

## SCHEME FOR CHOICE BASED CREDIT SYSTEM FOR B.Sc. HONOURS BIOCHEMISTRY

SEMESTER	CORE COURSE (14)		Credits	Ability Enhancement Compulsory Course (AECC), (2)	Credits	Skill Enhancement Course (SEC), (2)	Credits	Discipline Specific Elective: (DSE), (4)	Credits	Generic Elective: (GE), (4)	Credits
I	<b>BIOCHEM1C01TH</b>	Molecules of Life	4	<b>ENGL103</b> /Hindi/MIL Communication	4					<b>BIOCHEM1GE01:</b> Biochemistry of Cell	4
	<b>BIOCHEM1C01PR</b>	Molecules of Life	2								
	<b>BIOCHEM1C02TH</b>	Cell Biology	4								
	<b>BIOCHEM1C02PR</b>	Cell Biology	2								
II	<b>BIOCHEM2C03TH</b>	Proteins	4	<b>ENVS2AECC02</b> Environment Science	4					<b>BIOCHEM2GE02:</b> Intermediary Metabolism	4
	<b>BIOCHEM2C03PR</b>	Proteins	2								
	<b>BIOCHEM2C04TH</b>	Enzyme	4								
	<b>BIOCHEM2C04PR</b>	Enzymes	2								
III	<b>BIOCHEM3C05TH</b>	Metabolism of Carbohydrates and Lipids	4			<i>Any 1 SEC Subject in semester 3</i>	4			<b>BIOCHEM3GE03:</b> Gene Organization, Expression and Regulation	4
	<b>BIOCHEM3C05PR</b>	Metabolism of Carbohydrates and Lipids	2								
	<b>BIOCHEM3C06TH</b>	Membrane Biology and Bioenergetics	4								
	<b>BIOCHEM3C06PR</b>	Membrane Biology and Bioenergetics	2								
	<b>BIOCHEM3C07TH</b>	Metabolism of Amino Acids and Nucleotides	4								
	<b>BIOCHEM3C07PR</b>	Metabolism of Amino Acids and Nucleotides	2								
IV	<b>BIOCHEM4C08TH</b>	Human Physiology	4			<i>Any 1 SEC Subject in semester 4</i>	4			<i>Any 1 GE Subject in semester 4 with Theory &amp; Practical (Theory=4 &amp; Practical=2)</i>	6
	<b>BIOCHEM4C08PR</b>	Human Physiology	2								
	<b>BIOCHEM4C09TH</b>	Gene Organization, Replication and Repair	4								
	<b>BIOCHEM4C09PR</b>	Gene Organization, Replication and Repair	2								
	<b>BIOCHEM4C10TH</b>	Hormone: Biochemistry and Function	4								
	<b>BIOCHEM4C10PR</b>	Hormone: Biochemistry and Function	2								
V	<b>BIOCHEM5C11TH</b>	Concepts in Genetics	4					<i>Any 2 DSE Subjects in semester 5 with Theory &amp; Practical (Theory=4+4 &amp; Practical=2+2)</i>	12		
	<b>BIOCHEM5C11PR</b>	Concepts in Genetics	2								
	<b>BIOCHEM5C12TH</b>	Gene Expression and Regulation	4								
	<b>BIOCHEM5C12PR</b>	Gene Expression and Regulation	2								
VI	<b>BIOCHEM6C13TH</b>	Genetic Engineering and Biotechnology	4					<i>Any 2 DSE Subjects in semester 6 with Theory &amp; Practical (Theory=4+4 &amp; Practical=2+2)</i>	12		
	<b>BIOCHEM6C13PR</b>	Genetic Engineering and Biotechnology	2								
	<b>BIOCHEM6C14TH</b>	Immunology	4								
	<b>BIOCHEM6C14PR</b>	Immunology	2								
<b>Core Course Total Credits =</b>			<b>84</b>	<b>AECC T. Credits =</b>	<b>8</b>	<b>SE T. Credits =</b>	<b>8</b>	<b>Discipline Specific Total Credits =</b>	<b>24</b>	<b>Generic Elective T. Credits =</b>	<b>24</b>

**Total Credits: 84+8+8+24+24 = 148**

**TH:** Theory **PR:** Practical **C:** Core Courses; **GE:** Generic Elective; **AECC:** Ability Enhancement Compulsory Course; **SEC:** Skill Enhancement Courses; **DSE:** Discipline Specific Elective

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

## Core Course

**BIOCHEM1C01:** Molecules of Life

**BIOCHEM1C02:** Cell Biology

**BIOCHEM2C03:** Proteins

**BIOCHEM2C04:** Enzymes

**BIOCHEM3C05:** Metabolism of Carbohydrates and Lipids

**BIOCHEM3C06:** Membrane Biology and Bioenergetics

**BIOCHEM3C07:** Metabolism of Amino Acids and Nucleotides

**BIOCHEM4C08:** Human Physiology

**BIOCHEM4C09:** Gene Organization, Replication and Repair

**BIOCHEM4C10:** Hormone: Biochemistry and Function

**BIOCHEM5C11:** Concepts in Genetics

**BIOCHEM5C12:** Gene Expression and Regulation

**BIOCHEM6C13:** Genetic Engineering and Biotechnology

**BIOCHEM6C14:** Immunology

## Discipline Specific Elective

*(Any 2 DSE Subjects in semester 5 & any 2 DSE Subjects in semester 6 from the list)*

### Semester-V

**BIOCHEM5DSE01:** Nutritional Biochemistry

**BIOCHEM5DSE02:** Basic Microbiology

**BIOCHEM5DSE03:** Molecular basis of non-infectious human diseases

**BIOCHEM5DSE04:** Molecular basis of infectious diseases

### Semester-VI

**BIOCHEM6DSE05:** Developmental Biology

**BIOCHEM6DSE06:** Advanced cell biology

**BIOCHEM6DSE07:** Plant Biochemistry

**BIOCHEM6DSE08:** Research Methodology

## Generic Elective

*(Any 1 GE Subject in semester 1- 4 semester from the list)*

### Semester-1

**BIOCHEM1GE01:** Biochemistry of Cell

### Semester-2

**BIOCHEM2GE02:** Intermediary Metabolism

### Semester-3

**BIOCHEM3GE03:** Gene Organization, Expression and Regulation

### Semester-4

**BIOCHEM4GE04:** Fundamentals of Cell Biology and Immunology

**BIOCHEM4GE05:** Molecular Diagnostics

## Ability Enhancement Compulsory Course

**ENGL103:** English Communication

**ENVS2AECC02:** Environment Science

## Skill Enhancement Elective Course

*(Any 1 SEC Subject in semester 3 & any 1 SEC Subject in semester 4 from the list)*

### Semester-3

**BIOCHEM3SEC01:** Tools and Techniques in Biochemistry

**BIOCHEM3SEC02:** Protein Purification Techniques

**BIOCHEM3SEC03:** Clinical Biochemistry

### Semester-4

**BIOCHEM4SEC04:** Bioinformatics

**BIOCHEM4SEC05:** Recombinant DNA Technology

**BIOCHEM4SEC06:** Basics of forensic science

## CHOICE BASED CREDIT SYSTEM

### B.Sc. (Hons.) Biochemistry

SEMESTER I		SEMESTER II	
<b>BIOCHEM1C01</b>	Molecules of Life	<b>BIOCHEM2C03</b>	Proteins
<b>BIOCHEM1C02</b>	Cell Biology	<b>BIOCHEM2C04</b>	Enzymes
<b>ENGL103</b>	English/Hindi/MIL Communication	<b>ENVS2AECC02</b>	Environment Science
<b>BIOCHEM1GE01</b>	Biochemistry of Cell	<b>BIOCHEM2GE02</b>	Intermediary Metabolism

SEMESTER III		SEMESTER IV	
<b>BIOCHEM3C05</b>	Metabolism of Carbohydrates and Lipids	<b>BIOCHEM4C08</b>	Human Physiology
<b>BIOCHEM3C06</b>	Membrane Biology and Bioenergetics	<b>BIOCHEM4C09</b>	Gene Organization, Replication and Repair
<b>BIOCHEM3C07</b>	Metabolism of Amino Acids and Nucleotides	<b>BIOCHEM4C10</b>	Hormone: Biochemistry and Function
<b>BIOCHEM3SEC01-03</b>	<i>Any 1 SEC Subject in semester 3</i>	<b>BIOCHEM4SEC04-06</b>	<i>Any 1 SEC Subject in semester 4</i>
<b>BIOCHEM3GE03</b>	Gene Organization, Expression and Regulation	<b>BIOCHEM4GE04-05</b>	<i>Any 1 GE Subject in semester 4</i>

SEMESTER V		SEMESTER VI	
<b>BIOCHEM5C11</b>	Concepts in Genetics	<b>BIOCHEM6C13</b>	Genetic Engineering and Biotechnology
<b>BIOCHEM5C12</b>	Gene Expression and Regulation	<b>BIOCHEM6C14</b>	Immunology
<b>BIOCHEM5DSE01-04</b>	<i>Any 2 DSE Subjects in semester 5</i>	<b>BIOCHEM6DSE05-08</b>	<i>Any 2 DSE Subjects in semester 6</i>

**C:** Core Courses

**GE:** Generic Elective

**AECC:** Ability Enhancement Compulsory Course

**SEC:** Skill Enhancement Courses

**DSE:** Discipline Specific Elective

**HIMACHAL PRADESH UNIVERSITY  
SUMMER-HILL, SHIMLA-171005**

**B.Sc. (Honours) Biochemistry**

**GENERAL INSTRUCTIONS/ GUIDELINES FOR EXECUTION OF CURRICULUM**

---

- I. The B.Sc. (Honours) Biochemistry will be of three years duration semester-based Choice Based Credit System [CBCS] course.
- II. There will be broadly three types of courses for B.Sc. (Honours) Biochemistry degree program.
  1. The **Core Courses** (14 courses for honours; and 4 discipline specific papers) will be of 6- credits each including 2 credits assigned to the practical component. Thus a candidate will have to pass 14 courses for earning  $14 \times 6 = 84$  credits during six semesters. Each of the 6-credits courses will carry 100 marks. These 100 marks will be split into marks assigned for Theory [TH]: 50 marks; Practical [PR]: 30 marks and Internal Assessment [IA]: 20. The Internal Assessment [20 marks] will include one Multi Choice Questions (MCQ)-based examination of 15 marks [15 or 30 questions of 1.0 or 0.5 mark each as the case may be]; and Classroom Attendance Incentive marks (5 marks). The Lab-based practical will be of 2-hours [One credit]. A total of  $14 \times 6 = 84$  credits could be accumulated under these courses during the Honours degree program.
  2. The **Elective Courses** will be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/ subject/ domain or nurtures the candidate's proficiency / skill. The Elective Courses will include;

**Discipline Specific Elective [DSE] Courses:** A total of 4 courses offered under the main discipline/ subject of study is referred to as Discipline Specific Elective. These courses are discipline related and/ or interdisciplinary in nature. A total of  $4 \times 6 = 24$  credits could be accumulated under DSE courses during the Honours degree program.

**Generic Elective [GE] Courses:** A total of 4 courses of 6-credits each including 2 credits assigned for the practical component of each of these courses *i.e.* one course per 1<sup>st</sup> to 4<sup>th</sup> semester will be studied by the candidates. An elective course chosen from an unrelated discipline/ subject, with an intention to seek exposure beyond discipline(s) of choice is called Generic Elective Course. The purpose of this category of papers is to offer the students the option to explore disciplines of interest beyond the choices they make in Core and Discipline Specific Elective papers. Further, a course offered in a discipline/ subject may be treated as an elective by other

discipline/ subject and vice versa and such electives may also be referred to as Generic Elective Course. A total of  $4 \times 6 = 24$  credits could be accumulated under GE courses during the Honours degree program.

3. **Ability Enhancement Compulsory Courses [AECC]:** Ability Enhancement Courses are of two types; Ability Enhancement Compulsory Courses [AECC] and Skill Enhancement Courses [SEC]. A total of  $4 \times 4 = 16$  credits could be accumulated under these courses during the Honours degree program i.e.  $4 \times 2 = 8$  credits for AECC, and  $4 \times 2 = 8$  credits for SEC courses.

The AECC courses are the mandatory courses based upon the content that leads to knowledge enhancement; i. Environment Science and ii. English/ Hindi/ MIL Communication. All these are mandatory courses for obtaining a B.Sc. (Honours) degree in the concerned subject. These courses are mandatory for all disciplines. SEC courses are value-based and/ or skill-based and are aimed at providing hands-on-training, competencies, skills *etc.* A minimum of two such courses for obtaining an Honours degree are selected amongst the courses designed to provide value-based and/ or skill-based knowledge and may contain both theory and lab/ hands-on training. The main purpose of these courses is to provide students life-skills in hands-on mode so as to increase their employability.

- III. Practical [PR] component has been included in every core and discipline/ generic specific elective paper. The list of practicals to be conducted by the candidates has been provided alongside each of such courses. The marks (30 marks) for the practical examination will be split as follows;

Write up of Practical I:	5 marks
Write up of Practical II:	5 marks
Performance of any one of above practicals:	7 marks
Practical record/ notebook:	5 marks
Viva voce:	8 marks

- IV. **Classroom Attendance Incentive:** Those candidates who have greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CAI marks as follows:

$\geq 75\%$ but $< 80\%$	1 marks
$\geq 80\%$ but $< 85\%$	2 marks
$\geq 85$ but $< 90\%$	3 marks
$\geq 90\%$ but $< 95\%$	4 marks
$\geq 95\%$ to 100%	5 marks

- V. The candidate has to secure minimum pass marks individually in Theory paper, Practical as well as Internal Assessment to earn full credits in the concerned course. A candidate thus failing in any of these components shall be consider failed in that course.

VI. The admission to B.Sc. (Honours) Biotechnology programme of Himachal Pradesh University will be as per guidelines of Himachal Pradesh University, Shimla from time to time.

- i. The candidate should have passed 10+2 (class XII) Examination or its equivalent from a recognized Board/ University with any of the three subjects out of Physics, Chemistry and Biology or any other science subject with 50% or equivalent grade (for SC/ ST candidates marks of eligibility will be 45% or equivalent grade).
- ii. In case of candidates who are studying in University/Board/College/Schools in any of the foreign countries the eligibility/Qualifying marks will be the same as recognized/equivalent to 10+2 by the University or the association of the Indian University with 50% marks of equivalent grade (for SC/ ST candidates, eligibility will be 45% marks or equivalent grade).
- iii. The candidate who has appeared in the qualifying examination but whose result has so far not been declared can also apply but his/her eligibility for the entrance test will be purely provisional subject to the condition that he/she has to produced a passing certificate scoring at least the minimum percentage of marks as prescribed for the qualifying examination on the day and the specified time of counseling.

The candidate shall not be more than 22 years of age as on 01<sup>st</sup> July of the year of admission. Date of birth as recorded in the Secondary Education Board/ University Certificate Only will be considered as authentic.

# **B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE COURSES**

## **COURSE- BIOCHEM1C01TH MOLECULES OF LIFE (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 The foundations of biochemistry (4 Periods)**

Cellular and chemical foundations of life. Water: Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.

### **Unit 2 Carbohydrates and glycobiology (16 Periods)**

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). Carbohydrates as informational molecules, working with carbohydrates

### **Unit 3 Lipids and vitamins (20 Periods)**

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. Plant sterols. Lipids as signals, cofactors and pigments. Vitamins: Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis.

### **Unit 4 Amino acids and nucleic acids (20 Periods)**

Structure and classification, physical, chemical and optical properties of amino 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.

**COURSE- BIOCHEM1C01PR**  
**MOLECULES OF LIFE (PRACTICALS)**

1. Safety measures in laboratories.
2. Preparation of normal and molar solutions.
3. Preparation of buffers.
4. Determination of pKa of acetic acid and glycine.
5. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids.
6. Separation of amino acids/ sugars/ bases by thin layer chromatography.
7. Estimation of vitamin C.

**SUGGESTED READINGS**

1. Lehninger: Principles of Biochemistry (2013) 6<sup>th</sup> ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7<sup>th</sup> ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.



## **COURSE- BIOCHEM1C02TH CELL BIOLOGY (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Introduction to cell biology**

**(12 Periods)**

Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells), cells as experimental models. Tools of cell biology: Light microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, FACS. Centrifugation for subcellular fractionation.

### **Unit 2 Structure of different cell organelles**

**(24 Periods)**

Structure of nuclear envelope, nuclear pore complex. ER structure. Organization of Golgi. Lysosome. Structure and functions of mitochondria, chloroplasts and peroxisomes. Zellweger syndrome. Protein trafficking: Selective transport of proteins to and from 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. Lipid and polysaccharide metabolism in Golgi. Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion. Protein import and mitochondrial assembly, protein export from mitochondrial matrix. Import and sorting of chloroplast proteins

### **Unit 3 Cell wall and extracellular matrix**

**(14 Periods)**

Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata. Cytoskeletal proteins: Structure and organization of actin filaments. Treadmilling and role of ATP in microfilament polymerization, organization of actin filaments. Non-muscle myosin. Intermediate filament proteins, assembly and intracellular organization. Assembly, organization and movement of cilia and flagella.

### **Unit 4 Cell cycle, cell death and cell renewal**

**(10 Periods)**

Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis - brief outline. Salient features of a transformed cell.

**COURSE- BIOCHEM1C02PR  
CELL BIOLOGY (PRACTICAL)**

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

**SUGGESTED READINGS**

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

## **COURSE- BIOCHEM2C03TH PROTEINS (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Introduction to amino acids, peptides and proteins (14 Periods)**

Amino acids and their properties - hydrophobic, polar and charged. Biologically important peptides - hormones, antibiotics and growth factors. Multimeric proteins, conjugated proteins and metallo proteins. Diversity of function. Covalent structure of proteins: Organization of protein structure into primary, secondary, tertiary and quaternary structures. N-terminal and C-terminal amino acid analysis. Sequencing techniques - Edman degradation. Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. Mass spectrometric analysis, tandem MS. Solid phase peptide synthesis

### **Unit 2 Extraction and characterization of proteins for downstream processing (28 Periods)**

Solubilization of proteins from their cellular and extracellular locations. Use of simple grinding methods, homogenization, ultrasonication, French press and centrifugation. Separation techniques : Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization. Ion-exchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography, HPLC and FPLC. Characterization of proteins: Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF, SDS-PAGE and 2-D electrophoresis. Three dimensional structures of proteins: Nature of stabilizing bonds - covalent and non covalent. Importance of primary structure in folding. The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns. Ramachandran map. Techniques used in studying 3-D structures - X-ray diffraction and NMR. Motifs and domains. Tertiary and quaternary structures. Structures of myoglobin and haemoglobin

### **Unit 3 Protein folding and protein structure databases (6 Periods)**

Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamics of folding and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases - Alzheimer's and Prion based. Introduction to protein structure databases: Protein sequence and structure databases (PDB). Use of sequence and domain information. Viewing protein structures using *in silico* tool

### **Unit 4 Myoglobin, haemoglobin and specialized proteins (12 Periods)**

Oxygen binding curves, influence of 2,3-BPG, CO<sub>2</sub> and Cl<sup>-</sup>. Hill plot. Cooperativity between subunits and models to explain the phenomena - concerted and sequential models. Haemoglobin disorders. Antibodies and actin-myosin motors. Antibody structure and binding to antigens. ATP activated actin - myosin contractions. Membrane proteins: Integral and membrane associated proteins. Hydrophathy plots to predict transmembrane domains. Significance of membrane proteins - bacteriorhodopsin.

**COURSE- BIOCHEM2C03PR  
PROTEINS (PRACTICAL)**

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

**SUGGESTED READINGS**

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

## **COURSE- BIOCHEM2C04TH ENZYMES (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Introduction to enzymes**

**(10 Periods)**

Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUBMB classification of enzymes. Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Features of enzyme catalysis, catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

### **Unit 2 Mechanism of action of enzymes and enzyme kinetics**

**(20 Periods)**

General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues. Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions. Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot.  $K_m$  and  $V_{max}$ ,  $K_{cat}$  and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme. Bisubstrate reactions: Types of bi bi reactions (sequential - ordered and random, ping pong reactions). Differentiating bi substrate mechanisms (diagnostic plots, isotope exchange).

### **Unit 3 Regulation of enzyme activity**

**(16 Periods)**

Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbamoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage- zymogen. Multienzyme complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase). Isoenzymes - properties and physiological significance (lactate dehydrogenase). Involvement of coenzymes in enzyme catalysed reactions TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid.

### **Unit 4 Enzyme inhibition and Applications of enzymes**

**(14 Periods)**

Enzyme inhibition: Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors. Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes.

**COURSE- BIOCHEM2C04PR**  
**ENZYMES (PRACTICAL)**

1. Partial purification of acid phosphatase from germinating mung bean.
2. Assay of enzyme activity and specific activity, e.g. acid phosphatase.
3. Effect of pH on enzyme activity
4. Determination of  $K_m$  and  $v_{max}$  using Lineweaver-Burk graph.
5. Enzyme inhibition - calculation of  $K_i$  for competitive inhibition.
6. Continuous assay of lactate dehydrogenase.
7. Coupled assay of glucose-6-phosphate dehydrogenase.

**SUGGESTED READINGS**

1. Lehninger: Principles of Biochemistry (2013) 6<sup>th</sup> ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.
2. Biochemistry (2011) 4<sup>th</sup> ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.
3. Fundamentals of Enzymology (1999) 3<sup>rd</sup> ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

**COURSE- BIOCHEM3C05TH**  
**METABOLISM OF CARBOHYDRATES AND LIPIDS (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Basic design of metabolism**

**(9 Periods)**

Autotrophs, heterotrophs, metabolic pathways, catabolism, anabolism, ATP as energy currency, reducing power of the cell. Starve-feed cycle: Well-fed state, early fasting state, fasting state, early re-fed state, energy requirements, reserves and caloric homeostasis, five phases of glucose homeostasis.

**Unit 2 Carbohydrate metabolism**

**(26 Periods)**

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. 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. Calvin cycle, regulation of calvin cycle, regulated synthesis of starch and sucrose, photorespiration, C<sub>4</sub> and CAM pathways, synthesis of cell wall polysaccharides, integration of carbohydrate metabolism in plant cell.

**Unit 3 Fatty acid metabolism**

**(12 Periods)**

Digestion, mobilisation and transport of cholesterol and triacylglycerols, fatty acid transport to mitochondria,  $\beta$  oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal oxidation,  $\omega$  oxidation, ketone bodies metabolism, ketoacidosis. Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation

**Unit 4 Biosynthesis of membrane lipids**

**(13 Periods)**

Synthesis of prostaglandins, leukotrienes and thromboxanes. Synthesis of cholesterol, regulation of cholesterol synthesis. Synthesis of steroids and isoprenoids. Synthesis of membrane phospholipids in prokaryotes and eukaryotes, respiratory distress syndrome, biosynthesis of triacylglycerol, biosynthesis of plasmalogens, sphingolipids and glycolipids, lipid storage diseases.

**COURSE- BIOCHEM3C05PR**  
**METABOLISM OF CARBOHYDRATES AND LIPIDS (PRACTICALS)**

1. Estimation of blood glucose.
2. Sugar fermentation of microorganisms.
3. Assay of salivary amylase.
4. Isolation of lecithin, identification by TLC, and its estimation.
5. Isolation of cholesterol from egg yolk and its estimation.

**SUGGESTED READINGS**

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



**COURSE- BIOCHEM3C06TH**  
**MEMBRANE BIOLOGY AND BIOENERGETICS (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Introduction to biomembranes (16 Periods)**

Composition of biomembranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, planar bilayer and liposomes as model membrane systems. Membrane structures and dynamics: Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton, lipid rafts, caveolae and tight junctions. RBC membrane architecture. Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics - FRAP, TNBS labeling etc. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.

**Unit 2 Membrane transport (16 Periods)**

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins. Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na<sup>+</sup>-glucose symporter. ABC family of transporters - MDR, CFTR. Group translocation. Ion channels - voltage-gated ion channels (Na<sup>+</sup>/K<sup>+</sup> voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin. Vesicular transport and membrane fusion: Types of vesicle transport and their function - clathrin, COP I and COP II coated vesicles. Molecular mechanism of vesicular transport. Membrane fusion. Receptor mediated endocytosis of transferrin.

**Unit 3 Introduction to bioenergetics (10 Periods)**

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

**Unit 4 Oxidative phosphorylation and photophosphorylation (18 Periods)**

Mitochondria Electron transport chain - its organization and function. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. F<sub>0</sub>F<sub>1</sub>ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis. Alternative respiratory pathways in plants. General features of

photophosphorylation, historical background, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes and resonance energy transfer. Bacterial photophosphorylation in purple bacteria, Green sulfur bacteria and *Halobacterium salinarum*. Photophosphorylation in plants - structure of chloroplast, molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex and action of herbicides. Cyclic photophosphorylation and its significance. Photo inhibition. Evolution of oxygenic photosynthesis.

**COURSE- BIOCHEM3C06PR**  
**MEMBRANE BIOLOGY AND BIOENERGETICS (PRACTICALS)**

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. RBC ghost cell preparation and to study the effect of detergents on membranes.
4. Separation of photosynthetic pigments by TLC.
5. Isolation of mitochondria from liver and assay of marker enzyme SDH.
6. Study photosynthetic O<sub>2</sub> evolution in hydrilla plant.
7. Isolation of chloroplast from spinach leaves, estimation of chlorophyll and photosynthetic activity.

**SUGGESTED READINGS**

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

**COURSE- BIOCHEM3C07TH**  
**METABOLISM OF AMINO ACIDS AND NUCLEOTIDES (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Overview of amino acid metabolism**

**(18 Periods)**

Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups. Digestion and absorption of dietary proteins. Protein calorie malnutrition - Kwashiorkor and Marasmus. Nitrogen balance, transamination, role of pyridoxal phosphate, glucose-alanine cycle, Krebs's bicycle, urea cycle and inherited defects of urea cycle. Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Metabolism of one carbon units. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methylmalonic acidemia (MMA), homocystinuria and Hartnup's disease.

**Unit 2 Biosynthesis of amino acids**

**(16 Periods)**

Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation. Biosynthesis of creatine and creatinine, polyamines (putrescine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.

**Unit 3 Metabolism of purine and pyrimidine nucleotides**

**(20 Periods)**

*De novo* synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways. Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme 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.

**Unit 4 Integration of metabolism**

**(6 Periods)**

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

**COURSE- BIOCHEM3C07PR**  
**METABOLISM OF AMINO ACIDS AND NUCLEOTIDES (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.

**SUGGESTED READINGS**

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

## **COURSE- BIOCHEM4C08TH HUMAN PHYSIOLOGY (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Homeostasis and respiration**

**(16 Periods)**

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. **Respiration:** Organization of the pulmonary system. Mechanism of respiration, pulmonary ventilation and related volumes, pulmonary circulation. Principles of gas exchange and transport. Regulation of respiration. Pulmonary oedema and regulation of pleural fluid. Hypoxia, hypercapnea, pulmonary distress, emphysema, ARDS.

### **Unit 2 Cardiovascular and renal physiology**

**(16 Periods)**

Pressure, flow and resistance. Anatomy of heart. Physiology of the cardiac muscle, automaticity of the cardiac muscle contraction, excitation contraction coupling, relationship between cardiac cycle, heart sound, ventricular volumes and the ECG, control of cardiac function and output. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues. Portal circulations. Arterial pressure and its regulation. Hypertension, congestive heart disease, atherosclerosis and myocardial infarction. Anatomy of the kidney and the nephron. Regulation of renal blood flow. Cell biology of the Bowman's capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Micturition reflex and voluntary control of micturition. Regulation of ECF electrolyte and water content, blood volume and long term blood pressure. Blood buffer systems, renal and pulmonary control of blood pH, renal clearance. Assessment of kidney function. Acidosis and alkalosis. Glomerular nephritis, renal failure, dialysis and diuretics.

### **Unit 3 Gastrointestinal, hepatic physiology and Musculoskeletal system**

**(10 Periods)**

Histology of the gastrointestinal tract. Propulsion and motility of food and digested material. Enteric reflexes, secretory functions of the gastrointestinal tract, digestion and absorption of macro and micronutrients. Peptic ulcer, Sprue, celiac disease, IBD, regurgitation, diarrhoea and constipation. Anatomy of the hepatic lobule and blood flow into the liver. Formation and secretion of bile. enterohepatic cycle, reticuloendothelial system, metabolic importance of liver. Liver function tests. Jaundice, liver cirrhosis and fatty liver. **Musculoskeletal system** : Bone structure and formation. Physiology of muscle contraction in striated and non-striated muscle.

### **Unit 4 Reproductive physiology and Neurochemistry and neurophysiology**

**(18 Periods)**

Sex determination and differentiation. Development of female and male genital tracts. Spermatogenesis, capacitation and transport of sperm, blood testis barrier. Ovarian function and its control. Uterine changes, fertilization and implantation. Placenta as a feto- maternal unit, gestation and parturition. Central Nervous system. Peripheral Nervous system. Blood brain barrier and CSF. Membrane potentials. Synaptic transmission. Neurotransmitters. Sensory receptors and neural pathways. Somatic sensation, EEG, sleep, coma, learning and memory.

**COURSE- BIOCHEM4C08PR**  
**HUMAN PHYSIOLOGY (PRACTICALS)**

1. Hematology.
  - a. RBC and WBC counting
  - b. Differential leucocyte count.
  - c. Clotting time.
2. Estimation of haemoglobin.
3. Separation of plasma proteins.
4. Determination of total iron binding capacity.
5. Pulmonary function tests, spirometry and measurement of blood pressure.
6. Separation of isoenzymes of LDH by electrophoresis.
7. Histology of connective tissue, liver and/ brain permanent slides.
8. Case studies (Renal clearance, GFR, ECG).

**SUGGESTED READINGS**

1. Vander's Human Physiology (2008) 11<sup>th</sup> ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publications (New York), ISBN: 978-0-07-128366-3.
2. Harper's Biochemistry (2012) 29<sup>th</sup> ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN:978-0-07-176-576-3.
3. Textbook of Medical Physiology (2011) 10<sup>th</sup> ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1-4160-4574-8.
4. Fundamental of Anatomy and Physiology (2009), 8<sup>th</sup> ed., Martini, F.H. and Nath, J.L., Pearson Publications (San Francisco), ISBN: 10:0-321-53910-9 / ISBN: 13: 978-0321-53910-6.

**COURSE- BIOCHEM4C09TH**  
**GENE ORGANIZATION, REPLICATION AND REPAIR(THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Structure of DNA, genes and genomic organization (16 Periods)**

DNA structure, features of the double helix, various forms of DNA, denaturation and reassociation of DNA. Genome sequence and chromosome diversity, definition of a gene, organization of genes in viruses, bacteria, animals and plants. Nucleosome structure and packaging of DNA into higher order structures.

**Unit 2 Replication of DNA (20 Periods)**

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, relationship between replication and cell division, replication in eukaryotes. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine. Supercoiling of DNA and its importance, topoisomerases, critical role of topoisomerases in cell, topoisomerase inhibitors and their application in medicine.

**Unit 3 Recombination and transposition of DNA (12 Periods)**

Homologous recombination, proteins and enzymes in recombination, site-specific recombination, serine and tyrosine recombinases, biological roles of site-specific recombination, transposition, three classes of transposable elements, importance of transposable elements in horizontal transfer of genes and evolution.

**Unit 4 Molecular basis of mutations and DNA repair (12 Periods)**

Importance of mutations in evolution of species. Types of mutations - transition, transversions, frame shift mutations, mutations induced by chemicals, radiation, transposable elements, Ames test. Replication errors and mismatch repair system, repair of DNA damage, direct repair, base excision repair, nucleotide excision repair, recombination repair, translesion DNA synthesis.



**CCOURSE- BIOCHEM4C09PR**  
**GENE ORGANIZATION, REPLICATION AND REPAIR (PRACTICALS)**

1. Verification of Chargaff's rule by paper chromatography.
2. Ultraviolet absorption spectrum of DNA and RNA.
3. Determination of DNA and RNA concentration by A260nm.
4. Determination of the melting temperature and GC content of DNA.
5. To study the viscosity of DNA solutions.
6. Isolation of chromosomal DNA from *E. coli* cells.

**SUGGESTED READINGS**

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

**COURSE- BIOCHEM4C10TH**  
**HORMONE : BIOCHEMISTRY AND FUNCTION (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Introduction to endocrinology (8 Periods)**

Functions of hormones and their regulation. Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. General introduction to Endocrine methodology.

**Unit 2 Hormone mediated signaling (14 Periods)**

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP<sub>3</sub>, DAG, Ca<sup>2+</sup>, NO. Effector systems - adenylyclase, guanylyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin, erythropoietin receptor; ras - MAP kinase cascade, JAK - STAT pathway. Steroid hormone/ thyroid hormone receptor mediated gene regulation. Receptor regulation and cross talk. Growth factors: PDGF, EGF, IGF-II, and erythropoietin.

**Unit 3 Hypothalamic, pituitary and thyroid hormones (20 Periods)**

Hypothalamic - pituitary axis. 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. Thyroid hormone: Thyroid gland. Biosynthesis of thyroid hormone and its regulation; its physiological and biochemical action. Pathophysiology - Goiter, Graves disease, cretinism, myxedema, Hashimoto's disease. Hormones regulating Ca<sup>2+</sup> homeostasis: PTH, Vitamin D and calcitonin. Mechanism of Ca<sup>2+</sup> regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

**Unit 4 Pancreatic, GI tract, adrenal and reproductive hormones (18 Periods)**

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. Pathophysiology - diabetes type I and type II. Aldosterone, renin angiotensin system, cortisol, epinephrine and norepinephrine. Fight or flight response, stress response. Pathophysiology - Addison's disease, Conn's syndrome, Cushing syndrome. Reproductive hormones: Male and female sex hormones. Interplay of hormones during reproductive cycle, pregnancy, parturition and lactation. Hormone based contraception.

**COURSE- BIOCHEM4C10PR**  
**HORMONE: BIOCHEMISTRY AND FUNCTION (PRACTICALS)**

1. Glucose tolerance test.
2. Estimation of serum  $\text{Ca}^{2+}$ .
3. Estimation of serum T4.
4. HCG based pregnancy test.
5. Estimation of serum electrolytes.
6. Case studies.

**SUGGESTED READINGS**

1. Lehninger: Principles of Biochemistry (2013) 6<sup>th</sup> 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.
2. Vander's Human Physiology (2008) 11<sup>th</sup> ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
3. Endocrinology (2007) 6<sup>th</sup> ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
4. The Cell: A Molecular Approach (2009) 5<sup>th</sup> Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893-300-6.

## **COURSE- BIOCHEM5C11TH CONCEPTS IN GENETICS (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Introduction to model organisms and Mendelism (14 Periods)**

Model organisms: *Escherichia coli*, *Saccharomyces cerevisiae*, *Drosophila melanogaster*, *Caenorhabditiselegans*, *Daniorerio* and *Arabidopsis thaliana*, Basic principles of heredity. Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences.

### **Unit 2 Extention of Mendelism (10 Periods)**

Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropy gene interaction - epistatic and non epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy. Complementation test, limitations of *cis-trans* test, intragenic complementation, rII locus of phage T4 and concept of cistron. Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.

### **Unit 3 Linkage, crossing over and mapping techniques (16 Periods)**

Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in *Drosophila*, detection of linked loci by pedigree analysis in humans and somatic cell hybridization for positioning genes on chromosomes. Human pedigree analysis: Pedigree conventions, characteristics of dominant and recessive inheritance. Applications of pedigree analysis. Chromosomal aberration: Variations in chromosome number- monosomy and trisomy of sex and autosomes. Variations in chromosome structure - inversions, deletions, duplications and translocations.

### **Unit 4 Inheritance of complex traits & population genetics (20 Periods)**

Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hardy-Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle. Evolutionary genetics: Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation. The genetic control of development and sex determination: Model organism for genetic analysis, *Drosophila* development, maternal effect genes, morphogens and zygotic gene activity in development, sex chromosomes and sex determination, dosage compensation of X-linked genes. Organelle heredity and epigenetics: Extra nuclear inheritance, tests for organelle heredity and maternal effect, epigenetic mechanisms of transcriptional regulation & genomic imprinting.

**COURSE- BIOCHEM5C11PR**  
**CONCEPTS IN GENETICS (PRACTICALS)**

1. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.
2. Induction of polyploidy in onion roots.
3. Smear technique to demonstrate sex chromatin in buccal epithelial cells.
4. Monohybrid crosses in *Drosophila* for studying autosomal and sex linked inheritance.
5. PTC testing in a population and calculation of allele and genotype frequencies.
6. Study of abnormal human karyotype and pedigrees (dry lab)
7. Conjugation in bacteria

**SUGGESTED READINGS**

1. Genetics (2012) 6<sup>th</sup> ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
2. Genetics - A Conceptual Approach (2012), 4<sup>th</sup> ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.
3. An Introduction to Genetic Analysis (2010), 10<sup>th</sup> ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN:10: 1- 4292-2943-8.

## **COURSE- BIOCHEM5C12TH**

### **GENE EXPRESSION AND REGULATION (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

#### **Unit 1 Biosynthesis of RNA in prokaryotes and eukaryotes (16 Periods)**

RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, 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. Biosynthesis of RNA in eukaryotes: Comparison between prokaryotic and eukaryotic transcription. Transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, various types of RNA processing, transcription by RNA polymerase I and III. Inhibitors of eukaryotic transcription and their applications. Comparison of fidelity of transcription and replication.

#### **Unit 2 RNA splicing and genetic code (10 Periods)**

Chemistry of RNA splicing, the spliceosome machinery, splicing pathways, group I and group II introns, alternative splicing, exon shuffling, RNA editing. The genetic code: Degeneracy of the genetic code, wobble in the anticodon, features of the genetic code, nearly universal code.

#### **Unit 3 Biosynthesis of proteins and protein targeting (16 Periods)**

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. Protein targeting and degradation. Post translational modifications, glycosylation, signal sequences for nuclear transport, bacterial signal sequences, import of proteins by receptor mediated endocytosis, specialized systems for protein degradation.

#### **Unit 4 Regulation of gene expression in prokaryotes and eukaryotes (18 Periods)**

Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon, induction of SOS response, synthesis of ribosomal proteins, regulation by genetic recombination, transcriptional regulation in  $\lambda$  bacteriophage. Regulation of gene expression in eukaryotes. Heterochromatin, euchromatin, chromatin remodeling, regulation of galactose metabolism in yeast, regulation by phosphorylation of nuclear transcription factors, regulatory RNAs, riboswitches, RNA interference, synthesis and function of miRNA molecules, phosphorylation of nuclear transcription factors.

**COURSE- BIOCHEM5C12PR**  
**GENE EXPRESSION AND REGULATION (PRACTICALS)**

1. Extraction of total nucleic acids from plant tissue.
2. Diauxic growth curve effect.
3. Isolation of mRNA from yeast by affinity chromatography.
4. Effect of inhibitors on protein synthesis.
5. Accumulation of protein due to proteasome inhibitors.

**SUGGESTED READINGS**

1. Lehninger: Principles of Biochemistry (2013) 6<sup>th</sup> ed., Nelson, D.L. and Cox, M.M., W.H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.
2. Molecular Biology of the Gene (2008) 6<sup>th</sup> 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.

**COURSE- BIOCHEM6C13TH**  
**GENETIC ENGINEERING AND BIOTECHNOLOGY(THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Introduction to recombinant DNA technology (10 Periods)**

Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules, separation of DNA by gel electrophoresis. Extraction and purification of plasmid and bacteriophage DNA. Joining of DNA fragments: Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters. Synthetic oligonucleotides, synthesis and use.

**Unit 2 Cloning vectors for prokaryotes and eukaryotes (10 Periods)**

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and  $\lambda$  bacteriophage. Vectors for yeast, higher plants and animals.

**Unit 3 Transfection, clone identification, polymerase chain reaction and DNA sequencing (22 Periods)**

Uptake of DNA by cells, preparation of competent cells. Selection for transformed cells. Identification for recombinants - insertional inactivation, blue-white selection. Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Introduction of DNA into animal cells, electroporation. 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. Fundamentals of polymerase chain reaction, designing primers for PCR. Studying PCR products. Cloning PCR products. Real time PCR. DNA sequencing: DNA sequencing by Sanger's method, modifications based on Sanger's method. Automated DNA sequencing. Pyrosequencing.

**Unit 4 Expression of cloned genes and Applications of genetic engineering in Biotechnology (18 Periods)**

Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Challenges in producing recombinant protein in *E. coli*. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins. Applications of genetic engineering in Biotechnology: Site-directed mutagenesis and protein engineering. Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy. Applications in agriculture - plant genetic engineering, herbicide resistant crops, problems with genetically modified plants, safety concerns.



**COURSE- BIOCHEM6C13PR**  
**GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICALS)**

1. Isolation of plasmid DNA from *E. coli* cells.
2. Digestion of plasmid DNA with restriction enzymes.
3. Amplification of a DNA fragment by PCR.
4. Transformation of *E. coli* cells with plasmid DNA.
5. Hyper expression of poly histidine-tagged recombinant protein and purification using Ni-affinity resin.

**SUGGESTED READINGS**

1. Gene Cloning and DNA Analysis (2010) 6<sup>th</sup> ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
2. Principles of Gene Manipulation and Genomics (2006) 7<sup>th</sup> ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).

## **COURSE- BIOCHEM6C14TH IMMUNOLOGY (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Cells and organs of the immune system (14 Periods)**

Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT). Innate immunity and leukocyte extravasation: Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response. Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes.

### **Unit 2 Antibody structure and function (14 Periods)**

Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family. Generation of receptor diversity: Dreyer-Bennett hypothesis, multigene organization of Ig locus, mechanism of V region DNA rearrangement, ways of antibody diversification. Biology of the B lymphocyte: Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response, anatomical distribution of B cell populations.

### **Unit 3 Complement system, MHC complex and antigen presentation (20 Periods)**

Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies. 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. 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 4 Tolerance, autoimmunity, hypersensitivity and transplantation immunology (12 Periods)**

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. Transplantation immunology and vaccines: Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy and privileged sites. Vaccines - active and passive immunization, types of vaccines.

**COURSE- BIOCHEM6C14PR**  
**IMMUNOLOGY (Practicals)**

1. Isolation of lymphocytes from blood and macrophages from peritoneal cavity or spleen.
2. Purification of immunoglobulins.
3. Assays based on precipitation reactions - Ouchterlony double diffusion (ODD) and Mancini radial immunodiffusion.
4. Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
5. Enzyme linked immune-sorbent assay (ELISA).

**SUGGESTED READINGS**

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

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)  
DISCIPLINE SPECIFIC ELECTIVE**

**COURSE- BIOCHEM5DSE01TH**  
**NUTRITIONAL BIOCHEMISTRY (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Introduction to nutrition and energy metabolism (14 Periods)**

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.

**Unit 2 Dietary carbohydrates, lipids, proteins and health (20 Periods)**

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. 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. 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.

**Unit 3 Fat and water soluble vitamins and minerals (16 Periods)**

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. 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

**Unit4 Nutritional status, food and drug interactions and nutraceuticals (10 Periods)**

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. 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.

**COURSE- BIOCHEM5DSE01PR**  
**NUTRITIONAL BIOCHEMISTRY (PRACTICALS)**

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.

## **COURSE- BIOCHEM5DSE02TH BASIC MICROBIOLOGY (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 History of development of microbiology (12 Periods)**

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 microbiological techniques and golden era of microbiology, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

### **Unit 2 Diversity of microbial world (18 Periods)**

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.

### **Unit 3 Viruses and bacteria (14 Periods)**

An introduction to viruses with special reference to the structure and replication of the following: Poxvirus, Poliovirus, HIV, T4 and  $\lambda$  phage, lytic and lysogenic cycles. An account of typical eubacteria, chlamydiae & rickettsiae (obligate intracellular parasites), mycoplasma, and archaeobacteria (extremophiles). Applications of bacteria in industry, environment and food.

### **Unit 4 Algae, fungi and protozoa (16 Periods)**

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. 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. General characteristics with special reference to Amoeba. Scope of Microbiology.



**COURSE- BIOCHEM5DSE02PR**  
**BASIC MICROBIOLOGY (PRACTICALS)**

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

**COURSE- BIOCHEM5DSE03TH**  
**MOLECULAR BASIS OF NON-INFECTIOUS HUMAN DISEASES (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Nutritional disorders** **(10 Periods)**

Overview of major and minor nutrient components in the diet. Balanced diet and the concept of RDA. Nutrient deficiencies; Kwashiorkor and Marasmus, Scurvy, beriberi, pellagra and B12 deficiency, Xerophthalmia and Night blindness, Vitamin D deficiency, Vitamin K deficiency. Discuss with relation to biochemical basis for symptoms.

**Unit 2 Metabolic and lifestyle disorders** **(12 Periods)**

Obesity and eating disorders like Anorexia nervosa and Bulimia. Diabetes mellitus A metabolic syndrome and the relationship with hypertension, obesity, hypothyroidism and stress. Cardiovascular 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.

**Unit 3 Multifactorial complex disorders and cancer** **(20 Periods)**

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. Disorders of mood : Schizophrenia, dementia and anxiety disorders. Polycystic ovarian syndrome, Parkinson's disease, ALS.

**Unit 4 Diseases due to misfolded proteins and monogenic disease** **(18 Periods)**

Introduction to protein folding and proteasome removal of misfolded proteins; etiology and molecular basis for Alzheimer's, Prion diseases, Huntington's Chorea, sickle cell anemia, Thalassemia. In born errors in metabolism: PKU, Alkaptonuria, Maple syrup urine disease; Receptor and transport defects: Cystic fibrosis, Long QT syndrome, familial hypercholesterolemia, Achondroplasia. Hemoglobinopathies and clotting disorders.

**COURSE- BIOCHEM5DSE03PR**  
**MOLECULAR BASIS OF NON-INFECTIOUS HUMAN DISEASES**  
**(PRACTICALS)**

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.

**COURSE-BIOCHEM5DSE04TH**  
**MOLECULAR BASIS OF INFECTIOUS DISEASES (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Classification of infectious agents (12 Periods)**

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.

**Unit 2 Overview of diseases caused by bacteria (18 Periods)**

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.

**Unit 3 Overview of diseases caused by Viruses (12 Periods)**

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

**Unit 4 Overview of diseases caused by Parasites and other organism (18 Periods)**

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

**COURSE- BIOCHEM5DSE04PR**  
**MOLECULAR BASIS OF INFECTIOUS DISEASES (PRACTICALS)**

1. Permanent slides of pathogens. Mycobacterium tuberculosis, Leishmania, Plasmodium falciparum
2. WIDAL test
3. Gram staining
4. Acid fast staining 4. PCR based diagnosis
5. Dot Blot ELISA

**SUGGESTED READINGS**

1. Prescott, Harley, Klein's Microbiology (2008) 7<sup>th</sup> Ed., Willey, J.M., Sherwood, L.M., Woolverton, C.J. McGraw Hill International Edition (New York) ISBN: 978-007-126727.
2. Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition, Volume, 2. Churchill Livingstone Elsevier.
3. Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J. Ryan, C. George Ray, Publisher: McGraw-Hill
4. Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences

**COURSE- BIOCHEM6DSE05TH  
DEVELOPMENTAL BIOLOGY (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**UNIT 1 Gametogenesis and fertilization (10 Periods)**

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

**UNIT 2 Early embryonic development (20 Periods)**

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

**UNIT 3 Embryonic differentiation (20 Periods)**

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

**UNIT 4 Organogenesis (10 Periods)**

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

**COURSE- BIOCHEM6DSE05PR  
DEVELOPMENTAL BIOLOGY  
(PRACTICAL)PRACTICALS**

1. Identification of developmental stages of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of developmental stages of *Anopheles*.
4. Study of the developmental stages of *Drosophila* from stock culture/ photographs..
5. Study of different types of placenta.

**SUGGESTED READING**

1. Gilbert, S. F. (2006). *Developmental Biology*, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). *An introduction to Embryology*, International Thomson Computer Press.
3. Kalthoff, (2000). *Analysis of Biological Development*, II Edition, McGraw-Hill Professional.

**COURSE- BIOCHEM6DSE06TH  
ADVANCED CELL BIOLOGY (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Plasma Membrane and Nuclear Transport (10 Periods)**

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

**Unit 2 Cell-Cell Interaction (18 Periods)**

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.

**Unit 3 Cell Cycle and Programmed Cell Death (16 Periods)**

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.

**Unit 4 Cancer Biology and Advanced Methods in Cell Biology (16 Periods)**

Development and causes of cancer; Genetic Basis of Cancer; Oncogenes, Tumor Viruses; Molecular Approach to Cancer Treatment. Ultracentrifugation, Fluorescence Microscopy-FACS, Confocal Microscopy, Electron Microscopy, Plant and Animal Cell Culture, Immunohistochemistry.



**COURSE-BIOCHEM6DSE06PR**  
**ADVANCED CELL BIOLOGY (PRACTICALS)**

1. Isolation of organelles by sub-cellular fractionation.
2. Study of cell viability /death assay by use of trypan blue and MTT assay.
3. Study of apoptosis through analysis of DNA fragmentation patterns in mitochondria.
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.

## **COURSE- BIOCHEM6DSE07TH PLANT BIOCHEMISTRY (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Introduction to plant cell structure, photosynthesis and carbon assimilation and transportation (12 Periods)**

Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes. Structure of PSI and PSII complexes, Light reaction, Cyclic and non-cyclic photophosphorylation, Calvin cycle and regulation; C<sub>4</sub> cycle and Crassulacean acid metabolism (CAM), Photorespiration.

### **Unit 2 Respiration (12 Periods)**

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

### **Unit 3 Nitrogen metabolism and regulation of plant growth (18 Periods)**

Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. 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. Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light.

### **Unit 4 Secondary metabolites and plant tissue culture (18 Periods)**

Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids. Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.

**COURSE- BIOCHEM6DSE07PR**  
**PLANT BIOCHEMISTRY (PRACTICALS)**

1. Induction of hydrolytic enzymes proteinases /amylases/lipase during germination
2. Extraction and assay of Urease from Jack bean
3. Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables
4. Separation of photosynthetic pigments by TLC
5. Culture of plant plants (explants).

**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 ISBN-10:0122146743, ISBN-13:978-0122146749

## **COURSE- BIOCHEM6DSE08TH RESEARCH METHODOLOGY**

**Semester end examination: 80 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Introduction to research methodology** **(5 Periods)**  
Objectives and motivation in research.

**Unit 2 Defining the research problem** **(8 Periods)**  
Selecting and defining a research problem, Reviewing and conducting literature search, developing a research plan.

**Unit 3 Designing of experiment** **(12 Periods)**  
Different experimental designs – single and multifactorial design, making measurements and sources of error in measurements, Methods of data collection and record keeping.

**Unit 4 Data processing and statistical analysis** **(35 Periods)**  
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) 6<sup>th</sup> 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) 2<sup>nd</sup> ed., Kothari C.R., New Age International Publishers.
4. Research Methodology: A Step by Step Guide for Beginners (2005) 2<sup>nd</sup> ed., Kumar R., Pearson Education.
5. Biostatistics: A Foundation for Analysis in the Health Sciences (2009).

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)  
GENERIC ELECTIVE**

**COURSE- BIOCHEM1GE01TH**

## BIOCHEMISTRY OF CELL (THEORY)

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Biomolecules in their cellular environment, Amino acids and peptides (16 Periods)**

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

### **Unit 2 Sugars and polysaccharides**

**(10 Periods)**

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

### **Unit 3 Nucleosides, nucleotides and nucleic acids**

**(10 Periods)**

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

### **Unit 4 Lipids, Vitamins, coenzymes and metal ions and signalling molecules (24 Periods)**

Various classes of lipids and their distribution, storage lipids, structural lipids in membranes, lipids as signals, cofactors and pigments. Occurrence and nutritional role. Coenzymes and their role in metabolism. Metal ion containing biomolecules - heme, porphyrins and cyanocobalamin; their biological significance. Second messengers - cAMP, cGMP, IP<sub>3</sub>, diacyl glycerol, Ca<sup>2+</sup>, NO. Brief account of their importance and role in signalling and signal transduction.

**COURSE- BIOCHEM1GE01PR**  
**BIOCHEMISTRY OF CELL (PRACTICALS)**

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**

1. Lehninger: Principles of Biochemistry (2013) 6<sup>th</sup> 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) 7<sup>th</sup> ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

## **COURSE- BIOCHEM2GE02TH INTERMEDIARY METABOLISM (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Basic concepts and design of metabolism**

**(8 Periods)**

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

### **Unit 2 Carbohydrate metabolism**

**(18 Periods)**

Glycolysis and gluconeogenesis: Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis. Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis. The citric acid cycle: Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway. Oxidative phosphorylation: The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol-3-phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.

### **Unit 3 Photosynthesis, Calvin cycle and pentose phosphate pathway**

**(16 Periods)**

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, C<sub>4</sub> pathway. Pentose phosphate pathway, importance and regulation. Fatty acid synthesis and degradation: TAG as energy source,  $\beta$  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.

### **Unit 4 Amino acid catabolism and anabolism**

**(18 Periods)**

Protein degradation to amino acids, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation, synthesis of non-essential amino acids. Nucleotide metabolism: Biosynthesis - *de novo* and salvage pathways, regulation of nucleotide synthesis by feedback inhibition, degradation and excretion. Integration of metabolism: 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.



**COURSE- BIOCHEM2GE02PR**  
**INTERMEDIARY METABOLISM (PRACTICALS)**

1. Alcohol fermentation by yeast.
2. H<sub>2</sub>S 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) 7<sup>th</sup> ed., Campbell, M.K. and Farrel, S.O. Brooks/Cole, Cengage Learning (Boston), ISBN: 13:978-1-111-42564-7.

**COURSE- BIOCHEM3GE03TH**  
**GENE ORGANIZATION, EXPRESSION AND REGULATION(THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Structure of genes, chromosomes and Replication of genomes (20 Periods)**

Definition of a gene, chromosomal organization of genes in viruses, bacteria and eukaryotes. Supercoiling of DNA. General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Replication of DNA and telomeres in linear chromosomes. Replication of RNA genomes.

**Unit 2 Recombination of DNA and Gene mutations and repair (10 Periods)**

Homologous genetic recombination, Holliday model, proteins and enzymes mediating recombination. Molecular basis of mutations, multiple repair systems, mismatch repair, base excision repair, nucleotide excision repair, direct repair and translesion DNA synthesis.

**Unit 3 Transcription of genes and RNA processing (14 Periods)**

General features of gene transcription, prokaryotic and eukaryotic RNA polymerases, stages of transcription, initiation, elongation and termination. Inhibitors of transcription. Processing of eukaryotic mRNA, splicing of introns, alternate splicing and editing, ribosomal and tRNA processing.

**Unit 4 Protein synthesis and Regulation of gene expression (16 Periods)**

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. 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.

**COURSE- BIOCHEM3GE03PR**  
**GENE ORGANIZATION, EXPRESSION AND REGULATION**  
**(PRACTICALS)**

1. Quantitative determination of DNA and RNA by absorbance at 260 nm and using A<sub>260</sub>/A<sub>280</sub> 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) 6<sup>th</sup> 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.

**COURSE- BIOCHEM4GE04TH**  
**FUNDAMENTALS OF CELL BIOLOGY AND IMMUNOLOGY(THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1 Cells, organelles, membrane structure and function (14 Periods)**

Prokaryotic and eukaryotic cells. Plasma membrane, the nucleus, intracellular membranes and organelles, mitochondria, chloroplast, endoplasmic reticulum, Golgi complex, lysosome, peroxisome, cytoskeleton, extracellular matrix, cell wall. Mitosis and meiosis. Composition of membranes, membrane lipids, membrane proteins, isolation and characterization. Integral, peripheral and lipid anchored protein. Transport across membranes, simple and facilitated diffusion, active transport.

**Unit 2 Endoplasmic reticulum, golgi complex (12 Periods)**

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

**Unit 3 Signaling mechanisms, messengers and receptors and cell cycle (14 Periods)**

Chemical signals and cellular receptors. G-protein linked receptors, protein kinase associated receptors. Hormonal signalling, cell signals and apoptosis. Cell cycle and its regulation. Overview of the cell cycle. Regulation of the cell cycle, cyclin dependent kinases.

**Unit 4 Overview of the immune system, innate humoral and cell mediated immunity (20 Periods)**

Self versus non-self. Humoral and cellular immunity. Innate and adaptive immunity. Cells of the immune system, primary and secondary lymphoid tissues and organs. Cellular and humoral responses. Defensins. Non-immunological barriers. Cells and soluble mediators of innate immunity. Acute phase proteins. Cytokines. Complement system. Humoral B cell response: Structure of antibodies, types of immunoglobulins, generation of antibody diversity, B cell activation, theory of clonal selection, formation of plasma and memory cells; T-independent B-response; antigens, haptens carriers and adjuvants. T-cell development, MHC locus. Structure, function and distribution of MHC glycoproteins. Cell mediated immunity: Antigen processing and presentation. Cell mediated immune responses by different T-cell sub populations. Hypersensitive reactions. Concept of autoimmunity.

**COURSE- BIOCHEM4GE04PR**  
**FUNDAMENTALS OF CELL BIOLOGY AND IMMUNOLOGY**  
**(PRACTICALS)**

1. Visualization of animal and plant cell by methylene blue.
2. Identification of different stages of mitosis in onion root tip.
3. Isolation of organelles by sub-cellular fractionation.
4. Isolation of IgG from serum by ion exchange chromatography.
5. Antigen-antibody interaction by Ouchterlony double diffusion.

**SUGGESTED READINGS**

1. The World of the Cell (2009), 7<sup>th</sup> ed., Becker W.M., Kleinsmith, L.J., Hardin., J., Bertoni, and G.P., Pearson Benjamin Cummings (CA), ISBN: 978-0-321-55418-5.
2. Prescott, Harley, Klein's Microbiology (2008) 7<sup>th</sup> Ed., Willey, J.M., Sherwood, L.M., Woolverton, C.J. McGraw Hill International Edition (New York) ISBN: 978-007- 126727.
3. Molecular Cell Biology (2013) 7<sup>th</sup> Ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., Macmillan International Edition (New York), ISBN:13: 978-1-4641-0981-2.
4. 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.
5. Immunology: A Short Course (2009) 6<sup>th</sup> ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

**COURSE- BIOCHEM4GE05TH**  
**MOLECULAR DIAGNOSTICS (THEORY)**

**Semester end examination: 50 marks**

**Practical examination: 30 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1** **(15 Periods)**

**Enzyme Immunoassays:**

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immunohistochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

**Unit 2** **(15 Periods)**

Molecular methods in clinical microbiology:

Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

Laboratory tests in chemotherapy:

Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

**Unit 3** **(18 Periods)**

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Anti-idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno fluorescence. Radioimmunoassay.

**Unit 4** **(12 Periods)**

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

## **COURSE- BIOCHEM4GE05PR MOLECULAR DIAGNOSTICS (PRACTICAL)**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform/demonstrate RFLP and its analysis
2. Kirby-Bauer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
3. A kit-based detection of a microbial infection (Widal test)
4. Study of Electron micrographs (any four).
5. Perform any one immuno diagnostic test ( Typhoid, Malaria, Dengue)

### **SUGGESTED READING**

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Century-Crofts publication.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)  
ABILITY ENHANCEMENT COURSES**



**COURSE: ENGL103**  
**ENGLISH COMMUNICATION (THEORY)**

**COURSE- ENVS2AECC02**  
**ENVIRONMENT SCIENCE(THEORY)**

**Semester end examination: 80 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**UNIT 1**

**(20 Periods)**

Introduction to environmental studies & ecosystems: Multidisciplinary nature of environmental studies: Scope and importance; What is an ecosystem? The structure and function of ecosystem, Energy flow in an ecosystem, food chains, food webs and ecological succession, forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems; Levels of biological diversity such as genetic, species and ecosystem diversity; biogeography zones of India, biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation, endangered and endemic species of India, threats to biodiversity, habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions, conservation of biodiversity, *in-situ* and *ex-situ* conservation of biodiversity, concept of sustainability and sustainable development.

**UNIT 2**

**(15 Periods)**

Natural resources & its management and conservation: Land resources and land use change: Land degradation, soil erosion and desertification; Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations; Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state); Energy resources: Renewable and non renewable energy sources, use of alternate energy sources and growing energy needs.

**UNIT 3**

**(15 Periods)**

Environmental pollution & management: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, Solid waste management: Control measures of urban and industrial waste. Climate change, global warming, ozone layer depletion, acid rain and their impact on human communities and agriculture. Environment Laws: Environment Protection Act, Air (Prevention & Control of Pollution) Act, Water (Prevention and control of pollution) Act, Wildlife Protection Act, Forest Conservation Act; International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD); Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

## UNIT 4

(10 Periods)

Environment & social issues: Human population growth: Impacts on environment, human health and welfare; Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; environmental communication and public awareness.

### SUGGESTED READINGS:

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
4. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
7. McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29-64). Zed Books.
8. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
9. Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
10. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
11. Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.
12. Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.
13. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. Sri Chand Publishing, New Delhi.
14. Soini, E., Pijanowski, B., and Ewing, H. (eds). 2013. Conservation Biology: Voices from the Tropics. Springer, New York.
15. Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York: Norton.
16. World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press.

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)  
SKILL ENHANCEMENT COURSES**

## **COURSE- BIOCHEM3SEC01TH TOOLS AND TECHNIQUES IN BIOCHEMISTRY**

**Semester end examination: 80 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Biochemical reagents and solutions**

**(12 Periods)**

Safety practices in the laboratory. Preparation and storage of solutions. Concepts of solution concentration and storing solutions. Quantitative transfer of liquids, Preparation of a reagent of given molarity.

### **Unit 2 pH and concept of Buffer**

**(18 Periods)**

Concept of a buffer, Henderson-Hasselbach equation, working of a pH meter, Preparation of a buffer of given pH and molarity such as acetate buffer, phosphate buffer, tris buffer, citrate buffer etc.

### **Unit 3 Spectrophotometric techniques**

**(15 Periods)**

Principle and instrumentation of UV-visible and fluorescence spectroscopy, Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule). Determination of concentration of a protein solution by Lowry/BCA method and Bradford, and measurement of fluorescence spectrum using NAD/FAD/ Vitamin B12 or FITC.

### **Unit 4 Introduction and importance of virtual labs in biochemistry**

**(15 Periods)**

Identification and classification of carbohydrates, acid-base titration of amino acid, isolation of protein from the natural sources, qualitative analysis of carbohydrate, iso-electric precipitation of protein: casein from milk, quantitative estimation of ninhydrin, estimation of saponification value of fats and oils, separation of amino acids by TLC, detection of adulteration in milk, qualitative analysis of amino acid, estimation of iodine value of fats and oil, titration curve of amino acid, and detection of blood glucose by glucose estimation method.

## **SUGGESTED READINGS**

1. Physical Biochemistry: Principles and Applications (2010) 2<sup>nd</sup> 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) 2<sup>nd</sup> 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) 3<sup>rd</sup> 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.
4. Vlab.amrita.edu

## **COURSE- BIOCHEM3SEC02TH PROTEIN PURIFICATION TECHNIQUES**

**Semester end examination: 80 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Purification of a protein from a complex mixture (native or heterologously expressed) involving the following methods/technique (20Periods)**

Protein concentration (BSA, human serum) by using salting out, acetone or alcohol; dialysis, preparation of the sample, separation of protein by ion-exchange chromatography, gel filtration chromatography and affinity chromatography.

### **Unit 2 Characterization of a protein from a complex mixture (native or heterologously expressed) involving the following methods/techniques (10 Periods)**

Electrophoresis: Native, reducing and non reducing SDS-PAGE; separation of serum proteins and bovine serum albumin.

### **Unit 3 Spectral analysis (10 Periods)**

Wavelength scanning, absorption spectra of sodium azide, NADP, FAD, haemoglobin etc.

### **Unit 4 Protein; structure-function analysis (20 Periods)**

Sequence to structure prediction and its understating, structure-function relationship.  
Introduction to molecular docking and concept of free energy.

## **SUGGESTED READINGS**

1. Physical Biochemistry: Principles and Applications (2010) 2<sup>nd</sup> 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) 2<sup>nd</sup> ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN0-7167-1315-2/ ISBN0-7167-1444-2.
3. An Introduction to Practical Biochemistry (1998) 3<sup>rd</sup> 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.
4. Bioinformatics and Functional Genomics (2003), 1<sup>st</sup> ed., Pevsner, J., John Wiley & Sons, Inc. (New Jersey), ISBN 0-47121004-8.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2005), 3<sup>rd</sup> ed., Baxevanis, A.D. and Ouellette, B.F., John Wiley & Sons, Inc. (New Jersey), ISBN 0-47147878-4.

## **COURSE- BIOCHEM3SEC03TH CLINICAL BIOCHEMISTRY**

**Semester end examination: 80 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Introduction (12 Periods)**

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. Collection of blood and storage; separation and storage of serum.

### **Unit 2 Evaluation of biochemical changes in diseases (13 Periods)**

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 and lipid profile (15 Periods)**

Clinical significance of variations in blood glucose. Diabetes mellitus. Composition and functions of lipoproteins; clinical significance of elevated lipoprotein. Estimation of blood glucose by glucose oxidase peroxidase method and estimation of triglycerides.

### **Unit 4 Liver, renal function and cardiovascular tests for diseases and urine analysis**

**(20 Periods)**

Use of urine strip / dipstick method for urine analysis. Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin, Estimation of bilirubin (direct and indirect), Quantitative determination of serum creatinine and urea, 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 McGraw–Hill Publishing Company Limited (New Delhi). ISBN:9780070076594 / ISBN:9780070076631
2. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vo.II(20), Mukherjee, K.L., Tata McGraw – Hill Publishing Company Ltd. (New Delhi), ISBN: 9780070076648.
3. Medical Biochemistry (2005) 2<sup>nd</sup> ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia), ISBN:0-7234-3341-0.
4. Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi), ISBN:81-88237-41-8.

## **COURSE- BIOCHEM4SEC04TH BIOINFORMATICS**

**Semester end examination: 80 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Introduction to bioinformatics (10Periods)**

Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - genomics, proteomics, computer aided drug design (structure based and ligand based approaches) and Systems Biology. Applications of bioinformatics.

### **Unit 2 Biological databases and data retrieval (20 Periods)**

Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (RasMol, J mol), file formats; Sequence retrieval (protein and gene) from NCBI; Structure download (protein and DNA) from PDB; Molecular file formats - FASTA, GenBank, Genpept, GCG, CLUSTAL, Swiss-Prot, FIR; Molecular viewer by visualization software.

### **Unit 3 Sequence alignment and phylogenetic analysis (15Periods)**

Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTALW.

Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees - maximum parsimony, maximum likelihood and distance methods; BLAST suite of tools for pairwise alignment; Multiple sequence alignment using CLUSTALW; Generating phylogenetic tree using PHYLIP.

### **Unit 4 Protein structure prediction and Genome analysis (15 Periods)**

Levels of protein structure. Protein tertiary structure prediction methods - homology modeling, fold recognition and *ab-initio* methods. Significance of Ramachandran map. Introduction to genomics, comparative and functional genomics, gene structure in prokaryotes and eukaryotes, gene prediction methods and tools. Primary sequence analyses (ProtParam); Secondary structure prediction (GOR, nnPredict); Tertiary structure prediction (SWISS MODEL); Protein structure evaluation - Ramachandran map (PROCHECK); Gene prediction using GENSCAN and GLIMMER.



## **SUGGESTED READINGS**

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

## **COURSE- BIOCHEM4SEC05TH RECOMBINANT DNA TECHNOLOGY**

**Semester end examination: 80 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

### **Unit 1 Work flow for *in silico* cloning**

**(5 Periods)**

### **Unit 2 Preparation of media, antibiotic solution, culturing of *E. coli*, isolation of single colonies**

**(15 Periods)**

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: methods of isolation and characterization of plasmid by gel electrophoresis**

**(20 Periods)**

Isolation of plasmid by alkaline lysis method; Isolation of plasmid DNA using column chromatography (kit); Digestion of plasmid DNA with restriction enzymes and analysis of the fragments.

### **Unit 4 Cloning of a gene in a vector and functional analysis**

**(20 Periods)**

Polymerases chain reaction (parametric optimization, primer designing), ligation, introduction of DNA construct into host cells, selection of recombinants; 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* DH5 $\alpha$  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, 4<sup>th</sup> ed., Green M.R. and Sambrook J., Cold Spring Harbour Laboratory Press (New York). ISBN: 978-1-936113- 41-5 / ISBN: 978-1-936113-42-2.

**COURSE- BIOCHEM4SEC06TH**  
**BASICS OF FORENSIC SCIENCE (THEORY)**

**Semester end examination: 80 marks**

**Internal Assessment: 20 marks**

**Note:** The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

---

**Unit 1** **(15 Periods)**

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

**Unit 2** **(15 Periods)**

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

**Unit 3** **(15 Periods)**

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

**Unit 4** **(15 Periods)**

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

**SUUGESTED READINGS**

1. GC-MS Guide to Ignitable Liquids (1999), 1<sup>st</sup> ed., Newman, R., Gilbert, M., Lothridge, K. CRC Press, LLC (Florida), ISBN-13: 978-0849331077.
2. Medical Jurisprudence & Toxicology (1988), 25<sup>th</sup> ed., Tripathi M. M., Press Ltd. Allahabad, (India). ISBN-10: 9351439399
3. Analytical Toxicology (1987), Tiwari S.N., Govt. of India Publications, New Delhi, (India).
4. Forensic Science Hand Book (1982), 2<sup>nd</sup> ed., Saferstein, R: Vol I, II and III, Prentice Hall, (New Jersey), ISBN 978-0-13-220715-7
5. Criminalistics: An Introduction to Forensic Science (2002) 11<sup>th</sup> ed., Saferstein, R, Pearson, (London), ISBN-13: 000-0133458822

6. Forensic Science in Criminal Investigation & Trials(2003), 4<sup>th</sup> ed.,Sharma, B.R.Universal Law Publication, New Delhi (India), ISBN-13: 978-8175343320.
7. Chemical Criminalistics(1980),1<sup>st</sup> ed.,Maehly and Stromberg , Springer, ISBN-13: 978-3540107231
8. Analytical Methods in Human Toxicology, (1986) Part II, Curry, A.S.,Palgrave Macmillan (Basingstoke).ISBN-13: 978-0333368824.