COURSES SCHEME

&

SYLLABUS

FOR

M.SC.

BIO-CHEMISTRY

2015

COURSE SCHEME & SYLLABUS FOR M.SC. (BIO-CHEMISTRY)

SEMESTER – I

SR. 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	BIOANALYTICAL TECHNIQUES	3	0	0	3.0
6	PBC105	BIOCHEMISTRY LAB-I	0	0	6	3.0
7	PHU002	PROFESSIONAL COMMUNICATION	3	1	0	3.5
TOTAL			**18**	**2**	**10**	**24.0**

SEMESTER – II

SR. 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	PBT205	IMMUNOLOGY	3	1	2	4.5
4	PBC202	MEDICINAL CHEMISTRY AND NATURAL PRODUCTS	3	0	0	3.0
5	PCY 215	MOLECULAR SPECTROSCOPY	3	1	0	3.5
6	PBC203	BIOCHEMISTRY LAB-II	0	0	6	3.0
7	PCY205	COMPUTER PROGRAMMING AND APPLICATION	2	0	2	3.0
TOTAL			**17**	**3**	**12**	**24.5**

SEMESTER – III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBC301	MOLECULAR BIOLOGY AND RDNA TECHNOLOGY	3	0	2	4.0
2	PBC302	NUTRITIONAL AND CLINICAL BIOCHEMISTRY	3	0	2	4.0
3	PBC303	MOLECULAR BIOPHYSICS	3	1	0	3.5
4	PBC304	NANOBIOMATERIALS	3	0	0	3.0
5	PBC305	ELECTIVE - I	3	0	2	4.0
6	PBC306	SEMINAR	-	-	-	2.0
TOTAL			**15**	**1**	**6**	**20.5**

SEMESTER – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBC401	ENVIRONMENTAL BIOCHEMISTRY	2	0	0	2.0
2		ELECTIVE-II	3	0	0	3.0
3	PBC491	DISSERTATION	-	-	-	6.0
TOTAL			**6**	**0**	**0**	**11.0**

ELECTIVE-I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBC301	GENOMICS, METAGENOMICS AND PROTEOMICS	3	0	2	4.0
2.	PBC302	MOLECULAR MEDICINE AND DIAGNOSTICS	3	0	2	4.0
3.	PBC303	CELLULAR SIGNALING	3	0	2	4.0

ELECTIVE-II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1.	PBC401	BIOFUELS	3	0	0	3.0
2.	PBC402	MACROMOLECULAR STRUCTURES AND MODELING	3	0	0	3.0
3.	PBC403	BIOCATALYSIS	3	0	0	3.0

TOTAL NUMBER OF CREDITS: 80

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 Outcome: Students will acquire mathematical concepts in continuous learning and connecting ideas like numerical analysis, 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:

Sr. 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

Course Objective: To introduce structure, function and organization of various bio-molecules present in the living cell.

Introduction: 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.

Cell Structure and Functions: Structure of prokaryotic and eukaryotic cells, Intracellular organelles and their functions.

Amino Acids, Peptides and Proteins: Classification of amino acids and their properties, Polypeptides, Primary Structures - amino acid sequencing, Sequence determination, Chemical and Enzymatic hydrolysis of proteins to peptides, Secondary structures - forces responsible for holding of secondary structures, α-helix, β-sheets, Super secondary structure, Ramachandran Plot, Triple helix structure of collagen, Tertiary structure of protein-folding and domain structure, Quaternary structure.

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: Carbohydrates of glycoproteins and glycolipids, Role of sugars in biological recognition, Blood group substances, Carbohydrate metabolism - Kreb's cycle, Glycolysis, Glycogenesis and Glycogenolysis, Gluconeogenesis, Pentose Phosphate pathway.

Lipids: Properties of lipid aggregates-micelles, Bilayers, Liposomes and their biological functions, Biological membranes, Fluid Mosaic model of membrane structure.

Vitamins: General characteristics, Classification, Role of Vitamins, Fat and water soluble vitamins, Deficiency of vitamins and diseases.

Biocatalysis: Enzymes classification and nomenclature, Enzyme Kinetics, Mechanisms of enzyme catalysis, Active sites, Activators and inhibitors, Coenzyme, Isozymes.

Course Learning Outcomes (CLO):
The students will acquire knowledge of molecular structure of proteins, DNA, RNA, carbohydrates, lipids and vitamins, and organization and working principles of various components present in living cell.

Recommended Books:

1. *Jain, J.L., Jain, S., and Jain, N., Fundamentals of Biochemistry, S. Chand (2005).*
2. *Stryer, L., Berg, J.M., and Tymoczko, J.L., Biochemistry (2004).*
3. Voet, *D., and Voet, J.G., Biochemistry, John Wiley (1995).*
4. *Conn, E.E., and Stump, F., Outlines of Biochemistry, John Wiley (2006).*
5. *Nelson, D.L., and Cox, M.M., Principles of Biochemistry, W.H. Freeman (2004).*

Evaluation Scheme:

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

PBC101: BIOMOLECULES AND ENZYMOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The major objective is to help students know the structure and properties of macromolecules that interact to maintain and perpetuate 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 (CLO):

Knowledge on the structure and function of different biomolecules would enable the students to consolidate their focus on understanding various metabolic pathways crucial for the sustenance of living systems.

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

Evaluation Scheme:

Sr. No.	Evaluation	Marks
1	MST	25
2	EST	40
3	Sessional (May include Project/Quizes/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, being 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 characteristic 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 Outcome (CLO):

Knowledge in Cell Biology and Physiology is an important prerequisite for understanding the other branches of Life Sciences and the emerging areas of Biotechnology.

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, 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:

Sr. 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.

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 Nonheme Metalloproteins: 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.

Thermodynamics of Proteins: Thermal and chemical denaturations of proteins, Spectroscopic (CD, FTIR, NMR, Fluorescence) and calorimetric methods to study thermodynamics of proteins, Kinetic and thermodynamic controlled reactions, Thermodynamic models for reversible and irreversible reactions, Conformational stability estimation of proteins, Characterization of folding intermediates, Spectroscopic/calorimetric/bioinformatics methods to study protein-surfactant/denaturant/drug interactions.

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 Outcome (CLO):

The students will acquire knowledge of structure and biological functions of proteins, role of metals in biology, and kinetics, thermodynamics, and mechanism of protein folding.

Recommended Books:

1. *Huheey, J.E., Keiter, E. A., and Keiter, R.L., Inorganic Chemistry, Pearson Education (2008).*
2. *Cowan, J.A., Inorganic Biochemistry-An Introduction, Wiley-VCH (1997).*
3. *Cantor, C.R., and Schimmel, P.R., Biophysical Chemistry, Freeman (1980).*
4. *Van Holde, K.E., Johnson, W.C., and Ho, P.S., Principles of Physical Biochemistry, Pearson Education (1998).*

Evaluation Scheme:

Sr. 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	0	0	3.0

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

Colligative Properties: Definitions, factors affecting and physiological applications of osmosis, adsorption, colloids, surface tension and viscosity.

Acid, Bases and Buffers: Ionization, dissociation, acidity, basicity, theories of acid and bases, strength of acids and bases, acid-base equilibrium in aqueous and non-aqueous media. pH-dependent functions and structures of bio-molecules, Henderson–Hasselbach equation, use of indicators, buffers, amino acid titrations, biological buffers.

Centrifugation: Principles of sedimentation, relation between g and rpm, instrumentation, working and applications of preparative and analytical ultracentrifugation, isopycnic centrifugation, rate zonal centrifugation

Spectroscopic Techniques: Beer-Lambert's law and its verifications and applications, scattering, phosphorescence, fluorescence, luminescence, diffraction spectra, Application of UV-Visible and FTIR spectroscopy, turbidometry and nephlometry.

Chromatography: Principles, instrumentation, working and applications of paper partition chromatography, TLC, HPTLC, Affinity, Gel filtration, ion exchange, hydrophobic interaction and reverse phase (HPLC/FPLC) chromatography and GC.

Electrophoresis: Principles, factors affecting electrophoresis, support media used, instrumentation, denaturing/ non-denaturing/ non-reducing DNA and protein gel electrophoresis, working and applications of electrophoretic techniques-zone, disc, capillary, 2-D, pulsed-field gel electrophoresis, diagonal, isoelectric focusing, immune electrophoresis,

Sequencing Techniques: Principles and instrumentation, working and applications of purification of proteins/enzymes, protein sequencing techniques, DNA sequencing techniques, RNA sequencing techniques, protein and nucleic acid blotting techniques.

Radioisotope Techniques: 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.

Course Learning Outcome (CLO):
The students will learn the underlying principles of isolation, purification, quantification and characterization of biomolecules.

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:

Sr. 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 Objectives: To impart knowledge of methods and techniques for biomolecules separation and purification

Experiments:

1. Preparation of buffers and measurement of their pH.
2. Estimation of the pKa values of amino acids and proteins from their pH titration curves.
3. Verification of the Lambert Beer's law.
4. Characterization of the UV absorption spectra of aromatic amino acids, nucleic acids, nucleotides and proteins.
5. Study of the mutarotation of simple sugars using polarimetry.
6. Isolation and quantitation of Haemoglobin from RBC.
7. 1D and 2D ascending and descending paper chromatography of amino acids and sugars.
8. 1D and 2D ascending and descending TLC of Amino acids and sugars.
9. Column chromatography for proteins and amino acids.
10. Separation of proteins using HPLC.
11. Determination of the protein concentration using UV-Visible spectroscopy.
12. Determination of the urea and guanidine hydrochloride concentration using refrectometry.

Course Learning Outcome (CLO):

The students will acquire knowledge of isolation, separation and purification of biomolecules using various bioanalytical methods, and determination of the concentration of proteins and denaturants using UV-Visible spectroscopy and refractometry, respectively.

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:

Sr. No.	Evaluation	Marks
1	EST	70
2	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	30

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 (CLO):

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:

Sr. 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

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 and ion electrochemical potentials, membrane potentials, chemotaxis and chemoreceptors, chemo-osmotic theory, ion transport across energy transducing membranes, Influx and efflux mechanisms; Proton and electrochemical gradient; the transport and distribution of cations, anions and ionophores; Uniport, antiport and symport mechanisms; Order, organization and function of electron carriers in mitochondrial respiratory chain, the Q cycle and the stoichiometry of proton extrusion and uptake; P/O ratio, respiratory controls and oxidative phosphorylation; Uncouplers and inhibitors of energy transfer; ATP-synthetase complex, microsomal electron transport, partial reduction of oxygen, superoxides.

Intermediary Metabolism: Carbohydrate Metabolism: Glycolysis, citric acid cycle and their regulation; Energy generation and biosynthesis of energy rich bonds, electron transport, oxidative and photosynthetic phosphorylation, pentose phosphate pathway and its regulation; Gluconeogenesis; Interconversions of sugars; Biosynthesis of glycogen, starch and oligosaccharides; regulation of blood glucose homeostasis; Hormonal regulation of carbohydrate metabolism.

Lipid Metabolism: Fatty acid biosynthesis: Acetyl CoA carboxylase, fatty acid synthase complex; α, β, ω oxidation of fatty acids and lipoxidation; 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 (CLO):

From this course, the students would understand that living systems exchange energy and matter with the surroundings for their survival. Understanding of all these intricate and amazing metabolic plans would help in the biotechnological applications.

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:

Sr. 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 and health 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, Nonparametric 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

Procedural Languages - C language introduction: Variables, Data Types – Arrays (one and two dimensional arrays) - Functions: Types, Parameters, Recursion, Function prototype, and Standard C library -Structures. Pointers: Introduction, Pointer with variables, Arrays and Strings, Pointers and structures, Pointers and linked list – Unions - File handling: File I/O, File opening modes – C Preprocessor - Graphical Interfaces: Dialog Boxes, Dynamic Memory Allocation.

Algorithm: History, Principles, types, development and its complexity, Complexity of algorithms –NP complete problem- Polynomial-Reducibility-sorting problem and Fibonacci Problem; Algorithm types: Linear, Exhaustive search, Branch and Bound, divide and conquer, Expectation and Maximation (EM) with forward and backward algorithms, discriminative learning, Knuth-Morris- Pratt and Boyer-Moore algorithm for exact match and graph and maximum likelihood algorithm etc

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, 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

Elements of Graphics and Visualization: Basics of two and three dimensional computer graphics systems, modeling and rendering, and selected graphics software APIs. Other topics may include interactive graphics, animation, graphical user interfaces, and the graphical presentation of information.

Distributed and Grid Computing: Distributed and grid computing principles and technologies. Covers common modes of grid computing for scientific applications, development of grid-enabled applications, and future trends in grid computing

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, C programming, Multiple sequence alignment, DNA binding motif finding by sequence alignment

Course Learning Outcomes (CLO):

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

Recommended Books:

1. *Waterman, M.S., Introduction to Computational Biology: Maps, Sequences and Genomes. Waterman. Chapman and Hall/ CRC Press (1995).*
2. *Gottfried, B.S., Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill (1996).*
3. *DeGroot, M. H. and Schervish, M.J., Probability and Statistics, Addison-Wesley (2002).*

Evaluation Scheme:

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

PBT205: IMMUNOLOGY

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 and 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, Immunoelectrophoresis, 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

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

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 Outcome (CLO):

At the end of this course, students should be able to explain role of immune cells and their mechanism in preventing the body from foreign attack and infectious disease, cancer and other disease development. Students will be able apply the knowledge of immune associated mechanisms in medical biotechnology research.

Recommended Books:

1. *Janeway, C.A., Travers, P., and Walport M., Immunobiology: 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).*
3. *Roitt, I., Brostoff, J. and Male D., Immunology, Mosby Elsevier (2004).*
4. *Khan, F.H. The Elements of Immunology, Pearson Education (2009).*

Evaluation Scheme:

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

PBC202: MEDICINAL CHEMISTRY AND NATURAL PRODUCTS

L	T	P	Cr
3	0	0	3.0

Course Objective: The course aims to studying of drug design and development of various biological agents, chemistry and biology activities of natural products.

Chemistry of Cell Membrane: Drug receptor interaction, G-protein coupled receptors, ion channel linked receptors, ligand-receptors theories.

Drug Design Tools: Lead discovery and optimization, pharmacophoric identification and analogue approach of drug designing, electronic, steric and lipophilic molecular descriptions.

Rational Design of Enzymes Inhibitors: Design of non-covalently binding enzymes inhibitors. Current developments with respect to the inhibition of the following enzymes: Reverse transcriptase, Catechol-*O*-methyl transferase, acetylcholinesterase, glycinamide ribonucleotide transformylase, HMG CoA reductase, dihydrofolate reductase, phospodiesterase, protein kinase. Design of covalently binding enzyme inhibitors: Mechanism based inhibitors, affinity labels, pseudo-irreversible inhibitors. One example each from pyridoxyl phosphate dependent enzyme, GABA transferase, ornithine decarboxylase, monoamineoxidase, thymidylate synthase, creatine kinase and β-glucosidase inhibitors.

Antineoplastic Agents: Molecular mechanism of cancer, DNA interacting drugs.

Antiviral Agents: DNA and RNA viruses, retroviruses, strategies to design anti-HIV drugs, viral replication, medicinally significant negative strand viruses, development of new drugs.

Psychopharmacological Agents: Antidepressant drugs, Antianxiety agents and Antipsychotic agents: Introduction, biochemical basis of mental disorders, treatment approaches and SAR.

Natural Products: Introduction, Structure, Classification, Chemistry and Biological activities of terpenoids, steroids, alkaloids, flavonoids and coumarins.

Course Learning Outcomes (CLO):
The students will acquire knowledge of drug designing and development of various biological active agents and their mode of action, understand the effect of the drug into the body and what the body does to the drug, role of drugs to inhibit the particular enzymes and treatment of disease, and chemistry and biological activities of various natural products.

Recommended Books:

1. *Beale Jr. J.M., Block, J.H., Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry.*
2. *Pandeya, S.N., 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, John Wiley & Sons (2010).*
4. *Silverman, R.B., The Organic Chemistry of Drug Design and Drug Action, Elsevier.*

5. *Apsimon, J., Total synthesis of Natural Products (1-7) Wiley Interscience (1973-1988).*
6. *Torseel, K.B.G., Natural Product Chemistry. John Wiley and Sons, New York (1997).*

Evaluation Scheme:

Sr. 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 (CLO):

The students will acquire knowledge of Microwave, Infrared-Vibration-rotation Raman and infra-red Spectroscopy and their applications for chemical analysis, Electronic spectroscopy of different elements and simple molecules, and 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:

Sr. 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 amino acids and peptides using NMR spectrometer.
2. Structural analysis of amino acids and proteins using FTIR and CD spectrometer.
3. Study of the acid/base denaturation of proteins using fluorescence and CD spectroscopic techniques.
4. Study of the thermal/cold denaturations of proteins using UV-visible and CD spectroscopic techniques.
5. Determination of the Tm values of DNA and proteins.
6. Estimation of activation energy for a biochemical reaction.
7. Measurement of the enzymatic activity of enzymes.
8. Evaluation of the effect of pH and temperature on enzyme activity and kinetics.
9. Determination of the effect of metal ions on enzyme activity and kinetics.
10. Study of the kinetics of enzyme and determination of kinetic parameters.
11. Determination of structure based visco-elastic properties of proteins, nucleic acids, sugars, lipids using Ostwald's viscometer.

Course Learning Outcomes (CLO):
After successfully completion of this the course, the students will acquire the knowledge of structural, kinetics and thermodynamics characterization of biomolecules and proteins.

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. *Segel, F.H., Enzyme Kinetics, John Wiley and sons (1975).*
4. *Suelter, C.H., A Practical Guide to Enzymology, John Wiley and sons (1985).*

Evaluation Scheme:

Sr. No.	Evaluation	Marks
1	EST	70
2	Sessional (May include Project/Quizes/Assignments/Lab Evaluation)	30

PCY205: COMPUTER PROGRAMMING AND APPLICATION

L	T	P	Cr.
2	0	2	3.0

Introduction to Computer's general concept: Definition, Categories of Computer with description, Applications of Computers in various fields, CPU, Primary memory, secondary storage devices, Input/output devices, Computer as a system.

Programming Languages: Evolution of Programming Language, Tools used to convert computer program - compiler, interpreter, overview of machine language, assembly language, high level languages, Binary arithmetic for integer and fractional numbers.

C Programming: Introduction to algorithm, Flow charts, Problem solving methods, Need of programming languages. C character set, Identifiers and keywords, Data types, Declarations, Statement and symbolic constants, Input-output statements, Preprocessor commands, Operators, expressions and library functions, decision making and loop control statements, Functions, Storage Classes, Arrays, Strings, Pointers, Structure and union, File handling.

Laboratory Work: Laboratory experiments will be set in consonance with the materials covered in theory.

Recommended Books:

1. Peter Norton, Introduction to COMPUTERS, Tata McGraw Hill.
2. Kerninghan, B. W. and Ritchie D.M., The C Programming Language, PHI (1989)
3. Kanetkar, Y., Let Us C, BPB (2007).
4. Forouzan, A., Structured Programming Approach Using C, Cengage India Pvt Ltd (2008).
5. GaryB Shelly, Thomas J Cashman and Misty E Vermaat, Introductions to COMPUTERS, Cengage Learning (2008).

PBC301: MOLECULAR BIOLOGY AND RDNA TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: 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 (CLO):
After successful completion of the course, the students will get a thorough exposure to the genetic foundations of the living systems. Moreover, they will learn facile molecular techniques of rDNA technology for various useful genetic manipulations.

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:

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

PBC302: 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 (CLO):

This course represents the applied aspects of biochemistry. Apart from learning different metabolic pathways associated with nutrition, the students will be able to differentiate between normal and diseased conditions of the individuals.

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:

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

PBC303: MOLECULAR BIOPHYSICS

L	T	P	Cr
3	1	0	3.5

Course Objective: To explain the fundamental aspects of biomolecular structure, energetics, and structural dynamics of macromolecules.

Fluorescence Spectroscopy of Biomolecules: Fluorescent probes, Modification in methionine/ histidine/tryptophan/amine and carboxylic groups, Fluorescence life-time and quenching studies, Applications in proteins and membrane studies, Energy transfer for distance measurement in proteins and membranes, Use of fluorescence polarization and anisotropy, Measurement of anisotropy decay, Comparative study of rigid proteins, Internal flexibility of multi-domain proteins, Fluorescence dye-nucleic acid complexes.

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.

IR and Raman Spectroscopy of Biomolecules: Comparison of IR and Raman spectroscopy, Peptide bond vibrations, Conformation (α-helix, β-sheet, β -turns, random coils), Quantitative estimation of the structure from amide I, II & III band intensity in proteins.

NMR Spectroscopy of Biomolecules: NMR spectrometer and concept of FT spectroscopy, Nuclear Overhauser effect, 1D and 2D (COSY, NOESY) spectroscopic studies of proteins.

ESR and SPR Spectroscopy of Biomolecules: Introduction of ESR and SPR, Applications of ESR and SPR to simple biological systems, Identification of high and low spin configurations in metalloproteins by ESR, Ligand binding to heme proteins by ESR, Spin labelled ligands probe for rigidity of binding sites.

MS: The basic principles of mass spectrometry, Applications of mass spectrometry for the analysis of proteins.

Course Outcome: After successfully completion of the course**,** the students will get expertise of structural, kinetic, and thermodynamic characterizations of biomolecues using advanced spectroscopic techniques and methods.

Recommended Books:

1. *Lakowicz, J., Principles of Fluorescence Spectroscopy, Kluwer Academic and Plenum Publishers (1999).*
2. *Evans, J.N.S., Biomolecular NMR Spectroscopy, Oxford University Press (1998).*
3. *Campbell, I.D. and Raymond, A.D., Biological Spectroscopy, Benzamin/Cummings Publishing Company (1984).*

4. *McCammon, J.A. and Harvey, S.C., Dynamics of Proteins & Nucleic Acids, Cambridge University Press (1988).*
5. *Friefelder, D., Physical Biochemistry to Biochemistry and Molecular Biology, San Francisco: W.H. Freeman (1982).*
6. *Hinchliffe, A., Molecular Modeling for Beginners, John Wiley (2003).*

Evaluation Scheme:

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

PBC304: 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 (CLO):

The students will acquire knowledge of basic concepts of nanoscience and nanobiotechnology, Different types of nanomaterials and their size and shape dependent properties, and application of several nanomaterials in 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:

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

PBC401: ENVIRONMENTAL BIOCHEMISTRY

L	T	P	Cr
2	0	0	2.0

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

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.

Course Learning Outcome (CLO):
The candidate shall have knowledge of Ecology, Hydrosphere, Aqueous organic matter, Humic Material, Metals and Semi-Metals in Hydrosphere and Micro-biological processes of the environment.

Recommended Books:

1. *Vanloon G.W., and Duffy S.J., Environmental Chemistry, A Global Perspective Oxford University Press (2011).*
2. *De A. K., Environmental Chemistry, New Age International Publishers, New Delhi. (2006).*

Evaluation Scheme:

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

PBC301: GENOMICS, METAGENOMICS AND PROTEOMICS

L	T	P	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 anscriptomics.

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, Pedlock 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 application, 2D Gel Electrophoresis and its application, Mass Spectrometry and Protein identification, Shotgun proteomics, 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 (CLO):
After passing this course the students will know about various aspects of genomes of different types of organisms. They would know strategies and challenges of genome sequencing, comparative genomics, transcriptomics using microarray technology. The students will also know about metagenomics, and different methodologies used in proteomics as well as structural proteomics.

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

Evaluation Scheme:

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

PBC302: 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: Basic biochemistry, molecular biology and genetics relevant to Molecular Medicine. Human genome: implication and applications. Single Nucleotide Polymorphism. Gene therapy as a potential tool to cure human diseases. Recombinant molecules in medicine. Transgenic and knock out animal models. Stem cell research and its application in human health. Intellectual property right issues and ELSI (Evaluation of the Ethical, Legal and Social Implications program).

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 domains of nuclear receptors; ligand-mediated regulation of nuclear receptor function; nuclear receptor localization; receptor-ligand interactions and gene transcription regulation; histone (acetylase, deacetylase, methylase, demethylase), ATP dependent chromatin remodellers; receptor regulation by post-translational modifications, nuclear receptors as drug targets; xenobiotic receptors and drug metabolism; screening and analysis of therapeutic ligands by high-throughput microscopy, co-transfection and transcriptional assays; steroid hormones and their receptors; molecular basis of endocrinopathies: endocrine-related cancers ligand-independent transcriptional activation of steroid hormone receptors; endocrine disruptors and selective steroid receptor modulators; current concepts and future challenges.

Free Radicals and Metal ions in Biology and Medicine: Chemistry and biology of 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.

Cell Junctions: Biology and Diseases: Introduction to epithelial and endothelial junctional complexes; molecular composition, structure and function of tight junctions, adherens junctions, gap junctions and desmosomes; role in cell-cell adhesion; junctional diffusion barriers; 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, Viability assay, In vitro anticancer assay (MTT Assay), 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 (CLO):

Students in the basic science area will receive insights into the translational and clinical aspects of science and conversely students in clinical medicine will have the opportunity to gain new insights into molecular mechanisms, disease models and preclinical work.

Recommended Books:

1. *Towa, N.J. Methods in Molecular Medicine: Molecular Diagnosis of Genetic disease. Edited by Rob Elles. Humana Press Inc., (1996).*
2. *Ross, D.W. Introduction to Molecular Medicine, (2002).*
3. *Trent, R.J. Molecular Medicine, Genomics to Personalized Healthcare, (2012).*
4. *Runge, M.S Principles of Molecular Medicine: Patterson, Cam. (2006).*

Evaluation Scheme:

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

PBC303: CELLULAR SIGNALING

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of this course is to know how the living cells respond to various physical and chemical stimuli known as signal and how they communicate with each other.

Cell Communication and Surface Receptors: Cell communication Ionophores, gated channels (Voltage and Ligand), Cell surface receptors, G Protein–Coupled Receptors

Extracellular and Intracellular Signals: Extracellular signals: hormones, growth factors and cytokines**,** Autocrine, paracrine & endocrine systems, GTP binding proteins, Protein kinase (PK) A, C and G, Calmodulin dependent PK, tyrosine kinase, MAPK, stress activated PK, ribosomal S6 kinase; cross-talk between different signal transduction pathways, Receptor mediated endocytosis, nuclear transcription factors, angiogenesis, PKs associated with cell survival and death processes, Drugs targeting signalling molecules,

Phospholipases in Cell Signaling: Phospholipase A2 isoform in cardiovascular pathophysiology. Phospholipase C, phospholipase D, Arachidonic acid and lysophospholipids. Arachidonic acid (AA) metabolism. Role of AA mediators in different pathophysiological processes. Cyclooxygenase and lipoxygenase. Therapeutic intervention of PLA2 and its metabolites.

Calcium as Signaling Messenger Ca as an intracellular 2nd messenger. Inositol phospholipid metabolism, calcium transport in cellular and organelle membranes, Na^{+}/Ca^{+2} exchanger, Ca^{+2}-ATPase, Na^{+}/H^{+} exchanger, ion channels, Ca+2 transport system in sarcoplasmic reticulum, mitochondria and nucleus. Ca^{+2} binding proteins, Ca^{+2} in muscle contraction, sperm ejection, necrosis and apoptosis.

Oxidants as Signal Transducers: in cardiovascular, neuronal, & immune system, c-AMP response element binding protein (CREB) in mediating different signals in cells

Molecular and Cellular Basis of Stress Response: calpains, matrix metalloproteases, molecular chaperone, heat shock proteins as signal transducers in mitochondria and ER.

Signal Transduction and Cancer: Oncogenes, proto-oncogenes, Modes of action of oncogenes – G proteins – Ras, Growth factors – Erb, Sis Transcription factors – Fos, Jun, AP1, V-erbA , Tumor suppressor genes RB and retinoblastoma, APC and colon cancer. Modes of action of TS genes – p110, p16, p21, Phosphatase and tensin homolog (pTEN) p53 and cancer risk Selected examples – c-Myc and leukemia BRCA and breast cancer

Laboratory Work:
Different case studies will be analyzed and discussed in the practicals.

Recommended Books:

1. *Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., Molecular Cell Biology, Macmillan.*
2. *Alberts B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Molecular Biology of the Cell, Garland Science Publishing (2008).*
3. *John, T.H., Cell signaling, Oxford University press (2010).*
4. *Nelson D.L. and Cox, M.M., Lehninger Principles of Biochemistry, W.H. Freeman (2008).*
5. *Berg, J.M., Tymoczko, J.L. and Stryer, L., Biochemistry, W. H. Freeman (2006).*

Evaluation Scheme:

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

PBC401: 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 (CLO):
The students will acquire the knowledge of biofuel production technologies, and their 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:

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

PBC402: MACRO MOLECULAR STRUCTURE AND MODELLING

L	T	P	Cr
3	0	0	3.0

Course Objective: To provide the knowledge of basic theoretical aspects of molecular modeling techniques and to apply molecular modeling techniques to ongoing research in modern biology.

Principles of Protein Structures: Conformational maps for glycine and other natural amino acids, Conformationally constrained amino acids and their importance.

Introduction to Molecular Modelling: Concepts in molecular modeling, Coordinate systems, Cartesian coordinates and internal coordinates, Potential energy surfaces, Molecular graphics.

Force Fields: Empirical potential energy, Molecular mechanics, Force field methods**,** Force field models for the simulation of some biomolecules and water.

Energy Minimization: First derivative techniques, Steepest descent and conjugate gradients, Second derivative techniques, Hessian matrix and Newton-Raphson, Global optimisation (simulated annealing, Tabu search, genetic algorithms).

Molecular Dynamics: Introduction, Molecular Dynamics using simple models, Dynamics with continuous potentials, Constant temperature and constant dynamics, Conformation searching, Systematic search, Applications to protein folding.

Structure Prediction and Drug Design: Structure prediction - Introduction to comparative modeling, Constructing and evaluating a comparative Model, predicting protein structures by 'Threading', Molecular docking, SwissDock, AutoDock and HEX, Structure based De Novo ligand design, Drug discovery – Chemoinformatics – QSAR.

Course Learning Outcomes (CLO):
The students will acquire the knowledge of biomolecular structure, molecular modeling, and molecular dynamics simulations.

Recommended Books:

1. *Leach, A.R., Molecular Modelling Principles and Application, Longman (2001)*
2. *Haile, J.M., Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons (1997)*
3. *Gupta, S.P., QSAR and Molecular Modeling, Springer - Anamaya Publishers (2008)*
4. *Schliick, T. Molecular Modeling and Stimulation, Springer (2002).*

Evaluation Scheme:

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

PBC403: 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 (CLO):
The student should be able to acquire knowledge on enzyme catalyzed reactions, reaction mechanisms of enzymes from the different classes, explain and exemplify different 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:

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