SCHEME & SYLLABUS OF M.Sc. (BIOCHEMISTRY)
Effective from July 2016-17 batch and
Applicable to 3rd and 4th Semester of 2015-16 batch

FIRST SEMESTER

S. NO.	COURSE NO.	TITLE	L	T	P	Cr.
1.	PIM101	BASIC MATHEMATICS (FOR MEDICAL GROUP)	3	1	0	3.5
	PCY108	CHEMICAL BIOLOGY (FOR NON-MEDICAL GROUP)				
2.	PBC101	BIOMOLECULES AND ENZYMOLOGY	3	0	2	4.0
3.	PBC102	CELL BIOLOGY AND PHYSIOLOGY	3	0	2	4.0
4.	PBC103	BIOINORGANIC AND BIOPHYSICAL CHEMISTRY	3	0	0	3.0
5.	PBC104	BIO-ANALYTICAL TECHNIQUES	3	1	0	3.5
6.	PBC105	BIOCHEMISTRY LAB-I	0	0	6	3.0
7.	PHU002	PROFESSIONAL COMMUNICATION	2	1	0	2.5
		TOTAL	**17**	**3**	**10**	**23.5**

SECOND SEMESTER

S. NO.	COURSE NO.	TITLE	L	T	P	Cr.
1.	PBC201	BIOENERGETICS AND INTERMEDIARY METABOLISM	3	0	0	3.0
2.	PBT207	BIOSTATISTICS AND COMPUTATIONAL BIOLOGY	3	1	2	4.5
3.	PBT210	IMMUNOLOGY AND IMMUNOTHERAPY	3	1	2	4.5
4.	PCY211	MEDICINAL AND PHARMACEUTICAL CHEMISTRY	3	0	0	3.0
5.	PCY215	MOLECULAR SPECTROSCOPY	3	1	0	3.5
6.	PBC203	BIOCHEMISTRY LAB-II	0	0	6	3.0
7.	PBC204	PROGRAMMING for BIOINFORMATICS	2	0	2	3.0
		TOTAL	**17**	**3**	**12**	**24.5**

THIRD SEMESTER

S. NO.	COURSE NO.	TITLE	L	T	P	Cr
1.	PBC304	MOLECULAR BIOLOGY AND RDNA TECHNOLOGY	3	0	2	4.0
2.	PBC301	NUTRITIONAL AND CLINICAL BIOCHEMISTRY	3	0	2	4.0
3.	PBC303	BIOETHICS, BIOSAFETY AND IPR	2	0	0	2.0
4.	PBC302	NANO-BIOMATERIALS	3	0	0	3.0
5.		ELECTIVE - I	3	0	2	4.0
6.	PBC391	SEMINAR/MINOR PROJECTS*	-	-	-	2.0
		TOTAL	**14**	**0**	**6**	**19.0**

*MAY BE UNDERTAKEN/COMPLETED IN ACADEMIC OR INDUSTRY.

FOURTH SEMESTER

S. NO.	COURSE NO.	TITLE	L	T	P	Cr
1.	PBCXXX	ENVIRONMENTAL BIOCHEMISTRY AND ECOLOGY	3	0	0	3.0
2.		ELECTIVE-II	3	0	0	3.0
3.	PBC491	DISSERTATION	-	-	-	6.0
		TOTAL	6	0	0	12.0

ELECTIVE-I

S. NO.	COURSE NO.	TITLE	L	T	P	Cr
1	PBT311	GENOMICS, METAGENOMICS AND PROTEOMICS	3	0	2	4.0
2.	PBT312	MOLECULAR FARMING	3	0	2	4.0
3.	PBT313	MOLECULAR MEDICINE AND DIAGNOSTICS	3	0	2	4.0

ELECTIVE-II

S. NO.	COURSE NO.	TITLE	L	T	P	Cr
1.	PBCXXX	BIOFUELS	3	0	0	3.0
2.	PCY401	HETEROCYCLIC CHEMISTRY AND NATURAL PRODUCTS	3	0	0	3.0
3.	PBCXXX	BIOCATALYSIS	3	0	0	3.0

TOTAL NUMBER OF CREDITS: 79

PIM101: BASIC MATHEMATICS

L	T	P	Cr
3	1	0	3.5

Course objective: The objective is to develop basic computing skills and application of quantitative and statistical operations required for biological studies and rationalization of experimental designs.

Algebra: Linear and quadratic equations; Complex numbers, Argand plane and polar representation of a complex number, square root of a complex number; Permutations and Combinations; Binomial theorem for positive/negative index and its simple applications; Arithmetic and Geometric progression.

Trigonometry: Review of trigonometric functions, sum and product formulae for trigonometric functions, Trigonometric Equations .and C-D formulas for trigonometric functions; Identities related to sin (2x), cos(2x) and tan (2x).

Determinants and Matrices: Matrices, Operations on Matrices, Determinants and its properties, singular and non-singular matrices, Adjoint and inverse of a matrix and its properties; Solution of system of linear equations using Cramer's rule and inverse of a matrix.

Differentiation: Review of sets, relations and functions, Limit, Continuity and Differentiability, Differentiation of standard functions (polynomials, trigonometric, inverse trigonometric exponentials and logarithmic); Product rule, Quotient rule, Applications of derivatives in Graphing,

Integration: Integral as anti derivative. Integration by substitution, by partial fractions and by parts. Definite integral and its properties. Areas of bounded regions

Coordinate geometry: Rectangular Coordinate system, Straight lines, Circles (in standard form).

Course Learning Outcomes (CLOs): Students will be able to

1. analyze mathematical concepts in continuous learning and connecting ideas like numerical problems,
2. solve calculus, coordinate geometry to other subjects and support learning through applications of mathematics.

Recommended Books:

1. Mathematics, A Text book (Parts I & II), 2011, NCERT, New Delhi.
2. Thomas, G.B. and Finney, R.L. Calculus and Analytical Geometry, Pearson Education. (2007) 3. Shanti Narayan, Differential and Integral Calculus, S. Chand (2005).
4. Krishnamurthy V.K., Mainra V.P. and Arora J.L. An introduction to Linear Algebra. Associated East West Press (2007).

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	45
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	25

PCY108: CHEMICAL BIOLOGY

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Course Objective: To introduce molecular structure and interactions present in various bio-molecules that help in functioning and organization of living cell.

Introduction: Cell structure and functions, Scales of biological systems, Dimensions of bio-molecules and assemblies, Times of biological processes and biologically important energies, ATP. Water – physical properties and structure of water molecules, Interactions in aqueous solutions, Role of water in life, Biological buffers, Henderson-Hasselbalch equation.

Amino Acids and Peptides: Classification of amino acids and their properties, Polypeptides, Primary Structures, N-terminal and C-terminal determinations. Structure of peptide bond, synthesis of peptides, Solid phase peptide synthesis.

Nucleic Acids: Purine and pyrimidine bases, Nucleotides, Nucleosides, Base pairing via H-bonding, Structure of ribonucleic acids (RNA) and deoxyribonucleic acids (DNA), Double helix model of DNA, Chemical and enzymatic hydrolysis of nucleic acids, The chemical basis for heredity, An overview of replication of DNA, Transcription, Translation and genetic code.

Carbohydrates: Biologically important monosaccharides, disaccharides and polysaccharides, Glycoproteins, Role of sugars in biological recognition, Blood group substances, Carbohydrate metabolism - Glycolysis, Glycogenesis and Glycogenolysis, Gluconeogenesis, Pentose Phosphate pathway.

Lipids: Lipid classification, Lipid Bilayers, Membrane Proteins - integral membrane proteins, Lipid linked proteins, peripheral proteins, Overview of membrane structure and assembly. Liposomes, their biological functions.

Course Learning Outcomes (CLOs): Students will be able to

1. interpret molecular structure and interactions present in proteins, nucleic acids, carbohydrates and lipids
2. explain organization and working principles of various components present in living cell.

Recommended Books

1. *Voet, D.J., Voet, J.G., Pratt, C.W., Principles of Biochemistry,* **John Wiley, (2008).**
2. *Berg, J.M., and Tymoczko, J.L., Stryer, L., Biochemistry,* **W.H. Freeman** *(2007).*
3. *Garrett, R.H., Grisham, C.M., Biochemistry, Brooks/Cole, Cengage Learning,(2010.)*
4. *Conn, E.E., and Stump, F., Outlines of Biochemistry, John Wiley (2006).*

Evaluation Scheme:

MST	EST	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)
30	45	25

PBC101: BIOMOLECULES AND ENZYMOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisites: Chemistry, Cell Biology

Course Objective: The cells of living organisms contain thousands of biomolecules. From this course the students will know the structure-function relationship of these molecules, and their importance with regard to maintenance and perpetuation of the living systems.

Introduction: Molecular basis of life; Introduction to Biochemistry, intra and intermolecular forces, water as a biological solvent, electrostatic and hydrogen bonds, disulfide bridges, hydrophobic and hydrophilic molecules, physiological buffers, fitness of the aqueous environment for living organisms.

Carbohydrates: Structure of monosaccharides; Stereoisomerism and optical isomerism of sugars; Ring structures and anomeric forms, mutarotation, reactions of sugars; Derivatives of monosaccharides, disaccharides and trisaccharides; Structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides namely glycogen, starch, cellulose, chitin, agar, pectins, proteoglycans, sialic acids, blood group polysaccharides.

Lipids: Definition and classification; Structure and properties of fatty acids, essential fatty acids, prostaglandins, triacylglycerols; Biological significance of fats; Properties and functions of glycerophopholipids, sphingomyelins, glycolipids, isoprenoids and sterols.

Proteins: Structure, classification and properties of standard amino acids, non-standard amino acids; Titration of amino acids; Essential amino acids; Peptide bond and polypeptide chain, amino acid sequence determination; Primary, secondary, tertiary and quaternary structure of proteins, protein folding, denaturation and renaturation of proteins; Salting in and salting out of proteins; Fibrous proteins, globular proteins, lipoproteins, glycoproteins and nucleoproteins.

Nucleic acids and porphyrins: Purine and pyrimidine bases, Nucleotides and nucleic acids, Composition of DNA and RNA, structural features of nucleic acids, DNA double helix, denaturation and annealing of DNA; Structures and roles of different types of RNA; Central dogma of molecular biology; Gene, genome and chromosome; Chemical nature and physiological significance of porphyrins.

Enzymology: Brief history, general characteristics of the biocatalysts, the basis of cellular metabolism; IUB enzyme classification, Enzyme kinetics, Measurement and expression of enzyme activity; Mechanism of enzymatic catalysis, Active site, Activators and inhibitors, Coenzymes, cofactors, Isoenzymes, Michaelis-Menten equation, K_m and V_{max} values, allosteric enzymes, Regulation of enzyme activity (single-substrate and multi-substrate reactions); Industrial and clinical applications of enzymes.

Laboratory Work: Preparation of buffer solutions, Determination of pK values, Estimation of reducing sugars, total carbohydrates, amino acids and proteins, Quantitative analysis of lipids, Enzyme assays from microbes and eukaryotes, Basic strategies for enzyme purification, Enzyme kinetics, Estimation of total and available nitrogen, phosphorous and sulphur, Estimation of chlorophyll and other photosynthetic pigments.

Course Learning Outcomes (CLOs): Students will be able to

1. comprehend the importance of chemical foundation in living organisms.
2. analyze the various types of weak interactions between the biomolecules and water.
3. correlate how the large biomolecules such as proteins, carbohydrates, lipids, nucleic acids are made from the simple precursors.
4. interpret the structure-function relationships of the proteins, carbohydrates, lipids, and nucleic acids.

5. be familiar with the enzymes (biocatalysts), and their salient attributes including unique conformation and amazing catalytic properties.

Recommended Books:

1. *Nelson, D.L. and Cox, M.M., Lehninger Principles of Biochemistry, W.H. Freeman (2008).*
2. *Jain, J.L., Jain, S. and Jain, N., Fundamentals of Biochemistry, S. Chand and Company Ltd. (2005).*
3. *Rao, B.S. and Deshpande, V., Expt. Biochemistry: A student companion. Anshan Publication (2005).*

Wilson, K. and Walker, J., Practical Biochemistry, Principles and Techniques, Cambridge University Press (1995).

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	25
2.	EST	40
3.	Sessional (May include Project/Quizzes/Assignments/Lab Evaluation)	35

PBC102: CELL BIOLOGY AND PHYSIOLOGY

L	T	P	Cr
3	0	2	4.0

Course objective: The objective of this course is to provide exposure to the students on cells, structural and functional units of living organisms, and their intricate organization. Moreover, they will learn the functions and vital processes of an organism/an organ /system of organs.

Cellular organization: Microbial diversity and characterstic features; Microbes beyond cellular organization (viruses, viriodes, virusoids and prions); Architecture of eukaryotic cells-molecular organization and functions of plasma membrane, cell wall, structure and function of cell organelles-nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulumn, peroxisomes, plastids, vacuole, Structure and function of cytoskelton and its functions and its role in motility.

Cell division and cell cycle: Mitosis and Meiosis and their regulation, steps in cell cycle, control of cell cycle, carcinogenesis, characteristics of cancer cell.

Cell differentiation: Organogenesis, morphological, functional and biochemical maturation of tissues.

Blood and circulation: Composition of blood-structure and function of its constituents, blood coagulation and anticoagulants, Homeostasis, Myogenic heart, ECG, cardiac cycle, blood pressure.

Digestion: Classes of food, BMR and energy requirements, digestion, absorption and assimilation of food.

Excretion: Structure of nephron, formation of urine, glomerular filteration, tubular re-absorption, tubular secretion, Hormonal and renal regulation of body fluids and electrolyte balance,

Respiratory systems: Comparison of respiration in different animal species, gaseous transport and exchange, waste elimination, neural and chemical regulation of respiration.

The endocrine glands: Endocrine glands, secretion of hormones, mechanism of hormone action.

Neurophysiology: Introduction to structure and functions of neurons.

Photosynthesis, respiration and photorespiration: Photosynthetic pigments, light harvesting complexes, light reactions, photophosphorylation, electron transport, CO_2 fixation-C_3, C_4 and CAM pathway.

Laboratory Work *:* Morphology of prokaryotic and eukaryotic cells; Gram staining of different bacteria; Pure cultures of microbes; To study different plant and animal tissues from permanent slides; Different stages of mitotic divisions from onion root tips; Clotting and bleeding time of blood, Estimation haemoglobin, RBC counts, Osmotic fragility of RBC, Lymphocyte count in human blood; Estimation of photosynthetic pigments.

Course Learning Outcomes (CLOs): Students will be able to

1. comprehend the overall architecture of prokaryotic and eukaryotic cells and their internal structures including organelles.
2. assess the importance of various stages of cell cycle, and their regulation.
3. interpret the importance of cellular differentiation in the overall development of an organism.
4. comprehend some of the vital processes like circulation of blood, digestion, excretion.
5. analyze the role of the respiratory systems, endocrine glands, neuronal networks.
6. to be familiar with the biochemical processes involved in photosynthetic carbon reduction in plants.

Recommended Books:

1. *Alberts,B., Johnson,A., Lewis.J.,Raff, M.,Roberts,K.,and Walter ,P. Molecular Biology of the Cell, Garland Science Publishing.*
2. *Becker, W.M., Kleinsmith, L.J. and Haldin, J., The World of the Cell, 7th edition, Pearson Education (2008).*
3. *Devlin, R.M.., Plant Physiology, CBS Publishers and Distributors, N. Delhi*
4. *Salisbury and Rose. Plant Physiology. Wordsworth Publication Co., California, USA*
5. *Stuart, I .Fox. Human Physiology, McGraw Hill 2006.*
6. *Guyton and Hall, A Text book of Medical Physiology, , W.B. Saunders and Cunar, 2006.*

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	25
2.	EST	40
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	35

PBC103: BIOINORGANIC AND BIOPHYSICAL CHEMISTRY

L	T	P	Cr
3	0	0	3.0

Course objective: The objective of this course is to provide exposure to the students of structure, function, folding and dynamics of proteins.

Introduction: General terms, how and why does nature select inorganic elements? Inorganic Elements and evolution.Basic biological Coordination Chemistry. Kinetic and spectroscopic characteristics of bioinorganic systems.Systematic overview over tasks and examples of inorganic elements in biology

Non-redox active metals: Ion transport: membranes, energy, channels, pumps, Biomineralization

Iron Containing Heme Proteins: Haemoglobin and myoglobin as oxygen carriers, Bohr effect, Coordination chemistry of Fe(II) in haemoglobin and oxyhaemoglobin, Relaxed and tense (R & T) configurations of haemoglobin, Electronic formulations and mode of bonding of dioxygen in haemoglobin, Structure and functions of cytochromes and hemerythrins.

Iron Containing NonhemeMetalloproteins: Biochemistry of iron, Iron storage and transport by transferrin/ferritin. Model synthetic complexes of iron, Iron-sulfur proteins, Introduction to ferridoxins and rubredoxin.

Nonferrous Metalloproteins: Blue copper proteins, Zinc protein (carbonic anhydrase), Bio-inorganic chemistry of cobalt vitamin B_{12}, Metal deficiency and disease.

Metals in medicine: anti cancer agents, diabetes, arthritis, radionuclides and related applications

Thermodynamics of Proteins: Thermal and chemical denaturations of proteins, Spectroscopic (CD, FTIR, NMR, Fluorescence) and calorimetric methods to study thermodynamics of proteins, Conformational stability estimation of proteins

Protein Folding Kinetics: Ultrafast biological reactions, Methods and techniques of chemical relaxation, Effect of denaturants on rates of folding and unfolding, Chevon plots, Folding funnels.

Course Learning Outcomes (CLOs): Students will be able to

1. describe the role of metal ions in biology and their interaction with biological environments
2. explain the structure and biological functions of proteins
3. annotate kinetics, thermodynamics, and mechanism of protein folding
4. perform the techniques employed for the study of metalloprotein

Recommended Books

1. *Huheey, J.E., Keiter, E. A., and Keiter, R.L., Inorganic Chemistry, Pearson Education (2008).*
2. *Lippard, S.J., and Berg, J.M.*,Principles of Bioinorganic Chemistry, University Science Books*(1994)*
3. *Cowan, J.A., Inorganic Biochemistry-An Introduction, Wiley-VCH (1997).*
4. *Cantor, C.R., and Schimmel, P.R., Biophysical Chemistry, Freeman (1980).*

5. *Van Holde, K.E., Johnson, W.C., and Ho, P.S., Principles of Physical Biochemistry, Pearson Education (1998).*

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	50
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	20

PBC104: BIOANALYTICAL TECHNIQUES

L	T	P	Cr
3	1	0	3.5

Course objective: To develop the skills of the application of basic and advanced techniques employed in quantitative and qualitative analysis of biomolecules.

Absorption spectroscopy **:** Different type of radiations and their energy levels; Concept of monochromatic light; Lambert Beer's Law; Absorption Characteristics of nucleic acid and Proteins.

Fluorescence spectroscopy : Chromosphere and Oxochrome concept; Permissible and Non-permissible Transitions; Jablonoski energy diagram and Concept of Electronic Shells and Sub-Shells; Fluorescence Spectra and Concept of Quenching; Fluorescence blue, red, Hyper and Hypo Chromic Shifts; Extrinsic Fluorophore and Intrinsic Fluorophore; Factors Influencing Fluorescence Spectra and Quantum yield; Analysis of Protein Structure using Fluorescence Spectra.

CD and ORD Spectroscopy of Biomolecules: Introduction to CD and ORD. Relation between CD and ORD. Absorption by oriented biomolecules, Dichroic ratio of proteins and nucleic acids. Comparison of CD and absorption spectra. Determination of secondary structures content by CD. Determination of pH/temperature/co-solute effects on proteins by CD.

Centrifugation : Principles of Sedimentation, Relation between g and rpm, Instrumentation, Working and Applications of Preparative and Analytical Ultracentrifugation, Isopycnic Centrifugation, Rate Zonal Centrifugation.

Chromatography : Concept of partition co-efficient, Principles, Instrumentation, Working and Applications of Paper Partition Chromatography, TLC, HPTLC, Affinity, Gel filtration, Column, Ion Exchange, HPLC, FPLC and GC.

Electrophoresis and Blotting : Principles, Factors affecting Electrophoresis, Support Media used, Instrumentation, Denaturing/ Non-Denaturing/Non-Reducing DNA and Protein Gel Electrophoresis, Working and Applications of Electro Phoretic Techniques-Zone, Disc, Capillary, 2-D, Pulsed-field gel Electrophoresis, Diagonal, Iso electric focusing, Immune Electrophoresis, Immune Precipitation, Gel-shift mobility assay, Southern, Northern and Western blotting.

Sequencing Techniques : N-terminal, C-terminal and complete Protein Sequencing techniques, Maxam gillbert and Sanger's DNA sequencing techniques, Chromosomal walking, Nextgen Sequencing, Pyro-Sequencing, Illumina Platform, Human Genome Project, Direct and Indirect RNA Sequencing Techniques.

Radioisotope Techniques : Radioactive tracer technique, Nature detection and measurements of Radioactivity. GM counter, Scintillation Counter, Pulse Height Analyser, Isotope Dilution Analysis, Autoradiography, Application of Radioisotopes in Biological science, Safety measures in handling Isotopes.

Low resolution Microscopy : Concept of optical lenses and light path, Resolution of Lenses, Magnification, Optical microscopy, Bright field, Dark field, Phase contrast microscopy, Fluorescence Microscopy, Confocal microscopy.

High resolution Microscopy : Electron Microscopy (TEM and SEM) – Working Principle, Image formation process and Contrast , Image defects, Optimum resolution, Sample preparation, STEM, STM and AFM.

Flowcytometry : Concept of Flowcytometry, Concept of Cell Sorting, Analysis of Cell cycle and Apoptosis using FACS.

Course Learning Outcomes (CLOs): Students will be able to

1) explain mechanistically isolation, purification, quantification techniques of biomolecules.
2) perform procedure to characterize the biomolecules.
3) perform of characterization of cells and cellular components using microscopy and flow cytometry.

Recommended Books:

1. Greenberg, D.M., Metabolic Pathways. Vols. 2 and 3, Burlington Elsevier Science (2012).
2. Nelson, D.L., Cox, M.M., and Lehninger, A.L., Principles of Biochemistry, Worth Publishers, Freeman (2013).
3. Voet, D., Voet, J.G.,and Pratt, C.W., Principles of Biochemistry, Singapore:John Wiley & Sons (2013).

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	50
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	20

PBC105: BIOCHEMISTRY LAB-1

L	T	P	Cr
0	0	6	3.0

Course objective: To impart knowledge of methods and techniques for biomolecules separation and purification

Experiments:

1. Preparation of buffers and adjustment of pH.
2. Determination of titration curve of polybasic acid and calculate the pKa value.
3. Estimation of the pKa values of amino acids and proteins from their pH titration curves.
4. Preparation of standard curve of protein and determination of unknown concentration using Absorption spectroscopic technique and Bradford reagent.
5. Determination of DNA concentration using Diphenylamine (DPA) method.
6. Determination of reducing sugar concentration using dinitro-salycilic acid reagent.
7. Horizontal gel electrophoresis to visualize and quantitate DNA on gel.
8. 1D and 2D ascending TLC of various amino acids.
9. Determination of iodine number of lipid to calculate presence of unsaturation in the sample.
10. Demonstration of HPLC and GC for separation of small molecules.
11. Fluorescence spectra characterization of various amino acids.
12. Native gel electrophoresis of protein and staining of gel to visualization the bands
13. Denaturing gel electrophoresis of protein to determine molecular weight and subunit composition.

Minor Projects:

1. Minor project on characterization of unknown small molecules using HPLC technique.
2. Minor project on characterization of unknown samples using absorption and fluorescence spectroscopic techniques.

Course Learning Outcomes (CLOs): Students will be able to

1) quantify various biomolecules
2) characterize some physical properties of various biomolecules
3) determine the effect of temperature and pH on protein structure.

Recommended Books

1. Wilson, E., Walker, J., Practical Biochemistry-Principles and techniques, Cambridge University press (2010).
2. Boyer, R.F., Modern Experimental Biochemistry. Nenjamin/Cummings publishing company Inc. Redwoodcity, California (2012).
3. Scopes, R.K., Protein Purification Principles and Practice, Narosa Pub. House (1994).
4. Cantor C.R., Schimmel P.R. Biophysical Chemistry, W. A. Fremman and Company (1980).

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	EST	60
2.	Sessional (May include Project/Quizzes/Assignments/Lab Evaluation)	40

PHU002: PROFESSIONAL COMMUNICATION

L	T	P	Cr
3	1	0	3.5

Course Objective: To provide the students with essential skills required for effective communication, and, to apprise them of business communication and its role in corporate environment.

Essentials of Communication: Meaning, Definition, process and barriers.Emergence of communication as a key concept in the corporate and global world.

Methods and Modes of Communication: Verbal and nonverbal, Verbal Communication: Characteristics of verbal communication: Non-verbal Communication: Characteristics and types.

Listening: Importance of listening skills, cultivating good listening skills.

Written Communication: Paragraph and Essay writing, Book reviews, Movie Reviews, Editorials and articles.

Effective Business writing: Letters, Reports .Paper writing: Styles of paper writing: Short Communication, Review papers and Research papers, Referencing styles: MLA, Chicago Style and APA.

Presentations: Principles of effective presentation, power-point presentation, video and satellite conferencing.

Interviews and Group Activities: Personal interviews, group discussion and panel discussion(tutorial classes)

Course Learning Outcomes (CLOs): Students will have understanding of use of proper writing techniques relevant to the present day technological demands, including anticipating audience reaction.

Recommended Books:

1. *Lehman, C.M., DuFrene, D.D.,,and Walker, R, B-BCOM - An Innovative Approach to Learning and Teaching Business Communication. Cengage Learning New Delhi, 2011.*
2. *McMurrey, A.M and Buckley, J., Handbook for Technical Writing, Cengage Learning, New Delhi, 2008.*
3. *Lesikar, R.V and Flately, M.E., Basic Business Communication-Skills for Empowering the Internet Generation, Tata McGraw-Hill Publishing Company Limited. New Delhi, 2005.*

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	45
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	25

PBC201: **BIOENERGETICS AND INTERMEDIARY METABOLISM**

L	T	P	Cr
3	0	0	3.0

Prerequisite(s): Basic knowledge onbiomolecules, enzymes and living cells.

Course Objective: Bioenergetics deals with how the living cells harness energy and channel it to biological work whereas intermediary metabolism means how the cells extract and utilize energy through numerous enzyme-catalyzed reactions. The students will learn both the interrelated aspects.

Bioenergetics: Energy transformation, Laws of thermodynamics; Biological oxidations/reductions and energy transducing membranes; Gibbs energy, free energy changes, redox potentials, phosphate, electrochemicaland ionpotentials, membrane structure, ion transport across membrane and membrane potentials, membrane transport mechanisms.

Carbohydrate metabolism: Glycolysis, citric acid cycle and their regulation;, Order, organization and function of electron carriers in mitochondrial respiratory chain (electron transport), chemo-osmotic theory, oxidative and photosynthetic phosphorylation, pentose phosphate pathway and its regulation; Gluconeogenesis; Interconversions of sugars; Biosynthesis of glycogen, starch and oligosaccharides,

Lipid metabolism: Fatty acid biosynthesis:, fatty acid synthase complex; α, β, ω oxidation of fatty acids; Biosynthesis of triacylglycerols, phosphoglycerides and sphigolipids; Biosynthetic pathways for terpenes, steroids and prostaglandins; Ketone bodies; Metabolism of chylomicrons, LDL, HDL and VLDL; Free fatty acids, Lipid levels in pathological conditions.

Amino acid metabolism: Biosynthesis and degradation of amino acids and their regulation; Urea cycle and its regulation; In-born errors of amino acid metabolism.

Nucleic acid metabolism: Biosynthesis and degradation of purines and pyrimidines; Regulation of purine and pyrimidine biosynthesis; Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, inhibitors of nucleic acid biosynthesis

Hormonal control, cell signaling and integration of metabolism: Hormones and their receptors, signaling through G-protein, signal transduction pathways, second messengers; Hormonal controls and inter-relationships between carbohydrate, protein, lipid and nucleic acid metabolism.

Course Learning Outcomes (CLOs): Students will be able to

1. comprehend various biochemical changes that obey the basic thermodynamic principles.
2. correlate how the living organisms exchange energy and matter with the surroundings for their survival, and store free energy in the form of energy-rich compounds
3. recognize how the catabolic breakdown of the substances is associated with release of free energy; whereas, free energy is utilized during synthesis of biomolecules i.e., anabolic pathways
4. assess the crucial role of some hormones with regard to the integration of metabolic pathways.
5. apply the knowledge of metabolic pathways to biotechnological and biochemical research.

Recommended Books:

1. *Nelson, D.L. and Cox, M.M., Lehninger Principles of Biochemistry, W.H. Freeman (2008).*
2. *Metzler, D.E., Biochemistry - The Chemical Reactions of Living Cells, Vol. I &II,Elsevier (2002).*
3. *Berg, J.M., Tymoczko, J.L., Stryer, L., Biochemistry, WH Freeman and Company (2006).*
4. *Jain, J.L., Jain, S. and Jain, N., Fundamentals of Biochemistry, S. Chand and Company Ltd. (2005).*
5. *Glaser, R, Biophysics, Springer (2004).*

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	50
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	20

PBT207: BIOSTATISTICS AND COMPUTATIONAL BIOLOGY

L	T	P	Cr
3	1	2	4.5

Course Objective: This course will encompass the methodology and theory of statistics as applied to problems in the field of life sciences. The course will provide students with basic understanding and application of computational biology.

Introduction: Biology and statistics, Variables and data, Sampling and sampling errors in biological data, Sampling techniques, Probability and distribution.

Regression and Correlation Analysis: Simple, linear and multiple regression, Simple and multiple correlation.

Hypothesis Testing: Test of hypotheses, one and two sample analysis, Paired sample analysis, Non-parametric statistics and limitations. Confidence limits and tests of confidence, Single, Two and Multi-factorial analysis, Non-parametric Analysis of Variance, Multiple comparison tests – Tukey, Newman-Keul, Scheffe tests, Goodness of fit test.

Design of Experiments and Data Presentation: Response Surface Methods, Cantor Plots, Survivalship curves, Graph plotting and significance of Curves, Data representation

Programming Languages: Problem solving Technique: Algorithm, Flowchart, Compiling, Testing and Debugging, Documentation – Data structures – Array, Stack, Queue, Linked, List concepts

Algorithm: Principles, types, development and its complexity, Complexity of algorithms –NP complete problem- Polynomial-Reducibility-sorting problem and Fibonacci Problem; Algorithm types: Linear, Exhaustive search, Expectation Maximization (EM) with forward and backward algorithms

Dynamic Programming Methods of Sequence Analysis: Principles and its uses. Hidden Markov models in sequence analysis. Introduction of Markov Chain and Hidden Markov models. Forward-backward algorithm, Viterbi and Baum-Welch algorithms, Heuristics second generation alignment tool (Blast, FASTA, ClustalW), Monte Carlo method, Molecular dynamics

Molecular Computational Biology: DNA binding motif finding by sequence alignment, Gibbs sampling approaches, Bayesian network approach to study the gene expression network

Laboratory Work:

MS Excel and Graphpad Prism software, Data entry and graphical representation, Equation formulation and analysis for sample testing, correlation and regression, ANOVA, Multiple comparisons, Survivalship tests, Multiple sequence alignment, DNA binding motif finding by sequence alignment

Course Learning Outcomes (CLOs): Students will be able to

1. organize, summarize and display quantitative data and design to address public health and clinical problems.
2. calculate summary estimates, measures of variability and confidence intervals.
3. manipulate probabilities and the Normal and Binomial distributions.

Text Books:

1. *Waterman M.S., Introduction to Computational Biology: Maps, Sequences and Genomes.Waterman. Chapman and Hall/ CRC Press (1995) ISBN -10: 0412993910*
2. *Gottfried, B.S., Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill (1996). ISBN 10 0070240353*

Reference Books:

1. *De Groot M.H,. and Schervish M.J., Probability and Statistics, Addison-Wesley, (2002).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PBT210: IMMUNOLOGY AND IMMUNOTHERAPY

L	T	P	Cr
3	1	2	4.5

Course Objective: The objective of this course is to provide students with detail understanding of different cells of the immune system and their role in immune protection and application of immunological techniques. The course will provide knowledge about role of immune system in pathogenesis of infectious diseases, cancer, autoimmune disease, AIDS.

Basic Concept and Cells of the Immune System: Hematopoietic Stem Cells, Lymphocytes, Granulocytes and Monocytes, Cell participation in Innate and Adaptive Immunity, Antigen and Antibody, Antigen Presentation and processing, MHC

Cell Activation and Cell Mediated Immune Response: T and B cell maturation, activation and differentiation, T and B cell tolerance, Cytokines and its role in immune response, Cell mediated Cytotoxic Response: Cytotoxic T cell, NK cell and Antibody dependent cell mediated cytotoxicity, inflammatory response

Immunological Techniques: Cross reactivity, Precipitation and Agglutination reaction, Coomb's test, Immuno-electrophoresis, RIA, ELISA, ELISPOT assay, Western blotting, Immunofluorescence and Flow cytometry, Immunomagnetic and Immunodensity method of Cell isolation, Lymphocytes cell proliferation assay, Immunological database and immunoinformatics tool

Autoimmunity, Hypersensitivity and Immunodeficiency: Tolerance and Autoimmunity, Types and mechanism of autoimmune diseases, Hypersensitive reactions, Different types of Hypersensitive reactions, Primary and Secondary Immunodeficiency, AIDS

Immune Response to Infectious Disease, Cancer and Transplantation: Immune Response to viral, bacterial and other infections, Tumor immunity and Tumor antigens, Transplantation types, Immunological basis of graft rejection

Vaccine: Live and Killed Vaccines, Sub unit vaccines, Recombinant Vaccines, DNA vaccines, Peptide vaccines, Plant-based vaccines, Reverse vaccinology, Vaccines against infectious diseases,

Self-Learning: Immunotherapy, Immunosuppressive therapy, Immunostimulation, Cytokines therapy, Immunotherapy for infectious diseases, allergies, autoimmune diseases and cancer

Laboratory Work:
Blood film preparation and identification of cells, Immuno-diffusion, Hemagglutination, Agglutinaton inhibition, Rocket immunoelectrophoresis, Western blotting, ELISA, Epitope prediction using Immunoinformatics tool, Isolation of Peripheral blood mononuclear cells

Course Learning Outcomes (CLOs): Students will be able to

1. explain the role of immune cells and their mechanism in body defense mechanism.
2. apply the knowledge of immune associated mechanisms in medical biotechnology research.
3. adopt immunological techniques for industrial uses.
4. demonstrate the association of immune system with cancer, autoimmunity, transplantation and infectious disease.
5. find out new vaccine target and develop strategy to design new vaccine.

Text Books:

1. *Janeway C. A. Travers P., Walport M., Immuno biology: the immune system in health and disease, Garland Science Publishing New York (2012).*
2. *Owen J. A., Punt J., Strandfold S.A, Jones P.P., Kuby- Immunology W.H. Freeman & Company (2013).*

Reference Books:

1. *Roitt I., Brostoff J., Male D., Immunology, Mosby Elsevier (2004).*
2. *Khan F.H. The Elements of Immunology, Pearson Education (2009)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PCY211: MEDICINAL AND PHARMACEUTICAL CHEMISTRY

L	T	P	Cr
3	0	0	3.0

Prerequisite(s): None

Course Objective: To acquire knowledge of drug design and development, pharmacokinetics, and pharmacodynamics.

Drug Design: Development of new drugs, Procedures followed in drug design, Concepts of lead compound and lead modification, Concepts of pro-drugs and soft- drugs, Structure-activity relationship (SAR), Factors affecting bioactivity, Resonance, Inductive effect, Isosterism, Bio-isosterism, Spatial considerations. Theories of drug activity: Occupancy theory, Rate theory, Induced fit theory. Concepts of drug receptors. Physico-chemical parameters: Lipophilicity, Partition coefficient, electronic ionization constants, Steric. Free-Wilson analysis, Hansch analysis, Relationships between Free-Wilson and Hansch analysis. LD-50, ED-50.

Pharmacokinetics: Introduction to drug absorption, Disposition, Elimination using pharmacokinetics, Important pharmacokinetic parameters in defining drug disposition and in therapeutics.

Pharmacodynamics: Introduction, Elementary treatment of enzyme stimulation, Enzyme inhibition, Sulphonamides, Membrane active drugs, Drug metabolism, Xenobiotics, Biotransformation.

Antineoplastic Agents: Introduction, Cancer chemotherapy, Role of alkylating agents and antimetabolites in treatment of cancer, Antibiotics and mitotic inhibitors.

Cardiovascular Drugs: Introduction, Cardiovascular diseases, Drug inhibitors of peripheral sympathetic function, Central intervention of cardiovascular output.

Psychoactive Drugs: Introduction, CNS depressants, General anaesthetics, Mode of action of hypnotics, Sedatives, Anti-anxiety drugs, Benzodiazipines, Buspirone. Antipsychotic drugs - the neuroleptics, Antidepressants, Butyrophenones, Serendipity and drug development, Stereochemical aspects of psychotropic drugs.

Antibiotics: Cell wall biosynthesis, Inhibitors, β-lactam rings, Antibiotics inhibiting protein synthesis.

Course Learning Outcomes (CLOs): Students will be able to

1. explain the drug designing and development, their SAR and QSAR
2. describe action of different drugs
3. analyze drugs to inhibit the particular enzymes and treatment of diseases

Recommended Books

1. *Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Beale Jr., J.M., Block, J.H. (2012).*
2. *Pandeya, S.N., and Dimmock, J.R., An Introduction to Drug Design, New Age International (2008).*

3. *Abraham, D.J., and Rotella, D.P., Burger's Medicinal Chemistry and Drug Discovery, Vol-1, Ed. John Wiley & Sons (2010).*
4. *Brunton, L.L., Chabmer, B.A., and Knollmann, B.C., Goodman and Gilman's Pharmacological Basis of Therapeutics, Ed. McGraw-Hill (2011).*
5. *Silverman, R.B., The Organic Chemistry of Drug Design and Drug Action, Elsevier(2004)*
6. *Lednicer, D., Strategies for Organic Drug Synthesis and Design, John Wiley & Sons. (2008) .*

Evaluation Scheme

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	50
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	20

PCY215: MOLECULAR SPECTROSCOPY

L	T	P	Cr
3	1	0	3.5

Course Objective: To impart the knowledge of electronic, rotation, vibration. NMR, FTIR, ESR, spectroscopy and their applications.

Unifying Principles: Electromagnetic radiation, Interaction of electromagnetic radiation with matter, Natural line width and natural line broadening, Selection rules, Intensity of spectral lines, Born-Oppenheimer approximation, Rotational, Vibrational and Electronic energy levels.

Microwave Spectroscopy: Classification of molecules, Rigid rotor model, Effect of isotopic substitution on the transition frequencies, Intensities, Non-rigid rotor, Stark effect, Nuclear and electron spin interaction and Effect of external field, Applications.

Vibrational Spectroscopy: Infrared Spectroscopy– Simple harmonic oscillator, Vibrational energies of diatomic molecules, Zero point energy, Force constant and bond strengths; Anharmonicity, Vibration-rotation spectroscopy, P, Q, R branches, Breakdown of Oppenheimer approximation; Vibrations of polyatomic molecules, Selection rules, Normal modes of vibration, Group frequencies, Overtones, Hot bands, Factors affecting the band positions and intensities, Metal-ligand vibrations, Normal co-ordinate analysis.

Raman Spectroscopy - Classical and quantum theories of Raman effect, Pure rotational, Vibrational and Vibrational-Rotational Raman spectra, Selection rules, Mutual exclusion principle, Resonance Raman spectroscopy, Coherent anti Stokes Raman spectroscopy (CARS).

Electronic Spectroscopy: Energies of atomic and molecular orbitals, Vector representation of momenta and vector coupling, Spectra of hydrogen atom and alkali metal atoms. Vibronic transitions, Vibrational progressions and geometry of the excited states, Franck-Condon principle, Electronic spectra of polyatomic molecules, Emission spectra, Radiative and non-radiative decay, Internal conversion, Spectra of transition metal complexes, Charge-transfer spectra.

Magnetic Resonance Spectroscopy: Nuclear Magnetic Resonance Spectroscopy - Nuclear spin, Nuclear resonance, Saturation, Shielding of magnetic nuclei, Chemical shift and its measurements, Factors influencing chemical shift, Deshielding, Spin-spin interactions, Factors influencing coupling constant 'J', Classification (ABX, AMX, ABC, A_2B_2 etc.), Spin decoupling, Basic ideas about instrument, NMR studies of nuclei other than proton - ^{13}C, ^{19}F and ^{31}P, FT-NMR, Advantages of FT-NMR, Use of NMR in medical diagnostics.

Electron Spin Resonance Spectroscopy - Basic principles, Zero field splitting and Kramer's degeneracy, Factors affecting the 'g' value, hyperfine coupling constants, Spin, Hamiltonian, Measurement techniques, Applications.

Mossbauer Spectroscopy: Basic principles, Application of the technique to the studies of bonding, structures and oxidation state of Fe^{+2} and Fe^{+3} compounds.

Course Learning Outcomes (CLOs): Students will be able to

1. explain Microwave, Infrared-Vibration-rotation Raman and infra-red Spectroscopy and their applications for chemical analysis
2. analyze electronic spectroscopy of different elements and simple molecules.
3. comment on Nuclear Magnetic and Electron Spin Resonance Spectroscopy for organic compounds analysis, medical diagnostics.

Recommended Books

1. *Hollas, J.M., Modern Spectroscopy, John Wiley (1996).*
2. *Windawi, H., and Floyd, F.L.H., Applied Electron Spectroscopy for Chemical Analysis (Chemical Analysis Vol. 63), John Wiley (1982).*
3. *Parish, R.V., NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, Ellis Harwood (1991).*
4. *Chang,R., Basic Principles of Spectroscopy, McGraw-Hill (1971).*
5. *Ghosh, P.K., Introduction to Photoelectron Spectroscopy, John Wiley & Sons, New York (1983).*
6. *Carrington, A. and MacLachalan, A.D., Introduction to Magnetic Resonance, Harper and Row, New York, USA (1967).*

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	45
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	25

PBC203: **BIOCHEMISTRY LAB-II**

L	T	P	Cr
0	0	6	3.0

Course objective: To impart knowledge of thermodynamics and kinetics of biochemical reactions using advanced spectroscopic and physicochemical methods.

Experiments:

1) Structural analysis of protein-drug interaction using FTIR spectroscopy.
2) Fluorescence spectroscopic study for showing effect of temperature and pH on protein structure.
3) Drug binding kinetics study using tryptophan intrinsic fluorescence of protein.
4) Effect of temperature on DNA melting curve.
5) Demonstration of NMR spectroscopy for analysis of structure of small molecule.
6) Cellular fractionation and assay of different cellular enzymes.
7) Determination of catalase enzyme activity of various bacterial strains.
8) Demonstration of animal tissue/cell culture technique.
9) Minor project on protein drug interaction analysis.
10) Minor project: Research proposal writing

Course Learning Outcomes (CLOs): Students will be able to

1) find out the effect of temperature and pH on DNA and protein structure
2) analyze protein-drug binding reaction kinetics
3) perform assay on extract cellular proteins
4) analyze their role of cellular proteins in maintaining essential cellular functions

Recommended books:

1. Wilson, E., Walker, J., Practical Biochemistry-Principles and techniques, Cambridge University press (2010).
2. Boyer, R.F., Modern Experimental Biochemistry. Nenjamin/Cummings publishing company Inc. Redwoodcity, California (2012).
3. Scopes, R.K., Protein Purification Principles and Practice, Narosa Pub. House (1994).
4. Cantor C.R., Schimmel P.R. Biophysical Chemistry, W. A. Fremman and Company (1980)

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	EST	60
2.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	40

PCSXXX: PROGRAMMING FOR BIOINFORMATICS

L	T	P	Cr
2	0	2	3.0

Course objective: The course will provide students with basic understanding of Python programming language and its application to computational biology.

Introduction to Python: Basics of Python, Installation, Operators and Expressions, Control flow (if-else, Loops), Functions, Modules, Data Structures in python (List, Dictionary, Sets, Tuple), Problem Solving using Python, Object Oriented Programming Concepts(Classes, Polymorphism, Encapsulation), Input and Output (File Handling), Exceptions Handling, Standard Library, Command Line Argument, GUI Development in Python.

Introduction to Computational Biology Concepts (Using Biopython): Structure Analysis (Learn how to compare and align structures, identify ligand contacts, and extract ligands from PDB files), Trajectory Analysis (Learn how to analyze simulation trajectories, in particular handling large trajectory files that don't fit in memory), Conformational Sampling (Learn how to generate alternate protein conformations along ANM modes and to refine them using NAMD), Ensemble Analysis (Learn how to analyze large and heterogeneous ensembles of protein structures to infer dynamical properties), Elastic Network Models (Learn how to perform normal mode analysis and developing customized force constant functions), Druggability Suite (Learn how to setup and analyze druggability simulations containing small organic molecules using DruGUI) and Collective Molecular Dynamics (Learn how to sample transition pathways between known conformers using a multi scale hybrid methodology).

Bioinformatics (Advance): Parsing Bioinformatics file formats (BLAST, Clustalw, FASTA, Genbank), access to online services (NCBI, Expasy), interfaces to common and not-so-common programs (Clustalw, DSSP, MSMS), Applications and Prospects, Genome and protein information resources, sequence analysis, multiple sequence alignment, homology and analogy, pattern recognition, analysis package, NCBI basic alignment tools, DNA binding motif finding by sequence alignment, Gibbs sampling approaches, Regulatory module (a combination of DNA binding motifs) detection, Bayesian network approach to study the gene expression network based on expression quantitative trait loci (eQTL) data, Statistical methods for pre-mRNA alternative splicing

Introduction to Machine Learning: Supervised Learning, Unsupervised Learning, Clustering, Neural Network, Decision Tree, Support Vector Machine.

Laboratory Work: Basics of Python, Multiple Sequence Alignment, BLAST, Motif Finding, finding novel gene, Hands on ChemDraw and Marvin.

Assignment: Compulsory 4 weeks project on bioinformatics.

Course Learning Outcomes (CLOs): Students will be able to

1) write python program to understand biological processes.
2) generate *in silico* models for biological macromolecules
3) analyze interactions biological molecules using *in silico* modeling.

Recommended books:

1. *Guttag John, V, Introduction to Computation And Programming Using Python (2014).*
2. Karumanchi, N, Data Structure and Algorithmic Thinking with Python (2015).
3. Mckinney, W, Python For Data Analysis (2013).
4. Hetland, M, L, Beginning Python: From Novice To Professional (2008).
5. Downey, A, Elkner, J, Meyers, C, Learning with Python: How to Think Like a Computer Scientist (2015).

Web Resource*:*

1. ***Byte of Python*** *http://python.swaroopch.com/*
2. ***BioPython*** *http://biopython.org/DIST/docs/tutorial/Tutorial.html*
3. ***Protein Dynamics and Sequence Analysis*** *http://prody.csb.pitt.edu/tutorials*
4. ***Command Line Tools for Genomic Data Science*** *https://www.coursera.org/learn/genomic-tools*

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	25
2.	EST	35
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	40

PBC304: **MOLECULAR BIOLOGY AND rDNA TECHNOLOGY**

L	T	P	Cr
3	0	2	4.0

Prerequisites: Cell Biology, Biomolecules, Intermediary Metabolism

Course objective: The objective of this course to enable the students learn the basic techniques of rDNA technology such as molecular cloning, gene manipulation, production of recombinant proteins and other useful products along with generation of novel GMOs.

Molecular Biology: Architecture of viral, microbial, animal and plant genome; Unique and repetitive DNA, heterochromatin, euchromatin, transposons; Operons, interrupted genes, gene families; DNA replication- Unit of replication, enzymes involved in replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair; RNA synthesis and processing in prokaryotes and eukaryotes; Salient features of genetic code; Protein synthesis in prokaryotes and eukaryotes; fidelity of translation, translational inhibitors, post-translational modification of proteins. Control of gene expression in phages, viruses, prokaryotes and eukaryotes at transcription and translation level; Role of chromatin in regulating gene expression and gene silencing; Molecular basis of cellular differentiation, oncogenes and cancer; Epigenetic effects; Regulatory RNA; Genetic and metabolic disorders; Programmed cell death, aging and senescence.

Recombinant DNA Technology: Important milestones, aim and scope of rDNA technology; Restriction endonucleases and other enzymes used in molecular techniques; Prokaryotic and eukaryotic hosts; Different cloning and expression vectors; Molecular techniques for exploring genetic resources; Isolation & characterization of genes and their regulatory sequences, PCR and their applications, Classical & site-directed mutagenesis, Expression of cloned genes in prokaryotic and eukaryotic hosts, Overproduction of recombinant proteins and their purification, Relevance of genome projects, Various applications of gene technology: production of pharmaceuticals and other novel compounds, Molecular diagnosis of diseases, insect control, improved biological detergents, gene therapy, Microarrays and other high throughput systems-their applications, Ethical and safety aspects of gene technology.

Laboratory work: Small- and large-scale isolation of DNA, RNA, and proteins, Checking of purity and quality, Operon induction in the prokaryotes, Monitoring constitutive and inducible gene expression, Competent cells preparation, Bacterial transformation, Isolation of plasmid/bacteriophage DNA, Restriction analyses of DNA, Cloning in plasmid vectors, PCR amplification, applications of PCR, Gene expression in bacterial system, Reporter gene assay.

Course Learning Outcomes (CLOs): Students will be able to

1. analyze the architecture of prokaryotic and eukaryotic genome, and salient features of the genes.
2. comprehend the central dogma of molecular biology, and the essential details of some basic biological processes such as replication, transcription, translation, and the regulation of gene expression.
3. assess the contribution of some landmark discoveries for development of a number of molecular techniques used in rDNA technology.
4. select the suitable hosts for the individual vectors for different purposes.

5. recognize the extraordinary power of restriction and other enzymes in molecular cloning and genetic manipulations.
6. apply the principles of various metabolic pathways for generation of commercially useful products.

Recommended Books:

1. *Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P, Molecular Biology of the Cell, Garland Science Publishing (2008).*
2. *Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T., Lewin's GENES X, Jones and Bertlett Publishers (2011).*
3. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*
4. *Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., Concepts in Biotechnology, Universities Press (2007)*
5. *Fritsch, J. and Maniatis, E.F., Molecular Cloning, A laboratory Manual, Cold Spring Harbor Laboratory (1999).*

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	25
2.	EST	40
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	35

PBC301: **NUTRITIONAL AND CLINICAL BIOCHEMISTRY**

L	T	P	Cr
3	0	2	4.0

Course Objectives: From this course, the students will learn how the nutritional aspects are linked to various metabolic pathways involved in the growth and development of the living systems. Moreover, they will learn how metabolic disorders lead to various diseases.

Basic Concepts: Composition of Human body. Nutritional value of foods and effect of processing. Energy content and its measurement in foods. Thermogenic effect of foods.

Role of food proteins: Requirements and allowances. Proteins as building material, amino acid inter relationships. Protein quality and methods of determination. Factors affecting protein metabolism, Nitrogen balance studies and factors affecting it. Protein and amino acid requirement at different stages of development.

Carbohydrates and Energy metabolism: Dietary requirements and source of carbohydrates, Classification – Available and Unavailable. Physico-chemical properties and the physiological role. Energy requirement and measurement of energy requirement: Direct and Indirect calorimetry. Factors affecting requirements; BMR, SDA and activity. BMR and relation of temperature regulation to basal metabolism.

Lipids: Nutritional classification of dietary lipids, sources and their physiological functions.

Minerals and Food utilization: Nutritional significance. Dietary Macro elements, Calcium, Phosphorus, Magnesium. Trace Elements, Iron, Iodine, Zinc, Copper etc. Ingestion, digestion, absorption transport, storage and disposal of food nutrients (proteins, carbohydrates, fats, vitamins and minerals).

Primary Nutritional Diseases: Protein energy malnutrition, starvation, obesity, vitamin deficiency disorders and biochemical basis of causation and diagnosis of nutritional anemias.

Automation in Clinical Biochemistry: Automation in clinical biochemistry, gastric and blood disorders - Selection of Instruments, Quality assurance, Control of pre-analytical and analytical variables, quality control measurements. Good Clinical Practices: Gastric function and disorders: methods of evaluation, pancreatic diseases, Blood Disorder: mechanism of coagulation and fibrinolysis, variation of plasma proteins, abnormalities of blood formation, anemia, haemoglobinopathies, fecal and urine analysis.

Endocrinology: Insulin and glucagon: Various types of hyperglycemia, Diabetes mellitus Ketonemia ,ketonuria , Experimental diabetes , Hypoglycemia, Polyurea, Glucose tolerance test. Thyroid: Iodine metabolism, Hypo and Hyper thyroidism, B.M.R.and other test for evaluation of thyroid function. Parathyroid: Calcium and phosphorus metabolism. Abnormalities of Parathyroid function, Adrenal: Addison's disease and pheochromocytoma, Disorders of steroid metabolism, Test for evaluation of adrenal functions.

Liver disorders: Jaundice, fatty liver and liver function tests. Renal function test, Composition of cerebrospinal fluids, Lipid profile, Clinical Enzymology: Isoenzymes in health and disease. Clinical significance of GOT, GPT, Creatine kinase, LDH. Biochemical diagnosis of diseases

Laboratory work: Determination of serum and urine creatinine, serum bilirubin, serum chloride , Estimation of blood urea by Nesslerization method, Estimation of Serum amylase, Colorimetric determination of Calcium in food samples Iron in food samples Inorganic phosphorus in food samples Vitamin C in food samples, Estimation of Serum Cholesterol, Determination of Serum Uric Acid by

Henry Caraway's method, Determination of Icteric Index, SGOT, SGPT and alkaline phosphatase activity, Urine Analysis, Glucose Tolerance Test, estimation of Vitamin C and beta carotene

Course Learning Outcomes (CLOs): Students will be able to

1. comprehend the nutritional value of various foods and the effects of processing on food quality.
2. assess the importance of carbohydrates, proteins and lipids in foods with regard to carbon, nitrogen and energy requirements of the living organisms.
3. comprehend the significance of mineral nutrition.
4. recognize the growing importance of automation in clinical biochemistry.
5. be familiar with various endocrine systems, hormones, and their role in nutrition.
6. apply the steps of biochemical/clinical tests for disease diagnosis.

Recommended Books:

1. Talwar, G.P. Text book of Biochemistry & Human Biology.
2. Linten , Nutrional Biochemistry & Metabolism.
3. Skills, M.E. and Yong, V.R. Modern Nutrition in Health & Diseases.
4. Marshall, W.J. and Angert, S.K., Clinical Biochemistry – Metabolic and Clinical aspects.
5. Harper's Biochemistry.
6. Devli, T., Biochemistry with Clinical correlation.

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	25
2.	EST	40
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	35

PBC303 BIO-ETHICS, BIO-SAFETY AND IPR

L	T	P	Cr
2	0	0	2.0

Course objective: To impart knowledge of basic research ethics, safety procedures and Intellectual property rights.

Bio ethics:
Human rights, Human rights commissions, Animal rights, Patent privacy rights, Confidentiality, Universalism. Informed consent, Ethics on human sample handling, Ethics on stem cell research, Peer ethics, The Impact of Research on Values and Values on Research, Ethics on use of GMO, Risk assessment, Plagiarism, Proper documentation.

Bio-safety:
Bio safety: Bio safety, rights Strategic decision-making: Techno managerial aspects, return on investment, Regulations of biotechnology based products and industry, Biohazards, Laboratory and industry waste disposal, human safety, environmental and ecological hazards; Bioethics: Biotechnology information, communication and public perception, Radio safety, Future prospects of consumers and social acceptance, Laboratory Bio-safety level, Emergency evacuation plan.

Intellectual property right:
Intellectual property right, its importance, Different laws of IPR, R & D partnership, license agreement and joint venture, Economics, Patent and Special Topics Biotechnology R & D and industry, Business aspects of biotechnology or biochemistry or pharmaceutical companies, research and market place.

Course Learning Outcomes (CLOs): Students will be able to

1) analyze the ethical and social responsibilities for conducting a scientific experiment
2) perform the procedures to be followed to conduct any laboratory experiment safely
3) explain the IPR and its socio-economical impacts

Recommended Books:
1) Bioethics and Biosafety M. K. Sateesh, I. K. International Pvt. Ltd, India, 2008.
2) Bioethics and Biosafety in Biotechnology V Sree,Krishna, New Age International Publishers, India, 2007.
3) IPR, Biosafety And Bioethics, D Goel , S Parashar, Pearson Education India, 2013.

Evolution Skim:

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	50
3.	Sessional (May include Project/Quizzes/Assignments/Lab Evaluation)	20

PBC302 **NANOBIOMATERIALS**

L	T	P	Cr
3	0	0	3.0

Course objective: To introduce basic concepts of bionanotechnology and various applications of biomaterials, nanomedicine, drug delivery and biomedical devices.

Basic Concepts of Nanobiomaterials: Dimensions of nanoscience, Size of bulk versus nonmaterials, Speciality of nanoscience, Quantum dots and size effect, Classification and properties of nanomaterials, Effects of surface fictionalization and optical properties, Nanoparticle synthesis techniques, 1st, 2nd and 3rd generation bionanomaterials: Naturally occurring biomaterials, metal and alloys, biopolymers, hydrogels, bioactive and biodegradable ceramics.

Nanotechnology in Biomedical Applications: Application of Micro and Nano-electrochemical devices, converging technologies using MEMS and NEMS, advances in the manufacturing, types and applications of biosensors, Quantum dot technology in cancer treatment, DNA based artificial nanostructures and their applications

Nanomedicine and Novel Drug Delivery Systems: Microcapsules and microspheres, polymer therapeutics, dendrimers as drug carriers, bioresponsive hydrogels, orthopedic biomaterials.

Health and Environmental Impacts of Nanobiotechnology: Engineered Nanomaterials of relevance to human body, routes of entry: gastrointestinal tract, skin, lugs, Toxic mechanism, toxicological health effects caused by nanoparticles, relevant parameters in nanoparticle toxicology.

Course Learning Outcomes (CLOs): Students will be able to

1. comment on the basic concepts of nanoscience and nanobiotechnology
2. point out various types of nanomaterials and their size and shape dependent properties
3. apply of nanomaterials for development of nanobiotechnology.

Recommended Books:

1. Neimeyer, M. and Mirkin, C.A., Nanobiotechnology: Concepts, Applications and perspectives, Wiley VCH Weinheim (2004).

2. Goodsell, D.S. Bionanotechnology: Concepts, Lessons from Nature, Wiley-Liss (2004).

3. Rosethal, S.J. and Wright, D.W., Nanobiotechnology Protocols, Series Methods in Molecular Biology (2005).

4. Greco, R.S., Prinz, F.B. and Smith, R.L. Nanoscale Technology in Biological Systems, CRC press, (2005).

5. Vo-Dinh, T., Protein Nanotechnology Protocols, Instrumentation and Application, Series; Methods in Molecular Biology (2005).

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	50
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	20

PBC391 SEMINAR/ MINOR PROJECT

L	T	P	Cr
-	-	-	2.0

Prerequisite(s): None

Course Objective: To provide training for research work and handling of various instrument used in academic and industries

The students have to visit various reputed research institutes or industries according to their interest for six weeks (June-July). The training of these students is then evaluated by the faculty of school of chemistry and biochemistry. The evaluation is on the basis of 30 min presentation given by each student in the month of August. Grads are then decided on the basis of research work and presentation.

Course learning outcomes (CLOs): The students will be able to

1. comprehend safe laboratory practices for handling laboratory equipments and chemical reagents.
2. develop experimental skills for handling of various sophisticated instruments.
3. plot graphs, write project report, make power point presentation.

Recommended Books/literature

Literature from the websites of Royal Society of Chemistry, American Chemical Society, Elsevier, Wiley Sciences, Bantham, Springer etc.

Evaluation Scheme

REPORT	PRESENTATION
50	50

PBCXXX: Environmental Biochemistry and Ecology

L	T	P	Cr
3	0	0	3.0

Course Objective: To provide knowledge about biochemistry of environmental processes and ecology.

Ecology: Introduction to Earth's Atmosphere

Hydrosphere: The global distribution of water, Physical and Chemical properties of water.

Environmental Issues related to Aqueous Organic Matter: Organic matter in water; its origin, toxicity of specific organic compounds, Reaction with other organic species, Consumption of oxygen

Humic Material: Formation via degradative pathways and Synthetic pathways; Composition and Structure, Forms of humic materials as a proton acceptor, Complexing agent for metal ions, Reactions with small Organic Molecules, Association with soil or sediments.

Metals and Semi-Metals in Hydrosphere: Metals in aqueous environment; Classification, Types of complexes with metal-metal speciation in hydrosphere, Complexes with Ligands of Anthropogenic origin, Metal species and bioavailability.

Microbiological Processes: Classification of Microorganisms; Based on Phylum, Ecological Characteristics, Carbon Source, Electron Acceptor, Temperature, Morphology. The Carbon cycle, Biomass degradation by different processes, The Nitrogen cycle: N_2 fixation, denitrification etc., The Sulphur cycle: Sulphur release during decomposition, Sulphide Oxidation and Sulphate Reduction.

Origin of life: Origin of life (include in aspects of periodic environment and molecular evolution). Concepts of evolution, Theories of organic evolution. Mechanisms of speciation. Hardy-Weinberg genetic equilibrium. Genetic polymorphisms and selection.

Evolution and Ecosystem: Origin and Evolution of Economically important microbes. Interactions between Environment and Biota, Types of Ecosystems, Population Ecology and Biological Control. Community Structure and Organization, Concept of Habitat and Ecological niches, Limiting Factor, Energy Flow, Food Chain, Food Web and Tropic Levels, Ecological Pyramids and Recycling, Biotic Community- Concept, Structure, Dominance, Fluctuation and Succession. Ecosystem Dynamics and Management, Stability and Complexity of Ecosystems, Speciation and extinctions, environmental impact assessment. Principles of Conservation. Conservation Strategies. Sustainable Development. Concept of ecosystem, Ecological niche, Ecosystem of Shallow Water Body, Ecosystem of Deep Pond, Ecosystem of Sea, Ecosystem of Forest, Eco system of Farming Land.

Course Learning Outcomes (CLOs): Students will be able to

1) explain fundamentals of earth atmosphere and its interconnectivity between various components.
2) describe different elements of the environments and their impact on sustaining the environment.
3) interpret the fundamentals of ecology and its role in biological evolution.

Recommended Books:

1. Vanloon G.W., and Duffy S.J., Environmental Chemistry, A Global Perspective (2011) Oxford University Press.

2. De A. K., Environmental Chemistry, (2006), New Age International Publishers, New Delhi.

3. Smith R.L, Smith T.M. Ecology and field biology Lavoisier Publisher, 2002.

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	25
2.	EST	35
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	40

PBC491DISSERTATIONS

L	T	P	Cr
-	-	-	**6.0**

Course Objective: To provide training for literature survey, experimental research work, instrumental techniques and their operational procedure useful for their future profession.

The students are doing six months project work in any of the research laboratory in school of chemistry and biochemistry according to their interest and availability of the position (January-June). This dissertation is submitted in the form of thesis. The training of these students is then evaluated by committee members of the faculty of school of chemistry and biochemistry as well as one member from outside of Thapar University. The evaluation is on the basis of 30 min presentation given by each student in the month of August. Grades are then decided on the basis of their research work and presentation.

Course learning outcomes (CLOs): The students will be able to

1. analyze current literature research for research topic of his/her area of expertise.
2. rationalize the research gap for new innovation and design and execute independent experimental approach.
3. able analyze the data obtained from a particular experiment and make to plot graphs, power point presentations.
4. comprehend expertise for writing the research reports.
5. exposure for safe laboratory practices by handling high end equipments and chemical reagents.

Recommended Books/literature

Literature from the websites of Royal Society of Chemistry, American Chemical Society, Elsevier, Wiley Sciences, Bantham, Springer etc.

Evaluation Scheme

DISSERTATION	PRESENTATION
60	40

Elective-I

PBT311: GENOMICS, METAGENOMICS AND PROTEOMICS

P	L	T	Cr
3	0	2	4.0

Course Objective: The objective of this course is to teach genomes, metagenomes and proteomes their characteristics and sequencing to the students and their applications in comparative genomics and transcriptomics.

The Organization and Structure of Genomes: Prokaryotic genomes, Prokaryotic gene structure, Open reading frames, Conceptual translation, Termination sequences, GC content in prokaryotic genomes, Prokaryotic gene density, Eukaryotic genomes, Eukaryotic gene structure and open reading frames, GC content in Eukaryotes.

Genome Mapping and Sequencing: Sequence tags, RFLP, SNP, Padlock probes, Radiation hybrid mapping, HAPPY mapping, Sequencing Genomes-High throughput sequencing, clone-by-clone approach, Whole genome shot gun approach, quality of genome sequence, human genome sequencing project.

Comparative Genomics: Comparative genomics of bacteria, Comparative genomics of organelles, Comparative genomics of eukaryotes, Large scale mutagenesis and interference.

Analysis of Transcriptomes: Introduction, DNA microarray technology, Functional genomics, ESTs and SAGE, Allele mining and SNPs, Applications of genomics.

Metagenomics: Introduction to sequence based and function based metagenomics, filtering and quality assessment of high throughput sequence data, Clustering of high throughput sequence data, Taxonomic and genetic annotation of high throughput sequence data, Diversity analyses, Analyses of community composition and change, Metabolic reconstruction analyses, metatranscriptome and metaproteome analyses

Proteomics: Introduction to proteomics, Proteomics Technologies - Protein Arrays, Protein Chips and their applications, 2D Gel Electrophoresis and its application, Mass Spectrometry and Protein identification, Shotgun proteomics

Self-Learning: Role of Bioinformatics in Proteomics, Proteomics Databases, Protein-Protein Interactions - Concepts and Databases, Proteomics Analysis Tools at ExPaSy, Applications of Proteomics in Life Sciences.

Laboratory Work:
Comparison of genomes, comparison of introns in higher eukaryotes, CpG islands, SNPs, RAPD, ESTs & STS, Proteomics tools, Structural and functional predictions, Phylogenetic construction

Course Learning Outcomes (CLOs): Students will be able to

1. comprehend various aspects of genomes of different types of organisms.
2. design strategies for genome sequencing, comparative genomics, transcriptomics using microarray technology.
3. apply metagenomics and different methodologies in proteomics as well as structural proteomics.

Text Books:

1. *Primrose, S.B. and Twyman, R.M., Principles of gene manipulation and genomics. Blackwell Publishing (2006).*
2. *Akay, M. Genomics and Proteomics Engineering in Medicine and Biology, John Wiley (2007).*

Reference Books:

1. *Pennington, S.R. and Dunn, M. J., Proteomics: from protein sequence to function. Viva Books (2001).*
2. *Mount, D.W., Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press (2001).*
3. *Metagenomics – Sequencing from the environment, NCBI (2006)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

PBT312: MOLECULAR FARMING

L	T	P	Cr
3	0	2	4.0

Course Objective: The students will learn about molecular farming an emerging branch of plant biotechnology and wide range of products for molecular farming such as carbohydrates, fats, proteins, secondary products and commercially important molecules using plant systems as 'bioreactors'.

Introduction: Definition and common perception of molecular farming; Transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Relevance & advantages of plant-based molecular farming.

Strategic Details of Various Molecular Farming: Major targets for carbohydrate and lipid molecular farming; Introduction to the crucial metabolic pathways and the involved gene functions in plants & other suitable organisms; Various molecular approaches & strategies relevant to molecular farming; Production of carbohydrates: increased starch amount, amylose-free starch, high-amylose starch, cyclodextrins, fructans, trehalose; Production of lipids: medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, Production of rare fatty acids, polyunsaturated fatty acids having pharmaceutical and nutraceutical values, Critical evaluation on various case studies of molecular farming & their future prospects; Economic and regulatory considerations for molecular farming.

Production of Biodegradable Plastics in Plants: Various gene functions involved in the production of polyhydroxy butyrate (PHBs) & polyhydroxyalkanoate co-polymers; Strategies for production of biodegradable plastics in plants.

Self-Learning: Genetically engineered plants as protein factories, Enzymes for industrial and agricultural uses, medically related proteins-antibodies (plantibodies), subunit vaccines, protein antibiotics; The oleosin system: hirudin and insulin production, production of biopharmaceuticals in plants; Chloroplast: a clean high-level expression system for molecular farming based on single or multiple transgenes.

Laboratory Work:

Isolation & characterization of genomic & cDNA clones relevant to molecular farming, making genetic constructs, Transient expression studies in plants, Genetic transformation of plants, Gene expression studies, studying molecular techniques/protocols related to various case studies: production of carbohydrates, lipids, proteins, antibodies, edible vaccines.

Course Learning Outcomes (CLO's):

Students will be able to:

1. recognize the overall importance of plant molecular farming.
2. develop strategies for modification of various plant-made products such as carbohydrates, lipids, proteins and other novel molecules
3. generate transgenic plants that can produce commercially important proteins and enzymes
4. design strategy for production of biodegradable plastics in plants.
5. apply steps involved in downstream processing of plant-made products.

Text Books:

1. *Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Second Edition, Oxford University*

Press (2008).
2. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*

Reference Books:

1. *Satyanarayana, U., Biotechnology, Books and Allied (P) Ltd. (2005).*
2. *Barnum, S.R., Biotechnology-an Introduction, Thompson Brooks/Cole (2007).*
3. *Primrose, S.B., Molecular Biotechnology, Second Edition, Panima Publishing Corporation (2001).*

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

Evaluation Scheme:

PBT313: MOLECULAR MEDICINE AND DIAGNOSTICS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To provide an advanced understanding of the molecular basis of the pathogenesis, diagnosis and treatment of human diseases. To describe and discuss topics related to infectious diseases, chronic diseases, genetic diseases, endocrine disorders, malignancy and diseases arising from abnormal immune responses.

Concepts and Perspective of Molecular Medicine: Basics of Molecular Medicine. Gene therapy as a potential tool to cure human diseases. Recombinant molecules in medicine. Transgenic and knock out animal models.

Molecular Basis of Metabolic Disorders: Introduction to metabolic disorders and metabolic profiling. Reproductive disorders. Cardiovascular diseases. Disorders in hormonal action. Insulin dependent and independent diabetes. Ligand induced signaling and gene expression in eukaryotic cells. Importance of intracellular trafficking & its related pathogenesis. Molecular endocrinology in health and disease. Cancer and cell cycle.

Nuclear Receptors in Health and Disease: Nuclear Receptor superfamily: an introductory overview; structural and functional attributes of various nuclear receptors; epigenetic modifications, chromatin remodelling; receptor regulation by post-translational modifications, nuclear receptors as drug targets; xenobiotic receptors and drug metabolism; co-transfection and transcriptional assays; steroid hormones and their receptors; molecular basis of endocrinopathies, endocrine disruptors and selective steroid receptor modulators.

Free Radicals and Metal ions in Biology and Medicine: Reactive Oxygen Intermediates (ROI), Transition metals in oxidative processes, Mechanisms of lipid, protein and DNA oxidation, Antioxidants-small molecules and enzymes, Involvement of oxidative processes in ageing, cancer and atherosclerosis, Metal ions in gene regulation, Iron in human diseases-anaemia, thalassemia, primary and secondary hemochromatosis. Menkes' and Wilson's disease: Genetic disorders of copper transport. Metals and free radicals in Alzeihmer's disease and other neurodegenerative diseases

Self-Learning: Cell Junctions, regulation of paracellular permeability; signaling from the apical junctional complex and role in epithelial polarization, cell differentiation, proliferation and gene expression; junctional components targeted by disease causing micro-organisms; diseases associated with intercellular junctions including multiple sclerosis, type 1 diabetes, inflammatory bowel disease, and cancers of the breast, prostate and colon.

Laboratory Work:

Isolation and Culturing of Peripheral Blood Lymphocytes, Cell line culturing, Genomic DNA & RNA isolation from Blood and Tissues. RFLP-PCR for identification of SNP’s, RT-PCR for analyzing gene expression, PCR-SSCP technique for mutation identification, Evaluation of Antibody titre by direct ELISA,Methods for prototype development of Immunodiagnostics (ICT card), Preparation of chromosomes from blood samples

Course Learning Outcomes (CLOs): Students will be able to

1. receive insights into the translational and clinical aspects of science and conversely students in clinical medicine.
2. gain new insights into molecular mechanisms, disease models and preclinical work.
3. comprehend deleterious effects of reactive oxygen species, and the remedial measures.

Text Books:

1. *Methods in Molecular Medicine: Molecular Diagnosis of Genetic disease. Edited by ROB ELLES. Humana Press Inc., Towa, NJ, 356 pp. (1996).*
2. *Introduction to Molecular Medicine: Ross, Dennis W., XV, 153 p (2002).*

Reference Books:

1. *Molecular Medicine, Genomics to Personalized Healthcare: Trent, RJ. Academic Press (2012).*
2. *Principles of Molecular Medicine: Runge, Marschall S.; Patterson, Cam (Eds.) Humana (2006).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

PCYXXX: BIOFUELS

L	T	P	Cr
3	0	0	3.0

Course Objective: To acquire knowledge of different methods of biofuel production, application, and their advantages.

Introduction: Drivers for alternative fuels, security, cost and environmental considerations, carbon sequestration and the impact of biofuels, review of current processes for biofuel production from biomass.

Economic Models: Costing of current and future processes for biofuel production from biomass, biomass availability, models of biomass concentration and utilization.

Feedstock Chemistry: Chemistry of triglycerides and carbohydrates, Improving biomass yield and properties for easier processing and conversion, Pretreatment of biomass, Enzymatic hydrolysis, Processes and alternatives, Enzymes immobilization techniques.

Fermentation: Processes and alternatives, Aqueous processing of sugars.

Bio-Diesel and other alternative liquid fuels, Policy of biofuels, Biofuels around the world: Brazil, India and China.

Course Learning Outcomes (CLOs): Students will be able to

1. describe biofuel production technologies
2. Techniques of fermentation and applications

Recommended Books:

1. *Bhojvaid, P.K., Biofuels: Towards a greener and secure energy future, TERI Press (2006).*
2. *Adholeya, A., and Kumar P., Dadhich Production and Technology of Bio-diesel: Seeding a change, TERI press (2008).*
3. *Scragg, A. H., Biofuels: Production, Application and Development, CABI (2009).*
4. *Olsson, L., Biofuels, Springer, (2007).*
5. *Furfari, A., Biofuels: Illusion Or Reality? : the European Experience, Editions TECHNIP (2008).*

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	50
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	20

PCY401: HETROCYCLIC CHEMISTRY AND NATURAL PRODUCTS

L	T	P	Cr
3	0	0	3.0

Prerequisite(s): None

Course Objective: To introduce synthesis and reactivity of aliphatic and aromatic heterocyclic compounds, and importance of some natural products.

Nomenclature of Heterocycles: Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, Fused and bridged heterocycles.

Aromatic Heterocycles: Classification (structural type), Criteria of aromaticity (bond lengths, Ring current and chemical shifts in ^{1}H NMR-spectra, Empirical resonance energy, Delocalization energy and Dewar resonance energy, Diamagnetic susceptibility exaltations). Heteroaromatic reactivity and Tautomerism in aromatic heterocycles.

Heterocyclic Synthesis: Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions.

Small Ring Heterocycles: Three-membered and four-membered heterocycles - Synthesis and reactions of Aziridines, Oxiranes, Azetidines and Oxetanes.

Benzo-Fused Five-Membered Heterocycles: Synthesis and reactions of Benzopyrroles, Benzofurans, Benzothiophenes, Benzodiazoles and Benzotriazoles.

Five-Membered Heterocycles: Synthesis and reactions of Pyrrole, Thiophene, Furan, Pyrazoles, Oxazoles and Imidazoles.

Six-Membered Heterocycles: Synthesis and reactions of Quinoline, Isoquinoline, Coumarins, Chromones, Diazines, Triazines, Tetrazines and Thiazines.

Natural Products: Introduction, Structure, Chemistry of Terpenoids, Steroids, Alkaloids and Natural pigments.

Course Learning Outcomes (CLOs): Students will be able to

1. interpret nomenclature of different heterocyclic compounds.
2. describe synthesis and reactivity of fused, six membered and smaller heterocyclic compounds.
3. comment on classification and importance of various natural products.

Recommended Books

1. *Gilchrist, T.L., Heterocyclic Chemistry, Prentice Hall (1997).*
2. *Katritzky A.R., and Rees C.W., Comprehensive Heterocyclic Chemistry, Pergamon Press*

(1996).
3. *Gupta, R.R., Kumar M., and Gupta, V., Heterocyclic Chemistry Vo1.1-3, Springer Verlag (2008).*
4. *Torsell, K.B.G., Natural Product Chemistry, Apotekasocieteten (1997).*
5. *Koskinen, A., Asymmetric Synthesis of Natural Products, Wiley (1993).*
6. *Apsimon J., Total synthesis of Natural Products (1-7) Wiley Interscience (1973-1988).*

Evaluation Scheme

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	50
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	20

PBCXXX: **BIOCATALYSIS**

L	T	P	Cr
3	0	0	3.0

Course objectives: To acquaint students with fundamental concepts of biocatalysis, and various classes of enzymes, industrially useful reactions

Introduction to biocatalysis. Introduction of biocatalysis, organic catalysis and inorganic catalysis; Advantages and disadvantages of biocatalysis; Comparison with other catalysts; Biocatalysts as a technology; Biocatalysis and green chemistry

Biocatalyst characterization. Enzyme kinetics; Enzyme nomenclature; Basis of enzyme action; Theories of enzyme catalysis; Efficiency, stability, selectivity of Enzymes; Screening of enzyme activity; Biocatalysis with different enzymes: lipase, amidase, aminopeptidase, acylase, hydantoinase, lyases, oxidoreductase, nitrilase, epoxide hydrolase, hydoxylase, aldolases, decarboxylases; etc.; modified and artificial enzymes (eg. catalytic antibodies, chemically modified enzymes)

Biocatalytic synthesis. Regio and stereospecificity; Molecular transformations with biocatalysts, oxide-reduction reactions, C-C formation reactions, C-N formation reactions, hydrolytic reactions, additions/eliminations, isomerizations, halogenations; Hydroxy esters with carbonyl reductase, Alcohols with ADH; Techniques of immobilization of enzymes and whole cells-design, operation and kinetics of immobilized enzyme reactors.

Biocatalysts for environmental and industrial applications. Whole cells as biocatalysts; Microorganisms in degradation of xenobiotics and removal of heavy metals; Biocatalyst for synthesis of some chiral pharmaceutical intermediates; Enzymes in the food industry; Enzymes in brewing, in leather industry, in the paper and pulp industry, and in the textile industry; Enzymes for preservation; The future of enzyme applications

Course Learning Outcomes (CLOs): Students will be able to

1. demonstrate basics of enzyme catalyzed reactions and their mechanisms
2. describe different classes of enzymes and their function
3. explain enzyme-catalyzed processes for industrial production and environmental applications

Recommended Books

1. *Bommarius, A.S. and Riebel-Bommarius, B.R., Biocatalysis – Fundamentals and Applications, VCH-Wiley, Berlin, (2004).*
2. *Dixon, M. and Webb, E.C., Enzymes Longman, London, (1979).*
3. *Faber, K., Biotransformations in Organic Chemistry, Springer, Berlin, (2011).*
4. *Aehle, W., Enzymes in Industry: Production and Applications, Wiley, Berlin, (2007).*

Evaluation Scheme:

S.No.	Evaluation	Marks
1.	MST	30
2.	EST	50
3.	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	20