B.Sc. BIOCHEMISTRY
SEMESTER-I

Core - 1 (C-1)
MOLECULES OF LIFE (THEORY)

TOTALHOURS:60 **CREDITS:4**

Unit1 The foundations of Biochemistry **No.ofHours:15**

Cellular and chemical foundations of life. The hierarchy of the Molecular organization of cells, The origin of Biomolecules – Miller's postulate,
Energy transformation in living cells, ATP cycle

Water
Uniqueproperties,weakinteractionsinaqueoussystems,ionizationofwater,buffers,waterasareactant andfitnessoftheaqueousenvironment.

Unit3 Carbohydrates and glycobiology **No.ofHours:15**

Monosaccharides-
structure of aldose and ketose , ring structures of sugars, conformations of sugars, mutarotation, anomers,epimersandenantiomers,structureofbiologicallyimportantsugarderivatives,oxidationofs ugars.Formationofdisaccharides,reducingandnon-reducingdisaccharides.Polysaccharides–homo-andheteropolysaccharides,structuralandstoragepolysaccharides.Structureandroleofproteoglycans ,glycoproteinsandglycolipids(gangliosidesandlipopolysaccharides).
Carbohydratesasinformationalmolecules,workingwithcarbohydrates

Unit4 Lipids **No.ofHours:15**
Buildingblocksoflipids-fattyacids,glycerol,ceramide.Storagelipids-
triacylglycerolandwaxes.Structurallipidsinmembranes–
glycerophospholipids,galactolipidsandsulpholipids,sphingolipidsandsterols,structure,distribution androleofmembranelipids.Plantsteroids.Lipidsassignals,cofactorsandpigments

Unit5 Aminoacids, Nucleic acid and Vitamins **No.ofHours:15**
Structureandclassification,physical,chemicalandopticalpropertiesofaminoacids

Nucleicacids
Nucleotides- structureandproperties. Nucleic acid structure – Watson-
CrickmodelofDNA.StructureofmajorspeciesofRNA-
mRNA,tRNAandrRNA.Nucleicacidchemistry
-UVabsorption,effectofacidandalkalionDNA. Otherfunctionsofnucleotides-
sourceofenergy,componentofcoenzymes,secondmessengers.

Vitamins
Structureandactiveformsofwatersolubleandfatsolublevitamins,deficiencydiseasesandsymptoms, hypervitaminosis

C1: MOLECULES OF LIFE (PRACTICALS) SEMESTER-I

TOTALHOURS:60 **CREDIT:2**

1. Safety measures in laboratories.
2. Preparation of normal and molar solutions.
3. Preparation of buffers.
4. Determination of pKa of aceticacid and glycine.
5. Qualitative tests for carbohydrates, lipids,aminoacids, proteins and nucleicacids.
6. Separation of aminoacids/sugars/bases by thin layer chromatography and/or paper chromatography
7. Estimation of carbohydrates
8. Estimation of proteins
9. Estimation of vitamin C.

SUGGESTEDREADINGS

1. Lehninger:PrinciplesofBiochemistry(2013)6th ed.,Nelson,D.L.andCox,M.M.,W.H.Freemanand Company(NewYork),ISBN:13:978-1-4641-0962-1/ISBN:10:1-4292-3414-8.
2. TextbookofBiochemistrywithClinicalCorrelations(2011)7th ed.,Devlin,T.M.,John Wiley&Sons,Inc.(NewYork),ISBN:978-0-470-28173-4.

C-2:CELLBIOLOGY(THEORY)
SEMESTER-I

TOTALHOURS:60 **CREDITS:4**

Unit1 Introduction to cellbiology **No.of Hours:15**

Prokaryotic (archaeaandeubacteria)andeukaryoticcell(animalandplantcells), cells as experimental models.

Tools of cell biology
Light microscopy, phase contrast microscopy, fluorescence microscopy, confocalmicroscopy,electronmicroscopy,FACS.Centrifugationforsubcellularfractionation.

Unit2 Structureofdifferentcellorganelles **No.ofHours:15**

Structure of nuclear envelope, nuclear porecomplex.ERstructure.
Organization of Golgi. Lysosome.
Structure and functions of mitochondria,chloroplasts and peroxisomes. Zellwegersyndrome.

Prokaryotic and eukaryotic cellwall, cellmatrix proteins.Cell-matrix interactions and cell-cell interactions.
Adherencejunctions,tightjunctions,gapjunctions,desmosomes,hemidesmosomes,focaladhesionsandplasmodesmata.

Unit3 Protein trafficking **No.ofHours:15**

Selectivetransportofproteinstoandfromthenucleus.Regulationofnuclearproteinimportandexport.TargetingproteinstoER,smoothERandlipidsynthesis.ExportofproteinsandlipidsfromERandintoER.LipidandpolysaccharidemetabolisminGolgi.ProteinsortingandexportfromGolgi.Mechanismofvesiculartransport,cargoselection,coatproteinsandvesiclebudding,vesiclefusion.Proteinimportandmitochondrialassembly,proteinexportfrommitochondrialmatrix.Importandsortingofchloroplastproteins.

Unit4 Cell cycle, cell death and cell renewal **No.of Hours:15**

Eukaryotic cell cycle, Regulation of cell cycle, restriction point, and checkpoints. Cell division.

Apoptosis and necrosis-brief outline. Salient features of a transformed cell.

C-
C2:CELLBIOLOGY(PRACTICALS)SEMESTER-I

TOTALHOURS:60 **CREDITS:2**

1. Visualization of animal and plant cell by methylene blue.
2. Identification of different stages of mitosis in onion root tip.
3. Identification of different stages of meiosis in grass hopper testis.
4. Micrographs of different cell components (drylab).
5. Sub-cellular fractionation.
6. Visualization of nuclear fraction by acetocarmine stain.
7. Staining and visualization of mitochondria by Janus green stain.

SUGGESTEDREADINGS

1. TheCell:AMolecularApproach(2009)5th ed.,Cooper,G.M.andHausman,R.E.,ASMPress&Sunderland(WashingtonDC),SinauerAssociates,MA, ISBN:978-0-87893-300-6.
2. MolecularCellBiology(2012)7th ed.,Lodish,H.,Berk,A.,Zipursky,S.L.,Matsudaira, P.,Baltimore,D.andDarnell.J.,W.H.Freeman&Company(NewYork),ISBN:13:978-1-4641-0981-2/ISBN:10:1-4641-0981-8.
3. MolecularBiologyoftheCell(2008)5th ed.,Alberts,B.,Johnson,A.,Lewis,J.,and Enlarge,M.,GarlandScience(Princeton),ISBN:0-8153-1619-4/ISBN:0-8153-1620-8.

General Elective-1 (GE-1)
Biophysical Chemistry

Unit-I **No.of Hours:15**

Concept of Molarity, Normality, Preparation of Molar and Normal solutions, pH, determination of pH and pKa,
Buffers, buffering capacity, Handerson- Hasselbach equation, Physiological buffers – bicarbonate and phosphate buffers

Unit-II **No.of Hours:15**

Principle of different types of chromatography – TLC, Paper chromatography, Coloumn chromatography – size exclusion, ion exchange, hydrophobicinteraction/ Reversephase chromatography, affinitychromatography, HPLC and FPLC

Unit-III **No.of Hours:15**

Electrophoretic techniques, PAGE, SDS-PAGE, Agarose gel electrophoresis, IEF, Introduction to 2 D electrophoresis, Immunofocussing, staining of electrophoresis gels – Commassie blue, Silver staining, Activity staining

Unit-IV **No.of Hours:15**

Principle of Centrifugation, Types of rotors, RPM vs g value,
Analytical, Preparative and Ultracentrifugation techniques, Differential centrifugation.

SEMESTER-II

B.Sc.(HONOURS)BIOCHEMISTRY(CBCSSTRUCTURE)C-3:PROTEINS(THEORY)
SEMESTER-II

TOTALHOURS: 60 **CREDITS:4**

Unit 1 Introduction to aminoacids, peptides and proteins **No.ofHours: 15**

Aminoacids and their properties-hydrophobic, polar and charged. Biologicallyimportantpeptides-hormones, antibiotics and growth factors. Multimeric proteins,
Conjugated proteins and metalloproteins,
Diversity of function , Extraction of proteins for downstream processing
Solubilization of proteins from their cellular and extracellular locations, Use of simple grinding methods, homogenization, ultrasonication, Frenchpress and centrifugation.

Fractionation of proteins by Ammonium sulphate, solvent fractionation, dialysis and lyophilization.
Characterization of proteins - Determination of purity, molecularweight, extinction coefficient and sedimentation coefficient, IEF,SDS-PAGE

Unit 2 Covalent structure of proteins **No.of Hours:15**

Organization of protein structure into primary, secondary, tertiary and quaternary structures; N-terminal and C-terminal aminoacid analysis. Sequencing techniques - Edman degradation Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. Mass spectrometric analysis, tandem MS. Solid phase peptide synthesis

Unit 3 Three dimensional structures of proteins **No.ofHours:15**

Nature of stabilizing bonds-covalent and noncovalent. Importance of primary structure in folding.
The peptide bond-
bondlengthsandconfiguration.Dihedralanglespsiandphi.Helices,sheetsandturns.Ramachandranmap.Techniquesusedinstudying3-Dstructures-X-raydiffractionandNMR.Motifsanddomains.Tertiaryandquaternarystructures. Structures of myoglobin and haemoglobin

Specializedproteins-antibodiesandactin-myosinmotors
Antibody structure and binding to antigens. ATP activated actin-myosin contractions.
Membraneproteins

Unit 4 Protein folding and conformational diseases **No.of Hours: 15**
DenaturationandrenaturationofRibonucleaseA.Introductiontothermodynamicsoffoldingandmolteglobule.Assistedfoldingbymolecularchaperones,chaperoninsandPDI.Defectsinproteinfolding.Diseases–Alzheimer'sandPrionbased.

Introduction to protein structure databases

Proteinsequenceandstructuredatabases(PDB).Useofsequenceanddomaininformation.Viewing protein structures using *insilico* tools.

C-3:PROTEINS(PRACTICALS)

SEMESTER–II

TOTALHOURS:60 **CREDIT:2**

1. Estimation of proteins using UV absorbance and Biuret method.
2. Microassay of proteins using Lowry/Bradford method.
3. Isoelectric pH of casein.
4. Ammonium sulphate fractionation of serum proteins.
5. Separation of albumin from serum using anion-exchange chromatography.
6. SDS-PAGE analysis of proteins.

SUGGESTEDREADINGS

1. Lehninger:PrinciplesofBiochemistry(2013)6th ed.,Nelson,D.L.andCox,M.M.,W.H.Freemanand dCompany(NewYork),ISBN:13:978-1-4641-0962-1/ISBN:10:1-4292-3414-8.
2. PhysicalBiochemistry(2009)2nd ed.,Sheehan,D., Wiley-Blackwell(WestSussex), ISBN:9780470856024/ISBN:9780470856031.
3. TheToolsofBiochemistry(1977;Reprint2011)Cooper,T.G.,WileyIndiaPvt.Ltd.(NewDelhi),IS BN:978-81-265-3016-8.

C-4:ENZYMES (THEORY)
SEMESTER–II

TOTALHOURS:60 **CREDITS:4**

Unit 1 Introduction to enzymes **No.ofHours:15**

Nature of enzymes - protein and non-protein (ribozyme). IUBMB classification of enzymes.

Cofactor and prosthetic group, apoenzyme, holoenzyme. Involvement of coenzymes in enzyme catalysed reactions
TPP, FAD,NAD, pyridoxalphosphate, biotin, coenzymeA, tetrahydrofolate, lipoicacid.

Features of enzyme catalysis - Factors affecting the rate of chemical reactions, collision theory, activation energy and transition statetheory,
catalysis,reactionratesandthermodynamicsofreaction.Catalyticpowerandspecificityofenzymes (conceptofactivesite), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

Unit 2 Enzyme kinetics **No. of Hours:15**

Relationshipbetweeninitialvelocityandsubstrateconcentration,steadystatekinetics,equilibriumconstant-monosubstratereactions.Michaelis-Mentenequation,Lineweaver-Burkplot,Eadie-HofsteeandHanesplot.$K_m$andV_{max},K_{cat}andturnovernumber.EffectofpH,temperatureandmetalionsontheactivityofenzyme.

Bisubstrate reactions - Typesofbi bireactions(sequential– orderedand random,ping pong reactions).Differentiatingbisubstratemechanisms(diagnosticplots,isotopeexchange).

Enzyme inhibition Reversible inhibition (competitive,uncompetitive,non-competitive,mixed).

Unit 3 Applications and Mechanism of action of enzymes **No. of Hours: 15**

Applicationof enzymes in diagnostics
(SGPT,SGOT,creatinekinase,alkalineandacidphosphatases),enzymeimmunoassay(HRPO),enzymetherapy(Streptokinase).Immobilizedenzymes.

General features-proximity and orientation, strain and distortion, acid base and covalent catalysis - chymotrypsin,l ysozyme. Metal activated enzymes and metalloenzymes,
Transition state analogues, Mechanism based inhibitors-antibiotics as inhibitors.

Unit4 Regulation of enzyme activity **No. of Hours:15**

Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbomoylase), reversible covalent modification phosphorylation (glycogenphosphorylase).Proteolyticcleavage-zymogen**.**

Multienzyme complex as regulatory enzymes Occurrence and isolation, phylogenetic distribution and properties (pyruvatedehydrogenase, fattyacylsynthase) Isoenzymes - properties andphysiologicalsignificance(lactatedehydrogenase).

C-4:ENZYMES(PRACTICAL)SEMESTER–II

TOTALHOURS:60 **CREDITS:2**

1. Partial purification of acidphosphatase from germinating mungbean.
2. Assay of enzyme activity and specific activity,e.g.acidphosphatase.
3. EffectofpHonenzymeactivity
4. Determination of K_m and V_{max} using Lineweaver-Burk graph.
5. Enzyme inhibition-calculationof K_i for competitiveinhibition.
6. Continuous assay of lactatedehydrogenase.
7. Coupledassayofglucose-6-phosphatedehydrogenase.

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1. Lehninger:PrinciplesofBiochemistry(2013)6th ed.,Nelson,D.L.andCox,M.M.,W.H.FreemanandCompany(NewYork),ISBN:13:978-1-4641-0962-1/ISBN:10:1-4292-3414-8.
2. Biochemistry(2011)4th ed.,Donald,V.andJudithG.V.,JohnWiley&SonsAsiaPvt. Ltd.(NewJersey),ISBN:978-1180-25024.

FundamentalsofEnzymology(1999)3rd ed.,NicholasC.P.andLewisS., Oxfor

General Elective-2 (GE-2)
Bioenergetics and Introduction to metabolism

Unit-I **15 hours**

Energy transformations in living organisms. Laws of thermodynamics, concept of free energy, standard free energy, enthalpy and entropy. State functions, equilibrium constant and coupled reactions.

Types of chemical bonds: weak and covalent interactions.

Unit-II **15 hours**

Introduction to bioenergetics: Redox reactons. High energy phosphate compounds, ATP, creatine, 1,3-bisphosphoglycerate, acetyl-CoA, etc. Phosphorylation potential, phosphoryl group transfers, chemical basis of high standard free energy of hydrolysis of ATP.

Unit-III **15 hours**

Introduction to metabolism, catabolism & anabolism. Central metabolic pathways - Glycolysis, TCA cycle, all reactions with enzymes and their physiological significance.

Unit-IV **15 hours**

Oxidative phosphorylation, electron transport chain, organisation and function. Chemiosmotic hypothesis, proton motive force, ATP production, ATP synthetase and its mechanism. Inhibitors of electron transport chain, inhibitors and uncouplers of oxidative phosphorylation.