

**Syllabus of Biochemistry (Hons.)
for SEM-I & SEM-II under CBCS
(to be effective from
Academic Year: 2017-18)**



**The University of Burdwan
Burdwan, West Bengal**

1. Introduction

The syllabus for Biochemistry at undergraduate level using the Choice Based Credit system has been framed in compliance with model syllabus given by UGC.

The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weight age to both the core content and techniques used in Biochemistry.

The ultimate goal of the syllabus is that the students at the end are able to secure a job. Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques of mapping and understanding of the subject.

The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

It is essential that Biochemistry students select their general electives courses from Chemistry, Physics, Mathematics and/or any branch of Life Sciences disciplines.

While the syllabus is in compliance with UGC model curriculum, it is necessary that Biochemistry students should learn “Basic Microbiology” as one of the core courses rather than as elective while. Course on “Concept of Genetics” has been moved to electives.

Also, it is recommended that two elective courses namely Nutritional Biochemistry and Advanced Biochemistry may be made compulsory.

Type of Courses

Course type	Description	Number of Courses
		B. Sc. (Honours)
CC	Core Course	14
DSE	Discipline Specific Elective	4
GE	Generic Elective	4
AECC (ENVS & ENGLISH/MIL)	Ability Enhancement Compulsory Course	2
SEC	Skill Enhancement Course	2
TOTAL CREDIT		142

Structure at a glance for Biochemistry (H) at UG level, B.U.:

1st Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-1	Molecules of Life (Theo) Molecules of Life (Prac)	Core Course – I	4+2	75
CC-2	Cell Biology (Theo) Cell Biology (Prac)	Core Course – II	4+2	75
GE-1	Biochemistry of Cell (Theo + Prac)	Generic Elective – 1	4+2	75
AECC-1	ENVS	Ability Enhancement Compulsory Course – I	4	100
TOTAL			22	325

2nd Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-3	Proteins (Theo) Proteins (Prac)	Core Course – III	4+2	75
CC-4	Enzymes (Theo) Enzymes (Prac)	Core Course – IV	4+2	75
GE-2	Proteins and Enzymes (Theo + Prac)	Generic Elective – 2	4+2	75
AECC-2	Communicative Eng./MIL	Ability Enhancement Compulsory Course – II	2	50
TOTAL			20	275

3rd Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-5	Metabolism of Carbohydrates and Lipids (Theo) Metabolism of Carbohydrates and Lipids (Prac)	Core Course – V	4+2	75
CC-6	Physiology and Hormones (Theo) Physiology and Hormones (Prac)	Core Course – VI	4+2	75
CC-7	Physical Biochemistry (Theo) Physical Biochemistry (Prac)	Core Course – VII	4+2	75
SEC-1	Clinical Biochemistry or Bioinformatics and Biostatistics	Skill Enhancement Course – 1	2	50
GE-3	Fundamentals of Cell Biology and Immunology	Generic Elective – 3	4+2	75
TOTAL			26	350

4th Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-8	Membrane Biology and Bioenergetics (Theo) Membrane Biology and Bioenergetics (Prac)	Core Course – VIII	4+2	75
CC-9	Metabolism of Amino Acid and Nucleic Acid (Theo) Metabolism of Amino Acid and Nucleic Acid (Prac)	Core Course – IX	4+2	75
CC-10	Basic Microbiology and Microbial Genetics (Theo) Basic Microbiology and Microbial Genetics (Prac)	Core Course - X	4+2	75
SEC-2	Techniques in Biochemistry or Protein Purification Techniques	Skill Enhancement Course – II	2	50
GE-4	Fundamentals of Genetic Engineering	Generic Elective – 4	4+2	75
TOTAL			26	350

5th Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-11	Chromosome organization, DNA replication, Mutation and Repair (Theo) Chromosome organization, DNA replication, Mutation and Repair (Prac)	Core Course – XI	4+2	75
CC-12	Gene expression and regulation (Theo) Gene expression and regulation (Prac)	Core Course – XII	4+2	75
DSE-1	Nutritional Biochemistry (Theo + Prac) or Concept of Genetics (Theo + Prac)	Discipline Specific Elective	4+2	75
DSE-2	Infectious and Non-infectious Diseases (Theory) or Advanced Biochemistry (Theory)	Discipline Specific Elective	6	75
TOTAL			24	300

6th Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-13	Recombinant DNA Technology and Genetic Engineering (Theo) Recombinant DNA Technology and Genetic Engineering (Prac)	Core Course – XIII	4+2	75
CC-14	Immunology (Theo) Immunology (Prac)	Core Course – XIV	4+2	75
DSE-3	Neuro Biochemistry (Theo) or Molecular Diagnostics (Theo + Prac)	Discipline Specific Elective	6 or 4+2	75
DSE-4	Project Work or Dissertation followed by power point presentation	Discipline Specific Elective	6	75
TOTAL			24	300

1st Semester:

Course Code: CC-1

Course Title: Molecules of Life (Theo)

4 Credits

The foundations of biochemistry: Cellular and chemical foundations of life

Water

Unique properties, weak interactions in aqueous systems, ionization of water, water as a reactant and fitness of the aqueous environment. 02 lectures

Basic principles of Inorganic, Organic & Physical Chemistry

- Atomic structure and atomic properties:

Modern form of periodic table, periodicities of atomic-, ionic- and van der Waals radii, ionization energy, electron affinity, electronegativity, ionic potential. 03 lectures

- Chemical bonding:

Ionic bond, covalent bond, metallic bond, deformation of ions and Fajan's rule, hydrogen bonding, van der Waals' force, dipole moment, bond polarity. 03 lectures

- Redox properties:

Standard electrode potential, formal potential, complex formation and precipitation reaction on formal potential, disproportionation and comproportionation reactions. 03 lectures

- Metal ions in living systems:

Essential elements, toxic elements and their toxicities, classification of biological metal ions and ligands according to HSAB principle, chelation therapy. 03 lectures

- Bonding and stereochemistry:

Hybridisation of carbon (sp^3 , sp^2 , sp), localized and delocalized bonds, inductive effect, field effect, electromeric effect, conjugation, resonance, hyperconjugation, tautomerism, aromaticity. 03 lectures

- Organic reaction mechanism:

Classification of reagents (nucleophile, electrophile, free radical, regioselective and chemoselective), thermodynamics and kinetics of organic reactions, energy profiles: intermediate and transition state, substitution reactions (S_N1 , S_N2), elimination reaction ($E1$, $E2$, $E1CB$). 05 lectures

- Stereochemistry of carbon compounds

configuration and conformation of organic molecules, dihedral angle and angle of torsion – gauche, eclipsed and staggered arrangement, elementary idea about the conformational analysis of cyclohexane and its mono- and di-substituted derivatives (chair, boat and twist boat forms), Fisher, Newman, Sawhorse & Flying-wedge representation, configurational nomenclature – D/L, R/S; enantiomer, diastereomer, mesomer, racemic mixture, optical activity, optical isomerism, optical rotation, resolution of optical isomers. 06 lectures

- Biophysical properties

Viscosity: General features of fluid flow (streamlined and turbulent), nature of viscous drag for streamlined motion, Definition of viscosity coefficient, Origin of viscosity of liquids, expression for viscosity coefficient of liquids (no derivation): Poiseuille's equation, temperature dependence of viscosity coefficient of liquids, Stoke's law and terminal velocity, Determination of viscosity coefficient of liquids, Diffusion of solutes in solution, Fick's law. 05 lectures

Surface tension: Definition, angle of contact, interfacial tension, capillary rise, determination of surface tension, temperature effect. 03 lectures

Preliminary idea of Chemical equilibrium: Equilibrium constant, Le Chatelier's principle and its simple applications. Ionic equilibrium: Standard solution, Molar, Normal, Molal, Formal and percent strengths, Hydrolysis of weak acids and bases. pKa, pKb, pH, pOH acid- base neutralization curves, Buffer action definition, Henderson -Hasselbalch equation and preparation of buffers, buffer capacity, Solubility product principle and application. 04 lectures

Electrochemistry: Electrical conductance, cell constant, specific conductance and equivalent conductance., Variation of equivalent conductance of strong and weak electrolytes with dilution, Kohlrausch's law of independent migration of ions, ion conductance and ionic mobility, Equivalent conductance at infinite dilution for weak electrolytes and determination of dissociation constants of weak electrolytes from conductance measurements. EMF of cell (no derivation). 05 lectures

Lipids

Brief idea about lipids: fatty acids, triglycerides, P-lipids, sphingosine, ceramide, sphingomyelin, sterols and cholesterol, glycolipids, sphingolipids, (blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes). Structural Lipids in biological membranes – Phospholipases: phospholipase A2, phospholipase C, phospholipase D, Inositol tris- phosphate and diacyl glycerol as signaling molecules. 05 lectures

Amino Acids

Structure and classification, essential and non essential amino acids, physical, chemical and optical properties of amino acids. 04 lectures

Nucleic Acids

Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on nucleic acids. Other functions of nucleotides – source of energy, component of coenzymes. 06 lectures

Reference Books

1. Outlines of Biochemistry: Conn and Stumpf
2. Biochemistry: Debojyoti Das
3. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.
4. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1-4292-3414-
5. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4.
6. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.
7. Fundamental of Biochemistry, Voet and Voet.
8. *General and Inorganic Chemistry*, R. Sarkar, Part I, 2nd Edition, New Central Book Agency, Kolkata.
9. *Inorganic Chemistry*, R. L. Dutta, Part I, The New Book Stall, Kolkat.
10. *Bioinorganic Chemistry*, A. K. Das, Books and Allied (P) Ltd, Kolkata.
11. *Organic Chemistry*, I. L. Finar Volumes 1 and 2: Stereochemistry and chemistry of natural products, 5th Edition, ELBS.

12. *Organic Chemistry*, T. W. G. Solomons, C. B. Fryhle, S. A. Snyder, 11th Edition (International Student Version), Wiley.
13. *A Guide Book to Mechanism of Organic Chemistry*, P. Sykes, 6th Edition, Pearson.
14. *Physical Chemistry*, P. C. Rakshit, Sarat Book House, Kolkata.
15. *Physical Chemistry*, I. N. Levine, Tata McGraw-Hill.

Course Code: CC-1

Course Title: Molecules of Life (Prac.)

2 Credits

List of Practical:

1. Safety measures in laboratories, use and calibration of pipettes.
2. Preparation of normal, molar solutions and percent solutions.
3. Concept of pH and preparation of buffers.
4. Determination of pK_a of acetic acid and glycine.
5. Separation of amino acids by paper chromatography.
6. Separation of lipids by thin layer chromatography.

Course Code: CC-2

Course Title: Cell Biology (Theo)

4 Credits

Cells: Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells).

05 lectures

Subcellular organelles and membranes

Cell membrane-peripheral and integral membrane proteins. Structure of biological membranes – Gorter & Grendel Model, Danielli and Davson model, Unit membrane model and Singer and Nicolson model, Nucleus, lysosomes, endoplasmic reticulum, Golgi bodies, mitochondria, chloroplast, peroxisomes, cell wall. Endosymbiont hypothesis of the biogenesis of mitochondria and chloroplast, Marker enzymes and proteins of subcellular organelles, and their membranes, cytosol and cell membrane.

15 lectures

Cytoskeletal proteins

Structure and organization of actin filaments. Role of ATP in microfilament polymerization, organization of actin filaments. Non-muscle myosin. Intermediate filament proteins, assembly

and intracellular organization. Assembly, organization and movement of cilia and flagella.

10 lectures

Functional proteins

Outline of structural proteins, transport proteins and immunoglobulins. 03 lectures

Cell wall and extracellular matrix

Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata. 07 lectures

Protein trafficking

Regulation of nuclear protein import and export. Import and export of proteins and lipids in ER. Protein sorting and processing in Golgi. Mechanism of vesicular transport – the Dolichol phosphate pathway. 10 lectures

Cell cycle, cell death and cell renewal

Eukaryotic cell cycle and its Regulation. Cell division. Outline on apoptosis and necrosis. 03 lectures

Tools of Cell Biology

Cells as experimental models, Light microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, FACS, Differential and density gradient centrifugation for subcellular fractionations. 07 lectures

Reference Books:

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN: 978-0-87893-300-6.
2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), and ISBN: 13:978-1-4641-0981-2 / ISBN: 10: 1-4641-0981-8.
3. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J.
4. Enlarge, M., Garland Science (Princeton), ISBN: 0-8153-1619-4 / ISBN: 0-8153-1620-8.

Course Code: CC-2

Course Title: Cell Biology (Prac.)

2 Credits

List of Practical

1. Visualization of animal and plant cells by methylene blue & Micrographs of different cell components and study of mitosis and meiosis from permanent slides (dry lab);
2. Identification of different stages of mitosis in onion root tip;
3. Identification of different stages of meiosis in grasshopper testis/ onion flower bud anthers;
4. Isolation of different sub-organelles and their identification by respective marker enzyme/protein;
5. Staining and visualization of mitochondria by Janus green stain: &
6. Identification of live cells by Trypan blue exclusion test.

Course Code: Generic Elective-1 (Theo.)

4 Credits

[Only for the students of Biochemistry (Hons.)]

Course Title: Biochemistry of Cell

Biomolecules in their cellular environment

The cellular basis of life. Cellular structures – prokaryotes and eukaryotes. Chemical principles in biomolecular structure. Major classes of biomolecules. Role of water in design of biomolecules. 12 lectures

Amino acids and peptides

Types of amino acids and their chemistry, derivatives of amino acids and their biological role. Introduction to biologically important peptides. 08 lectures

Sugars and polysaccharides

Basic chemistry of sugars, optical activity. Disaccharides, trisaccharides and polysaccharides - their distribution and biological role. 08 lectures

Nucleosides, nucleotides and nucleic acids

Structures and chemistry, DNA structures and their importance, different types of RNA. Unusual DNA structures, other functions of nucleotides. 08 lectures

Lipids

Various classes of lipids and their distribution, storage lipids, structural lipids in membranes, lipids as signals, cofactors and pigments. 08 lectures

Vitamins, coenzymes and metal ions

Occurrence and nutritional role. Coenzymes and their role in metabolism, metal ion containing biomolecules, heme, porphyrins and cyanocobalamin – their biological significance. 8 lectures

Signalling Molecules

Second messengers - cAMP, cGMP, IP₃, diacyl glycerol, Ca²⁺, NO. Brief account of their importance and role in signalling and signal transduction. 08 lectures

References:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13; 978-1-4641-0962-1 / ISBN: 10-14641-0962-1.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4.

Course Code: Generic Elective-1 (Prac.)

2 Credits

[Only for the students of Biochemistry (Hons.)]

Course Title: Biochemistry of Cell

List of Practical

1. General safety procedures in a laboratory. Calibration and Use of auto pipettes.
2. Making solutions and buffer preparation - acetate and tris buffers.
3. Qualitative tests for biomolecules - carbohydrates, lipids, amino acids, proteins, bases and nucleic acids.
4. Separation of amino acids by paper chromatography.
5. Estimation of ascorbic acid in fruit juices.

2nd Semester:

Course Code: CC-3

Course Title: Proteins (Theo)

4 Credits

Introduction to amino acids, peptides and proteins

Amino acids and their properties - hydrophobic, polar and charged.

Biologically important peptides - hormones, antibiotics and growth factors. Multimeric proteins, conjugated proteins and metallo proteins. Diversity of function (Specific examples of Proteins/Peptides may be included under each category). 12 lectures

Extraction, Separation and Characterization of Proteins

Solubilization of proteins from their cellular and extracellular locations. Use of simple grinding methods, homogenization and centrifugation. Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilisation. Ion- exchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography, HPLC and FPLC.

Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF, SDS-PAGE and 2-D electrophoresis. 20 lectures

. Covalent structure of proteins

Organization of protein structure into primary, secondary, tertiary and quaternary structures. 03 lectures

Three dimensional structures of proteins

Nature of stabilizing bonds - covalent and non-covalent. Importance of primary structure in folding. The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns. Ramachandran plot. Techniques used in studying 3-D structures - X-ray diffraction and NMR (introductory). Motifs and domains. 10 lectures

Protein folding and conformational diseases

Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamics of folding and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding and associated diseases --- Alzheimer's disease. 07 lectures

Myoglobin and haemoglobin and Membrane Proteins

Structures of myoglobin and haemoglobin, Oxygen binding curves, influence of 2,3-Biphosphoglyceric acid, CO₂ and Cl⁻. Hill plot. Cooperativity between subunits and models to explain the phenomena – concerted and sequential models. Haemoglobin disorders and associated diseases – sickle cell anemia, and thalasemia. 08 lectures

Reference Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1-4292-3414-8.
2. Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
3. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.
4. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

Course Code: CC-3

Course Title: Proteins (Prac.)

2 Credits

List of practical

1. Verification of Lambert-Beer's Law
2. Estimation of proteins using UV absorbance and Biuret method.
3. Assay of proteins using Lowry/Bradford method, standard curve preparation.
4. Determination of Isoelectric pH of glycine and alanine.
5. Determination of molecular mass of protein by SDS-PAGE using bovine serum albumin as the standard.

Course Code: CC-4

Course Title: Enzymes (Theo)

4 Credits

Introduction to Enzymes

Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUBMB classification of enzymes. 07 lectures

Features of enzyme catalysis

Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. 10 lectures

Enzyme Kinetics

Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions. Michaelis-Menten equation, Lineweaver- Burk plot, Eadie-Hofstee and Hanes plot. K_m and V_{max} , K_{cat} and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme. 13 lectures

Enzyme inhibition

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors. 05 lectures

Mechanism of action of enzymes

General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues. 07 lectures

Regulation of enzyme activity

Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition, allosteric regulation (aspartate transcarbamoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage- zymogen.

Multienzyme complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase) Isoenzymes - properties and physiological significance (lactate dehydrogenase). 13 lectures

Involvement of coenzymes in enzyme catalysed reactions

TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid.

05 lectures

Reference Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1-4292-3414-8.
2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN: 978-1180-25024.
3. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.
4. Enzymes, (1973), Malcolm Dixon, Edwin Clifford Webb, Prentice Hall Press, ISBN: 0 58 2462177.
5. Biochemical Calculations, (1976) 3rd ed., Irwin H. Segel, John Wiley and Sons ISBN: 0 47 1774219

Course Code: CC-4

Course Title: Enzymes (Prac)

2 Credits

List of practical

1. Purification of alkaline phosphatase from germinating mung bean.
2. Assay of enzyme activity and specific activity of alkaline phosphatase.
3. Effect of pH on enzyme activity
4. Determination of K_m and V_{max} using Lineweaver-Burk graph.
5. Zymogram assay of protein.

Course Code: Generic Elective-2 (Theo)

4 Credits

[Only for the students of Biochemistry (Hons.)]

Course Title: Proteins and Enzymes

Introduction to proteins

Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function.

05 lectures

Isolation and analysis of proteins

Techniques to isolate and analyze proteins- salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, and IEF. Protein primary structure - sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides. Synthesis of peptides using Merrifield method.

15 lectures

Introduction to protein three-dimensional structures

Secondary structure- helices and sheets, Ramachandran maps. Nature of non-covalent bonds and covalent bonds in protein folding. Tertiary and quaternary structures.

07 lectures

Myoglobin and haemoglobin - structure and function

Oxygen binding curves, cooperativity models for haemoglobin.

03 lectures

Introduction to enzyme catalysis

Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature.

05 lectures

Enzyme Kinetics

Principles of reaction rates, order of reactions and equilibrium constants. Derivation of Michaelis-Menten equation. Significance of K_m and V_{max} . Catalytic efficiency parameters. Competitive and mixed inhibitions. Kinetics and diagnostic plots. Types of irreversible inhibitors.

15 lectures

Mechanisms of enzyme action and regulation

Mechanism of action of chymotrypsin. Inhibitors of enzymes - antibiotics. Allosteric Regulation of enzyme activity and its importance - aspartate transcarbamoylase.

05 lectures

Enzymes in medicine and industry

Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry. 05 lectures

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1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13; 978-1-4641-0962-1 / ISBN: 10-14641-0962-1.
2. Fundamentals of Enzymology (1999) 3rd ed., Price, N.C and Stevens, L., Oxford University Press Inc., (New York), ISBN:13: 978-0-19-806439-8.

Course Code: Generic Elective-2 (Prac.)

2 Credits

[Only for the students of Biochemistry (Hons.)]

Course Title: Proteins and Enzymes

List of Practical

1. Protein estimation by UV absorbance and Biuret method.
2. Protein microassay by Lowry/Bradford method.
3. Ammonium sulphate fractionation of crude homogenate from germinated mung bean.
4. Setting up assay for alkaline phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).
5. Determination of K_m and V_{max} of enzyme enriched fraction.

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**Syllabus of Biochemistry (Hons.)
for SEM-III & SEM-IV under
CBCS**

**(to be effective from
Academic Year: 2017-18)**



**The University of Burdwan
Burdwan, West Bengal**

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CC-7	Physical Biochemistry (Theo) Physical Biochemistry (Prac)	Core Course – VII	4+2	75
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CC-9	Metabolism of Amino Acid and Nucleic Acid (Theo) Metabolism of Amino Acid and Nucleic Acid (Prac)	Core Course – IX	4+2	75
CC-10	Basic Microbiology and Microbial Genetics (Theo) Basic Microbiology and Microbial Genetics (Prac)	Core Course - X	4+2	75
SEC-2	Techniques in Biochemistry or Protein Purification Techniques	Skill Enhancement Course – II	2	50
GE-4	Fundamentals of Genetic Engineering	Generic Elective – 4	4+2	75
TOTAL			26	350

5th Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-11	Chromosome organization, DNA replication, Mutation and Repair (Theo) Chromosome organization, DNA replication, Mutation and Repair (Prac)	Core Course – XI	4+2	75
CC-12	Gene expression and regulation (Theo) Gene expression and regulation (Prac)	Core Course – XII	4+2	75
DSE-1	Nutritional Biochemistry (Theo + Prac) or Concept of Genetics (Theo + Prac)	Discipline Specific Elective	4+2	75
DSE-2	Infectious and Non-infectious Diseases (Theory) or Advanced Biochemistry (Theory)	Discipline Specific Elective	6	75
TOTAL			24	300

6th Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-13	Recombinant DNA Technology and Genetic Engineering (Theo) Recombinant DNA Technology and Genetic Engineering (Prac)	Core Course – XIII	4+2	75
CC-14	Immunology (Theo) Immunology ((Prac)	Core Course – XIV	4+2	75
DSE-3	Neuro Biochemistry (Theo) or Molecular Diagnostics (Theo + Prac)	Discipline Specific Elective	6 or 4+2	75
DSE-4	Project Work or Dissertation followed by power point presentation	Discipline Specific Elective	6	75
TOTAL			24	300

3rd Semester

Course Code: CC-5

Course Title: Metabolism of Carbohydrates and Lipids (Theo)

4 credits

Concept of Bioenergetics

Entropy, enthalpy, free energy, catabolism, anabolism, ATP as energy currency, reducing power of the cell, metabolic pathways.

Glycolysis, Gluconeogenesis, pentose phosphate pathway and Glycogen metabolism

Glycolysis - a universal pathway, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis.

Synthesis of glucose from non-carbohydrate sources, reciprocal regulation of glycolysis and gluconeogenesis, pentose phosphate pathway and its importance.

Glycogenesis and glycogenolysis, regulation of glycogen metabolism, glycogen storage diseases.

Citric acid cycle

Production of acetyl CoA, reactions of citric acid cycle, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxalate pathway, coordinated regulation of glyoxalate and citric acid pathways.

Fatty acid oxidation

Digestion, mobilisation and transport of cholesterol and triacyl glycerols, fatty acid transport to mitochondria, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal oxidation, ω oxidation, ketone body's metabolism, ketoacidosis.

Fatty acid synthesis

Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation.

Biosynthesis of eicosanoids and cholesterol

synthesis of prostagladins, leukotrienes and thromboxanes. Synthesis of cholesterol, regulation of cholesterol synthesis, integration of carbohydrate and lipid metabolism. Inborn errors of carbohydrate & lipid metabolism.

Reference Books

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 / ISBN: 10:1-4641-0962-1.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4.
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

Course Code: CC-5

Course Title: Metabolism of Carbohydrates and Lipids (Prac.)

2 Credits

List of practical

1. Qualitative tests for carbohydrates and lipids
2. Separation of sugars by paper & thin layer chromatography.
3. Assay of salivary amylase.
4. Isolation of cholesterol from egg yolk and its estimation.

Course Code: CC-6

Course Title: Physiology and Hormones (Theo)

4 credits

Homeostasis and the organization of body fluid compartments

Buffer system in blood, Intracellular, extracellular and interstitial fluid. Homeostasis, control system and their components. Plasma as an extracellular fluid, RBC, blood coagulation: mechanism, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems. Anemias, polycythemia, haemophilia and thrombosis.

Cardiovascular physiology, Respiration, Digestive & Excretory

Physiology of the cardiac muscle, automaticity of the cardiac muscle contraction, excitation contraction coupling, control of cardiac function and output. Overview on digestive and excretory system, organization of the pulmonary system. Mechanism & regulation of breathing, pulmonary ventilation and related volumes, pulmonary circulation. Principles of gas exchange and transport. Regulation of respiration. Respiratory quotient.

Introduction to endocrinology

Hormones: Definitions & classifications, mode of secretion and transport of hormones in the circulation, Functions of hormones and their regulation. Endocrine, paracrine, autocrine, intracrine and neuroendocrine, Feedback Mechanism.

Thyroid hormone

Thyroid, hypothalamic and pituitary, Pancreatic, GI tract and adrenal hormones – their implications in health and diseases. Inborn errors associated with their dysregulation.

Introduction to plant growth regulations

Target cell, Receptor of plant hormones, Physiology and signalling of Auxins, ABA & C₂H₄.

Plant photophysiology

Basic mechanism of light absorption, Z-Scheme, PGRC, C₄, CAM & C₂ cycle and their significance in photomorphogenesis, Blue light response in plants.

Reference Books

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (New York), ISBN: 10-14641-0962- 1.
2. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
3. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education, ISBN: 978-81-317-2610-5.
4. The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, ISBN: 978-0-87893- 300-6.
5. Human Physiology (2016) 11th Ed., C. C. Chatterjee, CBS Publishers, ISBN: 10- 81239 2873-4.
6. Biochemistry (1978) 2nd Ed., Debajyoti Das, Academic Publishers.
7. Medical Physiology (2010) 12 Ed., Guyton and Hall, Saunders, ISBN: 10- 14160-4574-0.
8. Photomorphogenesis in Plants (1994) R. E. Kendrick and G. H. M. Kronenberg (Eds.), Springer.

Course Code: CC-6

Course Title: Physiology and Hormones (Prac.)

2 Credits

List of Practical

1. Estimation of haemoglobin.
2. Separation of plasma proteins.
3. Separation of isoenzymes of LDH by electrophoresis.
4. Estimation of serum Ca^{2+} .
5. Estimation of serum T4.

Course Code: CC-7

Course Title: Physical Biochemistry (Theo)

4 credits

Introduction

Special chemical requirement of biomolecules; factors affecting analyte structure and stability: pH, temperature and solvent polarity; buffering systems used in biochemistry, osmosis & reverse osmosis, colligative properties.

Chromatography

Principles of chromatography: liquid and gas chromatography; performance parameters: retention, resolution, basis of peak broadening, peak symmetry; chromatography equipment; modes of chromatography: ion exchange, gel filtration and affinity; brief overview on HPLC.

Spectroscopy-I

Theories of light (wave-particle duality); the electromagnetic spectrum; UV/visible absorption spectroscopy: physicochemical aspect, Beer-Lambert's law, Deviations of Beer Lambert's law; transitions, Applications of UV-visible spectroscopy in proteins and nucleic acids; Fluorescence and Chemiluminescence: theory, measurement, quenching, study of protein folding, application of fluorescence in cell biology.

Spectroscopy-II

Spectroscopic techniques using plane polarized light: polarized light, chirality of biomolecules, circular dichroism and linear dichroism.

Infrared Spectroscopy- Modes of molecular vibrations; Vibration of a diatomic molecule; Theory of Hooke's law; characteristic stretching frequencies of O-H, N-H, C-H, C-D, C=C, C=N, C=O, S-H functions; Factors affecting stretching frequencies (H-bonding, electronic factors, mass effects, bond multiplicity); Applications of FTIR for determination of secondary structure of proteins.

Hydrodynamics and Bio-calorimetry

Viscosity: definition, measurement, effect of solutes, sedimentation and ultracentrifuge: physical basis, subcellular fractionation, sedimentation velocity and sedimentation equilibrium; enthalpy, entropy and free energy: relationship between these parameters, activation energy.

Reference Books

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (New York), ISBN: 10-14641-0962- 1.
2. Physical Biochemistry, Principles and Applications (2009) 2nd Ed., David Sheehan, Wiley, ISBN: 10- 04708-5603-3
3. Physical Biochemistry, (1982) 2nd Ed., David Friefelder, W. H. Freeman, ISBN: 10- 07167-1444-2
4. Biophysical Chemistry, Principles and Techniques (2016) 4th Ed., Upadhyay and Upadhyay, Himalaya Publishing House, ISBN: 10-93514-2227-5
5. Physical Biochemistry (2005) 2nd Ed., Van Holde, Prentice Hall, ISBN: 10-01304-6427-9
6. Fundamentals of Photochemistry, K. K. Rohatgi-Mukherjee (2014) 3rd Ed., New Age International Publishers, ISBN: 978-81-224-3432-3.
7. P. C. Rakshit, Physical Chemistry: Revised and Enlarges (2014), 7th Ed., Sarat Book Publishers.
8. Vogel's text book of quantitative chemical analysis (1989), Arthur Vogel, Longman Scientific & Technical Publishers.

Course Code: CC-7

Course Title: Physical Biochemistry (Prac.)

2 Credits

List of Practicals

1. Preparation and determination of pH of various buffers: phosphate, carbonate and acetate; effect of acid and alkali on the pH of above mentioned buffers.
2. Determination of isoelectric point of amino acids (Glycine, Glutamic acid and Histidine)
3. Verification of Beer's law using spectrophotometric and/ colorimetric technique.
4. Column chromatography (size exclusion, ion-exchange)

Course Code: SEC-1

Course Title: Clinical Biochemistry

2 credits

Introduction

Organization of clinical laboratory, Introduction to instrumentation and automation in clinical biochemistry laboratories safety regulations and first aid. General comments on specimen collection, types of specimen for biochemical analysis. Precision, accuracy, quality control, precautions and limitations.

- a. Collection of blood and storage.
- b. Separation and storage of serum.
- c. Analysis of Cell Morphology

Evaluation of biochemical changes in diseases

Biochemical mechanisms associated with the diseases of blood, liver, kidney, lungs and heart.

Assessment of glucose metabolism in blood

Clinical significance of variations in blood glucose. Diabetes mellitus. Estimation of blood glucose by glucose oxidase peroxidase method.

Lipid profile

Biochemical mechanisms associated with lipid disorder. Cholesterol (LDL, HDL, VLDL, apoproteins etc.), triglycerides, estimation of triglycerides & cholesterol (LDL & HDL).

Liver function tests

Estimation of bilirubin, SGPT & SGOT.

Renal function tests and urine analysis

Routine urine tests: pH, albumin. Quantitative determination of serum creatinine and urea.

Tests for cardiovascular diseases

Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin. Assessment of hypertension by blood pressure measurement.

Reference Books

1. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. I (2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New Delhi). ISBN:9780070076594 / ISBN:9780070076631.
2. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. II (2010), Mukherjee, K.L., Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi), ISBN: 9780070076648.
3. Medical Biochemistry (2005) 2nd ed., Baynes, J.W. And Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia), ISBN: 0-7234-3341-0.
4. Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi), ISBN:81-88237-41-8.

Course Code: SEC-1

Course Title: Bioinformatics and biostatistics

2 credits

Bioinformatics

1. Basics of computer and operating systems.
2. Introduction to bioinformatics.
3. Computer networking.
4. Archiving and retrieval of informations : search engines, data basics, nucleic acid sequence, genomes, protein sequence & structure, bibliographic access of molecular biology data base, Entrez, sequence retrieval system (SRS)., protein identification resource (PIR).
5. Comparing the amino acid sequence using BLAST P and demonstration of the significance of different score in BLAST P output.
6. Sequence allignments and phylogenetic trees.

Biostatistics

Primary and secondary data, frequency distribution, diagramatic representation, population and sample, statistical regularity, mean, median, mode, standard deviation, correlation co-efficient and their significances, some simple related problems on methods of sampling, hypothesis, test of significance. Some mathematical idea on Biostatistics.

Reference Books

1. Bioinformatics: Sequence and Genome Analysis (2001), 1st ed., Mount, D.W. Cold Spring Harbor Laborator Press (New York), ISBN: 0-87969-608-7.
2. Bioinformatics and Functional Genomics (2003), 1st ed., Pevsner, J., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47121004-8.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2005), 3rd ed., Baxevanis, A.D. and Ouellette, B.F., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47147878-
4. Bioinformatics – Principles and Applications (2008), 1st ed. Ghosh, Z. and Mallick, B., Oxford University Press (India), ISBN: 9780195692303.

Course Code: GE-3

Course Title: Fundamentals of Cell Biology and Immunology (Theory)

4 credits

Membrane structure and function

Composition of membranes, membrane lipids, membrane proteins, isolation and characterization. Integral, peripheral and lipid anchored protein. Transport across membranes, simple and facilitated diffusion, active transport.

Endoplasmic reticulum and Golgi complex

The two types of endoplasmic reticulum, rough and smooth. The Golgi complex. Role of Golgi in protein glycosylation and protein trafficking.

Signalling mechanisms, messengers and receptors

Chemical signals and cellular receptors. G-protein linked receptors, protein tyrosine kinase receptors, growth factor. Hormonal signalling: Epinephrine, thyroxine, steroid hormone receptor mediated signalling.

Overview of the immune system

Self-versus nonself. Humoral and cellular immunity. Innate and adaptive immunity. Cells and organs of immune system, primary and secondary lymphoid tissues and organs. Cellular and humoral responses, Innate and adaptive immunity.

Reference Books

1. The World of the Cell (2009), 7th ed., Becker W.M., Kleinsmith, L.J., Hardin. J., Bertoni, and G.P., Pearson Benjamin Cummings (CA), ISBN: 978-0-321-55418-5.
2. Prescott, Harley, Klein's Microbiology (2008) 7th Ed., Willey, J.M., Sherwood, L.M.,
3. Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007- 126727.
4. Molecular Cell Biology (2013) 7th Ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M.,
5. Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., Macmillan International Edition (New York), ISBN: 13: 978-1-4641-0981-2.

6. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN: 13: 978-0-7167-8590-3 / ISBN: 10:0-7617- 8590-0.
7. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley&
8. Sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

Course Code: GE-3

Course Title: Fundamentals of Cell Biology and Immunology (Practical)

4 credits

List of Practicals

1. Visualization of different types of cells by methylene blue.
2. Isolation of sub-organelles by differential centrifugation technique and their verification.
3. Blood grouping.
4. Antigen-antibody interaction by Ouchterlony double diffusion.
5. Preparation of Polytene chromosome from Chironomous/Drosophila sp.

4th Semester

Course Code: CC-8

Course Title: Membrane Biology and Bioenergetics (Theo)

4 credits

Introduction to biomembranes

Composition of bio membranes - prokaryotic, eukaryotic and subcellular membranes. Membrane proteins. Monolayer, planer bilayer and liposomes as model membrane systems. Fluid Mosaic Model.

Membrane structures and dynamics

Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton, lipid rafts, caveolae and tight junctions. RBC membrane architecture.

Lateral, transverse and rotational motion of lipids and proteins. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.

Membrane transport

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins. Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Ca^{2+} -ATPases (Plasma membrane Ca^{2+} -ATPase + sarco/endoplasmic reticulum Ca^{2+} -ATPase). Secondary active transporters, Na^+ -glucose symporter. ABC family of transporters - MDR, CFTR. Group translocation. Ion channels - voltage-gated ion channels (Na^+/K^+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, and bacteriorhodopsin. Ionophores.

Vesicular transport and membrane fusion

Types of vesicle transport and their function - clathrin, COP I and COP II coated vesicles. Molecular mechanism of vesicular transport. Membrane fusion. Receptor mediated endocytosis of transferrin, envelope virus-host cell interaction.

Introduction to bioenergetics

Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

Oxidative phosphorylation

Mitochondria. Electron transport chain - its organization and function. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Fo-F1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation.

Reference Books

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 / ISBN: 10:1-4641-0962-1.
2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN: 13:978-1-4641-0981-2.
3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2.

Course Code: CC-8

Course Title: Membrane Biology and Bioenergetics (Prac.)

2 Credits

List of Practical

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. Isolation of mitochondria from liver and assay of marker enzyme SDH.

Course Code: CC-9

Course Title: Metabolism of Amino Acids and Nucleotides (Theo)

4 credits

Overview of amino acid metabolism

Nitrogen cycle, incorporation of ammonia into biomolecules. Digestion and absorption of dietary proteins. Protein calorie malnutrition - Kwashiorkar and Marasmus. Nitrogen balance, transamination, role of pyridoxal phosphate, Krebs's bicycle, urea cycle.

Catabolism of amino acids

Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Metabolism of one carbon units. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methylmalonic acidemia (MMA), homocystinuria and Hartnup's disease.

Biosynthesis of amino acids

Overview of amino acid bio-synthesis: Alanine, Tyrosine, Tryptophan, Arginine & Proline.

Precursor functions of amino acids

Biosynthesis of creatine and creatinine, catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, Gamma-Amino butyric acid). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.

Biosynthesis of purine and pyrimidine nucleotides

De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways.

Deoxyribonucleotides and synthesis of nucleotide triphosphate

Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides.

Degradation of purine and pyrimidine nucleotides

Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout.

Integration of metabolism

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver), systems biology (introductory).

Reference Books

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 / ISBN: 10:1-4641-0962-1.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4/BRV ISBN: 978-0-470-60152-5.

Course Code: CC-9

Course Title: Metabolism of Amino Acids and Nucleotides (Prac.)

2 credits

List of Practical

1. Assay of serum transaminases – SGOT and SGPT
2. Estimation of serum urea,
3. Estimation of serum uric acid
4. Estimation of serum creatinine

Course Code: CC-10

Course Title: Basic Microbiology and Microbial Genetics (Theo)

4 credits

Introduction

Spontaneous generation (abiogenesis), Biogenesis, Germ Theory of Disease, Koch's Postulates, Scope of Microbiology.

Microorganisms in biological world

Whittaker's Five-kingdom and three-kingdom concept of living organisms (General characteristics of those groups); General features of Eubacteria and Archaeobacteria.

Bacterial Morphology, subcellular structures and Staining

Morphology of bacteria, Slime layer, Mycelial morphology: Actinomycetes, Capsule, Cell wall, Ribosome, Cytoplasmic membrane (Fluid mosaic model of Singer - Nicholson); Cytoplasmic inclusion bodies - (inorganic, organic); Exospores & Cysts: types & structure; Endospore, Flagella, Pilus, Fimbriae (structure, composition and functions).

Definition of auxochrome; Chromophores; Acidic and Basic dyes; Classification of stains; Simple and differential staining: theories and mechanisms of gram staining; acid fast staining; endospore staining.

Microbial Nutrition

Nutritional types (definition and example) - Prototrophs, Autotrophs, Chemolithotrophs (ammonia, nitrite, sulfur, hydrogen, iron oxidizing bacteria);

Chemoorganotrophs, Effect of oxygen on growth - classification on the basis of oxygen requirement and tolerance.

Bacterial Growth and its regulation

Growth phases - Generation time. Bacterial growth curve, Batch culture. Continuous culture.

Synchronous culture (definition and brief description). Physical factors influencing growth such as temperature, pH, osmotic pressure, salt concentration.

Sterilization, disinfection, antiseptic, sanitizer, germicide (definition, application & examples); physical method of disinfection and sterilization - dry heat, moist heat, filtration, radiation (mode

of action, applications); Chemical control – dye solutions, alcohol, acid, alkali, halogen, heavy metal, phenol, phenol derivatives, formaldehyde, ethylene oxide, detergents (mode of action, applications).

Chemotherapeutic agents - sulphonamides, antibiotics, (definition types); mechanism of action and antimicrobial spectrum of penicillin, streptomycin, tetracycline, chloramphenicol, Nalidixic acid and metronidazole; drug resistance - phenomena and mechanism.

Microbial Genetics

Extra chromosomal genetic elements, Bacterial Chromosome (Fundamental differences with eukaryotic chromosome). Mechanism of genetic exchange – transformation, transduction and conjugation. Gene mapping in bacteria. An introduction to virus with special reference to the structure, replication of T4 and λ phage, lytic and lysogenic cycles.

Reference Books

1. General Microbiology (1999) 5th Edition: Stanier, RY., et al., Palgrave Macmillan, ISBN-10: 0333763645/ISBN-13: 978-0333763643
2. Microbiology 5th edition (2001): Pelczar. M., et al., Tata-McGraw Hill ISBN-10: 0074623206/ISBN-13: 978-0074623206
3. Principles of Microbiology 2nd edition(1997): Atlas, RM., McGraw-Hill, ISBN-10: 9339219872/ISBN-13: 978-9339219871
4. Fundamental principles of bacteriology (1999): Salle, AJ.,Tata- McGraw Hill, ISBN: 9781406707373/ 1406707376
5. Microbiology 6th Edition (2004): Prescott Lansing M. et al. McGraw Hill Higher Education ISBN-10: 0072951753/ ISBN-13: 978-0072951752

Course Code: CC-10

Course Title: Basic Microbiology and Microbial Genetics (Prac.)

2 credits

List of Practical

1. Microbiology Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter)
3. Preparation and sterilization of culture media for bacterial cultivation
4. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs
5. Staining of bacteria using Gram stain
6. Isolation of pure cultures of bacteria by streaking method.

Course Code: SEC-2

Course Title: Techniques in Biochemistry

2 credits

Basic Lab Practices and preparation of solutions

Safety practices in the laboratory. Preparation and storage of solutions. Concepts of solution concentration and storing solutions. Quantitative transfer of liquids. Concept of a buffer, Henderson-Hasselbach equation, working of a pH meter. Preparation of a buffer of given pH and molarity.

Spectrophotometric techniques

Principle and instrumentation of UV-visible and fluorescence spectroscopy:

- a. Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule)
- b. Measurement of fluorescence spectrum.
- c. Determination of concentration of a protein solution by Lowry/BCA method.

Reference Books

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN: 0-7167-1315-2 / ISBN: 0-7167-1444-2.
3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN: 13: 978-0-07-099487-4 / ISBN: 10: 0-07- 099487-0.

Course Code: SEC-2

Course Title: Protein Purification Techniques

2 Credits

Purification and characterization of a protein from a complex mixture (native or heterologously expressed) involving the following methods/techniques

- a. Preparation of the sample.
- b. Ion-exchange chromatography.
- c. Gel filtration chromatography.
- d. Affinity chromatography.
- e. Electrophoresis (Native & SDS page), 2D-electrophoresis.

Reference Books

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN: 0-7167-1315-2 / ISBN: 0-7167-1444-2.
3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN: 13: 978-0-07-099487-4 / ISBN: 10: 0-07- 099487-0.

Course Code: GE-4

Course Title: Fundamentals of Genetic Engineering (Theo)

4 credits

Introduction to recombinant DNA technology

Overview of recombinant DNA technology. Purification of plasmid and bacteriophage DNA. Enzymes used in manipulating DNA, Restriction Enzymes (blunt end, sticky end), ligase, polymerase (DNA polymerase & RNA polymerase), enzyme adapter. Concept of expression vectors and examples.

Cloning vectors for prokaryotes and eukaryotes

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on E. coli plasmids, pBR322, pUC8. Cloning vectors based on M13 and λ bacteriophage.

Construction, selection and identification of recombinants

Ligation of DNA molecules. Transformation and electroporation, selection for transformed cells. Identification for recombinants, blue-white selection. Identification of recombinant phages. Direct selection, marker rescue. Gene libraries. Identification of a clone from gene library, colony and plaque hybridization probing.

Polymerase chain reaction and DNA sequencing

Fundamentals of polymerase chain reaction. Analysis of PCR products. DNA sequencing by Sanger's method and automated DNA sequencing.

Expression of cloned genes

Vectors for expression of foreign genes in E. coli, cassettes and gene fusions. Production of recombinant protein by eukaryotic cells. Challenges in producing recombinant protein in E. coli. Fusion Proteins – Brief Overview.

Applications of genetic engineering in biotechnology

Production of recombinant pharmaceuticals such as insulin. Gene therapy. Genetically modified plants such as herbicide resistant crops with special reference to BT cotton.

Reference Books

1. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.
2. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell Publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
3. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S. B., and Twyman, R. M., Blackwell publishing (Oxford) ISBN: 13: 978-1-4051-3544-3.
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).
5. Recombinant DNA: Genes and Genomes 3rd edition (2007): Watson, James D., et al. W.H. Freeman ISBN-10: 1429203129/ISBN-13: 978-1429203128.

Course Code: GE-4

Course Title: Fundamentals of Genetic Engineering (Prac.)

2 credits

List of Practical

1. Ultraviolet absorption spectrum of DNA and RNA.
2. Isolation of plasmid DNA and restriction digestion.
3. Agarose Gel electrophoresis
4. Amplification of a DNA fragment by PCR and gel electrophoresis
5. Determination of transformation efficiency.

**Syllabus of Biochemistry (Hons.)
for SEM-V & SEM-VI under
CBCS**

**(to be effective from
Academic Year: 2017-18)**



**The University of Burdwan
Burdwan, West Bengal**

1. Introduction

The syllabus for Biochemistry at undergraduate level using the Choice Based Credit system has been framed in compliance with model syllabus given by UGC.

The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weight age to both the core content and techniques used in Biochemistry.

The ultimate goal of the syllabus is that the students at the end are able to secure a job. Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques of mapping and understanding of the subject.

The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

It is essential that Biochemistry students select their general electives courses from Chemistry, Physics, Mathematics and/or any branch of Life Sciences disciplines.

While the syllabus is in compliance with UGC model curriculum, it is necessary that Biochemistry students should learn “Basic Microbiology” as one of the core courses rather than as elective while. Course on “Concept of Genetics” has been moved to electives.

Also, it is recommended that two elective courses namely Nutritional Biochemistry and Advanced Biochemistry may be made compulsory.

Type of Courses

Course type	Description	B. Sc. (Honours)
CC	Core Course	14
DSE	Discipline Specific Elective	4
GE	Generic Elective	4
AECC (ENVS & ENGLISH/MIL)	Ability Enhancement Compulsory Course	(1+1)
SEC	Skill Enhancement Course	2
TOTAL CREDIT		142

Structure at a glance for Biochemistry (H) at UG level, B.U.:

1st Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-1	Molecules of Life (Theo) Molecules of Life (Prac)	Core Course – I	4+2	75
CC-2	Cell Biology (Theo) Cell Biology (Prac)	Core Course – II	4+2	75
GE-1	Biochemistry of Cell (Theo + Prac)	Generic Elective – 1	4+2	75
AECC-1	ENVS	Ability Enhancement Compulsory Course – I	4	100
TOTAL			22	325

2nd Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-3	Proteins (Theo) Proteins (Prac)	Core Course – III	4+2	75
CC-4	Enzymes (Theo) Enzymes (Prac)	Core Course – IV	4+2	75
GE-2	Proteins and Enzymes (Theo + Prac)	Generic Elective – 2	4+2	75
AECC-2	Communicative Eng./MIL	Ability Enhancement Compulsory Course – II	2	50
TOTAL			20	275

3rd Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-5	Metabolism of Carbohydrates and Lipids (Theo) Metabolism of Carbohydrates and Lipids (Prac)	Core Course – V	4+2	75
CC-6	Physiology and Hormones (Theo) Physiology and Hormones (Prac)	Core Course – VI	4+2	75
CC-7	Physical Biochemistry (Theo) Physical Biochemistry (Prac)	Core Course – VII	4+2	75
SEC-1	Clinical Biochemistry or Bioinformatics and Biostatistics	Skill Enhancement Course – 1	2	50
GE-3	Fundamentals of Cell Biology and Immunology	Generic Elective – 3	4+2	75
TOTAL			26	350

4th Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-8	Membrane Biology and Bioenergetics (Theo) Membrane Biology and Bioenergetics (Prac)	Core Course – VIII	4+2	75
CC-9	Metabolism of Amino Acid and Nucleic Acid (Theo) Metabolism of Amino Acid and Nucleic Acid (Prac)	Core Course – IX	4+2	75
CC-10	Basic Microbiology and Microbial Genetics (Theo) Basic Microbiology and Microbial Genetics (Prac)	Core Course - X	4+2	75
SEC-2	Techniques in Biochemistry or Protein Purification Techniques	Skill Enhancement Course – II	2	50
GE-4	Fundamentals of Genetic Engineering	Generic Elective – 4	4+2	75
TOTAL			26	350

5th Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-11	Chromosome organization, DNA replication, Mutation and Repair (Theo) Chromosome organization, DNA replication, Mutation and Repair (Prac)	Core Course – XI	4+2	75
CC-12	Gene expression and regulation (Theo) Gene expression and regulation (Prac)	Core Course – XII	4+2	75
DSE-1	Nutritional Biochemistry (Theo + Prac) or Concept of Genetics (Theo + Prac)	Discipline Specific Elective	4+2	75
DSE-2	Infectious and Non-infectious Diseases (Theory) or Advanced Biochemistry (Theory)	Discipline Specific Elective	6	75
TOTAL			24	300

6th Semester

Course Code	Course Title	Course Type	Credit per course	Marks
CC-13	Recombinant DNA Technology and Genetic Engineering (Theo) Recombinant DNA Technology and Genetic Engineering (Prac)	Core Course – XIII	4+2	75
CC-14	Immunology (Theo) Immunology ((Prac)	Core Course – XIV	4+2	75
DSE-3	Neuro Biochemistry (Theo) or Molecular Diagnostics (Theo + Prac)	Discipline Specific Elective	6 or 4+2	75
DSE-4	Project Work or Dissertation followed by power point presentation	Discipline Specific Elective	6	75
TOTAL			24	300

5th Semester:

Course Code: CC-11

Course Title: Chromosome Organization, DNA replication, Mutation and Repair (Theo)

4 Credits

Structure of DNA

DNA structure, features of the double helix, various forms of DNA.

Genes and genomic organization

Definition of a gene, organization of genes in viruses, bacteria, eukaryotes. Nucleosome structure and packaging of DNA into higher order structures.

Replication of DNA

DNA synthesis: DNA polymerases, replication fork, origin of replication, enzymes and proteins in DNA replication, various modes of replication, stages of replication of *E. coli* chromosome. Inhibitors of DNA replication and its applications. Supercoiling of DNA and its importance, topoisomerases – their inhibitors and application in medicine.

Recombination and transposition of DNA

Homologous recombination, proteins and enzymes in recombination, site-specific recombination, serine and tyrosine recombinases, biological roles of site-specific recombination, transposition, [different](#) classes of transposable elements, importance of transposable elements in horizontal transfer of genes and evolution.

Molecular basis of mutations

Importance of mutations in evolution of species; Types of mutations – transition, trans versions, frame shift mutations; Gene mutations: Induced versus spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Ames test.

Various modes of DNA repair

Replication errors and mismatch repair system, repair of DNA damage, direct repair, base excision repair, nucleotide excision repair, recombination repair, SOS Repair.

Reference Books

1. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN: 0-321-50781 / ISBN: 978-0-321-50781-5.
2. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W. H. Freeman & Company (New York), ISBN: 13: 978-1-4292-3414-6 / ISBN: 10-14641-0962-1.
3. Principles of Genetics (2010) 5th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia, ISBN: 978-0-470-39842-5.
4. A Text Book of Molecular Biology (2009): Sastri Sivarama, Padmanaban G and Subramanyam C., Macmillan Publishers India ISBN-10: 0333929330/ISBN-13: 978-0333929339.

Course Code: CC-11

Course Title: Chromosome Organization, DNA replication, Mutation and Repair (Theo) **2 Credits**

List of Practicals:

1. Verification of Chargaff's rule by paper chromatography.
2. Determination of the melting temperature and GC content of DNA.
3. Study of viscosity of DNA solutions.
4. Agarose gel electrophoresis and estimation of DNA size using markers
5. To perform Ames test in Salmonella/*E.coli* to study mutagenicity.

Course Code: CC-12

Course Title: Gene Expression and Regulation (Theo)

4 Credits

Biosynthesis of RNA in prokaryotes

RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA foot printing, the three stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Inhibitors of transcription and applications as anti-microbial drugs.

The genetic code

Degeneracy of the genetic code, wobble in the anticodon, features of the genetic code.

Biosynthesis of proteins

Messenger RNA, transfer RNA, attachment of amino acids to tRNA, the ribosome - initiation, elongation and termination of translation, regulation of translation. Comparison of prokaryotic and eukaryotic protein synthesis. Use of antibiotics in understanding protein synthesis and applications in medicine.

Regulation of gene expression in prokaryotes

Principles of gene regulation, negative and positive regulation, concept of operons (Loc & Tryp), regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon, induction of SOS response, synthesis of ribosomal proteins, regulation by genetic recombination, transcriptional regulation in λ bacteriophage.

Reference Books

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman & Company (New York), ISBN: 13: 978-1-4292-3414-6 / ISBN: 10-14641-0962- 1.
2. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN:978-0-321-50781-5.
3. Lewin's GENES (2013) 11th Ed., Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, Jones & Bartlett Learning, ISBN: 10- 14496-5985-3
4. A Text Book of Molecular Biology (2009): Sastri Sivarama, Padmanaban G and Subramanyam C. Macmillan Publishers India ISBN-10: 0333929330/ISBN-13: 978-0333929339
5. Biochemistry (2015): Berg, Jeremy M., Tymoczko, John L., Gatto, Gregory J. Jr., and Stryer, Lubert, W H Freeman & Co (Sd); ISBN-10: 1319036813/ ISBN-13: 978-1319036812
6. DNA Structure and Function(2006): Sinden Richard, CBS Publishers and Distributors, ISBN-10: 8131203255/ ISBN-13: 978-8131203255
7. Genetics (2012) 6th Ed., Snustad, D.P. And Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
8. Genetics - A Conceptual Approach (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN: 13:978-1-4292-7606-1 / ISBN: 10:1-4292-7606-1.
9. An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN: 10: 1- 4292-2943-8.

Course Code: CC-12

Course Title: Gene Expression and Regulation (Prac.)

2 Credits

List of Practicals

1. Extraction of total nucleic acids from bacterial cells and quantitative estimation of DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).
2. Concept of standard curve and estimation of unknown DNA concentration using Salmon sperm/calf thymus DNA.
3. Preparation of culture medium (LB) for *E.coli* (both solid and liquid) and raise culture of *E.coli* and demonstration of antibiotic resistance. (Culture of *E.coli* containing plasmid (pUC 18/19) in LB medium with/without antibiotic followed by interpretation of results).
4. Diauxic growth curve.
5. Induction of 'lac operon' and 'enzyme assay' (beta-galactocidase assay).

Course Code: DSE-1

Course Title: Nutritional Biochemistry (Theo)

4 Credits

Introduction to Nutrition and Energy Metabolism

Definition of Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. measurement of energy content of food, Physiological energy value of foods, SDA. Direct and Indirect Calorimetry, factors affecting thermogenesis, energy utilization by cells, energy output – Basal and Resting metabolism, physical activity, factors affecting energy input - hunger, appetite, energy balance; Energy expenditure in man. Estimating energy requirements, BMR factors Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Dietary carbohydrates and health

Digestion, absorption, utilization and storage, hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates, Dietary fibre, blood glucose level and GI tract functions.

Dietary lipid and health

Classification of lipids (brief), sources, functions, digestion, absorption, utilization and storage. Essential Fatty Acids; Functions of EFA & RDA, Lipotropic factors, role of saturated fat, cholesterol, lipoprotein and triglycerides. Importance of the following: a) Omega fatty acids & Calculation of Omega 3/ omega 6 ratio b) Phospholipids c) Cholesterol in the body d) Mono, Polyunsaturated and Saturated Fatty Acids.

Dietary Proteins and health

Various functions of proteins in the body (Brief discussions), Digestion and absorption. Essential and Non- essential amino acids. Amino acid Supplementation. Effects of deficiency of Amino Acid. Food source and recommended dietary allowances for different age group. Amino acid pool. NPU, Biological Value, Nitrogen balance. Protein calorie malnutrition.

Fat and water soluble Vitamins

Vitamin A, C, E, K and D: Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME), Deficiency. Role of Vitamin A & E as an antioxidant, function of Vitamin A in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis. Role of Vitamin C as cofactor in amino acid modifications. Niacin and NAD/ NADP. Vitamin B6: Dietary source, RDA, conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms. Vitamin B12: Dietary source, RDA, absorption, metabolic role Biochemical basis for deficiency symptoms.

Minerals

Calcium, Phosphorus and Iron – Distribution in the body digestion, Absorption, Utilization, Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA. Calcium: Phosphorus ratio, Role of iron in prevention of anemia. Iodine and iodine cycle. Iodine, Fluoride, Mg, Cu, Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Function, deficiency, Toxicity and Sources with special reference to Arsenic.

Assessment of Nutritional status

Anthropometric measurements; Z scores, BMI, skin-fold, circumference ratio. Biochemical assessment; Basal metabolic panel, Comprehensive metabolic panel, CBC, Urine Analysis, Assessment of Anemia, ROS assessment, GTT and glycosylated Hb.

Food and drug interactions and Nutraceuticals

Nutrient interactions affecting ADME of drugs, Alcohol and nutrient deficiency, Anti-depressants, psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition. Role of Food in medicine (Brief discussions).

Reference Books

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Nutrition for health, fitness and sport (2013); Williams.M.H, Anderson, D.E, Rawson, E.S. McGraw Hill international edition. ISBN-978-0-07-131816-7.
3. Krause's Food and Nutrition Care process. (2012); Mahan, L.K Strings, S.E, Raymond, J. Elsevier's Publications. ISBN- 978-1-4377-2233-8.
4. The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
5. Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press.
6. Biochemistry (2010) 14th edition: Das, Debajyoti. Academic Publishers (Kolkata), ISBN: 9789380599175, 938059917X.

Course Code: DSE-1

Course Title: Nutritional Biochemistry (Prac)

2 Credits

List of Practicals

1. Bioassay for vitamin B12/B1.
2. Homocystiene estimation.
3. Vitamin A/E estimation in serum.

Course Code: DSE-1

Course Title: Concept of Genetics (Theo)

4 Credits

Introduction to Genetics

Mendel's work on transmission of traits, Genetic Variation.

Mitosis and Meiosis

Mechanism of Mitosis & Meiosis.

Mendelian Genetics and its Extension

Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete dominance and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance.

Linkage, Crossing Over and Chromosomal Mapping

Linkage and crossing over, Cytological and Molecular basis of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence,

Sex Determination

Chromosomal mechanisms, Barr bodies, Dosage compensation.

Extrachromosomal Inheritance

Chloroplast mutation/Variation in Four o' clock plant and, Mitochondrial mutations in Neurospora, Maternal effects, Infective heredity- Kappa particles in Paramecium.

Chromosomal aberrations

Variations in chromosome number- monosomy and trisomy of sex and autosomes. Variations in chromosome structure - inversions, deletions, duplications and translocations.

Population genetics

Hardy-Weinberg law, predicting allele and genotype frequencies.

Reference Books

1. Genetics (2012) 6th ed., Snustad, D.P. And Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
2. Genetics - A Conceptual Approach (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN: 13:978-1-4292-7606-1 / ISBN: 10:1-4292-7606-1.
3. An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN: 10: 1- 4292-2943-8.
4. Concepts of Genetics (2016) 10th edition: Klug, William S., Cummings Michael R. and Spencers Charlotte A. Pearson Education India, ISBN-10: 9332577463/ISBN-13: 978-9332577466
5. iGenetics: A Molecular Approach (2016): Russel Peter J. Pearson Education India, ISBN-10: 9332571627/ISBN-13: 978-9332571624.

Course Code: DSE-1

Course Title: Concept of Genetics (Prac.)

2 Credits

List of Practicals

1. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.
2. Induction of polyploidy in onion roots.
3. Smear technique to demonstrate sex chromosome in buccal epithelial cells.
4. Chi-square and probability, Linkage, recombination, pedigree analysis of some human inherited traits; abnormal human karyotype and pedigrees, study of Hardy-Weinberg Law using simulations (dry lab).

Course Code: DSE-2

Course Title: Infectious and Non-Infectious Diseases (Theo)

6 Credits

Classification of infectious agents

Bacteria, Viruses, protozoa and fungi. Source, reservoir and transmission of pathogens, Antigenic shift and antigenic drift. Host parasite relationship, types of infections associated with parasitic organisms. Overview of viral and bacterial pathogenesis.

Overview of diseases caused by infectious agents

Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, Drug resistance and implications on public health.

Other bacterial diseases: Cholera, Typhoid, Diphtheria, Pertussis; Viral diseases: hepatitis, influenza and polio; Parasitic diseases: Malaria, Filariasis, Kala Jar; Diagnostics, Drug Resistance.

Lifestyle disorders

The factors and biochemistry underlying Diabetes, hypertension and related complications: the influence of genetics and environment on the condition and management.

Other diseases

Cancer: characteristics of a transformed cell, causes and stages of Cancer, molecular basis for neoplastic growth and metastasis, Proto-oncogenes and tumor suppressor genes; Cancer causing mutations; Tumor viruses; Biomarkers of cancer.

Introduction to protein folding and proteasome removal of misfolded proteins; etiology and molecular basis for Alzheimer's, Prion diseases, Huntington's Chorea, sickle cell anemia, Thalassemia.

Nutritional disorders: overview of major and minor nutrient components in the diet. Balanced diet and the concept of RDA. Nutrient deficiencies; Kwashiorkor and Marasmus, Scurvy, beri, pellagra, Xerophthalmia and Night blindness.

Reference Books

1. Prescott, Harley, Klein's Microbiology (2008) 7th Ed., Willey, J.M., Sherwood, L.M., Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007 **126727**.
2. Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition, Volume, 2. Churchill Livingstone Elsevier.
3. Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J. Ryan, C. George Ray, Publisher: McGraw-Hill
4. Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences
5. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
6. Introduction to Human Physiology (2013) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning.
7. Genetics (2012) Snustad and Simmons,
8. Cooper, G.M. and Hausman, R.E. 2009 the Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Guyton & Hall Textbook of Medical Physiology (2016) Second Edition: Hall, John E., Vaz, Mario, Kurpad, Anura, and Raj Tony. Elsevier Health, ISBN-10: 8131244660/ ISBN-13: 978-813124466.

Course Code: DSE-2

Course Title: Advanced Biochemistry (Theo.)

6 Credits

Cellular Signalling

1. Regulation of phospholipase A₂. Arachidonic acid metabolism – cyclooxygenase and lipoxygenase pathways, prostaglandins, thromboxanes, leukotrienes, platelet activating factor.
2. Regulation of phospholipase D-heterotrimeric G protein, ADP ribosylation factor and guanine nucleotide exchange factor. Mechanism for production of superoxide radicals by NADPH oxidase
3. Regulation of intracellular calcium under different stimulations like – angiotensin II, thromboxane A and endothelial ---; Plasma membrane Ca²⁺ ATPase (PMCA), Sarcoplasmic/endoplasmic reticulum Ca²⁺ ATPase (SERCA), Na⁺/Ca²⁺ exchange, Na⁺/K²⁺ ATPase, Na⁺/H²⁺ exchange, Voltage gated Ca²⁺ channels.
4. Mechanism of Sphingosine 1-phosphate in cell proliferation.
5. Mitochondria- mediated cellular apoptosis.

Drug Designing

1. Principles of drug design. Introduction to drug discovery development
2. Source of drug – synthetic and natural. Structural aspects of drug action. Approaches to new drug discovery: drugs derived from natural products as source for new drug discovery.
3. Enzymes as target for drug design. Receptor as target of drug design. Product design and application: prodrug from various functional groups (Ester prodrugs, amides imides, amines, carbonyl groups). Drug release and activation mechanisms.
4. Computer aided drug designing. Application of nanomaterials in drug designing.

Nutrigenomics and nutrigenetics

1. Basic concept of nutrigenomics and nutrigenetics. Effect of nutrition on gene expression.
2. Nutrient regulation: Insulin genes, Cancer genes.
3. Nutrigenetics approach for studying obesity, myocardial infarction and crohn's disease.

References

1. The Biochemistry of Cell signalling. Ernst J.M.Helmreich
2. Trends in Cellular Signalling. Dave E. Caplin
3. Cell Signalling principles and mechanisms. Wendell Lim, Bruce Mayer and Tony Pawson
4. Burger's Medicinal Chemistry and Drug Discovery. 6th Ed. Vol.1 Principles and practice, edited by M.E. Wolff Wiley & Sons, New York, 2003.

5. Principles of Medical Chemistry. 7th Ed. Edited by T.L. Lemke, D.A. Williams, V.F. Roche and S.W Zito, Williams and Wilkins, Philadelphia, 2013.
6. Recent Advances in Nutrigenetics and Nutrigenomics, Vol. 108, 1st Ed.C. Bouchard and J. M. Ordovas, Academic Press, Elsevier.eBook ISBN: 9780123984050, Hardcover ISBN: 9780123983978
7. Nutrigenomics. Carsten Carlberg, Stine Marie Ulven and Ferdinand Molnár, Springer.ISBN 978-3-319-30415-1
8. Nutrigenomics and Nutrigenetics in Functional Foods and Personalized Nutrition. Lynnette R. Ferguson, CRC Press, ISBN 9781439876800
9. Nutrigenomics and nutrigenetics. Jose M Ordovas and Vincent Mooser, Current Opinion in Lipidology. 15(2):101-108, APR 2004. PMID: 15017352

6th Semester:

Course Code: CC-13

Course Title: Recombinant DNA Technology and Genetic Engineering (Theo.) 4 Credits

Recombinant DNA technology and the related enzymes

Overview of recombinant DNA technology. Restriction modification system, restriction endonucleases and other enzymes used in manipulating DNA molecules (DNA polymerases, RNA Polymerases, Reverse Transcriptase, Ligases, Taq polymerase, Kinases).

Cloning vectors for prokaryotes and eukaryotes

Plasmids, classification, copy number and its regulation, incompatibility and curing, Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids – pBR322.

Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing.

Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters. Synthetic oligonucleotides.

Introduction of DNA into cells and selection for recombinant clones

Outline of the methods related to DNA uptake by a cell, natural and artificial competence, preparation of competent cells. Selection for transformed cells. Identification for recombinants - Sequence dependent and independent screening, southern-western, colony and plaque hybridization, insertional inactivation, α -complementation, blue-white selection. Introduction of phage DNA into bacterial cells. Identification of recombinant phages.

Expression of cloned genes

Vectors for expression of foreign genes in *E. coli*, Expression of gene with tag. Challenges in producing recombinant protein in *E. coli*.

Polymerase chain reaction

Fundamentals of polymerase chain reaction. Studying PCR products by gel electrophoresis.

Cloning of PCR products. Definition of quantitative PCR.

DNA sequencing

DNA sequencing by Sanger's method.

Applications of genetic engineering in Biotechnology

Applications in medicine. Recombinant vaccines. Applications in agriculture. Herbicide resistant crops, problems with genetically modified plants, safety concerns.

Reference Books

1. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
2. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).
4. Recombinant DNA: Genes and Genomes 3rd edition (2007): Watson, James D., et all. W.H. Freeman ISBN-10: 1429203129/ISBN-13: 978-1429203128.

Course Code: CC-13

Course Title: Recombinant DNA Technology and Genetic Engineering (Prac.) 2 Credits

List of Practicals

1. Isolation of plasmid DNA from *E.coli* cells.
2. Digestion of plasmid DNA with restriction enzymes and size estimation of fragments by gel electrophoresis.
3. Preparation of competent cells, transformation and estimation of its efficiency
4. Designing of primers for any selected gene and demonstration of PCR technique.
5. Blue-White Screening Demonstration.

Course Code: CC-14

Course Title: Immunology (Theo)

4 Credits

Cells and organs of the immune system

Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT).

Innate immunity

Anatomical barriers, cell types of innate immunity, connections between innate and adaptive immunity, cell adhesion molecules, chemokines.

Immunogens and antigens

Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes.

Structure and distribution of classes and subclasses of immunoglobulins (Ig), effector functions of antibody, antigenic determinants on Ig and Ig super family, antigen-antibody interaction.

Biology of the B and T lymphocyte

Antigen independent phase of B cell maturation and selection, humoral response – T- dependent and T-independent response, anatomical distribution of B cell populations.

Structure and role of T cell receptor. T cell development, generation of receptor diversity, selection and differentiation. General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC).

Generation of antibody diversity

Dreyer-Bennett hypothesis, multigene organization of I_g locus, mechanism of I_g genes, ways of antibody diversification.

MHC complex and antigen presentation

General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, pathways of antigen processing and presentation, complement activation and its biological consequences

Tolerance, autoimmunity and hypersensitivity

Organ specific and systemic autoimmune diseases, Hypersensitizing – Basic concepts of Type I, Type II, Type III and Type IV hypersensitivity.

Reference Books

1. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN: 13: 978-0-7167-8590-3 / ISBN: 10:0-7617-8590-0.
2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley & sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
3. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4.

Course Code: CC-14

Course Title: Immunology (Prac)

2 Credits

List of Practical

1. Blood smearing and differential leukocyte and total leukocyte counting
2. Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
3. Assays based on precipitation reactions - Ouchterlony double diffusion (ODD) and Mancini radial immunodiffusion.
4. Enzyme linked immune-sorbent assay (ELISA).

Course Code: DSE-3

Course Title: Neuro Biochemistry (Theo)

6 Credits

Chemical composition of brain

Formation, structure and biochemistry of myelin, chemistry of major brain lipids, developmental changes, lipid composition, biosynthesis and catabolism of major lipids, characteristics of brain lipids, regional variations. Energy metabolism-normal oxygen consumption by the brain, energy demanding functions, role of cerebral circulation, local cerebral blood flow and metabolism, effects of glucose deprivation, influence of age and development on cerebral energy metabolism; Chemistry, synthesis, storage and release of nervous neurotransmitters, transmitter action, synaptic modulation and mechanism of neural integration.

Neuromorphology and neurocellular anatomy

Central nervous system-General features of neurons. Structural aspects of neuron dendrites, axons, neurotubules, neurofilaments, synapse neuralgia, astrocytes, oligodendrocytes, epenchymal cells, schwa cells. Peripheral nervous system-muscle, nerve endings, sensory receptors and effectors endings, peripheral nerves, spinal and cranial nerves, plexuses ganglia, afferent pathways and sense organs. Spinal cord-Topographical anatomy, spinal nerves, spinal meninges, joint reflexes, gray and white matter of spinal cord.

Neurophysiology

Neural membrane, excitability, ion channels and transport of ions. Structure function correlation at the synapse; Transmission across the synapse: membrane potential in the steady state, action potential generation and propagation; Presynaptic events at the neuromuscular junction: cholinergic and non-cholinergic synapses; EEG patterns.

Neuronal membrane excitability, ion channels and transport of ions; Sensory transduction and the visual system, role of cGMP and Ca² signaling pathway

Brain disorders

Disorders of metabolism of brain: biochemical aspects of muscle diseases, sphingolipidosis and other lipid disorders; diseases involving myelin classification, and biochemistry of demyelinating diseases; Biochemical pathology of vitamin and nutritional deficiencies in brain, neurotoxic agents. Neurodegenerative disorders; Parkinson's and Alzheimer's disease, senile dementia.

Reference Books

1. Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology (Eighth Edition) by Scott Brady (Editor), George Siegel (Editor), R. Wayne Albers (Editor), Donald Price (Editor), Academic Press.
2. Neurobiology 3rd Edition(2002): Smith C. U. M. Wiley, ISBN-10: 0471560383/ISBN-13: 978-0471560388
3. Neuro-anatomy 5th edition (2014): Crossman Alan R., and Neary David, Churchill Livingstone, ISBN-10: 0702054054/ISBN-13: 978-0702054051.

Course Code: DSE-3

Course Title: Molecular Diagnostics (Theo)

4 Credits

Introduction to Biochemical Diagnostics

Evaluation of biochemical changes in diseases, basic hepatic, renal and cardiovascular physiology; Biochemical symptoms associated with these diseases; Inborn errors of metabolism examples.

Diagnostic Enzymes

Principles of diagnostic enzymology; Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase, lactate dehydrogenase, enzyme tests in determination of myocardial infarction, enzymes of pancreatic origin and biliary tract.

Immunodiagnosics

Introduction, antigen-antibody binding and assays; Immunoassays –types [RIA, ELISA, Chemiluminescent IA, FIA] and specific applications; Immunohistochemistry -principle and techniques. Immunodiagnosics for detection of infectious agents.

Molecular Diagnostics

Introduction to DNA based diagnostic techniques; Polymerase chain reaction in diagnostics and analysis, Analysis of DNA in forensic science and archaeology. Applications of DNA finger printing.

Karyotyping chromosome banding and fluorescence In-situ hybridization techniques

Disease identification and Genetic tests for following disorders: Thalassemia, Sickle Cell anemia, Down Syndrome, Cardio Vascular Disorder and Male infertility).

Reference Books

1. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. I (2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New Delhi). ISBN:9780070076594 / ISBN:9780070076631
2. Medical Biochemistry (2005) 2nd ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia), ISBN:0-7234-3341-0.
3. Recombinant DNA: Genes and Genomes 3rd edition (2007): Watson, James D., et all. W.H. Freeman ISBN-10: 1429203129/ISBN-13: 978-1429203128
4. Experimental Biochemistry: A Student Companion(2005), Rao, Sashidhar B., and Deshpande, Vijay M., I K International Publishing House Pvt. Ltd ISBN-10: 8188237418/ ISBN-13: 978-8188237418
5. Harpers Illustrated Biochemistry (2015) 30th edition, Rodwell Victor W, Bender David A., Botham Kathleen M., Kennely Peter J., and Weil P. Anthony, Mcgraw Hill Education, ISBN-13: 978-0071825344/ ISBN-10: 0071825347.

Course Code: DSE-3

2 Credits

Course Title: Molecular Diagnostics (Prac.)

List of Practical

1. Gram staining;
2. Dot Blot ELISA for insulin;
3. Lipid profile: triglycerides and total cholesterol;
4. Permanent slides (histology/cytology) for different types of cancer and comparison with slides from normal tissues; &
5. Permanent slides of pathogens: *Plasmodium vivax* and *P. falciparum*.

Course Code: DSE-4

Course Title: Project Work or Dissertation followed by power point presentation 6 Credits

This paper would focus on the project work / dissertation to be carried out by the students in the supervision of the teachers in the colleges. The topic of the project would be selected by each student in consultation with the teacher (Advisor). This would train the student to retrieve the literature and collate the information sufficient to make a power point presentation; the collated literature would also prepare the base for initiating the research. The student would carry out experiments to achieve the planned objectives, collation and analysis of data, presentation of the result in the form of a Dissertation. The grading would be based on continuous evaluation that would include punctuality, hard work, record keeping, intellectual inputs, data presentation, interpretation etc.