UNIVERSITY OF CALCUTTA

NotificationNo.CSR/28/19

It is notified for information of all concerned that the Syndicate in its meeting held on 27.08.2019 (vide Item No.06) approved the new revised syllabus for the B.Sc. Course of Studies in Biochemistry (Honours/General) under CBCS, incorporating some modifications of the previous notification (CSR/12/18, dt. 04.6,18), as laid down in the accompanying pamphlet.

The above shall take effect from the Odd Semester Examinations, 2019 & onwards.

Prof.(Dr.) Debasis Das
Registrar (Acting)

SENATE HOUSE
KOLKATA-700 073
The 2nd September, 2019

UNIVERSITY OF CALCUTTA

SYLLABUS

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THREE YEARS' B.Sc.

CBCS COURSE OF STUDIES

BIOCHEMISTRY (Honours & General)

2018

Contents

1. Scheme for CBCS Curriculum

1.1 Credit Distribution across Courses

		Credits	
Course Type	**Total Papers**	**Theory + Practical**	**Theory***
Core Courses	**14**	**14*4 =56 14*2=28**	**14*4=56**
Discipline Specific Electives	**4**	**4*4=16 4*2=8**	**4*4=16**
Generic Electives	***4***	***4*4=16 4*2=8***	***4*4=16***
Ability Enhancement Language Courses	**2**	**2*2=4**	**2*2=4**
Skill Enhancement Courses	**2**	**2*2=4**	**2*2=4**
Totals	**26**	**140**	

Credit distribution assuming that all four GE courses a student has chosen have practical components.

Sem	Core	Electives			Ability Enhancement	Total Credits
		General	Skill	Discipline		
I	6X2=12	6	-		2	20
II	6X2=12	6	-		2	20
III	6X3=18	6	2		-	26
IV	6X3=18	6	2		-	26
V	6X2=12	-	-	6X2=12	-	24
VI	6X2=12	-	-	6X2=12	-	24
Total Credits	84	24	4	24	4	140

Marking scheme for Honours & General Core & DSE courses:

1. 5 X 2 marks=10 marks (10 questions need to be set taking from all 'Units' in an uniform manner; students have to answer any 5 out of 10 questions)
2. 2 X 5 marks=10 marks (4 questions need to be set taking from all 'Units' in an uniform manner; students have to answer any 2 out of 4 questions)
3. 3 X 10 marks=30 marks [for a paper with 3 'Units', 6 questions need to be set taking 2 from each 'Unit' in an uniform manner; students have to answer any 3 questions taking at least one from each unit (for a Paper with 2 'Units', 6 questions need to be set taking 3 from each Unit; students have to answer any 3 questions taking at least one from each unit and the rest from any one Unit)

Structure of B.Sc. (Hons) Biochemistry under CBCS

Semester	Core Course	Course Code
I	CC-1: Molecules of Life	BCM-A-CC-1-1
I	CC-2: General Organic Chemistry	BCM-A-CC-1-2
II	CC-3: General Physical Chemistry	BCM-A-CC-2-3
II	CC-4: Enzymes	BCM-A-CC-2-4
III	CC-5: Bio-physical Chemistry	BCM-A-CC-3-5
III	CC-6: Metabolism of Carbohydrates and Lipids	BCM-A-CC-3-6
III	CC-7: Cell Biology	BCM-A-CC-3-7
IV	CC-8: Membrane Biology and Bioenergetics	BCM-A-CC-4-8
IV	CC-9: Metabolism of Amino Acids and Nucleotides	BCM-A-CC-4-9
IV	CC-10: Basic Microbiology and Microbial Genetics	BCM-A-CC-4-10
V	CC-11: Gene, Gene Expression and Regulation	BCM-A-CC-5-11
V	CC-12: Physiology and Hormones	BCM-A-CC-5-12
VI	CC-13: Genetic Engineering and Biotechnology	BCM-A-CC-6-13
VI	CC-14: Immunology	BCM-A-CC-6-14

Duration for Practical Examinations under CBCS curriculum

Core & DSE Practical Examinations:

Semester	Practical	Core Course	Marks	Duration
I	P1	Molecules of life	30	5 hrs
I	P2	Organic Chemistry	30	5 hrs
II	P3	General Physical Chemistry	30	5 hrs
II	P4	Enzymes	30	5 hrs
III	P5	Bio-Physical Chemistry	30	5 hrs
III	P6	Metabolism of Carbohydrates & lipids	30	**Clubbed; 6 hrs**
III	P7	Cell Biology	30	
IV	P8	Membrane biology & Bioenergetics	30	5 hrs
IV	P9	Metabolism of amino acids & nucleotides	30	**Clubbed; 2 days**
IV	P10	Basic Microbiology & Microbial Genetics	30	**6 hrs/day**
V	P11	Gene, Gene Expression and Regulation	30	**Clubbed; 2 days; 6hrs/day**
V	P12	Physiology &Hormones	30	
V	DSE-A-P1		30	5 hrs
V	DSE-B-P2		30	5 hrs
VI	P13+P14	RDT & Genetic Engineering +Immunology	60	**Clubbed; 2 days; 6hrs/day**
VI	DSE-A-P1		30	5 hrs
	DSE-B-P1		30	5 hrs

Discipline Specific Elective (*Any four*)

DSE-A

[Any one (A1 or A2) to be chosen for Semester 5]
DSE A1: Nutritional Biochemistry
DSE A2: Molecular basis of infectious human diseases

[Any one (A3 or A4) to be chosen for Semester 6]
DSE A3: Advanced Cell Biology
DSE A4: Molecular basis of non-infectious human diseases

DSE-B

[Any one (B1 or B2) to be chosen for Semester 5]
DSE B1: Advanced Biochemistry
DSE B2: Plant Biochemistry

[Any one (B3 or B4) to be chosen for Semester 6]
DSE B3: Molecular diagnostics
DSE B4: Research Methodology

Skill Enhancement Elective Course (*Any two; one in Semester III & one in Semester IV*)

Semester III
(Any one to be chosen)
SEC A: Tools and Techniques in Biochemistry
SEC A: Protein Purification Techniques

Semester IV
(Any one to be chosen)
SEC B: Clinical Biochemistry
SEC B: Recombinant DNA Technology

1.1 Scheme for Biochemistry (Honours) CBCS Curriculum

Semester	Course Name	Course Code	Course Detail	Credits
I	Core course–1	BCM-A-CC-1-1-TH	Molecules of Life	4
	Core course–1 Practical	BCM-A-CC-1-1-P	Molecules of Life	2
	Core course–2	BCM-A-CC-1-2-TH	General Organic Chemistry	4
	Core course–2 Practical	BCM-A-CC-1-2-P	Organic Chemistry	2
II	Core course–3	BCM-A-CC-2-3-TH	General Physical chemistry	4
	Core course–3 Practical	BCM-A-CC-2-3-P	General Physical chemistry	2
	Core course–4	BCM-A-CC-2-4-TH	Enzyme	4
	Core course–4 Practical	BCM-A-CC-2-4-P	Enzyme	2
III	Core course–5	BCM-A-CC-3-5-TH	Bio-Physical chemistry	4
	Core course–5 Practical	BCM-A-CC-3-5-P	Bio-Physical chemistry	2
	Core course–6	BCM-A-CC-3-6-TH	Metabolism of Carbohydrates and Lipids	4
	Core course – 6 Practical	BCM-A-CC-3-6-P	Metabolism of Carbohydrates and Lipids	2
	Core course–7	BCM-A-CC-3-7-TH	Cell Biology	4
	Core course–7 Practical	BCM-A-CC-3-7-P	Cell biology	2
	Skill Enhancement Course A	BCM-A-SEC-A	Any one of the following: Tools and Techniques in Biochemistry Protein Purification Techniques	2
IV	Core course–8	BCM-A-CC-4-8-TH	Membrane Biology and Bioenergetics	4
	Core course–8 Practical	BCM-A-CC-4-8-P	Membrane Biology and Bioenergetics	2

	Core course–9	BCM-A-CC-4-9-TH	Metabolism of Amino Acid and Nucleic Acid	4
	Core course–9 Practical	BCM-A-CC-4-9-P	Metabolism of Amino Acid and Nucleic Acid	2
	Core course–10	BCM-A-CC-4-10-TH	Basic Microbiology and Microbial Genetics	4
	Core course–10 Practical	BCM-A-CC-4-10-P	Basic Microbiology and Microbial Genetics	2
	Skill Enhancement Course B	BCM-A-SEC-B	Any one of the following: Clinical Biochemistry Recombinant DNA Technology	2
V	Core course–11	BCM-A-CC-5-11-TH	Gene, Gene Expression and Regulation	4
	Core course–11 Practical	BCM-A-CC-5-11-P	Gene, Gene Expression and Regulation	2
	Core course–12	BCM-A-CC-5-12-TH	Physiology and Hormones	4
	Core course–12 Practical	BCM-A-CC-5-12-P	Physiology and Hormones	2
	Discipline Specific Elective (A1 orA2)	BCM-A-DSE-A-5-TH	Theoretical	4
	Discipline Specific Elective A	BCM-A-DSE-A-5-P	Practical	2
	Discipline Specific Elective B (B1 or B2)	BCM-A-DSE-B-5-TH	Theoretical	4
	Discipline Specific Elective B	BCM-A-DSE-B-5-P	Practical	2
VI	Core course–13	BCM-A-CC-6-13-TH	Genetic Engineering and Biotechnology	4
	Core course–13 Practical	BCM-A-CC-6-13-P	Genetic Engineering and Biotechnology	2
	Core course–14	BCM-A-CC-6-14-TH	Immunology	4
	Core course–14 Practical	BCM-A-CC-6-14-P	Immunology	2
	Discipline Specific Elective A (A3 or A4)	BCM-A-DSE-A-6-TH	Theoretical	4
	Discipline Specific Elective A	BCM-A-DSE-A-6-P	Practical	2

	Discipline Specific Elective B (B3 or B4) BCM-A-DSE-B-6-TH	Theoretical	4
	Discipline Specific Elective B BCM-A-DSE-B-6-P	Practical	2

1.2 Choices for Discipline Specific Electives

Discipline Specific Elective A	Discipline Specific Elective B
[Any one (A1 or A2) to be chosen for Semester 5] DSE A1: Nutritional Biochemistry DSE A2: Molecular basis of infectious human diseases [Any one (A3 or A4) to be chosen for Semester 6] DSE A3: Advanced Cell Biology DSE A4: Molecular basis of non-infectious human diseases	[Any one (B1 or B2) to be chosen for Semester 5] DSE B1: Advanced Biochemistry DSE B2: Plant Biochemistry [Any one (B3 or B4) to be chosen for Semester 6] DSE B3: Molecular diagnostics DSE B4: Research Methodology

1.3 Choices for Skill Enhancement Courses

Skill Enhancement Course-1 (Any one) (SEM 3)	Skill Enhancement Course-2 (Any one) (SEM 4)	
SEC-1 Tools and Techniques in Biochemistry	SEC-3 Clinical Biochemistry	
SEC-2 Protein purification techniques	SEC-4 Recombinant DNA technology	

Core Course Detailed Syllabus

Core Course 1 – Molecules of Life (Semester 1) BCM-A-CC-1-1-TH

Molecules of Life	**4 Credits; 50 hours**
The foundations of biochemistry	
Cellular and chemical foundations of life **Unit-I**	
Water	
Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.	
Carbohydrates and glycobiology	
Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non- reducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). (definition, structure, functions, examples only) Carbohydrates as informational molecules, working with carbohydrates (applications of carbohydrate)	
Introduction to amino acids, peptides and proteins	
Amino acids: **Definition, classification & structures. Physico-chemical properties of amino acids(amphoteric molecules, ionisation, zwitterions, pk values, isoelectric point, Lambert-Beer's law, optical density, absorption spectra), titration of amino acids (glycine, glutamic acid, lysine, histidine), Formol titration of glycine (only reaction and principle), reaction of amino acids: reaction due to amino groups(reaction with mineral acids,alkyl halides, acetyl chloride, acetic anhydride in presence of base, nitrous acid, ninhydrin and fluorescamine), reaction due to carboxylic acid group (reaction with base, alcohol, $LiAlH_4$, metal oxide), separation and analysis of amino acids by paper & thin layer chromatography and HPLC.** **Unit-II** **Peptides & Proteins:** **Peptide bond: Definition, structure and geometry of peptide bond, example of**	

biologically important peptide and its functions in brief (glutathione-peptide of non protein origin), Merrifield solid-phase peptide synthesis using protection/ deprotection protocol (brief outline). N-terminal amino acid determination (Edman degradation, dansyl chloride reagent, Sanger's reagent) and C-terminal amino acid determination (carboxypeptidase and using hydrazine).

Proteins: Definition of structure, primary, secondary, tertiary and quaternary structure (definition and example), structure of globular protein (albumin, globulin, haemoglobin & myoglobin – Structure, function and occurrence in brief) and fibrous protein (keratin, collagen -role of Vitamin C in hydroxylation, elastin- Structure, function and occurrence in brief), Forces that stabilise structure of proteins, behaviour of proteins in solutions, salting in and salting out, absorbance of proteins, example of metalloprotein, lipoprotein. Biuret and Folin-Lowry test for protein.

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)

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.

Protein folding and conformational diseases

Denaturation and renaturation of Ribonuclease A (Preliminary concept only). Introduction to thermodynamics of folding and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases – Alzheimer's and Prion based.

Myoglobin and haemoglobin and Membrane Proteins

Structures of myoglobin and haemoglobin, Oxygen binding curves, influence of 2, 3-BPG, CO2 and Cl-. Hill plot. Cooperativity between subunits and models to explain the phenomena - concerted and sequential models.

Haemoglobin disorders

Integral and membrane associated proteins. Hydropathy plots to predict transmembrane domains. Significance of membrane proteins - bacteriorhodopsin.

Lipids

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Lipids as signals, cofactors and pigments (preliminary ideas only)

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 DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers (examples & functions only)

Reference Books

- **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.**
- **Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John**

  Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4.
- **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**

  Fundamental of Biochemistry, Voet and Voet- provide necessary details on latest edition

  Edited by Prof. Hiren K Das (JNU)

Core Course 1-P Molecules of Life Lab (Semester 1) BCM-A-CC-1-1-P

Molecules of Life 2 Credits; 60 hours

List of Practical

1. **Separation of amino acids by thin layer chromatography.**
2. **Qualitative test for carbohydrate, lipid, amino acids & proteins.**
3. **Assay of proteins using Lowry method, standard curve preparation**
4. **SDS-PAGE analysis of proteins (BSA, Lysozyme, Ovalbumin)**

Core Course 2 General and Organic Chemistry (Semester 1) BCM-A-CC-1-2-TH

4 Credits; 50 hours

Unit-I

1. Atomic Structure (briefly)

Concept of atomic orbital, shapes of s, p and d orbitals, radial and angular probability of s, p and d orbitals (qualitative idea). Many electron atoms, Pauli Exclusion Principle, Hund's rule of maximum multiplicity, exchange energy, Aufbau (building up) principle and its limitations, Electronic energy levels and electronic configurations of hydrogen like and polyelectronic atoms and ions (concept only), Ground state term symbols of atoms and ions (concept only).

2. Intermolecular forces

a. Ionic bonding

Size effects- radius ratio rules and their limitations. Packing of ions in crystals, Lattice energy (concept only), Born-Lande equation (derivation not required) and its applications; Born-Haber cycle (derivation not required) and its application. Preliminary ideas of solvent energy, polarizing power and polarisibility, ionic potential and Fajan's rules.

b. **Covalent bonding**

Lewis structures, formal charge, Preliminary idea of Valence Shell Electron Pair Repulsion (VSEPR) Theory, shapes of molecules and ions containing lone pairs and bond pairs. Partial ionic character of covalent bonds, bond moment and dipole moment, Partial ionic character from dipole moment values and electro negativity differences, Preliminary idea of valence Bond Theory (Heitler- London approach). Directional character of covalent bonds, hybridization, equivalent and non equivalent hybrid orbital, Bent's rule; Concept of resonance, resonance energy, resonance structures.bonding, non-bonding,antibonding molecular orbitals(concept only) elementary pictorial approach of H_2 and O_2 molecular orbitals , sigma and pi bonds, multiple bonding. Concept of Bond order, bond length, bond strength, bond energy

c. Weak Chemical Forces

Van der Waal's forces, ion-dipole, dipole–dipole interactions, London

forces, Hydrogen bonding; Effect of chemical forces on physical properties

d. Co-ordination compounds

Double salts and complex salts, Werner's theory, ambidentate and polydentate ligands, chelate complexes, Naming of co-ordination compounds (up to two metal centres). Isomerism of co-ordination compounds: Constitutional, geometrical and optical isomerism in respect co-ordination numbers 4 and 6. Determination of configuration of cis-, trans-, isomers by chemical methods.

3. Radioactivity

Laws of radioactivity, Radioactive decay, decay constant, average life of radio elements and its relation with half life, radioactive equilibrium, properties of α,β,γ radiations, radiation damage, radiation protection and safety aspects, units of radioactivity, radioactive carbon dating

Atomic Nucleus

Fundamental particles of atomic nucleus, atomic number and its significance, nucleus stability, neutron proton ratio and different modes of decay, nuclear biding energy, nuclear forces.

Applications of radioactive isotopes

Examples of radio isotopes (14C, 3H, 32P, 35S, 2H, 125I) and their uses in biological systems. Basic principles of liquid scintillation counter. Radiation absorption, Radiation therapy in cancer (examples only)

Unit-II

4. Stereochemistry of Carbon Compounds

Concept of hybridisation, resonance (including hyperconjugation), inductive effect Huckel's rules for aromaticity & antiaromaticity. dipole moment, bond distance, bond angles Tautomerism: keto-enol tautomerism Ionization of acids and bases: effect of structure, substituent and solvent on acidity and basicity (Simple Aliphatic and aromatic Acids, Phenols and amines). Stereochemistry Optical activity of chiral compounds: specific rotation, measurement of specific rotation by polarimeter, racemisation (general principle) resolution of simple acids and bases. Representation of molecules in saw horse, Fischer, flying-wedge and Newman formulae and their inter translations, Configuration: stereocentres: systems involving 1, 2, 3 centres, stereogenicity, chirotopicity. pseudoasymmetric (D/L and R/S descriptor threo/erythro and syn/anti nomenclatures ii) stereoaxis in C=C & C=N systems, cis/trans, syn/anti, E/Z descriptors. Coformation: Conformational nomenclature, eclipse, staggard, gauch and anti forms ; dihedral angel, torsion angel, energy barrier of rotation; Conformational analysis of ethane, propane and n-butane;Conformational analysis of cyclohexane(chair and boat forms), symmetry properties, optical activity and relative stabilities of cyclohexane systems; .

5. General treatment of reaction mechanisms (concept only)

Ionic and radical reactions; heterolytic and, homolytic bond cleavage
Reactive intermediates: carbocations (carbenium and carbonium ions), carbanions, carbon radicals, carbenes – structure using orbital picture, electrophilic/nucleophilic behaviour, stability, generation and fate. Reaction kinetics: transition state theory, rate constant and free energy of activation, free energy profiles for one step and two step reactions (concept only).

Nucleophilic substitution reactions- SN1, SN2 mechanisms. Effect of substrate structure, nucleophiles and medium on reactivity and mechanism; neighboring group participations.

Elimination Reactions- E1, E2 mechanisms. Saytzeff and Hofmann rules. Elimination vs substitution reaction.

Electrophilic and Activated Nucleophilic substitution reactions of Benzene (Nitration, sulphonation, Halogenation and Friedel Craft reactions)

Addition reactions to Carbon–carbon multiple bonds- Electrophilic additions mechanisms (concept only), ozonolysis.
Nucleophilic addition to carbonyl groups: relative reactivity of carbonyl compounds. Formation of acetal, Grignard reactions, Cannizzaro, aldol condensation.

6. Specific Reactions and Heterocycles

Heterocycles- Structural aspects of five and six membered heterocycles containing hetero atoms (furan, pyran, pyridine, pyrrole, furanose, pyranose, purines, pyrimidines).

Reference Books

1. Organic Chemistry (vol.1&2) – I. L. Finar
2. A Guide to Organic Reaction Mechanism- P. Sykes
3. Stereochemistry of Carbon Compounds- D. Nasipuri
4. Basic Stereochemistry of Organic Compounds- S. Sengupta
5. General &Inorganic Chemistry-R. P. Sarkar
6. Inorganic Chemistry-R. L. Dutta
7. New Concise Inorganic Chemistry-J. D. Lee

Core Course 2-P General Organic Chemistry (Semester 1) BCM-A-CC-1-2-P

2 Credits; 60 hours

List of Practical

1.Physical characteristics (colour, odour, texture)

2.Detection of special elements (N, Cl, S) by Lassaigne's tests.

3. Solubility and classification (Solvents: H_2O, 5% HCl, 5% $NaHCO_3$, 5% NaOH)

4.Detection of the following functional groups by systematic chemical tests: (aromatic amino ($–NH_2$), Amido ($–CONH_2$, including imide), aromatic nitro ($– NO_2$), Phenolic –OH, Carboxylic acid (–COOH), Carbonyl (>C= O); only one test for each functional group is to be reported)

*Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups in known and unknown organic compounds. Each student, during laboratory session, is required to analyze at least SIX (6) unknown organic samples. In practical examination, one unknown solid organic compound containing not more than two of the above functional groups (IV) shall be assigned to a candidate through a single draw lottery.

B. **LABORATORY RECORDS**

7. **Candidates at the practical examinations are required to submit the day to day record of all types of laboratory works prescribed in the syllabus performed by them and duly signed by their teachers. Marks of the laboratory records shall be awarded by the examiner at the practical examination. Candidates failing to submit their laboratory note books may be debarred from the examination.**

Practical Reference Books

(i) Advanced Practical Chemistry – Subhas Ch. Das

(ii) Handbook of Practical Chemistry – University of Calcutta

Core Course 3 General Physical Chemistry (Semester 2) BCM-A-CC-2-3-TH

General Physical Chemistry **4 Credits; 50 hours**

Unit-I

Principles of thermodynamics

(a) Definition of systems, surroundings and types of systems (isolated, closed and open). Extensive properties and intensive properties, concept of Thermodynamic equilibrium, concept of temperature, concept of heat and work, reversible work, irreversible work and maximum work.

(b) First law of Thermodynamics, internal energy as a state function, properties of a state function, definition of isothermal and adiabatic processes, Joule's experiment and its consequences. Joule-Thomson experiment and enthalpy as a state function, calculation of work done, heat changes for isothermal and adiabatic changes involving ideal gas.

(c) Statement of Second law of Thermodynamics and their equivalence, Carnot's cycle and Carnot's theorem, Absolute scale of temperature, concept of Entropy as a state function, Entropy changes in various Physical processes.

(d) Clausius inequality, condition of reversibility and irreversibility of a process, auxiliary state function-Helmholtz free energy and Gibbs free energy and their simple applications.

Unit-II

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.

Electrochemistry:

Flow of electrical charge: Electrical conductance, cell constant, specific conductance and equivalent conductance. Variation of equivalent conductances of strong and weak electrolytes with dilution, Kohlrausch's law of independent migration of ions, ion conductances and ionic mobility, Equivalent conductances at infinite dilution for weak electrolytes and determination of dissociation constants of weak electrolytes from conductance measurements. Basic concepts of electrochemical cell and cell reactions. EMF of cell (no derivation), types of electrode, glass electrode, determination of pH

of a solution and potentiometric titration, redox reaction.

Ideal and non- ideal Solutions and Thermodynamics of EMF of Cells

Ideal solutions: Raoult's law of relative lowering of vapour pressure (brief introduction). Thermodynamic derivation of colligative properties of solution (using chemical potential) and their inter relationships.

Non-ideal solutions: Concept of activity and activity coefficient with special reference to electrolyte solutions, statement of Debye-Huckel limiting law and its applications. Thermodynamic derivation of EMF, its use in measuring thermodynamic properties. (brief introduction)

Unit-III

Chemical Equilibrium: State of equilibrium and thermodynamic condition of equilibrium (condition of Minimum Gibbs' potential), Van't Hoff's reaction isotherm (deduction using chemical potential), Temperature dependence of Equilibrium constant (brief introduction). Preliminary idea of Chemical equilibrium: Equilibrium constant, Le Chatelier's principle and its simple applications.

(i) Homogeneous equilibrium : Use of different standard states to define K_p, K_c, K_x and their interrelations, examples of homogenous equilibrium in gas phase and ionic equilibrium in solution.

(ii) Heterogeneous equilibrium: Chemical equilibrium in different phases, Distribution/ partition constant.

Colloidal State: Electrokinetic phenomena- concept of Zeta potential, stability of colloids, mechanism of coagulation, Brownian motion, Electrical property of membrane, Donann membrane equilibrium. Gibbs adsorption isotherm-statement and significance, Surfactant, Micelle formation.

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

Reference Books

1. **Physical Chemistry-P.C.Rakshit**
2. **Lehninger Principles of Biochemistry-Nelson & Cox**
3. **Text Book of Physical Chemistry-K.L.Kapoor (Vol-II,V)**
4. **Physical Chemistry-Hrishikesh Chatterjee (Vol-I**
5. Text Book of Physical Chemistry-K. L. Kapoor (Vol-II,III,V)
6. Physical Chemistry-Hrishikesh Chatterjee(Vol-I,II)
7. Lehninger Principles of Biochemistry-Nelson &Cox
8. Molecular Spectroscopy-C. N. Banwell& McCash
9. Organic Spectroscopy-William Kemp
10. Techniques and Methods in Biology-K. L. Ghatak

Core Course 3-P General Physical Chemistry (Semester 2) BCM-A-CC-2-3-P

General Physical Chemistry	**2 Credits; 60 hours**
List of Practical	

1. **Safety measure in laboratories, use and calibration of pipettes**
2. **Preparation of normal, molar and percent solutions**
3. **Concept of pH and preparation of buffers.**
4. **Determination of specific rotation of a given optically active compound and %composition of its aqueous solution using Polarimeter.**
5. **Formol titration (acidic, basic, neutral amino acid)**

Core Course 4 Enzymes (Semester 2) BCM-A-CC-2-4-TH

4 Credits; 50 hours

Unit-I

1. Introduction to enzymes

a. Definition of enzymes, **Nature of enzymes, protein and non-protein (ribozyme)** differences between biocatalysts and chemical catalysts

b. Cofactors: metal ions (Zn^{+2}, Mg^{+2}, Fe^{2+}), coenzymes, (NAD^+, $NADP^+$, HSCoA, FH4, cobalamin), prosthetic groups (FAD, TPP, PALPO, biotin), apoenzyme and holoenzymes, co-substrate (NAD^+)- one reaction of each.

c. IUBMB Classification of enzymes, Name & two examples of each class with reaction

2. Features of enzyme catalysis , enzyme catalysis and basic thermodynamic principles of enzymatic reactions

a. Concept of active site, Catalytic power and specificity of enzymes (stereospecifity and geometric specificity)

b. Standard free energy change, Energy of Activation of both non enzymatic and enzymatic reactions; rate determining step, binding energy, Concept of Collision theory and Transition State theory, Transition state analogue

c. Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. proximity and orientation effect, strain and distortion theory

d. Mechanism of enzyme catalysis (basic concepts)

i) acid- base catalysis (example- RNase A)

ii) Metal ion catalysis: Metal activated enzymes (eg hexokinase) and metalloenzymes (eg carbonic anhydrase)

iii) covalent catalysis (example- chymotrypsin and lysozyme)

e. Catalytic reactions: Homogeneous catalysis, primary salt effects, Autocatalysis, Adsorption of gases on solids, Langmuir adsorption isotherm, Heterogeneous catalysis (one example of each type of catalysis)

Unit-II

3. Enzyme kinetics

Chemical Kinetics:

a. Concepts of rate, rate constant, order and molecularity of a reaction, integrated form of rate expressions of first order reaction (derivation); half-life period and its significance.

b. Pseudo-unimolecular reactions, multi step reactions, zero and fractional orders, rate expressions for complex reactions, opposing reaction, parallel reaction and consecutive reaction with example.

c. Factors on which enzyme catalyzed reactions depend: Substrate concentration, enzyme concentration, pH, temperature, Temperature dependence of rate constant, Arrhenius'equation, time, metal ions on the activity of enzyme (Zn^{+2}, Cu^{+2}, As^{+3}, Hg^{+2} - one example of each) .

d. Concept of pre steady state and steady state kinetics, initial rate, maximum velocity (Vmax), Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions, association and dissociation constant, Michaelis-Menten equation (derivation and graphical representation), Lineweaver- Burk plot, Eadie-Hofstee and Hanes plot. Km and Vmax, Kcat and turnover number, Kcat/Km.

Numerical problems on each section

4. Enzyme inhibition

a. Reversible inhibition (competitive, uncompetitive, non-competitive, mixed – one eg of each)

b. Irreversible inhibition- Mechanism based inhibitors (suicide substrate or suicide inhibitor) - antibiotics as inhibitors

Unit-III

5. Regulation of enzyme activity

a. Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition, allosteric regulation (aspartate transcarbamoylase),
b. Reversible covalent modification phosphorylation (glycogen phosphorylase).
c. Proteolytic cleavage- zymogen (chymotrypsinogen).
d. Multienzyme complex as regulatory enzymes. Occurrence and properties (pyruvate dehydrogenase, fatty acid synthase)
e. Isoenzymes - properties and physiological significance (lactate dehydrogenase).
f. Involvement of coenzymes in enzyme catalysed reactions

6. Extraction, Separation and Characterization of Proteins/enzymes

a. Solubilization of proteins from their cellular and extracellular locations. Use of simple

grinding methods, homogenization, ultrasonication, French press and centrifugation, sedimentation coefficient, (brief outline).

b. Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilisation.

c. Principles of chromatography: partition coefficient, phase systems, liquid and gas chromatography; HPLC, FPLC(brief concept), performance parameters: retention, resolution, basis of peak broadening, peak symmetry; chromatography equipment; modes of chromatography: Ion- exchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography

d. Determination of purity, specific activity, extinction coefficient and IEF, SDS-PAGE and molecular weight determination, 2-D electrophoresis.

- **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.**
- **Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt.Ltd. (New Jersey), ISBN: 978-1180-25024.**
- **Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.**
- **Enzymes, Malcolm Dixon, Edwin Clifford Webb- provide necessary details**
- **Biochemical Calculations, Segel- provide necessary details**

Core Course 4-P Enzymes (Semester 2) BCM-A-CC-2-4-P

Enzymes	**2 Credits; 60 hours**
List of Practical	

1. **Assay of enzyme activity and specific activity of Alkanine Phosphatases.**
2. **Effect of pH on the enzyme activity**
3. **Determination of Km and Vmax using Lineweaver-Burk graph.**
4. **Enzyme inhibition - calculation of Ki for competitive inhibition.**
5. **Ammonium sulphate fractionation of serum proteins. (Demonstration)**

Core Course 5 Bio-Physical Chemistry (Semester 3) BCM-A-CC-3-5-TH

Bio-Physical chemistry	**4 Credits; 50 hours**
Unit-I **Introduction**	
Special chemical requirement of biomolecules; factors affecting analyte structure and stability: pH, temperature and solvent polarity; buffering systems used in biochemistry, osmolarity and colligative properties	
Spectroscopy-I	
Theories of light (wave-particle duality); the electromagnetic spectrum; UV/visible absorption spectroscopy: physical basis, Beer Lambert's law, Deviations of Beer Lambert's law; transitions, Applications of UV-visible spectroscopy; UV-visible spectroscopy of proteins and nucleic acids;	
Unit-II **Spectroscopy-II**	
Spectroscopic techniques using plane polarized light: polarized light, chirality of biomolecules, circular dichroism and linear dichroism. Determination of 2D structures. **Infrared Spectroscopy- Modes of molecular vibrations; Vibration of a diatomic molecule; Application of Hooke's law; characteristic stretching frequencies of O-H, N-H, C-H, C-D, C=C, C=N, C=O functions; Factors affecting stretching frequencies (H-bonding, electronic factors, mass effects, bond multiplicity); Applications of infrared spectroscopy, Analysis and interpretation of IR data, FT-IR spectroscopy, Determination of secondary structure of proteins. Dihedral angles psi and phi. Helices, sheets and turns. Ramachandran map.**	
Unit-III **Application of spectroscopy** **Fluorescence and Chemiluminescence: physical basis, measurement, quenching, protein folding studies; resonance energy transfer, applications in cell biology.** **Techniques used in studying 3-D structures - X-ray diffraction and NMR (introductory) Motifs and domains. (bonding concept of protein, DNA)** **Hydrodynamics and Bio-calorimetry**	

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 (with 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.

Sedimentation: physical basis, subcellular fractionation, sedimentation velocity and sedimentation equilibrium; thermodynamic parameters: activation energy, enthalpy, entropy and free energy

Reference Books

- **Physical Biochemistry, Principles and Applications, David Sheehan**
- **Physical Biochemistry, David Friefelder- provide necessary details**
- **Biophysical Chemistry (Principles and Techniques); Upadhyay and Upadhyay- provide necessary details**
- **Physical Biochemistry, Van Holde- provide necessary details**

Core Course 5-P Bio-Physical Chemistry (Semester 3) BCM-A-CC-3-5-P

Bio-Physical Chemistry	**2 Credits; 60 hours**

List of Practical

1. Determination of viscosity coefficient of a given liquid/ solution with Ostwald viscometer.
2. Determination of extinction coefficient of different BSA solutions by spectrophotometer.
3. Column chromatography (size exclusion) by teaching kit. (Determination of Void volume)

Core Course 6 Metabolism of Carbohydrates and Lipids (Semester 3) BCM-A-CC-3-6-TH

Metabolism of Carbohydrates and Lipids	**4 Credits; 50 hours**
Unit-I **Basic design of metabolism**	
Autotrophs, heterotrophs, metabolic pathways, catabolism, anabolism, ATP as energy currency, reducing power of the cell.	
Glycolysis, Gluconeogenesis, pentose phosphate pathway and Glycogen metabolism	
Glycolysis - a universal pathway, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis, galactosemia. **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.	
Unit-II **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.	
Eicosanoids, cholesterol, steroids and isoprenoids	

Precursor, regulation, functions and physiological importance of prostagladins, leukotrienes and thromboxanes. Precursor, regulation, functions and physiological importance of Cholesterol, steroids and isoprenoids.
Membrane lipids
Precursor, regulation, functions and physiological importance of of membrane phospholipids in prokaryotes and eukaryotes, respiratory distress syndrome, Precursor, regulation, functions and physiological importance of triacylglycerol, plasmalogens, sphingolipids and glycolipids, lipid storage diseases.
Reference Books: • **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.** • **Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4.** • **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** • **Biochemistry Book edited by Hiren Das**

Core Course 6-P Metabolism of Carbohydrates and Lipids (Semester 3) BCM-A-CC-3-6-P
2 Credits; 60 hours

List of Practical

1. **Assay of amylase by Kit method.**
2. **Estimation of cholesterol from known source (Mustard oil)**
3. **Isolation of serum LDH by kit method.**
4. **Estimation of pure glucose by Nelson-Somogyi method.**

Core Course 7 Cell Biology (Semester 3)	BCM-A-CC-3-7-TH
Cell Biology	**4 Credits; 50 hours**
Unit-I **Introduction to cell biology**	
Prokaryotic (Archaea and Eubacteria) and eukaryotic cell (Animal and Plant cells),	
Tools of cell biology	
Cells as experimental models, Light microscopy, phase contrast microscopy, fluorescencemicroscopy, confocal microscopy, electron microscopy, Centrifugation for subcellular fractionation.	
Structure and functions of different cell organelles	
Structure of nuclear envelope, nuclear pore complex. ER structure. Organization of Golgi. Lysosome. Structure and functions of mitochondria, chloroplasts and peroxisomes. Zellweger syndrome. **Unit-II**	
Cytoskeletal proteins	
Structure and organization of actin and tubulin filaments. Intermediate filament proteins. Assembly, organization and movement of cilia and flagella (schematic representation).	
Cell wall and extracellular matrix	
Prokaryotic and eukaryotic cell wall, cell matrix proteins (concept & examples). Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata. (Schematically and briefly) **Unit-III**	
Protein transport	
Selective transport of proteins from cytosynthesis to the nucleus. Regulation of nuclear protein import and export. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER (only mechanism). Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion.	

Cell cycle, cell death and cell renewal

Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis - brief outline. Brief outline of FACS.

Reference Books

- **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.**
- **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.**
- **Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN: 0-8153-1619-4 / ISBN: 0-8153-1620-8.**

Core Course 7-P Cell Biology (Semester 3) **BCM-A-CC-3-7-P**

Cell Biology **2 Credits; 60 hours**

List of Practical

1. **Visualization of animal (Squamous epithelium) and plant (Onion) cells by methylene blue.**
2. **Micrographs of different cell components and study of mitosis and meiosis from permanent slides (dry lab).**
3. **Molecular weight determination of protein by SDS-PAGE/Native gel electrophoresis.**
4. **Western blot using College kit from HIMEDA or any other suitable company**

Core Course 8 Membrane Biology and Bioenergetics (Semester 4) BCM-A-CC-4-8-TH

Membrane Biology and Bioenergetics	**4 Credits; 50 hours**
Unit-I	
Introduction to biomembranes	
Composition of bio membranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, planer bilayer and liposomes as model membrane systems.	
Membrane structures and dynamics (Preliminary concept only)	
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. RBC membrane architecture. (diagram only) **Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics – FRAP (Example with experiments). Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.**	
Membrane transport (Definition & concept only)	
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. Secondary active transporters (Preliminary concept only)- lactose permease, Na+-glucose symporter. ABC family of transporters - MDR, CFTR. Ion channels - voltage-gated ion channels (Na+/K+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, and bacteriorhodopsin. Ionophores - valinomycin, gramicidin.	
Unit-II **Introduction to bioenergetics**	
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. ROS production and antioxidant mechanisms. Thermogenesis.

Reference Books

- 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.
- 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.
- Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
- 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

Core Course 8-P Membrane Biology and Bioenergetics (Semester 4) BCM-A-CC-4-8-P
2 Credits; 60 hours

List of Practical

1. Determination of CMC of detergents.
2. RBC ghost cell preparation.
3. Separation of photosynthetic pigment by TLC/ silica gel column.
4. Determination of phosphate from crude phospholipid (Lecithin/Cephalin)

Core Course 9 Metabolism of Amino Acids and Nucleotides (Semester 4) BCM-A-CC-4-9-TH

Metabolism of Amino Acids and Nucleotides	**4 Credits; 50 hours**
Unit-I **Overview of amino acid metabolism**	
Role of pyridoxal phosphate, glucose-alanine cycle, Kreb's bicycle, urea cycle and inherited defects of urea cycle.	
Catabolism of amino acids	
Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria.	
Biosynthesis of amino acids	
Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation.	
Precursor functions of amino acids	
Creatine and creatinine, polyamines (putresine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.	
Unit-II **Biosynthesis of purine and pyrimidine nucleotides**	
De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways.	
Deoxyribonucleotides and synthesis of nucleotide triphosphate	
Precursor 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, SCID, adenosine deaminase deficiency. DHFR,	

Metabolism of one carbon units.
Integration of metabolism
Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways).
Reference Books
▸ **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.** ▸ **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.** ▸ **Text Book of Molecular Biology by Sivarama Sastri, G Padmanavan and C. Subramanyam** ▸ **Harper's Biochemistry-details** ▸ **Lubert Stryer's Biochemistry-details**

Core Course 9-P Metabolism of Amino Acids and Nucleotides (Semester 4)

BCM-A-CC-4-9-P

Metabolism of Amino Acids and Nucleotides	**2 Credits; 60 hours**
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.**	

Core Course 10 Basic Microbiology and Microbial Genetics (Semester 4)
BCM-A-CC-4-10-TH 4 Credits; 50 hours

Unit-I

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 Archaebacteria (major difference within Eubacteria).

Staining techniques and bacterial Morphology and subcellular structures:

Definition of auxochrome; Chromophores; Acidic and Basic dyes; Classification of stains;
Simple and differential staining: theories of staining, Gram staining; acid fast staining; endospore staining; mechanism of gram 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). Bacterial cell wall biosynthesis and structure

Unit-II

Microbial Nutrition:

Nutritional types (definition and example) - Photoautotrophs, Photoorganotrophs, 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. Kinetics of growth, Batch culture. Continuous culture.
Synchronous culture (definition and brief description). Physical factors influencing growth temperature. pH, osmotic pressure, salt concentration.
Sterilization, disinfection, antiseptic, sanitizer, germicide, antimicrobial agent (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.

Unit-III

Microbial Genetics:

Plasmids and episomes. Nuclear material, Bacterial Chromosome (Fundamental differences with eukaryotic chromosome). Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria. An introduction to viruses with special reference to the structure, replication of T4 and λ phage, lytic and lysogenic cycles.

Core Course 10-P Basic microbiology and microbial genetics (Semester 4) BCM-A-CC-4-10-P

2 Credits; 60 hours

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.**

References:

1. Stanier, RY., et al., General Microbiology, 5th ed. Macmillan Press.

2. Pelczar. M., et al., Microbiology, 5th ed.,2000, Tata-McGraw Hill

3. Atlas, RM., Principles of Microbiology, 2nd ed.,1997, McGraw-Hill

4. Salle, AJ., Fundamental Principles of Bacteriology, 7th ed.,1999, Tata- McGraw Hill

5. Prescott, LM., Microbiology, 6th ed. 2005, McGraw-Hill.

Core Course 11 Gene, Gene Expression and Regulation (Semester 5) BCM-A-CC-5-11-TH

Gene, Gene Expression and Regulation	**4 Credits; 50 hours**
Unit-I **Structure of DNA**	
DNA structure, features of the double helix, various forms of DNA, denaturation and re association 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	
The chemistry of DNA synthesis, DNA polymerase, the 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 applications in medicine.	
Transposition of DNA	
Transposition, three 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.	
Unit-II **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, nearly universal 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.
Unit-III **Regulation of gene expression in prokaryotes**
Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon, induction of SOS response.
Mendel's principles & chromosomal basis of heredity and Extensions of Mendelism
Genetics: **Basic principles of Mendelian genetics (monohybrid and dihybrid, test and back crosses); Bacterial genetics-transformation, transduction, conjugation (mention of F^+/F^-, Hfr strain, function of pillus)**
Reference Books
▸ **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.** ▸ **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.** ▸ **Lewin's GENES**

- **Text Book of Molecular Biology by Sivarama Sastri, G Padmanavan and C. Subramanyam**
- **Stryer's Biochemistry**
- **DNA Structure and Function Richard R. Sinden- provide details for these books**
- **Genetics (2012) 6th ed., Snustad, D.P. And Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.**
- **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.**
- **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.**

Core Course 11-P Gene, Gene Expression and Regulation (Semester 5) BCM-A-CC-5-11-P

List of Practical	2 Credits; 60 hours

1. **Determination of the melting temperature and GC content of DNA.**
2. **Study of viscosity of DNA solutions (bacterial genomic DNA, plasmid DNA and DNA from different sp.[Calf thymus]).**
3. **Extraction of total nucleic acids (genomic DNA) from bacterial cells and quantitative estimation of DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement). Agarose gel electrophoresis and estimation of DNA size by using markers.**
4. **Concept of standard curve and estimation of unknown DNA concentration using calf thymus DNA.**
5. **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 pressure and interpretation of results).**
6. **Induction of lac operon and enzyme assay (beta-galactociadase assay).**

Core Course 12 Physiology and Hormones (Semester 5) BCM-A-CC-5-12-TH

Physiology and Hormones 4 Credits; 50 hours

Unit-I

Homeostasis and the organization of body fluid compartments

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

Cardiovascular physiology and Respiration

Relationship between cardiac cycle, control of cardiac function and output. Mechanism of respiration, pulmonary ventilation and related volumes, pulmonary circulation. Principles of gas exchange and transport. Regulation of respiration.

Digestive mechanism

Structure and functional organization, Biochemical mechanisms of carbohydrate, lipid, Protein or nucleic acid digestion, absorption

Excretory mechanism

Kidney: functional organization, GFR, selective re-absorption & secretion, buffering system, Acid base balance, acidosis and alkalosis, biochemical principles of water and electrolyte imbalance, polyuric states, nephrogenic Diabetes insipidus (antidiuretic hormone-vasopressin).

Unit-II

Introduction to endocrinology

Functions of hormones and their regulation. Chemical signalling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives.
HORMONE: Endocrine systems: Pituitary hormones functions and targets (tabular form)
Hypothalamic and pituitary hormones

Hypothalamic - Study the physiological and biochemical actions of hypothalamic hormones, pituitary hormones - GH, prolactin, TSH, LH, FSH, POMC

peptide family, oxytocin and vasopressin, feedback regulation cycle.

Endocrine disorders - gigantism, acromegaly, dwarfs, pigmies and diabetes insipidus.

Hormones of adrenals

Aldosterone, renin angiotensin system, cortisol, epinephrine and norepinephrine. (physiological and biochemical actions and their deficiencies) Fight or flight response, stress response.

Unit-III

Thyroid hormone

Name and biochemical actions of thyroid hormones and its regulations. Iodine requirement and deficiency of thyroid hormones.

Pancreatic and GI tract hormones

Regulation of release of insulin, glucagon, gastrin, secretin, CCK, GIP, adipolectin, leptin and ghrelin. Summary of hormone metabolite control of GI function. Physiological and biochemical action.

Hormone mediated signaling

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP3, DAG, Ca2+, NO. Effector systems - adenyl cyclase, guanyl cyclase, PDE, PLC.

Reference Books

- **Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10-14641-0962- 1.**
- **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.**
- **Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.**
- **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.

- **Human Physiology by C. C. Chatterjee-provide necessary details**
- **Biochemistry by Debajyoti Das-provide necessary details**
- **Medical Physiology by Guyton and Hall-provide necessary details**

Core Course 12-P Physiology and Hormones (Semester 5) BCM-A-CC-5-12-P

Physiology and Hormones	**2 Credits; 60 hours**
List of Practical	

1. **Estimation of haemoglobin.**
2. **Separation of plasma proteins by SDS-PAGE.**
3. **Separation of isoenzymes of LDH by electrophoresis (SDS-PAGE).**
4. **Estimation of serum Ca2+.**
5. **Estimation of serum cholesterol by PAP method.**

Core Course 13 Recombinant DNA Technology and Genetic Engineering
(Semester 6) BCM-A-CC-6-13-TH

Recombinant DNA Technology and Genetic Engineering	**4 Credits; 50 hours**
Unit-I **Introduction to recombinant DNA technology**	
Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules (DNA polymerases, RNA Polymerases, Reverse Transcriptase, Ligases, Taq polymerase, Kinases), separation of DNA by gel electrophoresis. Extraction and purification of plasmid and bacteriophage DNA.	
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, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. **The problem of selection, direct selection, marker rescue. Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.** **Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters. Synthetic oligonucleotides, synthesis and use.**	
Unit-II **Introduction of DNA into cells and selection for recombinant clones**	
Uptake of DNA by cells, preparation of competent cells. Selection for transformed cells. Identification for recombinants, Sequence dependent and independent screening, southern-western, colony and plaque hybridization - insertional inactivation, 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, cassettes and gene fusions. Challenges in producing recombinant protein in E. coli.	
Polymerase chain reaction	
Fundamentals of polymerase chain reaction, designing primers for PCR. Studying PCR	

products. Cloning PCR products. Quantitative PCR.

Unit-III

DNA sequencing

DNA sequencing by Sanger's method, modifications based on Sanger's method. Automated DNA sequencing.

Applications of genetic engineering in Biotechnology

Diagnostic use of PCR

Applications in medicine, production of recombinant pharmaceuticals such as insulin. Recombinant vaccines. Gene therapy. Applications in agriculture - plant genetic engineering, herbicide resistant crops, problems with genetically modified plants, safety concerns.

Reference Books

- Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
- 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.
- 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).

Recombinant DNA Technology by Watson

Core Course 13-P Recombinant DNA Technology and Genetic Engineering Lab
(Semester 6) BCM-A-CC-6-13-P

Recombinant DNA Technology and Genetic Engineering 2 Credits; 60 hours

List of Practical

Isolation of plasmid DNA from E. coli cells.
Digestion of plasmid DNA with restriction enzymes and size estimation of fragments by gel electrophoresis.
Preparation of competent cells, transformation and estimation of transformation efficiency.

Core Course 14 Immunology (Semester 6) BCM-A-CC-6-14-TH

Immunology	**4 Credits; 50 hours**
Unit-I **Cells and organs of the immune system**	
Hematopoiesis, cells of the immune system, primary andsecondary lymphoid organs and tissues (MALT).	
Innate immunity	
Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), 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), Ig fold, 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, and co-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).**	
Unit-II **MHC complex and antigen presentation**	
General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, linkage disequilibrium, pathways of antigen processing and presentation, complement activation and its biological consequences	
Tolerance, autoimmunity and hypersensitivity	
Organ specific and systemic autoimmune diseases, possible mechanisms of	

induction of autoimmunity, Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity.

Reference Books

- **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.**
- **Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.**
- **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.**

Core Course 14 P Immunology (Semester 6) BCM-A-CC-6-14-P

Immunology 2 Credits; 60 hours

List of Practical

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

Discipline Specific Electives (DSE)

BCM-A-DSE A1-TH

Nutritional Biochemistry **5th Semester**

Nutritional Biochemistry	**4 Credits; 50 hours**
Compulsory Elective	
Introduction to Nutrition and Energy Metabolism	
Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. measurement of energy content of food, Physiological energy value of foods, SDA. Measurement of energy expenditure. 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	
Review functions of carbohydrates. Digestion, absorption, utilization and storage, hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates, Dietary fibre, role of fibre in lipid metabolism, colon function, blood glucose level and GI tract functions.	
Dietary lipid and health	
Review of classification, sources, functions, digestion, absorption, utilization and storage. Essential Fatty Acids; Functions of EFA, RDA, – excess and deficiency of EFA. Lipotropic factors, role of saturated fat, cholesterol, lipoprotein and triglycerides. Importance of the following: a) Omega – fatty acids. Omega 3/ omega 6 ratio b) Phospholipids c) Cholesterol in the body d) Mono, Polyunsaturated and Saturated Fatty Acids. Dietary implications of fats and oils, Combination ratios of n6 and n3, MUFA, PUFA and SFA.	
Dietary Proteins and health	
Review of functions of proteins in the body, Digestion and absorption. Essential and Non- essential amino acids. Amino Acid Availability Antagonism, Toxicity and Imbalance, Amino acid Supplementation. Effects of deficiency. Food source and Recommended Dietary Allowances for different age group. Amino acid pool. NPU, Biological Value, Nitrogen balance. Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups. Digestion and absorption of dietary proteins. Protein calorie malnutrition - Kwashiorkar and Marasmus.	

Nitrogen balance, transamination.

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 as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis. Vitamin C role as cofactor in amino acid modifications. Niacin- Metabolic interrelation between tryptophan, Niacin and NAD/ NADP. Vitamin B6-Dietary source, RDA, conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms. Vitamin B12 and folate; 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, Physiology, Function, deficiency, Toxicity and sources with special reference to Arsenic

Assessment of Nutritional status

BMI, Biochemical assessment; Basal metabolic panel, Comprehensive metabolic panel, CBC, Urine Analysis, Assessment of Anemia, ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.

Food and drug interactions and Nutriceuticals

Alcohol, chewing tobacco and nutrient deficiency, Anti- depressants, psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition. Food as medicine.

Reference Books

- **Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.**
- **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.**

- **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.**
- **The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.**
- **Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press.**
- **Debojyoti Das's Biochemistry Book- provide details**

DSE A1-P
Nutritional Biochemistry Lab

Nutritional Biochemistry	**2 Credits; 60 hours**

List of Practical

1. **Estimation of Vit-C from fruit juice.**
2. **Estimation of calcium from milk.**
3. **Estimation of total phenolic content from black-Tea.**
4. **Determination of iodine number from vegetable oil.**
5. **Estimation of phosphorous from milk.**

BCM-A-DSE A2-TH **Semester 5**

Molecular basis of Infectious Human Diseases

Molecular basis of Infectious Diseases	**4 Credits; 50 hours**
Classification of infectious agents (brief introduction)	
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. Infection and evasion.	
Overview of diseases caused by infectious agents (brief introduction)	
Bacterial: Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including Typhoid, Diphtheria, Pertussis, Tetanus, Typhoid and Pneumonia. **Viral: Viral diseases including AIDS, hepatitis, influenza and polio: causative agents, Pathogenesis; Dengue & chikungunya** **Parasitic: Detailed study of Malaria, history, causative agents, Vectors, life cycle, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development. Other diseases including Leishmaniasis, Amoebiasis** **Fungal: Aspergillosis**	
Reference Books	
▸ **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.** ▸ **Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition, Volume, 2. Churchill Livingstone Elsevier.** ▸ **Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J. Ryan, C. George Ray, Publisher: McGraw-Hill** ▸ **Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences** ▸ **Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.** ▸ **Introduction to Human Physiology (2013) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning.**	

- Genetics (2012) Snustad and Simmons,
- Cooper, G.M. and Hausman, R.E. 2009 the Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Gyton's medical physiology

DSE A2-P

Molecular basis of Infectious Human Diseases Lab 2 Credits; 60 hours

1. Identification of bacterial contamination (CFU) from water, soil and food products
2. PCR based diagnosis (Demo & tutorial only)
3. Dot Blot & ELISA based diagnosis (Demo & tutorial only)
4. Permanent slides of pathogens. Mycobacterium tuberculosis, Leishmania, Plasmodium falciparum
5. WIDAL test (Demo & tutorial only)

BCM-A-DSE A3-TH: Advanced Cell Biology (Theory) 4 Credits; 50 hours

Semester 6

1 Plasma Membrane and Nuclear Transport No. of Hours : 8

Properties and Composition of Cell Membrane; Structure of Nuclear Envelope; Nuclear Pore Complex; Transport Across Nuclear Envelope; Regulation of Nuclear Protein Import and Export.

2 Cell-Cell Interaction No. of Hours : 12

Cell-Cell Interactions and Cell-Matrix Interactions; Components of Extracellular Matrix: Collagen and Non-Collagen Components; Tight Junctions; Gap Junctions; Desmosomes; Hemidesmosomes; Focal Adhesions And Plasmodesmata; Cell Wall; Role Of Cell Interaction In Development.

3 Cell Cycle and Programmed Cell Death No. of Hours :16

Overview of The Cell Cycle; Eukaryotic Cell Cycle; Events Of Mitotic Phase; Cytokinesis; Events Of Meiosis And Fertilization; Regulation Of Cell Division And Cell Growth; Apoptosis And Necrosis, Stem Cells And Maintenance of Adult Tissues, Hematopoiesis, Embryonic Stem Cells and Therapeutic Cloning.

4 Cancer Biology No. of Hours : 12

Development and causes Of Cancer; Genetic Basis of Cancer; Oncogenes, Tumor Viruses; Molecular Approach to Cancer Treatment.

5 Advanced Methods in Cell Biology No. of Hours : 12

Ultracentrifugation, Fluorescence Microscopy- FACS, Confocal Microscopy, Electron Microscopy, Plant and Animal Cell Culture, Immunohistochemistry.

DSE A3-P: ADVANCED CELL BIOLOGY (PRACTICALS) 2 Credits; 60 hours

1. Isolation of organelles by sub-cellular fractionation

2. Study of cell viability /death assay by use of trypan blue and tutorial for MTT assay.

3. Study of apoptosis through analysis of DNA fragmentation patterns (Ladder assay; tutorial for tunnel assay)

4. Identification and study of cancerous cells using permanent slides and photomicrographs.

SUGGESTED READINGS

1. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

2. Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6 edition. John Wiley & Sons. Inc.

3. Alberts, B., Johnson,A., Lewis, J., and Enlarge, M. 2008 Molecular Biology of the Cell. 5th ed., Garland Science (Princeton),

4. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J. 2012. Molecular Cell Biology. 7th ed., W.H. Freeman & Company (New York),

5. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

BCM-A-DSE A4-TH Molecular basis of Non-Infectious Diseases 4 Credits; 50 hours

Semester 6

Lifestyle disorders (examples only)
The factors and biochemistry underlying Diabetes and related complications e.g. hypertension, obesity: the influence of genetics and environment on the condition and management; Basic concepts of Hypothyroidism and stress, Cardio vascular disorders and Atherosclerosis- understanding the factors that contribute to the syndrome, the management of the conditions. Concept of Irritable bowel syndrome-biochemistry behind the disorder and the influence of diet, stress and environment on the condition.
Cancer (brief introduction)
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; Adeno carcinoma, Biochemical analysis of cancer (PSA, AFB protein marker).
Other diseases (brief introduction)
Introduction to protein folding and proteosome removal of misfolded proteins; etiology and molecular basis for Alzheimer's, Prion diseases (mad cow), Huntington's Chorea, sickle cell anemia, Thalassemia, Parkinson's.

DSE A4-P Molecular Basis of Non-Infectious Human Diseases Lab 2 Credits; 60 hours

1. **Estimation of homocysteine levels in serum**
2. **Estimation of glycosylated hemoglobin**
3. **Permanent slides for different types of cancer**
4. **Bone densitometry test demonstration (visit to a nearby clinic)**

BCM-A-DSE B1-TH **Semester 5**

Advanced Biochemistry

Advanced Biochemistry	**4 Credits; 50 hours**
Photosynthesis	
General Features of Photophosphorylation, Light Absorption, The Central Photochemical Event: Light-Driven Electron Flow, ATP Synthesis by Photophosphorylation, The Evolution of Oxygenic Photosynthesis	
Carbohydrate Biosynthesis in Plants and Bacteria	
Photosynthetic Carbohydrate Synthesis, Photorespiration and the C4 and CAM Pathways, Biosynthesis of Starch and Sucrose, Cell Wall Polysaccharides: Plant Cellulose and Bacterial Peptidoglycan, Integration of Carbohydrate Metabolism in the Plant Cell	
Biomolecular interaction	
Molecular interaction mechanisms and forces between molecules: selectivity, affinity, kinetics and thermodynamics. Various types of biomolecular interactions: protein-ligand, protein-protein, DNA-protein. (simple technique with example) Inhibition of interactions. Application of molecular interaction analysis in life science research, drug discovery and diagnostics	
Reference Books	
▸ **Lehninger's Biochemistry** ▸ **Lubert Stryer** ▸ **Book on Biomolecular Interactions**	

DSE B1-P

Advanced Biochemistry Lab	**2 Credits; 60 hours**
List of Practical	
1. **Separation of photosynthetic pigments by TLC/silica gel column.** 2. **Spectrophotometric quantitation of protein (Lowry) and preparation of standard curve.** 3. **Absorption spectrum of haemoglobin and determination of concentration and extinction coefficient.**	

BCM-A-DSE B2-TH **Plant Biochemistry (Theory)** **4 Credits; 50 hours**

Semester 5

1 Introduction to Plant cell structure **No. of Hours : 4**

Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes

2 Photosynthesis and Carbon assimilation **No. of Hours : 14**

Basic Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation, Basic concepts of Calvin cycle and regulation; C3 & C4 cycle, Photorespiration.

3 Respiration **No. of Hours :12**

Alternative reactions of glycolysis, Regulation of plant glycolysis, Glyoxalate cycle, Translocation of metabolites across mitochondrial membrane, TCA cycle, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.

4 Nitrogen metabolism **No. of Hours : 14**

Biological Nitrogen fixation by free living and in symbiotic association, Basic concepts of structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Preliminary concepts of Primary and secondary ammonia assimilation in plants; ammonia assimilation by Glutamine synthetase- glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

5 Regulation of plant growth **No. of Hours : 4**

Introduction to plant hormones and their effect on plant growth and development (basic concept only), Regulation of plant morphogenetic processes by light (Concept only).

6 Secondary metabolites (Definitions, examples and functions) **No. of Hours : 8**

Representatives alkaloids & examples, function of alkaloids, Examples of major phenolic groups, flavonoids, tannins and lignin, biological role of plant phenolics, terpenoids and representative examples from each class, biological functions of terpenoids.

7 Plant tissue culture (basic concept only) **No. of Hours : 4**

Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Applications of cell and tissue culture.

BCM-A-DSE B2-P **PLANT BIOCHEMISTRY (PRACTICALS)** **2 Credits; 60 hours**

1. Induction of hydrolytic enzymes proteinases /amylases/lipase during germination (Demo & tutorials only)
2. Separation of carotenes by silica gel chromatography
3. Separation of photosynthetic pigments by TLC
4. Culture of plants (explants) (Demo & tutorials only).

SUGGESTED READINGS

1. Plant Biochemistry (2008), Caroline Bowsher, Martin steer, Alyson Tobin, Garland science ISBN 978-0-8153-4121-5
2. Biochemistry and molecular Biology of plant-Buchanan (2005) 1 edition. Publisher: I K International. ISBN-10: 8188237116, ISBN-13: 978-8188237111.
3. Plant Biochemistry by P.M Dey and J.B. Harborne (Editors) (1997) Publisher: Academic Press

BCM-A-DSE B3-TH **Semester 6**

Molecular Diagnostics

Molecular Diagnostics	**4 Credits; 50 hours**
Introduction To Biochemical Diagnostics	
Inborn errors of metabolism.	
Diagnostic Enzymes	
Principles of diagnostic enzymology; Clinical significance of aspartateaminotransferase, alanine aminotransferase, creatine kinase, aldolase, lactatedehydrogenase, enzyme tests in determination of myocardial infarction, enzymes ofpancreatic origin and billiary tract.	
Immunodiagnostics	
Introduction, antigen-antibody binding and assays; Immunoassays –types [RIA,ELISA, Chemiluminescent IA, FIA] and specific applications; Immunohistochemistry-principle and techniques. Immunodiagnostics for detection of infectious agents,cancer, and autoimmune diseases; Immunosensors.	
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, Techniques of chromosome analysis. Application of genetic test. Karyotyping, chromosome banding and fluorescence In-situ hybridization techniques. **Disease identification and Genetic tests for following disorders: Thalassemia, Sickle Cell anemia, Down Syndrome, Sex-linked inherited disorders, Allelic susceptibility test for multifactorial disorders (Male infertility).**	
Reference Books	
▸ **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** ▸ **Medical Biochemistry (2005) 2nd ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia), ISBN:0-7234-3341-0.** ▸ **Recombinant DNA by Watson** ▸ **Experimental Biochemistry: A Student Companion** ▸ **Harper's Biochemistry**	

DSE B3-P

Molecular Diagnostics Lab

Molecular Diagnostics	**2 Credits; 60 hours**
List of Practical	

1. **Estimation of Surface antigen of Hepatitis B & Hepatitis C virus.**
2. **Lipid profile: triglycerides and total cholesterol.**
3. **Permanent slides (histology/cytology) for different types of cancer and comparison with slides from normal tissues**
4. **Permanent slides of pathogens: Plasmodium vivax and P. falciparum**
5. **Estimation of serum Alkaline phosphatase and Acid phosphatase.**

BCM-A-DSE B4-TH **Semester 6**

Research Methodology

Total Hours: 20 hrs Theory and 140 hrs Practical CREDITS: 6; 70 hours

1 Introduction to Research Methodology No. of Hours: 4

Objectives and motivation in research

2 Defining the Research Problem No. of Hours: 4

Selecting and defining a research problem, Reviewing and conducting literature search, developing a research plan.

3 Designing of Experiment No. of Hours: 4

Different experimental designs – single and multifactorial design, Making measurements and sources of error in measurements, Methods of data collection and record keeping.

4 Data Processing and Statistical Analysis No. of Hours: 8

Processing operations, tabulation, and graphical representation, Statistics in research: Concepts of sample and population, Measure of central tendency, dispersion, asymmetry (skewness, kurtosis), Normal distribution (p-value), Statistical tests and hypothesis (Standard error, t-test, chi-square test), and regression analysis, Report writing, Writing a research paper - abstract, introduction, methodology, results and discussion. Based on the teaching above, each student will undertake the following exercises.

1. **A teacher (adviser) who would guide the student will discuss with student and identify a topic of mutual interest.**
2. **The student will collect the literature, collate the information and write the same in the form of a term paper with proper incorporation of references using appropriate software such as EndNote.**
3. **The student will identify scope of research on the topic and will frame objectives to be addressed in the project through a work plan.**
4. **The student will write standard operating protocols (SOPs) and identify requirement for equipment and reagents.**
5. **Each student will be asked to make presentation about the project including literature available, objective sought and work plan including methodologies as described above.**

SUGGESTED READINGS

1. **Research in Education (1992) 6th ed., Best, J.W. and Kahn, J.V., Prentice Hall of India Pvt. Ltd.**
2. **At the Bench: A Laboratory Navigator (2005) Barker, K., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-087969708-2.**
3. **Research Methodology - Methods and Techniques (2004) 2nd ed., Kothari C.R., New Age International Publishers.**

4. **Research Methodology: A Step by Step Guide for Beginners (2005) 2nd ed., Kumar R., Pearson Education.**
5. **Biostatistics: A Foundation for Analysis in the Health Sciences (2009) 9th ed., Daniel W.W., John Wiley and Sons Inc.**
6. **Statistics at the Bench: A Step-by-Step Handbook for Biologists (2010) Bremer, M. and Doerge, R.W., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-0-879698-57-7.**

Skill Enhancement Courses

BCM-A-SEC A1-TH **Semester 3**

Techniques in Biochemistry

Tools and Techniques in Biochemistry	**2 Credits; 30 hours**
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. **Exercise: Preparation of a buffer of given pH and molarity.**	
Spectrophotometric techniques	
Principle and instrumentation of UV-visible and fluorescence spectroscopy. **Exercises** **a. Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule)** **b. Determination of concentration of a protein solution by Lowry/BCA method.** **c. ELISA**	
Introduction and importance of virtual labs in biochemistry: Video from Youtube	
Reference Books	
▸ **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.** ▸ **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.** ▸ **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.**	

BCM-A-SEC A2-TH **Semester 3**

PROTEIN PURIFICATION TECHNIQUES **2 Credits; 30 hours**

TOTAL HOURS: 30 **CREDITS: 2**

1 Purification and characterization of a protein from a complex mixture (native or heterologously expressed) involving the following methods/techniques No. of Hours : 24

Exercises: Preparation of the sample. Ion-exchange chromatography. Gel filtration chromatography. Affinity chromatography. Electrophoresis.

Unit 2 Demonstration of High Performance Liquid Chromatography (HPLC) No. of Hours : 6

SUGGESTED READINGS

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: 0-07099487

BCM-A-SEC B1-TH **Semester 4**
Clinical Biochemistry **2 Credits; 30 hours**

Clinical Biochemistry
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. **Exercises** **a. Collection of blood and storage.** **b. Separation and storage of serum.** **c. Analysis of Cell Morphology**
Evaluation of biochemical changes in diseases
Basic hepatic, renal and cardiovascular physiology. Biochemical symptoms associated with disease and their evaluation. Diagnostic biochemical profile.
Assessment of glucose metabolism in blood
Clinical significance of variations in blood glucose. Diabetes mellitus. **Exercise: Estimation of blood glucose by glucose oxidase peroxidase method.**
Lipid profile
Composition and functions of lipoproteins. Clinical significance of elevated lipoprotein. **Exercise: Estimation of triglycerides.**
Liver function tests
Exercise: Estimation of bilirubin (direct and indirect).
Renal function tests and urine analysis
Use of urine strip / dipstick method for urine analysis. **Exercise: 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.

Exercise: Assessment of hypertension by blood pressure measurement,

Reference Books

- **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**
- **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.**
- **Medical Biochemistry (2005) 2nd ed., Baynes, J.W. And Dominiczak, M.H., ElsevierMosby Ltd. (Philadelphia), ISBN: 0-7234-3341-0.**
- **Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi), ISBN:81-88237-41-8**
- **Hawk's book**

BCM-A-SEC B2-TH **Semester 4**

RECOMBINANT DNA TECHNOLOGY **2 Credits; 30 hours**

1 Work flow for in-silico cloning **No. of Hours : 2**

Unit 2 Preparation of media, antibiotic solution, culturing of E. coli, isolation of single colonies **No. of Hours : 6**

Exercises Preparation of LB broth and agar. Inoculation of medium. Preparation of glycerol stocks of bacterial strains. Obtaining isolated colonies by streak plate method. Preparation of stock solutions.

Unit 3 Overview of plasmid vectors and methods of isolation **No. of Hours : 8**

Exercises Isolation of plasmid by alkaline lysis method. Isolation of plasmid DNA using column chromatography (kit).

Unit 4 Characterization of plasmid by gel electrophoresis **No. of Hours : 2**

Exercise Digestion of plasmid DNA with restriction enzymes and analysis of the fragments.

Unit 5 Cloning of a gene in a vector and functional analysis **No. of Hours : 12**

Polymerases chain reaction (parametric optimization, primer designing), ligation, introduction of DNA construct into host cells, selection of recombinants.

Exercises Amplification of DNA segment/gene of interest by PCR. Purification of PCR product, digestion of insert and vector by restriction enzymes for directional cloning, purification of insert and digested vector by gel extraction. Ligation of vector and insert. Preparation of competent cells of E. coli DH5α and transformation with the ligation mixture. Functional selection of recombinants (blue/white selection and eGFP fluorescence).

SUGGESTED READINGS 1. Molecular Cloning: A laboratory Manual (2012) Vol. 1-3, 4th ed., Green M.R. and Sambrook J., Cold Spring Harbour Laboratory Press (New York). ISBN: 978-1-93611341-5 / ISBN: 978-1-936113-42-2.

B.Sc. (General) BIOCHEMISTRY

(CBCS STRUCTURE)

BIOCHEMISTRY GENERIC ELECTIVES (Semesters 1-4)

[To be chosen by students studying other Hons subjects]

(CBCS STRUCTURE)

Detailed syllabus

BCM-G-1-1-TH GE-1 (CC-1): BIOCHEMISTRY OF CELL (THEORY)

SEMESTER - 1

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Biomolecules in their cellular environment **No. of Hours : 6**

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.

Unit 2 Amino acids and peptides **No. of Hours : 10**

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

Unit 3 Sugars and polysaccharides **No. of Hours : 10**

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

Unit 4 Nucleosides, nucleotides and nucleic acids **No. of Hours : 10**

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

Unit 5 Lipids **No. of Hours : 10**

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

Unit 6 Vitamins, coenzymes and metal ions **No. of Hours : 8**

Occurrence and nutritional role. Coenzymes and their role in metabolism. Metal ion containing biomolecules - heme, porphyrins and cyanocobalamin; their biological significance.

Unit 7 Signalling molecules **No. of Hours : 6**

Second messengers - cAMP, cGMP, IP3, diacyl glycerol, Ca^{2+}, NO. Brief account of their importance and role in signalling and signal transduction.

BCM-G-1-1-P GE-1: BIOCHEMISTRY OF CELL (PRACTICALS)

SEMESTER - 1

TOTAL HOURS: 60 **CREDITS: 2**

- **General safety procedures in a laboratory. Use of auto pipettes. Making solutions and buffer preparation - acetate and tris buffers.**

- **Qualitative tests for biomolecules - carbohydrates, lipids, amino acids, proteins, bases and nucleic acids.**

- **Separation of amino acids by paper chromatography.**
- **Separation of sugars/bases by TLC and their identification.**
- **Estimation of ascorbic acid in fruit juices.**

SUGGESTED READINGS

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.**

BCM-G-2-2-TH GE-2 (CC-2): PROTEINS AND ENZYMES (THEORY)

SEMESTER-2

Total Hours : 50 **CREDITS: 4**

1 Introduction to proteins **No. of Hours : 4**

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

2 Isolation and analysis of proteins **No. of Hours : 12**

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

3 Introduction to protein three-dimensional structures **No. of Hours : 10**

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

4 Myoglobin and haemoglobin - structure and function **No. of Hours : 4**

Oxygen binding curves, cooperativity models for haemoglobin.

5 Introduction to enzyme catalysis **No. of Hours : 8**

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

6 Enzyme kinetics **No. of Hours : 10**

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

7 Mechanisms of enzyme action and regulation **No. of Hours : 6**

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

8 Enzymes in medicine and industry **No. of Hours : 6**

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

BCM-G-2-2-P GE-2: PROTEINS AND ENZYMES (PRACTICALS)

SEMESTER-2

Total Hours: 60 **CREDITS: 2**

- **Protein estimation by UV absorbance and Biuret method.**
- **Protein microassay by Lowry/Bradford method.**
- **Ammonium sulphate fractionation of crude homogenate from germinated mung bean.**
- **Setting up assay for acid phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).**
- **Determination of Km and Vmax of enzyme enriched fraction.**
- **Inhibition of acid phosphatase activity by inorganic phosphate.**

SUGGESTED READINGS

3. **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.**
4. **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.**

BCM-G-3-3-THGE-3 (CC-3): INTERMEDIARY METABOLISM (THEORY)

SEMESTER-3

Total Hours: 50 **CREDITS: 4**

1 Basic concepts and design of metabolism **No. of Hours : 4**

The nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency.

2 Glycolysis and gluconeogenesis **No. of Hours : 6**

Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis.

3 The citric acid cycle **No. of Hours : 6**
Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway.

4 Oxidative phosphorylation **No. of Hours : 6**
The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol-3-phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.

5 Photosynthesis, Calvin cycle and pentose phosphate pathway No. of Hours : 8
The light reaction, chlorophyll, accessory pigments, reaction centres, two photo systems, generation of proton gradient and NADPH, Calvin cycle, synthesis of glucose, starch, sucrose, regulation, C4 pathway. Pentose phosphate pathway, importance and regulation.

6 Glycogen metabolism **No. of Hours : 6**
Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis.

7 Fatty acid synthesis and degradation **No. of Hours : 6**
TAG as energy source, β oxidation of fatty acids in mitochondria and peroxisomes, ketone bodies. Biosynthesis of fatty acids - elongation and unsaturation of fatty acids. Regulation of fatty acid oxidation and synthesis.

8 Amino acid catabolism and anabolism **No. of Hours : 6**

Protein degradation to amino acids, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation, synthesis of non-essential amino acids.

9 Nucleotide metabolism **No. of Hours : 6**

Biosynthesis - *de novo* and salvage pathways, regulation of nucleotide synthesis by feedback inhibition, degradation and excretion.

10 Integration of metabolism **No. of Hours : 6**

Brief role of hormones - catecholamines, insulin, glucagon; metabolic shifts to provide fuel to brain during fasting and starvation, role of cortisol in signalling stress - increase in gluconeogenesis and muscle protein breakdown.

BCM-G-3-3-P GE-3: INTERMEDIARY METABOLISM (PRACTICALS)

SEMESTER 3

Total Hours: 60 **CREDITS: 2**

1. **Alcohol fermentation by yeast.**

2. **H2S production, indole production and ammonia production by bacteria.**
3. **Urea estimation.**
4. **Uric acid estimation.**
5. **Nitrogen fixation by cyanobacteria.**

SUGGESTED READINGS

1. **Biochemistry (2012) 7th ed., Campbell, M.K. and Farrel, S.O. Brooks/Cole, Cengage Learning (Boston), ISBN: 13:978-1-111-42564-7.**

BCM-G-4-4-TH GE-4 (CC-4): GENE ORGANIZATION, EXPRESSION AND REGULATION (THEORY) SEMESTER-4

Total Hours: 50 **CREDITS: 4**

1 Structure of genes and chromosomes **No. of Hours : 8**

Definition of a gene, chromosomal organization of genes in viruses, bacteria and eukaryotes. Supercoiling of DNA.

2 Replication of genomes **No. of Hours : 12**

General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Replication of DNA and teleomeres in linear chromosomes. Replication of RNA genomes.

3 Recombination of DNA **No. of Hours : 4**
Homologous genetic recombination, Holliday model, proteins and enzymes mediating recombination.

4 Gene mutations and repair **No. of Hours : 6**
Molecular basis of mutations, multiple repair systems, mismatch repair, base excision repair, nucleotide excision repair, direct repair and translesion DNA synthesis.

5 Transcription of genes **No. of Hours : 10**
General features of gene transcription, procaryotic and eukaryotic RNA polymerases, stages of transcription, initiation, elongation and termination. Inhibitors of transcription.

6 RNA processing **No. of Hours : 4**
Processing of eukaryotic mRNA, splicing of introns, alternate splicing and editing, ribosomal and tRNA processing.

7 Protein synthesis **No. of Hours : 10**
Features of the genetic code, amino acylation of tRNAs, structure and assembly of ribosomes; three stages of protein synthesis - initiation, elongation and termination. Inhibitors of protein synthesis.

8 Regulation of gene expression **No. of Hours : 6**

Regulation of transcription in prokaryotes, concept of operons. Lac operon - control by negative and positive regulatory proteins, Trp operon - control by attenuation. Regulation of transcription in eukaryotes, regulatory sequences - enhancers, silencers response elements, nucleosome alterations, DNA-protein interactions and RNA interference.

BCM-G-4-4-P GE-4: GENE ORGANIZATION, EXPRESSION AND REGULATION (PRACTICALS)

SEMESTER - IV

Total Hours : 60 **CREDITS: 2**

- **Quantitative determination of DNA and RNA by absorbance at 260 nm and using A260/A280 ratio to distinguish between them.**
- **To study the viscosity of DNA solutions.**
- **Isolation of chromosomal DNA from *E. coli.***
- **Isolation of total RNA from yeast cells.**

SUGGESTED READINGS

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.**

Structure of B.Sc. (General) under CBCS

Semester	CORE COURSE (CC) (12)	Ability Enhancement Compulsory Courses (AECC) (2)	Skill Enhancement Courses (SEC) (4)	Discipline Specific Elective DSE (6)	Total Credits
1 (3TH+3P/ U)	CC-1 Subj X CC-1 Subj Y CC-1 Subj Z	AECC-1			20
2 (3TH+3P/ U)	CC-2 Subj X CC-2 Subj Y CC-2 Subj Z	AECC-2			20
3 (3TH+3P/ U)	CC-3 Subj X CC-3 Subj Y CC-3 Subj Z		SEC-A1 (1TH+0P/U) (To be chosen X or Y or Z)		20
4 (3TH+3P/ U)	CC-4 Subj X CC-4 Subj Y CC-4 Subj Z		SEC-B1 (1TH+0P/U) (To be chosen X or Y or Z)		20
5			SEC-A2 (1TH+0P/U) (To be chosen from the same subject that was chosen for A1)	DSE-A (3TH+3P/U) Subj. X1 Subj. Y1 Subj. Z1	20
6			SEC-B2 (1TH+0P/U) (To be chosen from the same subject that was chosen for B1)	DSE-B (3TH+3P/U) Subj. X2 Subj. Y2 Subj. Z2	20

TH: Theory, P: Practical, TU: Tutorial

- **CC/DSE: Each Theory and Practical Course have 4 and 2 credits respectively/ Each Theory and Tutorial Course have 5 and 1 credits respectively**
- **CC: 4 courses each from three subjects (e.g. X, Y & Z) viz. Zoology, Biochemistry & Botany**
- **DSE: 2 courses each from 3 subjects [one course from each subject under each semester (5 & 6))**
- **AECC & SEC: Each course has 2 credits**
- **AECC-1: Communicative English/MIL; AECC-2: Environmental studies**
- **SEC: 4 courses; two courses each from any two subjects**
- **DSE/SEC: Group (A & B) for specified semesters**

Overall Scheme of B.Sc. (General) in Life Sciences with Biochemistry as one of the three (3) core subjects under CBCS

Core Course Biochemistry (General) (one out of three subjects)

CC-1 (GE) BIOCHEMISTRY OF CELL (Semester 1)

CC-2 (GE) PROTEINS AND ENZYMES (Semester 2)

CC-3 (GE) INTERMEDIARY METABOLISM (Semester 3)

CC-4 (GE) GENE ORGANIZATION, EXPRESSION AND REGULATION ((Semester 4)

- **DSE-Biochemistry (2 courses each from 3 subjects [one course from each subject under each semester (5 & 6)]**

DSE-A (Semester 5; any one may be chosen)

A1. NUTRITIONAL BIOCHEMISTRY

A2. BASIC MICROBIOLOGY

DSE-B (Semester 6; any one may be chosen)

B1. MOLECULAR BASIS OF INFECTIOUS DISEASES

B2. MOLECULAR BASIS OF NON-INFECTIOUS HUMAN DISEASES

SEC (any four (total); two courses each from any two subjects) (SEMESTERS 3 & 4)

Biochemistry

SEC-A1. TOOLS AND TECHNIQUES IN BIOCHEMISTRY

SEC-A2. CLINICAL BIOCHEMISTRY

SEC-B1. PROTEIN PURIFICATION TECHNIQUES

SEC-B2. RECOMBINANT DNA TECHNOLOGY

Detailed Scheme of B.Sc. (General) in Life Sciences with Biochemistry as one of the three (3) core subjects under CBCS

SEMESTER	COURSE OPTED	COURSE NAME	Credits
1	Ability Enhancement Compulsory Course-1	Communicative English/MIL	2
	Core Course Biochemistry 1	BIOCHEMISTRY OF CELL	4
	Core Course Biochemistry 1 Practical	BIOCHEMISTRY OF CELL	2
	Core Course Subj A 1		4
	Core Course Subj A 1 Practical		2
	Core course Subj B 1		4
	Core Course Subj B 1 Practical		2
Total Credit			20
2	Ability Enhancement Compulsory Course-2	Environmental Science	2
	Core course Biochemistry 2	PROTEINS AND ENZYMES	4
	Core Course Biochemistry 2 Practical	PROTEINS AND ENZYMES	2
	Core Course Subj A 2		4
	Core Course Subj A 2 Practical		2
	Core Course Subj B 2		4
	Core Course Subj B Practical 2		2
Total Credit			20
3	Core Course Biochemistry 3	INTERMEDIARY METABOLISM	4
	Core Course Biochemistry 3 Practical	INTERMEDIARY METABOLISM	2
	Core Course Subj A 3		4
	Core Course Subj A 3 Practical		2
	Core Course Subj B 3		4
	Core Course Practical Subj B 3		2

	Skill Enhancement Course-A1	SEC-A1	2
Total Credit			**20**
4	**Core Course Biochemistry 4**	**GENE ORGANIZATIO, EXPRESSION AND REGULATION**	4
	Core Course Biochemistry–4 Practical	**GENE ORGANIZATION, EXPRESSION AND REGULATION**	2
	Core Course Subj A 4	**Subj A IV**	4
	Core Course Subj A 4 Practical	**Subj A IV Practical**	2
	Core Course Subj B 4	**Subj B IV**	4
	Core Course Subj B 4 Practical	**Subj B IV**	2
	Skill Enhancement Course-B1	**Sec-B1**	2
Total Credit			**20**
5	**Discipline Specific Elective Biochemistry 1**	DSE-A-TH Biochemistry 1	4
	Discipline Specific Elective Biochemistry 1 Practical	DSE-A-P Biochemistry 1	2
	Discipline Specific Elective Subj X1	DSE-A-TH **Subj X** 1	4
	Discipline Specific Elective Subj X1 Practical	DSE-A-P **Subj X**1	2
	Discipline Specific Elective Subj Y1	DSE-A-TH **Subj Y1**	4
	Discipline Specific Elective Subj Y1 Practical	DSE-A-P Subj Y1	2
	Skill Enhancement Course –A2	SEC-A2	2
Total Credit			**20**

6	**Discipline Specific Elective Biochemistry -II**	DSE Biochemistry II	4
	Discipline Specific Elective Biochemistry II Practical	DSE Biochemistry II	2
	Discipline Specific Elective Subj A II	DSE Subj A II	4
	Discipline Specific Elective Subj A II Practical	DSE Subj A II	2
	Discipline Specific Elective Subj B II	DSE Subj B II	4
	Discipline Specific Elective Subj B II Practical	DSE Subj B II	2
	Skill Enhancement Course -IV	SEC-IV	2
Total Credit			**20**
Grand Total Credit			**120**

Detailed Syllabus

Core Course (General)

BCM-G-1-1-TH B.Sc. (General) BIOCHEMISTRY (CBCS STRUCTURE)

CC-1: BIOCHEMISTRY OF CELL (THEORY)

SEMESTER - 1

TOTAL HOURS: 50 CREDITS: 4

1 Biomolecules in their cellular environment No. of Hours: 6

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.

2 Amino acids and peptides No. of Hours: 10

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

3 Sugars and polysaccharides No. of Hours: 10

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

4 Nucleosides, nucleotides and nucleic acids No. of Hours: 10

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

5 Lipids No. of Hours : 10

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

6 Vitamins, coenzymes and metal ions No. of Hours : 8

Occurrence and nutritional role. Coenzymes and their role in metabolism. Metal ion containing biomolecules - heme, porphyrins and cyanocobalamin; their biological significance.

7 Signalling molecules No. of Hours : 6

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

BCM-G-1-1-P BIOCHEMISTRY OF CELL (PRACTICALS)

SEMESTER-1

TOTAL HOURS: 60 CREDITS: 2

1. General safety procedures in a laboratory. Use of auto pipettes. Making solutions and buffer preparation - acetate and tris buffers.

2. Qualitative tests for biomolecules - carbohydrates, lipids, amino acids, proteins, bases and nucleic acids.

3. Separation of amino acids by paper chromatography.
4. Separation of sugars/bases by TLC and their identification.
5. Estimation of ascorbic acid in fruit juices.

SUGGESTED READINGS

6. 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.
7. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

BCM-G-2-2-TH B.Sc. (General) BIOCHEMISTRY (CBCS STRUCTURE)
CC-2: PROTEINS AND ENZYMES (THEORY)

SEMESTER-2

Total Hours: 50 CREDITS: 4

1 Introduction to proteins No. of Hours: 4
Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function.

2 Isolation and analysis of proteins No. of Hours : 12
Techniques to isolate and analyze proteins- salt fractionation, ion-exchange chromatography,
gel permeation, HPLC, SDS-PAGE, IEF. Protein primary structure - sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides. Synthesis of
peptides using Merrifeld method.

3 Introduction to protein three-dimensional structures No. of Hours : 10
Secondary structure- helices and sheets, Ramachandran maps. Nature of non-covalent bonds
and covalent bonds in protein folding. Tertiary and quaternary structures.

4 Myoglobin and haemoglobin - structure and function No. of Hours : 4
Oxygen binding curves, cooperativity models for haemoglobin.

5 Introduction to enzyme catalysis No. of Hours : 8
Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature.

6 Enzyme kinetics No. of Hours : 10
Principles of reaction rates, order of reactions and equilibrium constants. Derivation of Michaelis-Menten equation. Significance of Km and Vmax. Catalytic efficiency parameters. Competitive and mixed inhibitions. Kinetics and diagnostic plots. Types of irreversible inhibitors.

7 Mechanisms of enzyme action and regulation No. of Hours : 6
Mechanism of action of chymotrypsin. Inhibitors of enzymes - antibiotics. Regulation of enzyme activity and its importance - aspartate transcarbamoylase.

8 Enzymes in medicine and industry No. of Hours : 6
Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry.

BCM-G-2-2-P PROTEINS AND ENZYMES (PRACTICALS)

SEMESTER-2

Total Hours: 60 **CREDITS: 2**

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 acid phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).

5. Determination of Km and Vmax of enzyme enriched fraction.

6. Inhibition of acid phosphatase activity by inorganic phosphate.

SUGGESTED READINGS

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.

BCM-G-3-3-TH B.Sc. (General) BIOCHEMISTRY (CBCS STRUCTURE)
CC-3: INTERMEDIARY METABOLISM (THEORY)
SEMESTER-3

Total Hours: 50 CREDITS: 4

1 Basic concepts and design of metabolism No. of Hours : 4
The nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency.

2 Glycolysis and gluconeogenesis No. of Hours : 6
Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis.

3 The citric acid cycle No. of Hours : 6
Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and
glyoxylate pathway.

4 Oxidative phosphorylation No. of Hours : 6
The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol-3-
phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.

5 Photosynthesis, Calvin cycle and pentose phosphate pathway No. of Hours : 8
The light reaction, chlorophyll, accessory pigments, reaction centres, two photo systems, generation of proton gradient and NADPH, Calvin cycle, synthesis of glucose, starch, sucrose, regulation, C4 pathway. Pentose phosphate pathway, importance and regulation.

6 Glycogen metabolism No. of Hours : 6
Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis.

7 Fatty acid synthesis and degradation No. of Hours : 6
TAG as energy source, β oxidation of fatty acids in mitochondria and peroxisomes, ketone bodies. Biosynthesis of fatty acids - elongation and unsaturation of fatty acids. Regulation of
fatty acid oxidation and synthesis.

8 Amino acid catabolism and anabolism No. of Hours : 6
Protein degradation to amino acids, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation, synthesis of non-essential amino acids.

9 Nucleotide metabolism No. of Hours : 6
Biosynthesis - *de novo* and salvage pathways, regulation of nucleotide synthesis by feedback
inhibition, degradation and excretion.

10 Integration of metabolism No. of Hours : 6
Brief role of hormones - catecholamines, insulin, glucagon; metabolic shifts to provide fuel to
brain during fasting and starvation, role of cortisol in signalling stress - increase in gluconeogenesis and muscle protein breakdown.

BCM-G-3-3-P INTERMEDIARY METABOLISM (PRACTICALS)
SEMESTER-3
Total Hours: 60 **CREDITS: 2**
1. Alcohol fermentation by yeast.
2. H2S production, indole production and ammonia production by bacteria.
3. Urea estimation.
4. Uric acid estimation.
5. Nitrogen fixation by cyanobacteria.
SUGGESTED READINGS
1. Biochemistry (2012) 7th ed., Campbell, M.K. and Farrel, S.O. Brooks/Cole, Cengage Learning (Boston), ISBN: 13:978-1-111-42564-7.

BCM-G-4-4-TH B.Sc. (General) BIOCHEMISTRY (CBCS STRUCTURE)
CC-4: GENE ORGANIZATION, EXPRESSION AND REGULATION
(THEORY)

SEMESTER-4
Total Hours: 60 CREDITS: 4

1 Structure of genes and chromosomes No. of Hours: 8
Definition of a gene, chromosomal organization of genes in viruses, bacteria and eukaryotes.
Supercoiling of DNA.

2 Replication of genomes No. of Hours : 12
General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Replication of DNA and teleomeres in linear chromosomes. Replication of RNA genomes.

3 Recombination of DNA No. of Hours : 4
Homologous genetic recombination, Holliday model, proteins and enzymes mediating recombination.

4 Gene mutations and repair No. of Hours : 6
Molecular basis of mutations, multiple repair systems, mismatch repair, base excision repair,
nucleotide excision repair, direct repair and translesion DNA synthesis.

5 Transcription of genes No. of Hours : 10
General features of gene transcription, procaryotic and eukaryotic RNA polymerases, stages
of transcription, initiation, elongation and termination. Inhibitors of transcription.

6 RNA processing No. of Hours : 4
Processing of eukaryotic mRNA, splicing of introns, alternate splicing and editing, ribosomal
and tRNA processing.

7 Protein synthesis No. of Hours : 10

Features of the genetic code, amino acylation of tRNAs, structure and assembly of ribosomes; three stages of protein synthesis - initiation, elongation and termination. Inhibitors of protein synthesis.

8 Regulation of gene expression No. of Hours : 6

Regulation of transcription in prokaryotes, concept of operons. Lac operon - control by negative and positive regulatory proteins, Trp operon - control by attenuation. Regulation of transcription in eukaryotes, regulatory sequences - enhancers, silencers response elements, nucleosome alterations, DNA-protein interactions and RNA interference.

BCM-G-4-4-P GENE ORGANIZATION, EXPRESSION AND REGULATION (PRACTICALS)

SEMESTER-4

Total Hours: 60 **CREDITS: 2**

1. Quantitative determination of DNA and RNA by absorbance at 260 nm and using A260/A280 ratio to distinguish between them.

2. To study the viscosity of DNA solutions.

3. Isolation of chromosomal DNA from *E. coli.*

4. Isolation of total RNA from yeast cells.

SUGGESTED READINGS

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.

B.Sc. (General) BIOCHEMISTRY (CBCS STRUCTURE)

Discipline Specific Electives (DSE)

(DSE-A in 5th Semester & DSE-B in 6th Semester)

(Any one from A1 & A2; any one from B1 & B2)

BCM-G-DSE-A1-TH: NUTRITIONAL BIOCHEMISTRY (THEORY)

TOTAL HOURS: 50 **CREDITS: 4**

1 Introduction to Nutrition and Energy Metabolism **No. of Hours: 8**

Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. measurement of energy content of food, Physiological energy value of foods, SDA. Measurement of energy expenditure. 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.

2 Dietary carbohydrates and health **No. of Hours: 8**

Review functions of carbohydrates. Digestion, absorption ,utilization and storage, hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates, Dietary fiber, role of fibre in lipid metabolism, colon function, blood glucose level and GI tract functions.

3 Dietary lipid and health **No. of Hours: 8**

Review of classification, sources, functions, digestion, absorption, utilization and storage. Essential Fatty Acids; Functions of EFA, RDA, – excess and deficiency of EFA. Lipotropic factors, role of saturated fat, cholesterol, lipoprotein and triglycerides. Importance of the following: a) Omega – fatty acids. Omega 3/ omega 6 ratio b) Phospholipids c) Cholesterol in the body d) Mono, Polyunsaturated and Saturated Fatty Acids. Dietary implications of fats and oils, Combination ratios of n6 and n3, MUFA, PUFA and SFA.

4 Dietary Proteins and health **No. of Hours: 8**

Review of functions of proteins in the body, Digestion and absorption. Essential and Nonessential amino acids. Amino Acid Availability Antagonism, Toxicity and Imbalance, Amino acid Supplementation. Effects of deficiency. Food source and Recommended Dietary Allowances for different age group. Amino acid pool. NPU, Biological Value , Nitrogen balance. PEM and Kwashiorkor.

5 Fat and water soluble Vitamins **No. of Hours: 8**

Vitamin A, C, E,K and D Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion(ADME), Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E

as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis. Vitamin C role as cofactor in amino acid modifications. Niacin-Metabolic
interrelation between tryptophan, Niacin and NAD/ NADP. Vitamin B6-Dietary source, RDA, conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms. Vitamin B12 and folate; Dietary source, RDA, absorption, metabolic role Biochemical basis for deficiency symptoms.

6 Minerals No. of Hours: 12

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, Physiology, Function, deficiency, Toxicity and Sources

7 Assessment of Nutritional status No. of Hours: 4

Anthropometric measurements; Z scores, BMI, skinfold, circumference ratios. Biochemical assessment; Basal metabolic panel, Comprehensive metabolic panel, CBC, Urine Analysis, Assessment of Anemia, ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.

8 Food and drug interactions and Nutriceuticals No. of Hours: 4

Nutrient interactions affecting ADME of drugs, Alcohol and nutrient deficiency, Antidepressants,
psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition. Food as medicine.

DSE-A1-P: NUTRITIONAL BIOCHEMISTRY (PRACTICALS)

TOTAL HOURS: 60 CREDITS: 2

1. Bioassay for vitamin B12/B1.
2. Homocystiene estimation.
3. Serum/ urine MMA estimation.
4. Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
5. Determination of oxidative stress: TBARS, antioxidant enzymes in hemolysate.
6. Vitamin A/E estimation in serum.
7. Bone densitometry /bone ultrasound test demonstration (visit to a nearby clinic)

SUGGESTED READINGS

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.

BCM-G-DSE-A2-TH: BASIC MICROBIOLOGY (THEORY)
SEMESTER –5

Total Hours: 50 **CREDITS: 4**

1 History of Development of Microbiology **No. of Hours: 12**

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various micobiological techniques and golden era of microbiology, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

2 Diversity of Microbial world **No. of Hours: 8**

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

3 Viruses, viroids and prions **No. of Hours: 10**

An introduction to viruses with special reference to the structure and replication of the following: Poxvirus, Poliovirus, HIV, T4 and λ phage, lytic and lysogenic cycles.

4 Bacteria **No. of Hours: 10**

An account of typical eubacteria, chlamydiae & rickettsiae (obligate intracellular parasites), mycoplasma, and archaebacteria (extremophiles). Applications of bacteria in industry, environment and food.

5 Algae **No. of Hours: 6**

History of phycology; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Applications of Algae in agriculture, industry, environment and food.

6 Fungi **No. of Hours: 6**

Historical developments in the field of Mycology, significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic Importance of Fungi in Agriculture, environment, Industry, medicine, food, biodeterioration, mycotoxins

7 Protozoa **No. of Hours: 4**

General characteristics with special reference to Amoeba

DSE-A2-P: BASIC MICROBIOLOGY (PRACTICALS)

Total Hours : 60 CREDITS: 2

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.

7. Estimation of CFU count.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W M.T.Brown Publishers.

2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company

BCM-G-DSE-B1-TH: MOLECULAR BASIS OF INFECTIOUS DISEASES (THEORY)
Semester 6

Total Hours: 50 **CREDITS: 4**

1 Classification of infectious agents **No. of Hours: 12**

Bacteria, Viruses, protozoa and fungi. Past and present emerging and re-emerging infectious diseases and pathogens. 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. Infection and evasion.

2 Overview of diseases caused by bacteria **No. of Hours: 18**

Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including Typhoid, Diphtheria, Pertussis, Tetanus, Typhoid and Pneumonia.

3 Overview of diseases caused by Viruses **No. of Hours: 12**

Detailed study of AIDS, history, causative agent, pathogenesis, Diagnostics, Drugs and inhibitors. Other viral diseases including hepatitis, influenza, rabies, chikungunya and polio.

4 Overview of diseases caused by Parasites **No. of Hours: 8**

Detailed study of Malaria, history, causative agents, Vectors, life cycle, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development. Other diseases including leishmaniasis, amoebiasis.

5 Overview of diseases caused by other organisms **No. of Hours: 10**

Fungal diseases, General characteristics. Medical importance of major groups, pathogenesis, treatment.

DSE-B1-P: MOLECULAR BASIS OF INFECTIOUS DISEASES (PRACTICALS)
Total Hours: 60 **CREDITS: 2**

1. Permanent slides of pathogens. Mycobacterium tuberculosis, Leishmania, Plasmodium falciparum
2. WIDAL test (Tutorial & demo)
3. Gram staining (Not to be set in the examinations)
4. Acid fast staining (Not to be set in the examinations)
4. PCR based diagnosis (Tutorial & demo)
5. Dot Blot & ELISA (Tutorial & demo)

SUGGESTED READINGS

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.
44
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

BCM-G-DSE-B2-TH: MOLECULAR BASIS OF NON-INFECTIOUS HUMAN DISEASES (THEORY)
SEMESTER –6
Total Hours: 60 **CREDITS: 4**

1 Nutritional disorders **No. of Hours: 10**
Overview of major and minor nutrient components in the diet. Balanced diet and the concept of RDA. Nutrient deficiencies; Kwashiorkor and Marasmus, Scurvy, beri beri, pellagra and B12 deficiency, Xerophthalmia and Night blindness, Vitamin D deficiency, Vitamin K deficiency. Discuss with relation to biochemical basis for symptoms.

2 Metabolic and Lifestyle disorders **No. of Hours: 12**
Obesity and eating disorders like Anorexia nervosa and Bullemia. Diabetes mellitus A metabolic syndrome and the relationship with hypertension, obesity, hypothyroidism and stress. Cardio vascular disorders and Atherosclerosis-defining the broad spectrum of ailments that fall in this category, understanding the factors that contribute to the syndrome, stages of disorder and the management of the condition. Irritable bowel syndrome- biochemistry behind the disorder and the influence of diet, stress and environment on the condition.

3 Multifactorial complex disorders and Cancer **No. of Hours: 20**
Understanding the definition of multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic makeup in the onset of 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; Biochemical analysis of cancer; Molecular approaches to cancer treatment.

4. Diseases due to misfolded proteins **No. of Hours: 8**
Introduction to protein folding and proteosome removal of misfolded proteins; etiology and molecular basis for Alzheimer's, Prion diseases, Huntington's Chorea, Polycystic ovarian syndrome, Parkinson's disease, ALS.

5 Monogenic diseases **No. of Hours: 10**
In born errors in metabolism: PKU, Alkaptonuria, Maple syrup urine disease; Receptor and transport defects: Cystic fibrosis, Long QT syndrome, familial hypercholesterolemia, sickle cell anemia, Thalassemia. Achondroplasia. Hemoglobinopathies and clotting disorders. Disorders of mood : Schizophrenia, dementia and anxiety disorders.

DSE-B2-P: MOLECULAR BASIS OF NON-INFECTIOUS HUMAN DISEASES (PRACTICALS)
SEMESTER – IIV/VI
Total Hours: 60 **CREDITS: 2**
1. Anthropometric measurements for normal and high risk individuals and identifications for Kwashiorkor, Marasmus and Obesity
2. Estimation of homocysteine levels in serum
3. Estimation of glycosylated hemoglobin

4. Permanent slides for different types of cancer
5. Diagnostic profile for assessment of CVS and Diabetes mellitus using case studies.
6. Bone densitometry test demonstration (visit to a nearby clinic)

SUGGESTED READINGS

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Introduction to Human Physiology (2013) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning.
3. The World of the cell, 7th edition (2009)
4. Genetics (2012) Snustad and Simmons,
5. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Skill Enhancement Courses (SEC)
Biochemistry (General)
(Any two of the following courses may be chosen)

BCM-G-SEC-A1-TH: TOOLS AND TECHNIQUES IN BIOCHEMISTRY
SEMESTER–3

TOTAL HOURS: 30 **CREDITS: 2**

1 Biochemical reagents and solutions **No. of Hours: 18**

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.

Exercise:

Preparation of a buffer of given pH and molarity.

2 Spectrophotometric techniques **No. of Hours: 6**

Principle and instrumentation of UV-visible and fluorescence spectroscopy.

Exercises:

Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule).

Measurement of fluorescence spectrum.

Determination of concentration of a protein solution by Lowry/BCA method.

3 Introduction and importance of virtual labs in biochemistry **No. of Hours: 6**

SUGGESTED READINGS

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.

BCM-G-SEC-A2-TH: PROTEIN PURIFICATION TECHNIQUES
SEMESTER–4

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Purification and characterization of a protein from a complex mixture (native or heterologously expressed) involving the following methods/techniques

No. of Hours: 24

Exercises:
Preparation of the sample.
Ion-exchange chromatography.
Gel filtration chromatography.
Affinity chromatography.
Electrophoresis.

2 Demonstration of High Performance Liquid Chromatography (HPLC)

No. of Hours: 6

SUGGESTED READINGS

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.

BCM-G-SEC-B1-TH: CLINICAL BIOCHEMISTRY
SEMESTER–3

TOTAL HOURS: 30 **CREDITS: 2**

1 Introduction **No. of Hours: 4**

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

Exercises:

Collection of blood and storage.

Separation and storage of serum.

2 Evaluation of biochemical changes in diseases **No. of Hours: 4**

Basic hepatic, renal and cardiovascular physiology. Biochemical symptoms associated with disease and their evaluation. Diagnostic biochemical profile.

Unit 3 Assessment of glucose metabolism in blood **No. of Hours: 4**

Clinical significance of variations in blood glucose. Diabetes mellitus.

Exercises:

Estimation of blood glucose by glucose oxidase peroxidase method.

4 Lipid profile **No. of Hours: 4**

Composition and functions of lipoproteins. Clinical significance of elevated lipoprotein.

Exercises:

Estimation of triglycerides.

5 Liver function tests **No. of Hours: 4**

Exercises

Estimation of bilirubin (direct and indirect).

6 Renal function tests and urine analysis **No. of Hours: 6**

Use of urine strip / dipstick method for urine analysis.

Exercises:

Quantitative determination of serum creatinine and urea.

7 Tests for cardiovascular diseases **No. of Hours: 4**

Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin.

Exercises:

Estimation of creatine kinase MB.

SUGGESTED READINGS

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-

BCM-G-SEC-B2-TH: RECOMBINANT DNA TECHNOLOGY
SEMESTER-4

TOTAL HOURS: 30 **CREDITS: 2**

1 Work flow for *in silico* cloning **No. of Hours: 2**

2 Preparation of media, antibiotic solution, culturing of *E. coli*, isolation of single colonies **No. of Hours : 6**

Exercises:
Preparation of LB broth and agar.
Inoculation of medium.
Preparation of glycerol stocks of bacterial strains.
Obtaining isolated colonies by streak plate method.
Preparation of stock solutions.

3 Overview of plasmid vectors and methods of isolation **No. of Hours: 8**
Exercises:
Isolation of plasmid by alkaline lysis method.
Isolation of plasmid DNA using column chromatography (kit).

4 Characterization of plasmid by gel electrophoresis **No. of Hours: 2**
Exercise:
Digestion of plasmid DNA with restriction enzymes and analysis of the fragments.

5 Cloning of a gene in a vector and functional analysis **No. of Hours: 12**
Polymerases chain reaction (parametric optimization, primer designing), ligation, introduction of DNA construct into host cells, selection of recombinants.
Exercises:
Amplification of DNA segment/gene of interest by PCR.
Purification of PCR product, digestion of insert and vector by restriction enzymes for directional cloning, purification of insert and digested vector by gel extraction.
Ligation of vector and insert.
Preparation of competent cells of *E. coli* DH5α and transformation with the ligation mixture.
Functional selection of recombinants (blue/white selection and eGFP fluorescence).

SUGGESTED READINGS

1. Molecular Cloning: A laboratory Manual (2012) Vol. 1-3, 4th ed., Green M.R. and Sambrook J., Cold Spring Harbour Laboratory Press (New York). ISBN: 978-1-936113-41-5