabolite using HPLC

Colorimetry

1. Isolation and estimation of starch from potato (Anthrone method)
2. Isolation and estimation of glycogen from liver (Anthrone method)
3. Estimation of Total carotenoids (Spectroscopic method)
4. Estimation of fructose in fruits (Resorcinol method)
5. Estimation of ascorbic acid (DNPH method)
6. Estimation of Vitamin E (Dipyrridyl method)
7. Estimation of methionine (Sodium nitroprusside method)
8. Determination of saponification and iodine number of fat or oil

Fluorimetry

9. Estimation of thiamine from cereals or fruits
10. Estimation of riboflavin

Titrimetry

11. Estimation of lactose in milk
12. Estimation of calcium in milk

Separation techniques

13. Separation of amino acids by paper chromatography- circular, ascending & Descending.

14. Separation of plant pigments by TLC.
15. Separation of plant pigments by column chromatography.
16. Estimation of quercetin using HPLC (Demo).

Cell biology:

15. Preparation of standard buffer and determination of pH of buffers.
16. Subcellular fractionation by differential centrifugation and purity assessment with marker enzymes (Group Experiment).
17. Salting out of proteins using ammonium sulphate precipitation

SUGGESTED READINGS

1. Jayaraman, J., (2007). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi.

2. Sadasivam, S.,and Manickam, A., (2009). Biochemical Methods, New Age, International Publishers, New Delhi.

3. Singh, S.P., (2009). Practical Manual of Biochemistry, CBS Publishers, New Delhi.

Semester I

18BCP112 **PRACTICAL – II** **4H-2C**

PLANT BIOCHEMISTRY AND MICROBIOLOGY

Instruction hours/week: L:0 T:0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

- Build up the knowledge of the students in medicinal plant phytochemical screening.
- Open up the students to detailed plant physiological studies to pave way for plant tissue culture techniques.
- Students will have knowledge on some of the general methods used in the study of microorganisms and to recognize and compare structure and function of microbes and factors affecting microbial growth.

Course outcomes (CO's)

1. The students are able to perform medicinal plant phytochemical screening and plant tissue culture techniques, to study detail on plant physiological properties.
2. Prepare stained smears, culture micro-organisms, perform tests to identify bacteria and fungi, and to study microbial growth control methods.

Plant Biochemistry

1. Phytochemical screening of any one selected medicinal plant
2. Estimation of Tannins
3. Estimation of Flavonoids
4. Estimation of Chlorophyll
5. Estimation of Phenols

MICROBIOLOGY

6. Isolation of pure culture – serial dilution, pour plate, spread plate, streak plate methods.
7. Colony morphology – colony counting.
8. Staining techniques- simple, differential, spore, and fungal staining.
9. Antibiotic resistance / sensitivity test (Disc method)
10. Estimation of bacteria- growth curve of bacteria and generation time.
11. Identification of microorganisms – biochemical tests (IMVIC test)(Group Experiment)
12. Microbiology of potable water
13. Isolation, characterization and purification of ANY one of the following microbial enzymes
    a) Amylase
    b) Protease
14. Assay of Antibacterial of ANY ONE selected medicinal plant by Disc or Well diffusion and broth dilution method.
15. Assay of antifungal activity of ANY ONE selected medicinal plant by Disc or Well diffusion. TLC- Bioautography.

PLANT TISSUE CULTURE (Group experiment)

16. Preparation of tissue culture media
17. Surface sterilization
18. Induction of meristem culture
19. Callus induction.
20. Regeneration of shoot and root from callus culture.

SUGGESTED READINGS

1. Wagner, H., and Bladt, S., (1996). Plant drug analysis. Springer Science & Business media 2nd edition

2. Jayaraman, J., (2011). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi.

3. Kannan, N., (2003). Laboratory Manual in Microbiology, Panima Publishing Corporation, Bangalore.

4. Sadasivam, S.,and Manickam, A., (2009). Biochemical Methods, New Age, International Publishers, New Delhi.

5. Singh, S.P., (2009). Practical Manual of Biochemistry, CBS Publishers, New Delhi.

6. Talib, V.H., (2007). A Handbook of Medical Laboratory Technology, CBS publishers,2nd edition. New Delhi.

7. Varley, H., (2003). Practical Clinical Biochemistry, CBS Publishers, New Delhi.

Semester II

18BCP201 REGULATION OF METABOLIC PATHWAYS 4H-4C

Instruction hours/week: L: 4 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

- To shed knowledge on generation and transformation of energy in metabolic pathways.
- To know the various metabolic pathways associated with carbohydrate, lipid , protein and nucleic acid metabolism, their regulation and associated disorders.
- To understand the inter relationship of carbohydrate, lipid , protein and nucleic acid metabolism and understand the importance of TCA cycle.
- To aware about the homeostatis of glucose of metabolites by intrinsic and extrinsic control mechanism.

Course outcomes (CO's)

1. Gain knowledge on glucose anabolic and catabolic pathways that ultimately control the glucose homeostatis.
2. Able to explain the role of lipids, their metabolism and their stringent control by hormones and other factors.
3. Understand the anabolic and catabolic processes associated with amino acids and nucleic acids and their regukation.
4. Able to understand the energy homeostatis during starvation and energy excess

UNIT I: Introduction to control of enzyme activity

Allosteric interaction; Reversible covalent modification; proteolytic action; control of amount of enzyme; control of rates of enzyme degradation; feed back inhibition; feed forward stimulation. Role of compartmentation. Elucidation of Metabolic pathways- Single- and Multi-step pathways. Experimental approaches to study the metabolism- using metabolic inhibitors and isotopes.

UNIT II: Carbohydrate Metabolism

An overview of Glycolysis and Gluconeogenesis. Role of LDH. Regulation of Glycolysis and Gluconeogenesis-Reciprocal control of Glycolysis and Gluconeogenesis, TCA cycle-steps, regulation at branch points; Glycogen Metabolism: Overview of glycogenesis and glycogenolysis. Reciprocal control of glycogenesis and glycogenolysis. Alternative pathways of metabolism-HMP shunt, Entner- doudoroff pathway, glucoronate and Glyoxalate pathway, cori cycle. Hormonal regulation of fuel metabolism; Metabolic disorders-Diabetes mellitus and insipidus.

UNIT III: Lipid metabolism

An overview of fatty acid synthesis and degradation, Regulation of fatty acid synthesis-control of acetyl CoA carboxylase and fatty acid synthetase complex; Reciprocal control of fatty acid synthesis and degradation. Biosynthesis of triacyl glycerol, phosphatidyl choline, phosphotidyl ethanolamine and sphingomyelin and their regulation. Synthesis and

degradation of cholesterol and its regulation. Metabolism of prostaglandins-COX and LOX pathways. Metabolic fate of VLDL, LDL and HDL. Obesity and regulation of body mass. Metabolic disorders- Atherosclerosis, Hyper and hypo lipoproteinemia.

UNIT IV: Amino acid metabolism

Regulation of synthesis of pyruvate, serine, glutamate, aspartate, aromatic and histidine family of amino acids (Flow chart only) . Key role of glutamate dehydrogenase and glutamine synthetase in nitrogen metabolism and their allosteric regulations. Amino acid degradation- Oxidative deamination, Non oxidative deamination,decarboxylation and transamination. Ammonia formation and disposal- urea cycle and its regulation. Catabolism of carbon skeleton of amino acids.Biosynthesis of heme (porphyrin) and its regulations. Molecules derived from amino acids. Metabolic disorders- Alkaptonuria, phenyl ketonuria.

UNIT V: Nucleic acid metabolism

De novo synthesis of purine and its regulation – Role of PRPP amino transferase. De novo synthesis of pyrimidine and its regulation – Role of aspartate carbomyl transferase. Regulation of deoxy ribonucleotides by activators and inhibitors. Intergration of metabolism. Metabolism during starvation. Tissue specific metabolism- Metabolic profile of major organs- Brain, Muscle, Liver and Adipose tissue. Metabolic disorders- Gout, SCID.

SUGGESTED READINGS

1. Lehninger, L., Nelson, D.L., and Cox, M.M., (2012). Principles of Biochemistry, 6th edition WH Freeman and Company, New York.

2. Murray, R.K., Bender, D.A., Botham, K.M., and Kennelly, P.J., (2012). Harper's illustrated Biochemistry, 29th Edition. McGraw-Hill Medical. London.

3. Donald Voet and Judith Voet ,2004. Biochemistry, John Wiley and Sons,. 2ndEedition. New York

4. Leubert Stryer, 2009. Biochemistry, W.H. Freeman and Company. New York.

5. Pamila C. Champ and Richard A. Harvey ,2008. Biochemistry, Lipponcott Company, Philadelphia.

6. Smith. 2003. Principles of Biochemistry, McGraw– Hill International Book Company, London.

7. Zubay, G., (2009). Biochemistry, W.C Brown Publishers, Saunders and Company, Philadelphia.

Semester II

18BCP202 **MOLECULAR BIOLOGY** **4H-4C**

Instruction hours/week: L: 4 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

The course aims to provide students with a basic understanding of

- Organization of DNA in a genome and the mechanism behind replication, transcription and translation.
- Regulation of gene expression in prokaryotes and Eukaryotes.

Course outcomes (CO's)

At the end of the course, student will be able to

1. Understand the structure of nucleic acids and the DNA replication process
2. Learn about the process of transcription
3. Understand the mechanism of translation
4. Learn about gene regulation in prokaryotes
5. Learn about gene regulation in eukaryotes

UNIT I: Molecular structure of genes

Molecular definition of gene, chromosomal organization of genes and non-coding DNA, protein coding genes, tandomly repeated genes, single sequence DNA. Structural organization of eukaryotic chromosomes- histone proteins, chromatin, functional elements. Mobile DNA elements- bacterial IS elements, transposons, viral transposons and non- viral transposons. Mutation- types.

UNIT II: DNA replication and repair

General features of chromosomal replication. Enzymology of DNA replication, DNA replication machinery. Replication in prokaryotes and eukaryotes- Initiation, elongation and termination. DNA damage-types. Repair mechanism of DNA damage-all types.

UNIT III: Transcription

Prokaryotic gene transcription- Initiation, elongation and termination. Eukaryotic gene transcription- transcription unit, RNA polymerases- types, Transcription and processing of mRNA, tRNA and rRNA. Regulatory sequences in protein coding genes-TATA box, initiators, CpG island, promoter-proximal element, activators and repressors of transcription, Multiple transcription control elements. Regulation of transcription factor activity by lipid-soluble hormones.

UNIT IV: Translation

Deciphering genetic code, features. Wobble hypothesis. Initiation, elongation and termination of prokaryotic and eukaryotic translation. Fidelity of translation. Post translational modifications-all types; Protein targeting-Targeting protein to nucleus, ER, Golgi complex. Protein degradation- ubiquitin mediated degradation.

UNIT V: Prokaryotic gene regulation

Operon model, Lac, trp and ara operons. Regulatory proteins-DNA binding domain, protein-protein interaction domain. Recombination- holiday model, Rec BCD enzymes, Rec A protein, Messelson Radding model, site- specific recombination. Antisense RNA technology.

Eukaryotic gene regulation: Transcriptionally active chromatin, chromatin remodeling, DNA binding transactivators and coactivators. Regulation of gene expression by intracellular and intercellular signal, RNAi.

SUGGESTED READINGS

1. Watson, J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A., and Weiner, A. M., (2005) Molecular biology of the gene, The Benjamin/Cummings publishing companies, Inc, California.

2. Lewin, B., (2008) Genes IX, Oxford University Press, 9th Edition, Oxford, London,

3. Weaver, R. F., (2008) Molecular biology, WCB McGraw-Hill companies, 6th Edition.Inc, New York.

4. Lodish, H., Berk, A., Kaiser, C.A., and Krieger, M.,. (2012). Molecular Cell Biology, 7th edition. W.H. Freeman & Company,

5. Lehninger, L., Nelson, D.L., and Cox, M.M., (2012). Principles of Biochemistry, WH Freeman and Company, 6th Edition, New York.

6. Kornberg, A., Baker, A., (2005). DNA replication, W.H. Freeman and Co, USA.

7. Cooper, G.M., and Hausman, R.E., (2013). Cell-A Molecular Approach, 6th Edition.. Sinauer Associates. USA

Semester II

17BCP203 DEVELOPMENTAL GENETICS 4H-4C

Instruction hours/week: L: 4 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objective

- Specific objectives of this course are to provide an understanding and discuss ramifications of inherence, gene structure and function, gene mutation, and research related to genetics and its applications.
- To comprehend cellular mechanisms of developmental stages.

Course outcomes (CO's)

1. Comprehensive, detailed understanding of the chemical basis of heredity
2. Comprehensive and detailed understanding of genetic methodology and how quantification of heritable traits in families and populations provides insight into cellular and molecular mechanisms.
3. Comprehensive detailed understanding of cellular mechanisms of developmental stages.

UNIT-I: Mendelian Principle and experiments

Mendelian inheritance-principles; Mendel‟s experiments-monohybrid, dihybrid trihybrid and multihybrid crosses. Interaction of genes: incomplete dominance, codominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes; lethal genes. Environmental influence of gene expression: penetrance and expressivity; temperature, light, phenocopies. Environmental effects and twin studies; human intelligence. Quantitative or polygenic inheritance: Inheritance of kernel color in wheat; corolla length in tobacco skin color inheritance in man, transgressive and regressive variation. Multiple alleles; Sex determination; Extra chromosomal inheritance. Genetic abnormalities

UNIT-II: Prenatal Screening

Amniocentesis; Prenatal diagnosis of genetic diseases, XX and XY karyotyping, DNA/RNA probes. DNA probes in the diagnosis of infectious diseases; Mycobacterial, plasmodial, HIV and HPV infections during development. Molecular probes in diagnosis of genetic diseases: Down syndrome, Cystic fibrosis, Sickle cell anemia, Alkaptonuria, Phenylketonuria, Kleinfelter syndrome and Cancer (breast cancer,Leukaemia, Burkets lymphoma).

UNIT-III: Developmental Stage I

Gametogenesis – Origin of germ cells – Significance of different stages of gametogenesis Oogenesis – Types of eggs–growth, development and maturation of oocyte, Egg envelopes, Polarity and symmetry, Spermatogenesis–Sperm Structure, Types of sperm, Fertilization – Approach of spermatozoon–Reaction of egg, essence of activation – Changes in egg cytoplasm during fertilization.

UNIT-IV: Developmental Stage II

Cell division in cleavage – Chemical changes–Patterns of embryonic cleavage – Morula and Blastula – Role of egg cortex – Morphogenetic gradients – Fate map – Gastrulation –

Primary organ, Rudimental organs, Organizer – Morphogenetic movements- invagination, extension, ingression movements and locomotion.

UNIT-V: Developmental Stage III

Organogenesis: Induction and differentiation of Brain, eye, ear, limb, Heart, kidney, Development of Immune system, Genetic basis of differentiation – selective action of genes–gene action in development – Nuclear transplantation–apoptosis during development– aging–Teratogens and Teratogenesis.

SUGGESTED READINGS

1. Berrill, N.J., (1980). Developmental Biology, McGraw-Hill Inc.,US.
2. Diwan, A.P., Dhakad. N.K., (1996). Animal Regeneration, Anmol Publication Pvt. Ltd, New Delhi.
3. Browder. L.W., Erickson C.A., and Jeffery. W.R., (1991). Developmental Biology, Saunder College Publishing House, Philadelphia.
4. Strickberger, M.W., (2015). Genetics, 3rd edition, Pearson Education India.
5. Benjamin Lewin, (2004). Genes VIII, Oxford University Press.
6. Singh, B. D., (2009). Genetics, Kalyani Publishers, New Delhi.
7. Gupta, P.K., (2009). Genetics, Rastogi Publications, Meerut, India.

Semester II

18BCP204 **BIOINFORMATICS** **4H-4C**

Instruction hours / week: L: 4 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

To make the students

- To make students understand the essential features of the interdisciplinary field of science for better understanding the biological data.
- To create students opportunity to interact with algorithms, tools and data in current scenario.
- To make the students look at a biological problem from a computational point of view.
- To find out the methods for analyzing the expression, structure and function of proteins, and understanding the relationships between species.

Course outcomes (CO's)

1. The student will choose biological data, submission and retrieval from databases.
2. The students will be able to experiment pair wise and multiple sequence alignment and will analyze the secondary and tertiary structures of protein sequences.
3. The student will understand the data structure (databases) used in bioinformatics and interpret the information (especially: find genes; determine their functions), understand and be aware of current research and problems relating to this area.

UNIT I: Concepts of Bioinformatics

Definition, concepts of Bioinformatics: Objectives, History of Bioinformatics, Milestones, Genome sequencing projects, Human Genome Project- Science, applications and ELSI.

Introduction to Biological databases: Types of databases, sequence databases-nucleic acid sequence databases, GenBank, protein sequence database, Swiss-Prot, PIR, motif database-PROSITE, structural databases, bibliographic databases and organism specific databases-GMOD- Searching and retrieval of data-Entrez and SRS.

UNIT II: Sequence Alignment

Introduction to sequence Alignment: Pairwise and multiple sequence alignment, substitution matrices, Dynamic programming algorithms-Needleman and Wunsch and Smith-Waterman, Similarity searching programs, BLAST, FASTA, Multiple sequence alignment – CLUSTAL, Introduction and application to phylogenetic trees, basic terminologies, Phylogenetic analysis-PHYLIP theory of phylogeny, tree building methods.

UNIT III: Protein prediction strategies and programs

Protein Secondary Structure Prediction, three dimensional structure prediction-Comparative modeling, threading, Concepts of Molecular modeling, Model refinement, evaluation of the model, protein folding and visualization of molecules – Visualization tools-RasMol, Deep View.

UNIT IV: Gene Identification and Prediction

Genome sequencing, Genome database-SWISS-2D PAGE database, Gene Mark, Gene Scan, Pattern Recognition, Global gene expression studies-DNA Micro array.

UNIT V: Applications of Bioinformatics

Applications of Bioinformatics-Molecular medicine, biotechnology, agricultural, Computer Aided Drug Designing-structure and ligand based drug designing, ADME profiles, QSAR. receptors, docking, Introduction to molecular dynamics simulation.

SUGGESTED READINGS

1. Lesk, A.M., (2014). Introduction to Bioinformatics, 4th edition. Oxford University Press, Oxford.

2. Attwood, K., and Parry-Smith, J., (2003). Introduction to Bioinformatics, Pearson Education, Singapore.

3. Baxevanis, A.D., and Quellette, B.F.F., (2001). Practical Guide to the Analysis of Genes and Proteins, John Wiley & Sons, New York.

4. Mount, D.W., 2013. Bioinformatics: Sequence and Genome Analysis. 2nd edition, Cold Spring Harbour Laboratory Press, New York.

5. Ignacimuthu, S., (2013). Basic Bioinformatics, 2nd edition Alpha Science Intl Ltd Chennai.

6. Rastogi, S.C., Mendiratta, N and Rastogi, P., (2004). Bioinformatics – Concepts, Skills, Applications. CBS Publishers & Distributiors, New Delhi.

7. Rastogi S.C and Mendiratta, N., (2006). Bionformatics Methods and applications Genomics, Proteomics and Drug Discovery 2nd Edition, Parag Rastogi Publication, India.

8. Sundararajan, S., and Balaji, R., (2003). Introduction to Bioinformatics, Himalaya Publishing House, Mumbai.

Semester II

18BCP205A **CORE ELECTIVE –II** **4H-4C**

RECOMBINANT DNA TECHNOLOGY

Instruction hours/week: L:4 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objectives

- To make the student to understand the concept of gene manipulation and gene transfer technologies.
- To understand the concept of recombinant DNA technology or genetic engineering
- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineering techniques.

Course outcomes (CO's)

1. An understanding on application of genetic engineering techniques in basic and applied experimental biology
2. Proficiency in designing and conducting experiments involving genetic manipulation.
3. Describe DNA fingerprinting, and restriction fragment length polymorphism (RFLP) analysis and their applications.

UNIT I: Introduction to gene manipulation

Basic techniques- Isolation and purification of nucleic Acids, Agarose gel Electrophoresis. Hybridization of nucleic acids-probes and types. Hybridization techniques-Southern, Northern, Western blotting. DNA and RNA markers.

UNIT II: Gene cloning vectors

Plasmids, bacteriophages, phagemids, cosmids, Artificial chromosomes- BAC, YAC, HAC. Restriction mapping of DNA fragments, Map construction, Cloning in *E. coli*- Vector engineering and codon optimization. Gene expression in *E.coli*. Expression vector- PET vector. Genomic library.

UNIT III: Isolation and characterization of gene transcripts

Introduction, Converting mRNA transcripts into cDNA, Screening representative cDNA libraries, Functional sequencing of cDNA expression libraries. Expressed cDNAs compared with computer databases. Characterization of recombinant proteins- Processing, purification and refolding and stabilization-Insulin, hGH, tpA.

UNIT IV: Mutagenesis

Site-directed mutagenesis, *In vitro* mutagenesis-Linkers, synthetic oligonucleotides and transposons, Role of Tagging in gene analysis, Identification and isolation of genes through T-DNA or transposons.

Gene therapy- Different strategies for gene therapy, therapeutics based on targeted exhibition of gene expression and mutation correction *in vivo*, Gene therapy for inherited diseases, ADA, FH, Cystic fibrosis.

UNIT V: Transgenics

Gene transfer techniques- Microinjection, biolistic methods, vector based transfer.

Transgenic plants: Agrobacterium & Ti plasmids. Methods of engineering herbicide resistance plants, Stress resistance plants and modification of plant nutritional content (amino acids, β- carotene) Plants as bioreactors: edible vaccines.

Transgenic animals: Method of Engineering transgenic mice, transgenic cattle- applications Biosafety- regularities and concerns. Societal impact of genetically modified food.

SUGGESTED READINGS

1. Glick, B.R., Pasternak, J.J., and Patten, C.L., (2009). Molecular Biotechnology, 4th edition, Panima Publishing Corporation, Delhi.

2. Watson, J.D., Gilamn, M., Witkowski, J., and Zotler, M., (2006). Recombinant DNA, 3rd Edition. W.H. Freeman Company, New York.

3. Kingsman, S .M., and Kingsman, A.J., (2001). Genetic Engineering: An Introduction to Gene Analysis and Exploitation in Eukaryotes, 6th Edition. Blackwell Scientific Publication, Oxford.

4. Kreuzer, H., and Massay, A., (2008). Molecular Biology and Biotechnology, 3rd Edition Aim Press, Washington,DC.

5. Primrose, S. B., (2003). Molecular Biotech, 2nd edition, Panima Publications, New Delhi.

6. Sambrook, J., Fritch, E.F., and Maniate, T., (2001). Molecular Cloning, A Laboratory Manual, Cold Spring Harbor Laboratory Press, New York.

7. Strachan, T., and Read, A.P., (2003). Human Molecular Genetics, 3rd edition. John Wiley and Sons,Toronto. Canada.