**KURUKSHETRA UNIVERSITY, KURUSKHETRA**
**('A+' Grade NAAC Accredited)**

# DEPARTMENT OF BIOCHEMISTRY
## Curriculum for M. Sc. Biochemistry (Semester System)
## Under CBCS Scheme of Examination (w.e.f. 2020-2021) in phased manner

**Semester – I**

| Paper code | Title of Paper | Type of paper | Hours/ week | Credits | Internal Assessment | External Marks | Total Marks | Duration of Exam (Hrs) |
|---|---|---|---|---|---|---|---|---|
| BCH-101 | Structure and Function of Biomolecules | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-102 | Cell Biology | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-103 | Proteins and Proteomics | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-104 | Bioenergetics and Metabolism -I | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-105 | Practical-1 (Based on papers BCH-101 and BCH-102) | Core | 8 | 4 | 20 | 80 | 100 | 8 |
| BCH-106 | Practical-2 (Based on papers BCH-103 and BCH-104) | Core | 8 | 4 | 20 | 80 | 100 | 8 |
| **Total** | | | | **24** | | | **600** | |

**Semester –II**

| Paper code | Title of Paper | Type of paper | Hours/ week | Credits | Internal Assessment | External Marks | Total Marks | Duration of Exam (Hrs) |
|---|---|---|---|---|---|---|---|---|
| BCH-201 | Metabolism -II | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-202 | Clinical Biochemistry | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-203 | Enzymology | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-204 | Molecular Biology -I | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-205 | Seminar | Core | 1 | 1 | - | - | 25 | |
| BCH-206 | Food Biochemistry | Open Elective | 2 | 2 | 10 | 40 | 50 | 3 |
| BCH-207 | Practical-3 (Based on papers BCH-201 and BCH 202) | Core | 8 | 4 | 20 | 80 | 100 | 8 |
| BCH-208 | Practical-4 (Based on papers BCH-203 and BCH-204) | Core | 8 | 4 | 20 | 80 | 100 | 8 |
| **Total** | | | | **27** | | | **675** | |

**Semester –III**

| Paper code | Title of Paper | Type of paper | Hours/ week | credits | Internal Assessment | External Marks | Total Marks | Duration of Exam (Hrs) |
|---|---|---|---|---|---|---|---|---|
| BCH-301 | Molecular Biology -II | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-302 | Immunology | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-303 | Plant Biochemistry | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-304A | Nutritional Biochemistry | Elective | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-304B | Human Physiology | Elective | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-305 | Seminar | Core | 1 | 1 | - | - | 25 | |
| BCH-306 | Clinical Diagnostics in Health and Disease | Open Elective | 2 | 2 | 10 | 40 | 50 | 3 |
| BCH-306A* | Summer/industrial training | Project Report | | | | 50 | 50 | |
| BCH-307 | Practical-5 (Based on papers BCH-301 and BCH-302) | Core | 8 | 4 | 20 | 80 | 100 | 8 |
| BCH-308 | Practical-6 (Based on papers BCH-303 and BCH-304A&B) | Core | 8 | 4 | 20 | 80 | 100 | 8 |
| **Total** | | | | **27** | | | **675** | |

*****The students entering in 3rd semester of their programs(PG) w.e.f. 2020-21 onwards will be allowed to opt for summer/Industrial training (with a recognized industry research laboratory/company)in lieu of open elective paper (BCH-306) for minimum 4 weeks duration and can be done only during summer vacation falling in the period intervening between 2nd and 3rd Semester.

**Semester –IV**

| Paper code | Title of Paper | Type of paper | Hours/ week | Credits | Internal Assessment | External Marks | Total Marks | Duration of Exam (Hrs) |
|---|---|---|---|---|---|---|---|---|
| BCH-401 | Biostatistics and Bioinformatics | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-402 | Biotechniques | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-403 | Genetic Engineering | Core | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-404A | Basics of Microbiology | Elective | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-404B | Genetics & Evolution | Elective | 4 | 4 | 20 | 80 | 100 | 3 |
| BCH-405 | Practical-7 (Based on papers BCH-401 and BCH-402) | Core | 8 | 4 | 20 | 80 | 100 | 8 |
| BCH-406 | Practical-08 (Based on papers BCH-403 and BCH-404A&B) | Core | 8 | 4 | 20 | 80 | 100 | 8 |
| **Total** | | | | **24** | | | **600** | |
| **Grand Total (Semester I-IV)** | | | | | | | **2550** | |

## Program Outcomes (POs)

**PO1**: Toacquaintstudents with recent knowledge and techniques in recent basic and applied biological sciences.

**PO2:** To develop understanding of organismal, cellular, biochemical and environmental basis of life.

**PO3:** To develop insight into ethical implication of biological research for environmental protection and good laboratory practices and biosafety.

**PO4:** To develop problem solving innovative thinking and robust communication and writing skills in youth with reference to biological, environmental and nutritional sciences.

**PO5:** To understand application of biotic materials in health, medicine, food security for human well-being and sustainable development.

**PO6:** To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in the field of life sciences for self-reliance.

## Program Specific Outcomes (PSOs)

**PSO1:** An ability to acquire in-depth theoretical and practical knowledge of Biochemistry in the broad range of fields including Structure and Function of Biomolecules, Cell Biology, Intermediary Metabolism, Enzymology, Plant Biochemistry, Immunology, Molecular Biology, Clinical Biochemistry, Nutritional Biochemistry, Biotechniques, Genetic Engineering, Biostatistics and Bioinformatics, Microbiology, Genetics and Evolution.

**PSO2:** Diligently learn and link the applicability of the theoretical and practical knowledge imparted in routine life to the understanding of cellular, molecular, biochemical and metabolic basis of life and understand the role of scientific developments in relation to professional and everydayuse.

**PSO3:** Acquire necessary knowledge and skills to appear for competitive exams for higher studies and to undertake a career in research, either in industry or in an academic set up.

**PSO4:** An ability to work independently, demonstrate scientific writing, possess effective presentation skills to explain various concepts of Biochemistry, ability to formulate research hypothesis and contribute to team work and participate constructively in classroom discussions.

***Core***

**M. Sc. (Biochemistry) Semester- I**

**Paper: BCH-101**

**Structure and Function of Biomolecules**

**Total Marks:100**

**External Marks: 80** **Time allowed: 3 hrs**

**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions and covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. The candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:**

- To introduce the student to the structure and function of biomolecules and understand the chemical principles in life processes.
- To familiarize student about the hormones and disorders associated with the over- or under-production of hormones.

**Course outcomes:**

After completion of the course, the students will be able to:

101.1 Have an overview of importance of biomolecules starting from the simplest molecule, water.

101.2 Understand the structure of biomolecules and enumerate the role of carbohydrate, amino acids, lipids and nucleotides and their cellular functions in physiology and pathology.

101.3 Have an integrated understanding of hormones and their related disorders.

101.4 Have brief knowledge of system biology.

## SECTION - A

**Water and Carbohydrates:** Water and its physicochemical properties; Classification of carbohydrates; Occurrence, characteristics, structure and functions of monosaccharides, disaccharides, oligosaccharides and polysaccharides; structure and conformation of sugars; monosaccharides: stereoisomerism and optical isomerism; chemical reactions of the functional groups; sugar derivatives; Glycoproteins; peptidoglycan, proteoglycan, N-linked and O-linked glycoproteins bacterial cell wall polysaccharides; blood group polysaccharides; glycobiology, glycomics

## SECTION - B

**Amino acids and nucleotides:** Structure, nomenclature, classification, acid-base properties of amino acids and their applications, chemical reactions of amino acids; stereoisomerism and optical properties of amino acids; non-natural amino acids;Structure and properties of purines and pyrimidine bases; structure and functions of nucleotides.

## SECTION - C

**Lipids:** Classification of lipids; structures, nomenclature and properties of fatty acids; structure, properties and functions of acylglycerols, plasmalogens, phospholipids, sphingolipids, glycolipids, steroids, prostaglandins and eicosanoids, bile acids lipoamino

acids; chemical composition and biological role of lipoproteins; structure and functions of fat soluble vitamins.

**SECTION - D**

**Hormones:** General characteristics, classification, chemistry and functions of thyroid, parathyroid, adrenal, pancreatic, gastric and reproductive hormones; hypothalamus and pituitary; detection of hormones; hormone replacement therapy; pheromones.

**Suggested reading:**


1. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M M Cox (2017), Macmillan / Worth publishers/ W H Freeman and Company.
2. Biochemistry (2004) by J David Rawn, Panima Publishing Corporation, New Delhi.
3. Biochemistry, 6th edition, by R H Garrett and C M Grisham (2017), Saunders College Publishing, New York.
4. Biochemistry, 7th edition, by Jeremy M. Berg (2015), W H Freeman and Co., New York.
5. Fundamentals of Biochemistry, 2nd ed., by Donald Voet, Judith G. Voet and Charlotte W Pratt (2006), John Wiley and Sons, INC.
6. Textbook of Medical Physiology, 13th ed., A C Guyton and J E Hall (2015) Elsevier.
7. Biochemistry, 4th ed. Zubay, G., (2009). Wm.C Brown Publishers, Saunders and Company, Philadelphia.


**Teaching Learning Process**

- Teaching is supported by Classroom Lectures, Power point presentations/ICT and related videos.
- Written assignments are assigned.
- Knowledge of the students is assessed through Oral test/surprise tests/ internal assessments.

**CO-PO mapping matrix for BCH 101 (Structure and Functions of Biomolecules)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH101.1 | 3 | 3 | - | 2 | - | 2 |
| 101.2 | 3 | 3 | - | 2 | - | 2 |
| 101.3 | 3 | 3 | - | 2 | - | 2 |
| 101.4 | 3 | 3 | - | 2 | - | 2 |
| Average | 3 | 3 | - | 2 | - | 2 |

**CO-PSO mapping matrix for BCH 101 (Structure and Functions of Biomolecules)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 101.1 | 3 | 3 | 3 | 3 |
| 101.2 | 3 | 3 | 3 | 3 |
| 101.3 | 3 | 3 | 3 | 3 |
| 101.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 3 |

***Core***

**M. Sc. (Biochemistry) Semester- I**

**Paper: BCH-102**

**Cell Biology**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions and covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. The candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:**

- To provide students with a comprehensive understanding of molecular biology of cells and the key techniques involved in cell biology.
- To help students know the processes of cell death and cell renewal.

**Course outcomes:**

After completion of the course, the students will be able to:

102.1 Provide detailed information regarding bio-membranes, membrane transport.

102.2 Understand the composition, structure and functions of various organelles and other cellular components in the context of the cells they constitute and their biological activities.

102.3 Explain the communications of cells with other cells and to the environment.

102.4 Acquire the knowledge of cell death and cell renewal that can facilitate the research abilities among them in different areas of biology and medicine.

**SECTION – A**

Prokaryotic and eukaryotic cells, Common and distinguishing features between them.

**Plasma membrane**: An overview of membrane functions; Brief history of studies on plasma membrane structure, chemical composition of membranes: membrane lipids, membrane carbohydrates and membrane proteins, Glycocalyx, membrane lipids and membrane fluidity, the dynamic nature of the plasma membrane, methods of introducing a membrane-impermeant substance into a cell.

**Membrane transport of small molecules:**

Principlesofmembranetransport,Passivediffusion,Facilitateddiffusionandcarrierproteins,ionchannels,activetransport driven by ATP hydrolysis and by iongradients

**Mitochondria:**Mitochondrialstructure and function,mechanismofoxidative phosphorylation, criticalroles of mitochondria in cell metabolism besides ATPproduction

**SECTION – B**

**Chloroplastandotherplastids**: structureofchloroplast,role of chloroplasts in photosyntheticmetabolism, differenttypesofplastids

**Peroxisomes:** structure and functions of peroxisomes and their involvement in photorespiration.

**Cell wall:** bacterial and eukaryotic cellwall

**Endoplasmic reticulum:** ER and protein secretion, targeting proteins to the ER, insertion of proteins into the ER membrane, protein folding and processing in the ER, SER and lipid synthesis

**Golgiapparatus:**OrganizationoftheGolgicomplex, protein glycosylation within the Golgi, lipid and polysaccharide metabolism in the Golgi

**Lysosomes:**Majorcharacteristicsanditsroleinintracellulardigestion.

## SECTION-C

**TheCytoskeleton:**Microfilaments:structureandorganization,muscle contractility;Microtubules:structureanddynamicorganizationofmicrotubules,Microtubuleorganizingcenters:centrosomes and basal bodies; Microtubule motor proteins; Cilia and flagella: structure and functions, Intermediate filaments: intermediate filament proteins; assembly, intracellular organization and functions of intermediate filaments

**Cellular interactions:** Extracellular matrix: matrix structural proteins, matrix polysaccharides, matrix adhesion proteins, Interactions of cells with extracellular materials: integrins, focal adhesions and hemidesmosomes;Interactionsofcellswithothercells:Adhesionjunctions,Tightjunctions,GapjunctionsandPlasmodesmata.

## SECTION – D

**Nucleus:**Nuclearenvelope and traffic between the nucleus and the cytoplasm, structure of the nucleus envelope, nuclearporecomplex,Organization of Nucleolus

**TheCellcycle:**Overviewof eukaryotic cellcycle,Regulation of cell cycle by cell growth and extracellular signals, cell cycle checkpoints, Regulators of cell cycle progression: protein kinases and cell cycle regulation, families of cyclins and cyclin-dependent kinases, DNA damagecheckpoints

**Celldeathandcellrenewal**:Apoptosis(Programmedcelldeath), caspases: the executioners of apoptosis, centralregulatorsofapoptosis:TheBcl-2family;Stemcells andtheirproperties,medicalapplicationsofadultstemcells,embryonicstemcellsandtherapeuticcloning.

**Suggested reading:**


1. CellandMolecularBiology-Conceptsandexperiments,7th ed.(2008)GeraldCarp-Wiley&Sons
2. The Cell: A Molecular Approach, G.M. Cooper R.E. Hausman (2007), 6th ed. ASMPress
3. CellandMolecularBiology,8thed.E.D.P.DeRobertis&E.M.F.DeRobertis(2001),Lippincott Williams andWilkins
4. MolecularBiologyoftheCell(2008)5th ed.Albertsetal.GarlandScience,TaylorandFrancisGroup
5. Molecular Cell Biology (2008) 6th ed. Lodishet al., W.H. Freeman &Company


**Teaching Learning Process:**

- Teaching is supported by Classroom Lectures, Power point presentations/ICT and related videos.
- Written assignments are assigned.
- Knowledge of the students is assessed through Oral test/surprise tests/ internal assessments.

**CO-PO Mapping Matrix for the course BCH-102 (Cell Biology)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-102.1 | 3 | 3 | - | 1 | 3 | 2 |
| BCH-102.2 | 3 | 3 | - | 1 | 3 | 2 |
| BCH-102.3 | 3 | 3 | - | 1 | 3 | 2 |
| BCH-102.4 | 3 | 3 | - | 2 | 3 | 3 |
| Average | 3 | 3 | - | 1.25 | 3 | 2.25 |

**CO-PSO Mapping Matrix for the course BCH-102 (Cell Biology)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-102.1 | 3 | 3 | 3 | 1 |
| BCH-102.2 | 3 | 3 | 3 | 1 |
| BCH-102.3 | 3 | 3 | 3 | 1 |
| BCH-102.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 1.5 |

***Core***

**M.Sc. (Biochemistry) Semester- I**

**Paper: BCH – 103**

**Proteins and Proteomics**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:**

- To understand proteins, their structure, conformation and dynamics, protein folding, and protein purification and their separation.
- To aware about the various aspects of mass spectrometry including MALDI-TOF, ESI-MS, MS/MS and X-ray crystallography for prediction of three-dimensional structure of protein.

**Course outcomes:**

After studying this course, students will be able to:

103.1 Understand the structure, conformation and folding of proteins.

103.2 Learn various methods of protein purification and their separation

103.3 Know the various aspects of mass spectrometry and X-ray crystallography

103.4 Apply the mass spectrometry and X-ray crystallography for prediction of the three-dimensional structure of proteins.

## SECTION - A

**Primary structure of proteins:** An overview of protein structure; hierarchy of protein structure; Ramachandran plot; Determination of primary structure of protein – determination of N and C-terminal residue; Determination of amino acid composition of protein and determination of sulfhydryl groups; location of disulfide bonds; Chemical synthesis of peptides; Structure and function of some biologically important polypeptides. **Secondary and tertiary structure of proteins:**Alpha helix and beta structure; Collagen helix and other types of helical structures; Super secondary structures; Amino acid sequence and three dimensional structure; Domains; Forces stabilizing the secondary and tertiary structure

## SECTION - B

**Sequencing, protein folding and denaturation:** Protein sequencing; Sequenators;Quaternary structure of protein; Structure and function of hemoglobin and cytochrome c; Denaturation and renaturation of proteins; Characteristics of molten globule

state; Proteins involved in folding; Models of protein folding; Chaperones and Lavinthal paradox; Protein conformation and diseases.

## SECTION - C

**Protein purification and separation techniques:** Protein purification; criteria of purity, and fold purification; Ion-exchange, gel-filtration and affinity chromatography techniques; High performance liquid chromatography (HPLC); Iso-electric focusing (IEF); Native-PAGE and SDS-PAGE; Detection and quantification of proteins in gels; Recovery of proteins from gels.

## SECTION - D

**Proteomics:** Overview and tools; Two-dimensional PAGE; Protein spot detection; Mass spectrometry: matrix assisted laser desorption ionization MS, Electrospray ionization MS, and tandem MS for protein identification; Identification of protein-protein interactions; Protein complexes; X-ray crystallography; Transmembrane domains; Functional proteomics; Application of proteome analysis.

**Suggested readings:**


1. Biochemistry, 7th edition, by Jeremy M. Berg (2015), W H Freeman and Co., New York.
2. Fundamentals of Biochemistry, 6th ed., by Donald Voet, Judith G Voet and Charlotte W Pratt, John Wiley and Sons, INC.
3. Principles of Peptide synthesis (2012), 2nd ed., M Bodansky, Springer - Verlag Berlin, Heidelberg.
4. Principles of Proteomics (2004), R M Twyman, 7th edition, BIOS Scientific Publishers.
5. Handbook of Proteomic Method (2010), P Michael Conn, Humana Press, Totowa, New Jersey, USA.


**CO-PO mapping matrix for BCH 103 (Proteins and Proteomics)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 103.1 | 3 | 3 | -- | -- | - | -- |
| 103.2 | 3 | 1 | 1 | 3 | -- | 1 |
| 103.3 | 3 | -- | 2 | 3 | -- | 2 |
| 103.4 | 2 | -- | 2 | 2 | -- | 1 |
| Average | 2.75 | 1.0 | 1.25 | 2.0 | -- | 1.0 |

**CO-PSO mapping matrix for BCH 103 (Proteins and Proteomics)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 103.1 | 3 | 2 | 2 | 2 |
| 103.2 | 2 | 3 | 3 | 2 |
| 103.3 | 3 | 3 | 3 | 3 |
| 103.4 | 2 | 3 | 2 | 2 |
| Average | 2.5 | 2.75 | 2.5 | 2.25 |

***Core***

**M.Sc. (Biochemistry) Semester- I**

**Paper: BCH – 104**

**Bioenergetics and Metabolism-I**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives**:

- To provide students a comprehensive understanding of energetics and metabolic pathways of carbohydrate and lipid metabolism including their regulation in living systems.

**Course outcomes:**

After studying this course, students will be able to:

104.1 Understand the concept of free energy change, coupled reactions, high energy compounds and redox reactions and its application to the study of metabolism.

104.2 Describe various anabolic and catabolic pathways like glycolysis, Kreb's cycle, HMP shunt, glycogen metabolism etc. and their regulation for better understanding of physiology and therapeutic applications.

104.3 Comprehend reactions and regulation of pathways involved in the metabolism of lipids and correlate with the metabolic disorders at molecular level.

104.4 Have an insight of electron transport chain and mechanism of ATP synthesis during catabolism of molecules.

## SECTION – A

Bioenergetics: Concept of Free energy; standard Free energy; Relationship between standard free-energy change and equilibrium constant; Coupled reactions; High-energy compounds. Biological oxidation: Oxidation & reduction; Oxidation-reduction half reactions; Nernst equation, measurement of standard reduction potentials; Calculation of $\Delta G$ from standard reduction potentials; Enzymes involved in oxidation and reduction (oxidases, dehydrogenases, hydroperoxidases and oxygenases). Introduction to Metabolism and Experimental approaches for studying metabolism.

## SECTION – B

Carbohydrate Metabolism:Reactions, energetics and regulation of glycolysis; Feeder pathways for glycolysis; Fate of pyruvate under aerobic and anaerobic conditions; Pasteur effect; Pyruvate dehydrogenase complex and its regulation; Reactions, regulation and amphibolic nature of TCA Cycle; Anaplerotic reactions; Glyoxalate cycle; Pentose

Phosphate Pathway; Gluconeogenesis; Cori cycle; Biosynthesis of lactose and sucrose; Glycogenesis and Glycogenolysis; Control of glycogen metabolism; Maintenance of blood glucose levels.

**SECTION – C**

Lipid Metabolism: Mobilization and hydrolysis of triacylglycerols; Fatty acid oxidation: Franz Knoop's experiment; β-oxidation of saturated, unsaturated and odd-chain fatty acids; Peroxisomal β-oxidation; Minor pathways of fatty acid oxidation (α- and ω- oxidations); Formation and utilization of Ketone bodies; Biosynthesis of saturated fatty acids; Elongation and desaturation of fatty acids; Biosynthesis of triacylglycerols; Regulation of fatty acid metabolism; Cholesterol biosynthesis and its regulation; Biosynthesis of glycerophospholipids and sphingolipids; Breakdown of sphingolipids by lysosomal enzymes; Formation of prostaglandins, prostacyclins, thromboxanes and leukotrienes from arachidonic acid.

**SECTION – D**

Mitochondrial Electron Transport Chain and Oxidative Phosphorylation**:** Mitochondrial Transport Systems; Nature, order and organization of the components of electron transport chain; electron flow from NADH and $FADH_2$ to $O_2$; sites of ATP production; inhibitors of electron transport chain; Coupling between oxidation and phosphorylation; Chemiosmotic hypothesis of oxidative phosphorylation; Mechanism of ATP synthesis: Structure of proton-translocating ATP synthase; Binding Change Mechanism for proton-driven ATP synthesis; Uncoupling of oxidative phosphorylation; Control of oxidative phosphorylation.

**Suggested readings:**


1. Lehninger: Principles of Biochemistry, 4th edition, by David L. Nelson and M.M. Cox (2005) Maxmillan/ Worth publishers/ W. H. Freeman & Company.
2. Fundamentals of Biochemistry, 3rd edition, by Donald Voet and Judith G Voet (2004) , John Wiley & Sons, NY
3. Biochemistry, 2nd edition, by R.H. Garrett and C. M. Grisham (1999). Saunders College Publishing, NY.
4. Biochemistry, 6th edition, by Jeremy M. Berg (2007). W.H. Freeman & Co., NY.
5. Harper's Biochemistry, 26th edition, by R.K. Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V. W. Rodwell (2003). Prentice Hall International.
6. Biochemistry, 3rd edition, by C.K. Mathews, K.E. vans Holde and K.G. Ahern (2000). Addison-Wesley Publishing Company.
7. Biochemistry (2004) by J. David Rawn, Panima Publishing Corporation, New Delhi.


**Teaching Learning Process**

- Teaching is supported by Classroom Lectures, Powerpoint presentations andrelated videos.
- Oral or written assignments are assigned.
- Knowledge of the students is tested through surprise tests and internal assessments.

**CO-PO Mapping Matrix for the course BCH-104 (Bioenergetics and Metabolism-I)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-104.1 | 3 | 3 | - | 2 | 1 | 1 |
| 104.2 | 3 | 3 | - | 2.5 | 1 | 2 |
| 104.3 | 3 | 3 | - | 2.5 | 1 | 2 |
| 104.4 | 3 | 3 | - | 2 | 1 | 1 |
| Average | 3 | 3 | - | 2.25 | 1 | 1.5 |

**CO-PSO Mapping Matrix for the course BCH-104 (Bioenergetics and Metabolism-I)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-104.1 | 3 | 3 | 3 | 2 |
| 104.2 | 3 | 3 | 3 | 2 |
| 104.3 | 3 | 3 | 3 | 2 |
| 104.4 | 3 | 3 | 3 | 2 |
| Average | 3 | 3 | 3 | 2 |

***Core***

**M.Sc. (Biochemistry) Semester - I**

**Paper: BCH –105**

**Practical-1 (Based on papers BCH-101 and BCH-102)**

**Total Marks:100**

**External Marks: 80** **Time allowed: 8hrs**

**Internal Assessment: 20** **Credits: 4**

**Course outcomes:**

After completion of the course, the students will be able to:

1. Get more acquainted with the basic practical techniques related to various biomolecules and techniques involved in cell biology.
2. Standardize and qualitatively& quantitatively estimate various biomolecules including carbohydrates, lipids and proteins in the biological samples.
3. Get an insight/awareness about the safe laboratory practices.
4. Understand the principle and working of different types of Light microscopy and Electron microscopy and its applications in various fields of research.

**List of experiments**

1. To study biochemistry laboratory safety rules and guidelines
2. Preparation of buffers
3. Qualitative estimation of carbohydrates
4. Qualitative estimation of proteins/amino acids
5. Qualitative estimation of lipids
6. Quantitative estimation of proteins by Lowry's method
7. Quantitative estimation of proteins by Bradford method
8. Quantitative estimation of total sugars
9. Quantitative estimation of reducing sugars by Nelson-Somoyogi's method
10. Solubility test for lipids
11. To detect the presence of glycerol in given sample by acrolein method
12. Characterization of lipids (Acid value, Saponification value and Iodine number)
13. Extraction of lipids from tissues using Soxhlet's apparatus
14. To determine pka of acetic acid/glycine
15. Subcellular fractionation of organelles from animal/plant tissue
16. To demonstrate: Light microscopy, Fluorescence microscopy, Confocal microscopy, Electron microscopy (scanning and transmission)

**CO-PO Mapping Matrix for the course BCH-105(Practical-1)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-105.1 | 3 | 3 | - | 1 | 3 | 3 |
| BCH-105.2 | 3 | 3 | - | 1 | 3 | 3 |
| BCH-105.3 | 3 | - | 3 | - | - | 1 |
| BCH-105.4 | 3 | 3 | - | - | - | 3 |
| Average | 3 | 2.25 | 0.75 | 0.5 | 1.5 | 2.5 |

**CO-PSO Mapping Matrix for the course BCH-105(Practical-1)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-105.1 | 3 | 3 | 2 | 1 |
| BCH-105.2 | 3 | 3 | 2 | 1 |
| BCH-105.3 | 3 | 3 | 2 | 1 |
| BCH-105.4 | 3 | 3 | 2 | 2 |
| Average | 3 | 3 | 2 | 1.25 |

***Core***

**M.Sc. (Biochemistry) Semester - I**

**Paper: BCH –106**

**Practical-2 (Based on papers BCH-103 and BCH-104)**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 8hrs**
**Internal Assessment: 20** **Credits: 4**

**Course Outcomes:**

After completion of the course, the students will be able to:

1. Well acquainted with the titration and spectrophotometric estimation of biomolecules
2. An understanding of different chromatographic techniques and their application in purifications and separations of biomolecules
3. Develop skills of using various equipment involved in biomolecules purification and separation
4. Develop skills in carrying out research projects by employing basic biochemical techniques

**List of experiments**

1. Titration of a weak acid using a pH meter
2. Verification of Beer-Lambert's law and determination of absorption coefficients
3. Concentration of a protein sample by ultrafiltration (using stirred cell)
4. Separation of amino acids and carbohydrates in a mixture by Paper chromatography
5. Separation of lipids/amino acids by TLC
6. Purification of an enzyme by ion-exchange chromatography
7. Purification of an enzyme by gel filtration chromatography
8. Determination of void volume of a gel filtration column
9. Determination of molecular weight of an enzyme by gel filtration
10. Separation of proteins by Native PAGE and SDS PAGE
11. Determination of molecular weight of a protein by SDS PAGE

**CO-PO mapping matrix for BCH 106 (Practical-2)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 106.1 | 3 | 3 | 2 | 2 | - | 2 |
| 106.2 | 3 | 3 | 2 | 2 | - | 2 |
| 106.3 | 3 | 3 | 2 | 2 | - | 2 |
| 106.4 | 3 | 3 | 2 | 2 | - | 2 |
| Average | 3 | 3 | 2 | 2 | - | 2 |

**CO-PSO mapping matrix for BCH 106 (Practical-2)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 106.1 | 3 | 3 | 3 | 3 |
| 106.2 | 3 | 3 | 3 | 3 |
| 106.3 | 3 | 3 | 3 | 3 |
| 106.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 3 |

***Core***

**M.Sc. (Biochemistry) Semester- II**

**Paper: BCH – 201**

**Metabolism–II**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objective:**

- To provide students a comprehensive understanding of the metabolism of amino acids, nucleotides, porphyrins, and secondary plant products, integration of metabolism, organ specific metabolism, metabolic changes during starvation and food intake and ethanol metabolism.

**Course outcomes**:

After the completion of the course, the students will be able to:

210.1 Understand the pathways involved in the catabolism and biosynthesis of amino acids, porphyrins and nucleotides.

210.2 Know the chemical nature and Metabolism of secondary metabolites produced by plants such as isoprenoids, phenylpropanoids, alkaloids etc.

210.3 Understand the integration of metabolism

210.4 Understand the organ specific metabolic profiles, metabolic changes during starvation and food intake, and ethanol metabolism in liver.

## SECTION – A

Amino acid degradation: General reactions of amino acid metabolism: Transamination; Oxidative, non-oxidative deamination and decarboxylation reactions; Role of glutamine in ammonia transport; Glucose-Alanine Cycle; Urea Cycle; Metabolic breakdown of individual amino acids (both essential and non-essential)

## SECTION – B

Amino acid biosynthesis: Biosynthesis of non-essential and essential amino acids; Regulation of amino acid biosynthesis; Amino acids as biosynthetic precursors of phosphocreatine, glutathione, dopamine, non-epinephrin and epinephrin, GABA, histamine, serotonin, polyamines (spermine and spermidine), and indole-3-acetic acid. Porphyrins: Structure of porphyrins; Important porphyrins occurring in nature; Biosynthesis of heme and its regulation; Degradation of heme; Regulation of heme biosynthesis; Chlorophyll biosynthesis.

## SECTION – C

Nucleotide metabolism**:** *De novo* biosynthesis and regulation of purine and pyrimidine nucleotides; Salvage pathways of purines and pyrimidines; Ribonucleotide reductase and formation of deoxyribonucleotides (dNTPs) from ribonucleotides (NTPs); Catabolism of purine and pyrimidine nucleotides; Chemotherapeutic agents as inhibitors of enzymes in nucleotide biosynthetic pathways; Biosynthesis of nicotinamide coenzymes, flavin coenzymes and coenzyme A. Integration of metabolism: basic strategy of catabolic metabolism; Recurring motifs in metabolic regulation; Major metabolic pathways and control sites; Key junctions in metabolism (glucose-6-phosphate, pyruvate and acetyl CoA); Organ specific metabolic profile; Metabolic changes induced by food intake and starvation; Ethanol metabolism in the liver.

## SECTION – D

Secondary plant metabolism: Primary and secondary metabolites; Isoprenoids: introduction, different classes with examples; biosynthesis of carotenoids (Limonene, Lycopene and β-Carotene); Alkaloids: definition, classification according to their heterocycles with examples; physiologically active alkaloids (used in medicine and plant chemical defense); Phenylpropanoids: Introduction; overview of products of the phenylpropanoid metabolism; Biosynthesis of lignin; Flavonoids: nature; classification of aglycons with examples; functions of flavonoids; Nature of Tannins, Cyanogenic glycosides and Glucosinolates.

**Suggested readings:**


1. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox (2017) Maxmillan/ Worth publishers/ W. H. Freeman & Company.
2. Fundamentals of Biochemistry, 3rdedition ,by Donald Voet and Judith G Voet (2004) , John Wiley & Sons, NY
3. Biochemistry, 7th edition, by Jeremy M. Berg (2015). W.H. Freeman & Co., NY.
4. Harper's Biochemistry, 31st edition, by R.K. Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V. W. Rodwell (2018). Prentice Hall International.
5. Biochemistry (2004) by J. David Rawn, Panima Publishing Corporation, New Delhi
6. Plant Biochemistry & Molecular Biology, 3rd ed., by Hans –Walter Heldt (2010), Academic Press
7. Biochemistry and Molecular Biology of Plants by Bob, B. Buchanan, W. Gruissen and R.L.Jones (215). Published by John Wiley & sons, UK


**Teaching Learning Process**

- Teaching is supported by Classroom Lectures, Power point presentations/ICT and related videos.
- Written assignments are assigned.
- Knowledge of the students is assessed through Oral test/surprise tests/ internal assessments.

**CO-PO mapping matrix for BCH 201 (Metabolism II)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 201.1 | 3 | 3 | - | 2 | - | 2 |
| 201.2 | 3 | 3 | - | 2 | - | 2 |
| 201.3 | 3 | 3 | - | 2 | - | 2 |
| 201.4 | 3 | 3 | - | 2 | - | 2 |
| Average | 3 | 3 | - | 2 | - | 2 |

**CO-PSO mapping matrix for BCH 201 (Metabolism II)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 201.1 | 3 | 3 | 3 | 3 |
| 201.2 | 3 | 3 | 3 | 3 |
| 201.3 | 3 | 3 | 3 | 3 |
| 201.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 3 |

***Core***

**M.Sc. (Biochemistry) Semester - II**

**Paper: BCH – 202**

**Clinical Biochemistry**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will set nine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:**

- To bring awareness among students for practicing quality control for accuracy of results.
- To explain the patho-physiology and metabolic basis of common disorders.
- Assessment of organ function tests.

**Course outcomes:**

After successful completion of the course, students will be able to:

202.1 Know the principles and practice of quality control, handling of biological fluids and theirsignificance in maintaining good health; understand clinical significance of plasma proteins and blood disorders.

202.2 Explain the role of enzymes and other biochemical markers in clinical diagnostics and organ function tests; use the knowledge of metabolism of xenobiotics in various interdisciplinary courses.

202.3 Learn the etiology of disorders associated with carbohydrates, amino acids, lipids, nucleic acids, vitamins & minerals metabolism.

202.4 Understand and explain disorders associated with various hormones, disorders of acid-base and electrolytes balance in the body and neuropsychiatric disorders.

## SECTION-A

**Clinicalbiochemistryandqualityassurance:**biologicalsamples(blood,urineandcerebrospinalfluid):chemicalcomposition, collection,processing, storage and preservation;Qualitycontrol:accuracy, precision, Specificity, Sensitivity, Levy Jening's chart.
**Blood:** clinical significance and functions of plasma proteins (albumin, alpha 1-antitrypsin, haptoglobin, caeruloplasmin, transferrin, C-reactive protein); Disorders of hemoglobin: thalassemia, anemia (different types) and porphyrias.

## SECTION- B

**Clinical enzymology:** Enzymes as diagnostic tool; Clinically important enzymes: alkaline phosphatase, acid phosphatase, aldolase, creatine kinase, LDH, AST, ALT, lipase, amylase and 5'-nucleotidase; isoenzymes and their diagnostic importance. **Organ function tests**: Assessment of liver, kidney, exocrine pancreas and G.I. tract function tests. **Detoxification:** Phase I and Phase II reactions**.**

## SECTION- C

**Metabolicdisorders:**Disordersofcarbohydratemetabolism:Diabetesmellitus, diabetic ketoacidosis,hypoglycemia,glycogenstorage disease and galactosemia; glucose tolerance test; disorders of lipid: Refsum's disease, fatty liver and lipotropic factors, hypolipoproteinemia and hyperlipidemia.Atherosclerosis: pathogenesis and risk factors; Disorder of amino acid metabolism: Maple syrup urine disease, phenylketonuria, Alkaptonuria, cystinuria and homocystinuria; disorder of nucleic acid metabolism: Gout, Lesch-Nyhan Syndrome, Hypouricemia, Orotic Aciduria; disorders of calcium, magnesium, phosphorous, iron, copper and selenium metabolism; disorders of fat soluble (A, D, E and K) and water soluble vitamins (Thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid, vitamin $B_{12}$ and ascorbic acid)

## SECTION- D

**Hormone disturbances:** disturbances related to protein hormones (anterior and posterior pituitary), steroid hormones and thyroid hormones.

**Electrolyte and acid base balance:** disorders of electrolytes (hypernatremia, hyponatremia, hypokalemia, hyperkalemia, hyperchloremia, hypochloremia); water and acid base balance (metabolic and respiratory acidosis, metabolic and respiratory alkalosis)

**Neuropsychiatric disorders:** Alzheimer's & Parkinson's disease.

**Suggested readings:**


1. Textbook of Biochemistry for Medical student by Vasudevan DM (2019), 9th edition, Jaypee Brothers Medical Publishers
2. Teitztext book of clinical chemistry(1999), 3rd edition, Carl A. Burtis and Edward R. Ashwood, W. B. Saunders Company.
3. Harper's Biochemistry, 31st edition, by R.K.Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V.W.Rodwell (2018) Prentice Hall International.
4. Textbook of Biochemistry with Clinical Correlations, 6th edition by T.M. Devlin (2005).Wiley-liss.
5. Biochemistry by U. Satyanarayana (2002). Books and allied (P) Ltd.
6. Text Book of Biochemistry & Human Biology by G.P. Talwar (1989) Prentice Hall, New Delhi.


**Teaching Learning Process**

- Teaching is supported by Classroom Lectures, Powerpoint presentations andrelated videos.
- Oral or written assignments are assigned.
- Knowledge of the students is tested through surprise tests and internal assessments.

**CO-PO Mapping Matrix for the course BCH-202 (Clinical Biochemistry)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-202.1 | 3 | 3 | 3 | 2 | 3 | 3 |
| 202.2 | 3 | 3 | - | 2 | 2 | 3 |
| 202.3 | 3 | 3 | - | 2 | 2 | 2 |
| 202.4 | 3 | 3 | - | 2 | - | 2 |
| Average | 3 | 3 | 0.75 | 2 | 1.75 | 2.5 |

**CO-PSO Mapping Matrix for the course BCH-202 (Clinical Biochemistry)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-202.1 | 3 | 3 | 3 | 2 |
| 202.2 | 3 | 3 | 3 | 2 |
| 202.3 | 3 | 3 | 3 | 2 |
| 202.4 | 3 | 3 | 3 | 2 |
| Average | 3 | 3 | 3 | 2 |

***Core***

**M.Sc. (Biochemistry) Semester - II**

**Paper: BCH –203**

**Enzymology**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. The candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:**

- To introduce students to various theoretical and practical aspects of enzymology.
- To develop their interest in the structure, function and kinetics of enzyme and their role as catalyst and regulator of cell metabolism.
- It serves as foundation for more advanced enzymology courses.

**Course outcomes:** After successful completion, students will be able to:

203.1 Distinguish the fundamentals of enzyme properties, nomenclature, characteristics and mechanism.

203.2 Study of factors affecting enzymatic reactions, application of biochemical calculations for enzyme kinetics and plotting graphs based upon kinetic data.

203.3 Describe the concept of enzyme inhibition. Students will know how to construct enzyme inhibitors.

203.4 Conceptualize the co-operative behavior of enzyme, Allosteric enzyme and understanding of regulatory mechanism of enzyme action.

## SECTION – A

**Introduction:** Historical perspectives; General characteristics; Nomenclature and classification; Introduction to the following terms with examples – Holoenzyme, apoenzyme, cofactors, coenzymes, prosthetic groups, metalloenzymes, turnover number, enzyme activity units (I.U and Katal), and specific activity.Multienzyme systems and multifunctional enzymes with specific examples and significance. Enzyme specificity: **Types of specificity;** three-point attachment theory to explain stereospecificity; Lock-and-key hypothesis; Induced- fit hypothesis; Hypothesis involving strain or transition-state stabilization.**Enzyme Catalysis:** Role of $NAD^+$/$NADP^+$, FMN/FAD, coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, lipoic acid, biocytin, Vitamin $B_{12}$ Coenzyme, and tetrahydrofolate coenzymes in enzyme catalysis; Common features of active sites;Reactionco-ordinate diagram; Proximity & orientation, acid-base catalysis, and covalent catalysis; Mechanism of action of chymotrypsin, ribonuclease, carboxypeptidase, and lysozyme

## SECTION – B

**Enzyme assay**: Introduction; Kinetic and coupled enzyme assays. **Enzyme Kinetics**: Factors affecting enzyme activity; Arrhenius plot; Derivation of Michaelis-Menten equation for unisubstrate reactions; Km and its significance; $K_{cat}/K_m$ and its importance; Measurement of $K_m$ and $V_{max}$ by Lineweaver-Burk plot and other linear transformations of MM equation; Bi-substrate reactions: Sequential and ping-pong mechanisms with examples and determination of $K_m$ and $V_{max}$ for each substrate (derivations excluded); Use of initial velocity studies, product-inhibition studies and isotope exchange at equilibrium for determining the kinetic mechanism of a bisubstrate reaction.

## SECTION - C

**Methods of studying fast reactions:** A brief account of rapid mixing techniques, flash photolysis and relaxation methods. **Enzyme inhibition**: Reversible (competitive, non-competitive, and uncompetitive) and irreversible (affinity labels and suicide inhibitors) enzyme inhibitors; Determination of $K_i$. **Investigation of active site structure:** Methods for identification of binding and catalytic sites- Trapping the enzyme-substrate complex, use of substrate analogues, chemical modification of amino acid side chains in enzymes, enzyme modification by proteases and effect of changing pH.

## SECTION - D

**Enzyme regulation:** Coarse and fine control of enzyme activity; Enzyme induction & Repression; Feedback inhibition; Allosteric enzymes with aspartate transcarbamoylase as an example; Concerted and sequential models for action of allosteric enzymes; Negative and Positive Cooperativity; Hill plot; Scatchard plot; Regulation by reversible and irreversible covalent modification of enzymes; Isoenzymes. **Ribozyme and Abzyme**

**Suggested readings:**


1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer (2007). Horwood Publishing.
2. Fundamentals of Enzymology, 3rd edition, by Nicholas C. Price and Lewis Stevens (1999) Oxford University Press.
3. Principles of Enzymology for Food Science by J.R. Whitaker (2018). Marcel Dekkar Publishers.
4. Structure and Mechanism in Protein Science, 2nd edition, by Alan Fersht (1999). W.H. Freeman and Co., NY.
5. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox Maxmillan/ Worth publishers/ W.H. Freeman & Company.

**CO-PO mapping matrix for BCH 203 (Enzymology)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 203.1 | 2 | 2 | - | 1 | - | - |
| 203.2 | 3 | 3 | - | 1 | - | 1 |
| 203.3 | 2 | 2 | 2 | 1 | 2 | 2 |
| 203.4 | 3 | 2 | -- | - | - | - |
| Average | 2.5 | 2.25 | 0.5 | 0.75 | 0.5 | 0.75 |

**CO-PSO mapping matrix for BCH 203 (Enzymology)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 203.1 | 3 | 3 | 3 | 2 |
| 203.2 | 3 | 2 | 3 | 2 |
| 203.3 | 2 | 3 | 3 | 3 |
| 203.4 | 3 | 3 | 1 | 2 |
| Average | 2.75 | 2.75 | 2.5 | 2.5 |

***Core***

**M. Sc. (Biochemistry) Semester - II**
**Paper: BCH-204**
**Molecular Biology-1**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions and covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. The candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:**

- To impart education in basic molecular mechanisms vital for cell survival.
- To educate students in molecular biology so that they can pursue advanced course and research.

C**ourse outcome**

204.1Students learn about central diagram of molecular sinology.
204.2They also learn about DNA, RNA and protein synthesis.
204.3They also learn about DNA damages and various repair mechanism.
204.4Understand molecular mechanisms behind protein targeting.

## SECTION - A

**Basic Concepts of Genetic Information:** Nucleic acids as the genetic material - experimental evidences; Chargaff's rules Structure of DNA, Structural polymorphism of DNA (A, B and Z-DNA) various forces responsible for stability of DNA, DNA topology, topological and geometric properties, DNA supercoiling, Topoisomerases in prokaryotes and eukaryotes, DNA organization in prokaryotes and eukaryotes, C-value paradox, denaturation: different ways for carrying out denaturation, renaturation: requirements, kinetics, significance, various classes of DNA: highly repetitive, moderately repetitive and unique sequence, RNA: structure and types.

## SECTION - B

**DNA replication, mutations and DNA repair:** Possible modes of DNA replication, Meselson-Stahl experiment, DNA polymerases and other enzymes involved in DNA replication, Okazaki fragments, Mechanism of replication in prokaryotes and eukaryotes, inhibitors of DNA replication, molecular basis of mutations, DNA repair mechanisms like direct, base-excision, nucleotide-excision, mismatch, SOS and recombinational repair.

## SECTION - C

**Transcription and post-transcriptional modifications:** RNA polymerase/s in prokaryotes and eukaryotes, DNA footprinting technique, initiation, elongation and termination of transcription in prokaryotes and eukaryotes, inhibitors of transcription, RNA replicase, reverse transcriptase, post-transcriptional modifications: different types of introns and their

splicing mechanisms, processing of mRNA, rRNA and tRNA precursors, overlapping genes and split genes.

**SECTION - D**

**Protein synthesis, targeting and degradation:** Characteristics of the genetic code, biological significance of degeneracy, decoding the code, Wobble hypothesis, ribosomes structure and function in prokaryotes and eukaryotes, Aminoacyl tRNA-synthetases, various factors and steps involved in protein synthesis in prokaryotes and eukaryotes, polyribosomes, post-translational processing, signal hypothesis and protein targeting to lysosomes, Plasma membrane, extracellular matrix and different compartment of mitochondria and chloroplast, protein degradation.

**Suggested readings:**


1. Molecular Biology of the Gene, Watson et al, 7th Edition.
2. Lehninger's Principles of Biochemistry, 7th edition.
3. Molecular Cell Biology, Lodish et al, 8th edition.
4. Principles of Biochemistry, Moran et. al., 5th edition.
5. Fundamentals of Biochemistry, Voet et. al, 6th edition.
6. Biochemistry, L Stryer. 9th edition.


**CO-PO mapping matrix for BCH 204 (Molecular Biology I)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 204.1 | 2 | 3 | -- | 1 | -- | -- |
| 204.2 | 2 | 3 | -- | 2 | 1 | -- |
| 204.3 | 1 | 2 | 1 | 1 | 2 | -- |
| 204.4 | 1 | 3 | -- | 1 | 1 | -- |
| Average | 1.5 | 2.75 | 0.25 | 1.25 | 1.0 | -- |

**CO-PSO mapping matrix for BCH 204 (Molecular Biology I)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 204.1 | 3 | 3 | 3 | 3 |
| 204.2 | 3 | 2 | 3 | 3 |
| 204.3 | 3 | 3 | 3 | 2 |
| 204.4 | 1 | 3 | 2 | 1 |
| Average | 2.5 | 2.75 | 2.75 | 2.25 |

***Core***

**M. Sc. (Biochemistry) Semester - II**

**Paper: BCH-205**

**Seminar**

**Total Marks: 25** **Credits:** 1

**Course outcomes**

After the completion of the course, the students will be able to:

205.1Work independently, critically analyze research literature and use different digital sources to explain the concepts of Biochemistry.

205.2 Demonstrate latest scientific developments from disciplinary perspective to its professional and everyday use.

205.3 Formulate logical and convincing arguments and to substantiate critical readings of scientific texts in order to develop scientific temper in biological sciences.

**CO-PO mapping matrix for BCH 205 (Seminar)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 205.1 | 3 | 3 | 2 | 3 | 2 | - |
| 205.2 | 3 | 3 | 3 | 2 | 3 | - |
| 205.3 | 3 | 3 | 3 | 3 | - | - |
| Average | 3 | 3 | 2.66 | 2.66 | 1.66 | - |

**CO-PSO mapping matrix for BCH 205 (Seminar)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 205.1 | 3 | 3 | 2 | 2 |
| 205.2 | 3 | 3 | 2 | 2 |
| 205.3 | 3 | 3 | 2 | 3 |
| Average | 3 | 3 | 2 | 2.33 |

***Open Elective***

**M.Sc. (Biochemistry) Semester - II**

**Paper: BCH – 206**

**Food Biochemistry**

**Total Marks: 50**
**External Marks: 40** **Time allowed: 3 hrs**
**Internal Assessment: 10** **Credits: 2**

**Note:** The examiner will setfive questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & two others, selecting one from both sections.

**Objectives:**

- To focus on different sources of nutrients along with their nutritional importance.
- To help students know the basic concepts of food toxicity and safety and nutritional disorders.

**Course outcomes:**

After the completion of the course, the students will be able to:

206.1 Acquire detailed knowledge regarding dietary sources and nutritional importance of different nutrients.

206.2 Describe different food toxicants, nutritional disorders and various applications of

## SECTION A

Classes and sources of nutrients (overview), energy value of foods, Basal metabolic rate, specific dynamic action, nutritional importanceofcarbohydrates, Glycemic index,fibresinnutrition,nutritionalimportanceoflipids,essentialfattyacids,nutritional importance of proteins, nitrogen balance, mutual supplementation of proteins, concept of balanced diet, Vitamins: major functions,dietarysources,deficiencysymptomsoffatsolubleandwatersolublevitamins,hypervitaminosisoffatsoluble vitamins; Minerals: major functions, dietary sources, deficiency symptoms and toxicity symptoms of major and trace minerals

## SECTION B

**Food toxicity and safety:** Microbial contamination, environmental contamination, natural toxins, agricultural residues, intentional food additives.

**Applications of major enzymes in food industry**

**Nutritional disorders:**Lipoproteins and cardiovascular disease: ‘good’ and ‘bad’ cholesterol, risk factors for cardiovascular disease.

**Nutrition and Cancer:** Associations between nutritional factors and common cancer sites; effect of different foods, beverages, physical parameters and other additional factors on cancer.

**Suggested readings:**


1. Biochemistry by U. Satyanarayana (2002). Books and allied (P) Ltd.
2. Essentials of Human Nutrition by J. Mann and A.S. Truswell (2008) 3rd ed. Oxford University Press Inc., New York.
3. Contemporary Nutrition by Wardlaw Smith (1996) 6th ed. Mc Graw Hill Inc., New York.
4. Nutritional Biochemistry by S. Ramakrishnan and S. Venkat Rao (1995) T. R. Publications.
5. *Food Chemistry* by Owen Fennema (1996) 3rd ed. CRC Press.
6. Food Science Chemistry and Experimental Foods by M. Swaminathan (1990). The Bangalore Printing and Publishing Co. Ltd.


**Teaching Learning Process:**

- Teaching is supported by Classroom Lectures, Power point presentations/ICT and related videos.
- Written assignments are assigned.
- Knowledge of the students is assessed through Oral test/surprise tests/ internal assessments.

**CO-PO Mapping Matrix for the course BCH-206 (Food Biochemistry)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-206.1 | 3 | 3 | - | - | 3 | - |
| BCH-206.2 | 3 | 3 | 1 | - | 3 | - |
| Average | 3 | 3 | 0.5 | - | 3 | - |

**CO-PSO Mapping matrix for the course BCH-206 (Food Biochemistry)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-206.1 | 3 | 3 | 3 | 1 |
| BCH-206.2 | 3 | 3 | 3 | 1 |
| Average | 3 | 3 | 3 | 1 |

***Core***

**M.Sc. (Biochemistry) Semester - II**

**Paper: BCH –207**

**Practical-3 (Based on papers BCH-201 and BCH-202)**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 8hrs**
**Internal Assessment: 20** **Credits:4**

**Course outcomes:**

After the completion of the course, the students will be able to:

207.1 Elucidate the basic elements of clinical biochemistry and specialized tests of biochemistry.

207.2 Develop the skills of performing basic biochemical tests important in clinical investigations and to develop familiarity with biochemical laboratory techniques.

207.3 Deal with the handling of the various biological specimens including the process of collection, preservation and storage.

207.4 Get an insight about the diseases of various organs such as pancreas, liver, bones, kidney, heart and muscle by estimating different enzymes and metabolites.

**List of experiments**

1. Collection, preservation and physical examination of urine sample
2. Tests for analysis of abnormal urine constituents
3. To determine the blood group and Rh factor of the blood sample
4. Collection, preservation and separation of blood plasma and serum
5. Estimation of blood sugar by o-toluidine reagent
6. To estimate urea in the given blood sample
7. To estimate creatinine in the given serum sample
8. Estimation of haemoglobin by Sahl's method
9. Estimation of serum cholesterol by Zak's method
10. Quantitative estimation of alkaline phosphatase in the given serum sample
11. Quantitative estimation of acid phosphatase in the given serum sample
12. To determine serum proteins and albumin-globulin ratio by Biuret method
13. Quantitative estimation of SGPT in the given serum sample
14. Quantitative estimation of SGOT in the given serum sample
15. Quantitative estimation of uric acid in the given serum sample

16. Quantitative estimation of LDH in the given serum sample

**CO-PO mapping matrix for BCH 106 (Practical-3)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-207.1 | 3 | 3 | 1 | 1 | 3 | 3 |
| BCH-207.2 | 3 | 3 | 1 | 1 | 3 | 3 |
| BCH-207.3 | 3 | 3 | 1 | 1 | 3 | 3 |
| BCH-207.4 | 3 | 3 | 1 | 1 | 3 | 3 |
| Average | 3 | 3 | 1 | 1 | 3 | 3 |

**CO-PSO mapping matrix for BCH 106 (Practical-3)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-207.1 | 3 | 3 | 3 | 2 |
| BCH-207.2 | 3 | 3 | 3 | 2 |
| BCH-207.3 | 3 | 3 | 3 | 2 |
| BCH-207.4 | 3 | 3 | 3 | 2 |
| Average | 3 | 3 | 3 | 2 |

***Core***

**M.Sc. (Biochemistry) Semester - II**

**Paper: BCH –208**

**Practical-4 (Based on papers BCH-203 and BCH-204)**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 8hrs**
**Internal Assessment: 20** **Credits: 4**

**Course outcomes:**

After the completion of the course, the students will be able to:

208.1 Learn about use of instrumentation in design, execution and critical interpretation of experiments
208.2 Learn appropriate concepts, quantitative analysis and laboratory techniques
208.3 Develop the skills of extraction, purification assay of enzymes from plant and animal tissue.
208.4 Demonstrate the proficiency in concepts, manipulations and biochemical calculations

**List of Experiments**

1. Estimation of DNA by diphenylamine reaction
2. Estimation of RNA by orcinol reaction
3. Assay of acid phosphatase enzyme from plant/animal tissue and calculation of specific activity
4. Assay of alkaline phosphatase enzyme from plant/animal tissue and calculation of specific activity
5. Effect of substrate concentration on enzyme activity of acid/alkaline phosphatase
6. Effect of enzyme concentration on enzyme activity of acid/alkaline phosphatase
7. Effect of temperature and $P^H$ on the activity of acid/alkaline phosphatase
8. Effect of $P^H$ on the activity of acid/alkaline phosphatase
9. Determination of $K_m$, and V max
10. Determination of $P^H$ optima of an enzyme
11. Demonstration of enzyme immobilization
12. Partial purification of an enzyme by Ammonium Sulphate fractionation

**CO-PO mapping matrix for BCH 208 (Practical-4)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 208.1 | 3 | 2 | 2 | 3 | - | 3 |
| 208.2 | 3 | 2 | 2 | 3 | - | 3 |
| 208.3 | 3 | 2 | 2 | 3 | - | 3 |
| 208.4 | 3 | 2 | 2 | 3 | - | 3 |
| Average | 3 | 2 | 2 | 3 | - | 3 |

**CO-PSOmapping matrix for BCH 208 (Practical-4)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 208.1 | 3 | 3 | 3 | 3 |
| 208.2 | 3 | 3 | 3 | 3 |
| 208.3 | 3 | 3 | 3 | 3 |
| 208.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 3 |

***Core***

**M. Sc. (Biochemistry) Semester - III**

**Paper: BCH – 301**

**Molecular Biology – II**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. The candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:**

- The objective is to acquaint the students to most recent advances in molecular biology.
- Prepare students for finding careers and pursue Ph.D. in related fields.

**Course outcomes:**

301.1 Students learn about gene expression and its regulation at different levels
301.2 Correlation of rapid advances in molecular biology, developmental biology to a better understanding of disease including cancer
301.3 Molecular mechanism controlling cell cycle
301.4 Explain how molecular defects can lead to development of cancer.

## SECTION - A

**Gene regulation:** Various levels of control of gene expression in prokaryotes and eukaryotes, operon concept, regulation of expression of lac, galactose, araBAD, tryptophan operons and lambda phages, regulation of ribosome synthesis, motifs involved in DNA-protein, protein-protein interactions;Variousregulatory sequences in eukaryotes, molecular aspects of regulation of gene expression at transcription level viz. repression by nucleosomes, DNase sensitivity and hypersensitivity, histone modifications etc., at post-transcriptional level like regulation of RNA splicing, RNA transport, RNA stability; at translational, post-translational and protein degradation level.

## SECTION - B

**Transposable genetic elements:** Non-replicative and replicative transposition, transposable genetic elements in bacteria, yeast, maize, drosophila and significance of transposable elements.

**Interaction of nucleic acids with small molecules:** Reactions of nucleic acids with non-carbon electrophiles, nitrogen electrophiles, carbon electrophiles, anticancer drugs,

photochemical modifications of nucleic acids, effects of ionizing radiations on nucleic acids.

## SECTION - C

**Molecular Biology of Cancer:** Benign and malignant tumors, types of cancers, cancer causing agents- radiations, chemical compounds, DNA and RNA viruses; mechanism of carcinogenesis; important characteristics of cancerous cells; proto-oncogenes and oncogenes, gain of function mutations of proto-oncogenes-growth factors, growth factor receptors, intracellular signal transducers, nuclear transcription factors, cell cycle control proteins, apoptotic proteins, DNA repair proteins into oncogenes; Rb and $P^{53}$ as tumor suppressor genes, telomerase expression and immortalization of cells.

## SECTION – D

**Drosophila development and its regulation:** Various stages of oogenesis, blastulation, gastrulation to form three cell layers, morphogen gradient, details of three classes of pattern control genes like egg-polarity genes, segmentation genes, homeotic selector genes and imaginal discs.

**Genomics:** Structural genomics-construction of cytological maps based on banding pattern, physical maps based upon contigs, sequence-tagged sites (STSs), expressed-sequence tags (ESTs), genetic maps based upon RFLP, microsatellites, variable number tandem repeats; Map position- based cloning of genes; The human genome project; functional genomics-DNA microarray, serial analysis of gene expression (SAGE); comparative genomics-prokaryotic, chloroplast, mitochondria and eukaryotic genomes; evolution of genomes in the cereal grasses and mammals.

**Suggested Readings:**


1. Principles of Gene Manipulation, R.W. Old, S B Primose & R Twyman, 7th edition.
2. Principles of Genetics, Snustad et. al., 8th edition.
3. Molecular Cell Biology, Lodish et al, 8th edition.
4. Molecular Biology of the Gene, Watson et al, 7th Edition.
5. Nucleic acids in Chemistry and Biology, G M Blackburn & M.J. Gait, 3rd edition.


**CO-PO mapping matrix for BCH 301 (Molecular Biology II)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 301.1 | 2 | 3 | - | 1 | 1 | - |
| 301.2 | 2 | 2 | 1 | 1 | - | 1 |
| 301.3 | 1 | 3 | - | - | 1 | 1 |
| 301.4 | 2 | 1 | - | 1 | - | 1 |
| Average | 1.75 | 2.25 | 0.25 | 0.75 | 0.5 | 0.75 |

**CO-PSO mapping matrix for BCH 301 (Molecular Biology II)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| BCH 301.1 | 3 | 3 | 3 | 3 |
| 301.2 | 3 | 3 | 3 | 2 |
| 301.3 | 3 | 2 | 2 | 2 |
| 301.4 | 2 | 2 | 2 | 2 |
| Average | 2.75 | 2.5 | 2.5 | 2.25 |

***Core***

**M.Sc. (Biochemistry) Semester - III**

**Paper: BCH-302**

**Immunology**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. The candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:** The objective of this course is to:

- Learn about different components of immune system and how they work.
- To understand structure and function of immune system.
- Study mechanisms involved in immune system development and responsiveness.
- Failure of immune system will also be discussed

**Course outcomes:** After successful completion of course, students will be able to:

302.1 Compare and contrast the different types of immunity and their correlation for effective immune response, overview of immune system (including its cells and organs). Design and model of different types of immunoglobulins and antigens.

302.2 Conceptualization of molecular basis of Antigen Antibody interaction, immune cell interactions, recognition molecules and immunomodulatory molecules.

302.3 Understanding of genetic basis of diversity of immune response and also knowledge of immunization.

302.4 Knowledge of immune response against infectious agents and tumors, adverse effects of immune response including autoimmune disorders, hypersensitivity and immunodeficiency disorders.

## SECTION - A

**Introduction to immune system:** Memory, specificity, diversity, innate and acquired immunity, self vs non-self discrimination, structure and functions of primary and secondary lymphoid organs. **Cells involved in immune responses:** Phagocytic cells and their killing mechanisms; T and B lymphocytes. **Nature of antigen and antibody:** Antigens vs immunogen, haptens, structure and functions of immunoglobulins; isotypic, allotypic and idiotypic variations.

## SECTION - B

**Humoral and cell mediated immune responses:** Kinetics of primary and secondary immune responses, complement activation and its biological consequences, antigen processing and presentation, cytokines and costimulatory molecules- role in immune responses, T and B cell interactions.**Major Histocompatibility Complex(MHC) genes and**

**products**:polymorphism of MHC genes, role of MHC antigens in immune responses, MHC antigens in transplantation.

## SECTION - C

**Generation of diversity in immune system:** Clonal selection theory- concept of antigen specific receptor, organization and expression of immunoglobulin genes- generation of antibody diversity, Organization and expression of T-cell receptor genes- generation of T cell receptor diversity. **Immunization:** Active & passive immunization.

## SECTION - D

**Tolerance vs activation of immune system:** Immune tolerance, immunosuppression, hypersensitivity (Types I, II, III and IV).**Immune responses in diseases:** Immune responses to infectious diseases- viral, bacterial and protozoal; cancer and immune system, immunodeficiency disorders and autoimmunity.

**Suggested Readings:**


1. Immunology, 13th ed. by Roitt et al., Mosby Publications.
2. Cellular and Molecular Immunology, 9thed. by Abbas and Litchman, Saunders Publication.
3. Kuby Immunology, 7th ed. by R.A. Goldsby et al, W.H. Freeman & Co.
4. Immunology: an introduction, 4th Edition by Ian R Tizard, Saunders College Publishing.


**CO-PO mapping matrix for BCH 302 (Immunology)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 302.1 | 2 | 2 | -- | 1 | 1 | -- |
| 302.2 | 2 | 3 | -- | 1 | 2 | -- |
| 302.3 | 1 | 3 | -- | 1 | -- | -- |
| 302.4 | 1 | 3 | -- | 2 | -- | 2 |
| Average | 1.5 | 2.75 | -- | 1.25 | 0.75 | 0.5 |

**CO-PSO mapping matrix for BCH 302 (Immunology)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 302.1 | 3 | 3 | 3 | 3 |
| 302.2 | 3 | 3 | 2 | 3 |
| 302.3 | 2 | 3 | 2 | 2 |
| 302.4 | 3 | 2 | 2 | 2 |
| Average | 2.75 | 2.75 | 2.25 | 2.5 |

***Core***

**M.Sc. (Biochemistry) Semester - III**

**Paper: BCH – 303**

**Plant Biochemistry**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objective**:

- To provide students a comprehensive understanding of different plant metabolic processes such as carbon metabolism, nitrogen metabolism, sulphur metabolism, plant hormones and biochemical defense mechanisms against pathogen.

**Course outcomes**: After the completion of the course, the students will be able to:

303.1 Understand the light phase of photosynthesis and pathways of $CO_2$ assimilation in $C_3$, $C_4$ and CAM plants.

303.2 Get an insight about the Sucrose and starch metabolism in plants and Electron transport chain in plant mitochondria.

303.3 Explain the various plant processes viz. nitrate assimilation, biological nitrogen fixation and sulphate assimilation in plants.

303.4 Understand biochemical defense mechanisms against pathogens and molecular mechanism of action of different plant hormones that can facilitate their research abilities in the field of plant sciences.

## SECTION – A

Chemical and physical composition of higher plant cell wall. **Light reactions of Photosynthesis:** Photosynthetic pigments, chlorophyll excitation by absorption of light energy and its return to the ground state, Requirement of an antenna to capture light, van Niel equation, Hill equation, Cyclic electron transport in purple photosynthetic bacterium, Red drop and Emerson enhancement effect, Photosystem I & II, Non-cyclic, cyclic and pseudocyclic photosynthetic electron transport, Inhibitors of non-cyclic electron transport, Regulation of energy distribution between PS I and PS II, Photophosphorylation: coupling between electron transport and phosphorylation, chemiosmotic hypothesis, chloroplast ATP synthase, binding change mechanism of ATP synthesis and uncouplers of photophosphorylation.

## SECTION – B

Pathway and regulation of $CO_2$ assimilation in $C_3$, $C_4$ & CAM plants. Photorespiration: pathway and significance. Metabolism of Sucrose and Starch: Biosynthesis and degradation of starch and sucrose; role of fructose 2, 6- bisphosphate in carbon

partitioning between sucrose and starch. **Electron transport in plant mitochondria:** Electron transport complexes and pathway of electron flow in plant mitochondria; cyanide - resistant respiratory pathway.

## SECTION – C

**Nitrogen Metabolism:** Nitrogen Cycle**;** Nitrate Assimilation: nitrate uptake, nitrate & nitrite reduction and regulation of nitrate assimilation. **Biological nitrogen fixation**: Nitrogen fixing organisms, structure and mechanism of action of nitrogenase, Legume-Rhizobiumsymbiosis(Abriefaccount),Leghaemoglobin,Strategiesforprotectionofnitrogena seagainsttheinhibitory effect of oxygen, Uptake hydrogenase, Ammonia assimilation, *nif*genes of *Klebsiella pneumoniae* and their regulation, and synthesisofamidesandureides.**Sulphateassimilation**:sulphateuptakeanditsassimilationinto cysteine.

## SECTION – D

Biochemical defense mechanisms in plants against pathogens; Plant hormones: Physiological effects and molecular mechanism of action of auxins, gibberellins, cytokinins, ABA and ethylene. Phytochromes as light sensors.

**Suggested Reading:**


1. BiochemistryandMolecularBiologyofPlantsbyBob,B.Buchanan,W.GruissenandR.L.Jo nes(2000). Published by American Society of Plant Physiologists and distributed by Panima Educational Book Agency, NewDelhi.
2. PlantBiochemistry&MolecularBiology,3rded.,byHans–WalterHeldt(2005),AcademicPress
3. IntroductiontoPlantBiochemistry,T.W.GoodwinandE.I.Mercer(1983).PergamonPress, Oxford
4. PlantPhysiology,2ndedition,byL.TaizandEZeigler(1998),SinauerAssociates,Inc.,Publis hers


**Teaching Learning Process:**

- Teaching is supported by Classroom Lectures, Power point presentations/ICT and related videos.
- Written assignments are assigned.
- Knowledge of the students is assessed through Oral test/surprise tests/ internal assessments.

**CO-PO Mapping Matrix for the course BCH – 303 (Plant Biochemistry)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-303.1 | 3 | 3 | - | 1 | 1 | 1 |
| BCH-303.2 | 3 | 3 | - | 1 | 1 | 1 |
| BCH-303.3 | 3 | 3 | - | 1 | 1 | 1 |
| BCH-303.4 | 3 | 3 | - | 2 | 2 | 3 |
| Average | 3 | 3 | - | 1.25 | 1.25 | 1.5 |

**CO-PSO MappingMatrix for the course BCH – 303 (Plant Biochemistry)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-303.1 | 3 | 3 | 3 | 1 |
| BCH-303.2 | 3 | 3 | 3 | 1 |
| BCH-303.3 | 3 | 3 | 3 | 1 |
| BCH-303.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 1.5 |

***Elective***

**M.Sc. (Biochemistry) Semester – III**

**Paper: BCH – 304A**

**Nutritional Biochemistry**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:**

- To focus on the health benefits of typical nutrients including macro and micro minerals and vitamins and of nutraceuticals and functional foods.
- To know the basic concepts of food toxicity and safety.
- To help students understand the nutritive value of common Indian foods and nutritional disorders.

**Course outcomes:** After the completion of the course, the students will be able to:

304A.1 Acquire detailed knowledge regarding nutritional importance of different nutrients and how diet influences health.

304A.2 Explain the importance of vitamins and minerals for maintaining good health.

304A.3 Get an insight about the various food toxicants, food additives, nutraceuticals and functional foods

304A.4 Describe different nutritional disorders and various applications of major enzymes in food industry.

## SECTION A

Composition of human body, Energy content of foods, respiratory quotient of food stuffs, measurement of energy expenditure (directandindirectcalorimetry),BMR:measurementandsignificanceofBMR,factorsaffecting BMR;Specificdynamicaction (SDA);Carbohydrates:nutritionalimportance,sourcesofavailablecarbohydrates;fibresinnutrition:beneficialeffects,adverse effects and their sources, glycemic index, alternative sweeteners; Lipids: nutritional importance, major classes of dietary lipids, properties and composition of plasma lipoproteins, essential fatty acids and their physiological functions; Proteins: nutritional importance, nitrogen balance, assessment of nutritive value of proteins, concept of balanceddiet.

## SECTION B

Minerals:nutritionalsignificance,dietarysources,deficiencysymptomsandtoxicitysymptomsofmajorandtraceminerals Vitamins: dietary sources, physiological functions and specific deficiency diseases associated with fat and water soluble vitamins, hypervitaminosis of fat

solublevitamins

## SECTION C

Food toxicity and safety: Microbial contamination, Environmental contamination, Natural food toxins and Antinutrients: naturally occurring food borne toxicants, protease inhibitors, hemagglutinin, hepatotoxins, allergens, oxalates, toxin from mushrooms,animalfoodstuffs andseafoods;Agriculturalresidues,Intentionalfoodadditives:typesoffoodadditives-attributes and related health concerns; Nutraceuticals: different types of Dietary supplements and typical ingredients of Functionalfoods

## SECTION D

**Applications of major enzymes in food industry**

**Nutritional disorders:** Lipoproteins and cardiovascular disease: 'good' and 'bad' cholesterol, development of cardiovascular disease and risk factors for cardiovascular disease

Protein energy malnutrition: etiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkor diseases

Nutrition and Cancer: Associations between nutritional factors and common cancer sites; effect of different foods, beverages, physical parameters and other additional factors on cancer.

**Suggested readings:**


1. Biochemistry by U. Satyanarayana (2002). Books and allied (P)Ltd.
2. EssentialsofHumanNutritionbyJ.MannandA.S.Truswell(2008)3rded.Oxford University Press Inc., NewYork
3. ContemporaryNutritionbyWardlawSmith(1996)6th ed.McGrawHill Inc.,New York
4. NutritionalBiochemistrybyS.RamakrishnanandS.VenkatRao(1995) T.R. Publications
5. *Food Chemistry* by Owen Fennema (1996) 3rd ed. CRCPress.
6. FoodScienceChemistryandExperimentalFoodsbyM.Swaminathan(1990). The Bangalore Printing and Publishing Co.Ltd.


**Teaching Learning Process:**

- Teaching is supported by Classroom Lectures, Power point presentations/ICT and related videos.
- Written assignments are assigned.
- Knowledge of the students is assessed through Oral test/surprise tests/ internal assessments.

**CO-PO Mapping Matrix for BCH–304A(NutritionalBiochemistry)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-304A.1 | 3 | 1 | - | - | 1 | 1 |
| BCH-304A.2 | 3 | 1 | - | - | 1 | 1 |
| BCH-304A.3 | 3 | 1 | 3 | - | 1 | 1 |
| BCH-304A.4 | 3 | 2 | - | - | 3 | 3 |
| Average | 3 | 1.25 | 0.75 | - | 1.5 | 1.5 |

**CO-PSO Mapping Matrix forBCH–304A(NutritionalBiochemistry)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-304A.1 | 3 | 3 | 2 | 1 |
| BCH-304A.2 | 3 | 3 | 2 | 1 |
| BCH-304A.3 | 3 | 3 | 3 | 2 |
| BCH-304A.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 2.5 | 1.75 |

***Elective***

**M.Sc. (Biochemistry) Semester - III**

**Paper: BCH – 304B**

**Human Physiology**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:**

- To explain basic physiology of various systems, regulation of body's organ systems and to understand the principal of homeostasis.
- To understand the concept of biosignaling

**Course outcomes:**

After studying this course, students will be able to:

304B.1 Understand the basic mechanisms of secretion and stimulation of alimentary tract glands and describe the physiology of digestion in humans.

304B.2 Gain knowledge about physiology of respiration, understand acid-base homeostasis in the human body, anatomical and physiological aspects of nephron.

304B.3 Have an overview of neurotransmission, blood composition and blood coagulation.

304B.4 Learn physiological functions of various hormones and an overview of ligand receptor interactions and their role in signal transduction

## SECTION-A

**Gastrointestinal Physiology**: Secretory functions of the alimentary tract: General principles of alimentary tract secretion; Basic mechanism of stimulation of alimentary tract glands; Basic mechanism of secretion by glandular cells; Lubricating and protective properties of mucus and importance of mucus in gastrointestinal tract; Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids and proteins

## SECTION- B

**Respiration**: Components of respiratory system and their functions; transfer of blood gases- $O_2$ and $CO_2$; Bohr effect; role of chloride ions in oxygen transport; effect of 2,3-BPG on $O_2$ affinity of Hb; Clinical importance of 2,3-BPG.

**Acid Base Balance**: Acid base balance; Role of blood buffers; respiratory and renal mechanism in the maintenance of blood pH;

**Excretory System**: Structure of nephron; formation of urine; tubular re-absorption of glucose, water and electrolytes; tubular secretion; regulation of water and electrolyte balance; role of kidneys and hormones in their maintenance.

## SECTION – C

**General principles of nervous system**: Structure of a neuron, resting potential, action potential, propagation of action potentials as an impulse; types of synapses; role of $Ca^{+2}$ in release of neurotransmitter from pre-synaptic membrane; function of receptor proteins and secondary messenger on the postsynaptic neuron; Characteristics of some important neurotransmitters (Dopamine, GABA, Glutamate, Acetylcholine, Serotonin, NO).

**Blood Cells and Blood Clotting**: Blood components and their function; plasma proteins; blood coagulation.

## SECTION – D

**Hormones**: Classification and mechanism of action, physiological functions, regulation of growth hormones, ADH, oxytocin, thyroid hormones, mineralocorticoid, glucocorticoid, insulin, glucagon, parathyroid hormone, and male and female reproductive hormones.

**Biosignaling**: General features of signal transduction, G protein-coupled receptors and Second messengers (cAMP, diacyl glycerol, inositol triphosphate and $Ca^{2+}$ ions), receptor tyrosine kinases

**Suggested readings:**


1. Textbook of Medical Physiology, 13th edition, A C Guyton & J E Hall. (2015) Elsevier.
2. Human physiology, 12th edition by Stuart Ira Fox (2011) McGraw-Hill Education (ISE editions)
3. Tortora's Principles of Anatomy & Physiology, 15th edition by Gerard J. Tortora & Bryan H. Derrickson (2017) John Wiley & Sons
4. Vander's Human physiology, 15th edition by Hershel Raff, Eric Widmaier& Kevin Strang (2018) McGraw-Hill Education
5. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox (2017) Maxmillan/ Worth publishers.Freeman& Co. New York.


**Teaching Learning Process**

- Teaching is supported by Classroom Lectures, Powerpoint presentations andrelated videos.
- Oral or written assignments are assigned.
- Knowledge of the students is tested through surprise tests and internal assessments.

**CO-PO Mapping Matrix for the course BCH-304B (Human Physiology)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-304B.1 | 3 | 3 | - | 3 | 2 | 1 |
| 304B.2 | 3 | 3 | - | 3 | 2 | 1 |
| 304B.3 | 3 | 3 | - | 3 | 2 | 1 |
| 304B.4 | 3 | 3 | - | 3 | 2 | 1 |
| Average | 3 | 3 | - | 3 | 2 | 1.25 |

**CO-PSO Mapping Matrix for the course BCH- 304B (Human Physiology)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-304B.1 | 3 | 3 | 3 | 2 |
| 304B.2 | 3 | 3 | 3 | 2 |
| 304B.3 | 3 | 3 | 3 | 2 |
| 304B.4 | 3 | 3 | 3 | 2 |
| Average | 3 | 3 | 3 | 2 |

***Core***

**M. Sc. (Biochemistry) Semester - II**

**Paper: BCH-305**

**Seminar**

**Total Marks: 25** **Credits:** 1

**Course outcomes**

After the completion of the course, the students will be able to:

305.1Work independently, critically analyze research literature and use different digital sources to explain the concepts of Biochemistry.

305.2 Demonstrate latest scientific developments from disciplinary perspective to its professional and everyday use.

305.3 Formulate logical and convincing arguments and to substantiate critical readings of scientific texts in order to develop scientific temper in biological sciences.

**CO-PO mapping matrix for BCH 305 (Seminar)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 305.1 | 3 | 3 | 2 | 3 | 2 | - |
| 305.2 | 3 | 3 | 3 | 2 | 3 | - |
| 305.3 | 3 | 3 | 3 | 3 | - | - |
| Average | 3 | 3 | 2.66 | 2.66 | 1.66 | - |

**CO-PSO mapping matrix for BCH 305 (Seminar)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 305.1 | 3 | 3 | 2 | 2 |
| 305.2 | 3 | 3 | 2 | 2 |
| 305.3 | 3 | 3 | 2 | 3 |
| Average | 3 | 3 | 2 | 2.33 |

***Open Elective***

**M.Sc. (Biochemistry) Semester - III**

**Paper: BCH – 306**

**Clinical Diagnostics in Health and Disease**

**Total Marks: 50**

**External Marks: 40** **Time allowed: 3 hrs**

**Internal Assessment: 10** **Credits: 2**

**Note:** The examiner will setfive questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & two others, selecting one from both sections.

**Objective:**

- To provide students with the basic knowledge and understanding of the role of clinical biochemistry in diagnosis of various diseases.

**Course outcomes:** After the completion of the course, the students will be able to:

306.1 Have an overview of clinical biochemistry in the diagnosis of common diseases.

306.2 Understand the pathology of common disease

306.3 Have an overview of common biochemical and molecular markers of common diseases.

306.4 Understand how these biochemical and molecular are employed to develop a diagnosis

## SECTION - A

Introduction to health and disease; **General biochemical test:** Blood group, Hb, total cell count, differential cell count (TLC and DLC), ESR, Bleeding time, clotting time, Urine analysis (protein, sugar and pigments), blood sugar, GTT and acetylated Hb. **General microbiological tests:** culture and sensitivity (urine and blood) tests. **Biochemical tests in clinical medicine– diagnostic tests and their clinical significance**:Liver function tests: SGOT, SGPT, ALP;Kidney function tests: Urea and creatinine; Cardiac function tests: blood pressure, lipid profile – HDL-c, LDL-c, total cholesterol, triglycerides, electrolytes;lung function tests.

## SECTION - B

**Molecular diagnosis of viral diseases:** HIV (I and II), H1N1, Chickungunya, Dengue, viral hepatitis (B and C). **Diagnosis of infectious diseases:** tuberculosis**,** cholera, Typhoid and malaria; TORCH – panel; Infection in pregnancy; microscopic examination of body fluids, ELISA and PCR tests.

**Suggested readings**:


1. Teitz text book of clinical chemistry and Molecular diagnostics (2012), 5th edition, Carl A Burtis and Edward R Ashwood, W B Saunders Company.
2. Harper's Biochemistry, 31st ed., by R.K.Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V W Rodwell (2018), Prentice Hall International.
3. Textbook of Biochemistry with Clinical Correlations, 5th ed., T.M. Devlin (2002), Wiley-Liss.
4. Biochemistry, 5th ed., U. Satyanarayana (2017), Books and allied (P) Ltd.


**Teaching Learning Process:**

- Teaching is supported by Classroom Lectures, Power point presentations/ICT and related videos.
- Written assignments are assigned.
- Knowledge of the students is assessed through Oral test/surprise tests/ internal assessments.

**CO-PO mapping matrix for BCH 306 (Clinical Diagnostics in Health and Disease)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 306.1 | 3 | 3 | - | 2 | 1 | 2 |
| 306.2 | 3 | 3 | - | 2 | 1 | 2 |
| 306.3 | 3 | 3 | - | 2 | 1 | 2 |
| 306.4 | 3 | 3 | - | 2 | 2 | 2 |
| Average | 3 | 3 | - | 2 | 1.25 | 2 |

**CO-PSO mapping matrix for BCH 306 (Clinical Diagnostics in Health and Disease)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 306.1 | 2 | 3 | 2 | 2 |
| 306.2 | 2 | 3 | 2 | 2 |
| 306.3 | 2 | 3 | 2 | 2 |
| 306.4 | 2 | 3 | 2 | 2 |
| Average | 2 | 3 | 2 | 2 |

***Open Elective***

**M.Sc. (Biochemistry) Semester - III**

**Paper: BCH – 306A**

**Summer/Industrial Training**

**(Only for Biochemistry students)**

**Total Marks: 50**

The students M.Sc. Biochemistry entering in 3rd semester of their programs(PG) w.e.f 2020-21 onwards will be allowed to opt for summer/Industrial training in lieu of open elective paper (BCH-306) keeping in view the following guidelines:-

1. Can be opted in 3rd semester only
2. Can do the summer/industrial training only after taking permission from the Chairperson of the department in writing.
3. Will be of minimum 4 weeks duration and can be done only during summer vacation falling in the period intervening between 2nd and 3rd Semester.
4. Can be done with a recognized industry research laboratory/company.
5. Every student opting for summer training will submit a report separately and present the same before a committee of the three teachers constituted by the chairperson of the department. The committee will award the marks out of 50 after evaluating the report and performance of the student during presentation.
6. Student will append a certificate in the report from the industry/research laboratory/company where she has done summer training.
7. No TA/DA or stipend will be provided by the University for doing the summer training.

**Course outcomes:**

After the completion of the course, the students will be able to:

1. Impart practical and project based training for preparing students to pursue higher education and career in research in the field of life sciences.

2. Develop problem m solving innovative thinking with strong communication and writing skills, develop understanding of biological sciences with respect to recent knowledge and techniques.

3. Articulate specific ideas, scientific writing authentic reporting and effective presentation skills.

**CO-PO mapping matrix for BCH 306A (Summer/Industrial Training Project Report)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 305.1 | 3 | 3 | 3 | 3 | 2 | 3 |
| 305.2 | 3 | 3 | 3 | 3 | 2 | 3 |
| 305.3 | 3 | 3 | 3 | 3 | 2 | 3 |
| Average | 3 | 3 | 3 | 3 | 2 | 3 |

**CO-PSO mapping matrix for BCH 306A (Summer/Industrial Training Project Report)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 305.1 | 3 | 3 | 3 | 3 |
| 305.2 | 3 | 3 | 3 | 3 |
| 305.3 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 3 |

***Core***

**M.Sc. (Biochemistry) Semester - III**

**Paper: BCH –307**

**Practical-5 (Based on papers BCH-301 and BCH-302)**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 8hrs**
**Internal Assessment: 20** **Credits: 4**

**Course outcomes**:
After the completion of the course, the students will be able to:

307.1 Develop skills in carrying out research projects by employing molecular biology and basic immunological techniques

307.2 Learn appropriate concepts, qualitative analysis and laboratory techniques

307.3 Demonstrate the proficiency extraction, separation and manipulation of nucleic acid by employing basic molecular biology techniques

307.4 Acquire insight knowledge regarding the important methods in Molecular Biology and immunology and able to exhibit their proficiency and skills in research.

**List of experiments**

1. Extraction of DNA from plant tissue/Human blood and checking of its purity
2. Preparation of plasmid DNA
3. Agarose gel electrophoresis of DNA
4. Isolation of cytoplasmic RNA
5. Electrophoresis of RNA on denaturing gels
6. Restriction digestion of DNA by restriction endonuclease
7. Construction of restriction map of plasmid DNA
8. Electrophoretic separation of isoenzymes
9. Ligation of DNA fragments
10. ELISA
11. Immunodiffusion
12. Purification of IgG from serum

**CO-PO mapping matrix for BCH 307 (Practical-5)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 307.1 | 3 | 3 | 2 | 3 | - | 3 |
| 307.2 | 3 | 3 | 2 | 3 | - | 3 |
| 307.3 | 3 | 3 | 2 | 3 | - | 3 |
| 307.4 | 3 | 3 | 2 | 3 | - | 3 |
| Average | 3 | 3 | 2 | 3 | - | 3 |

**CO-PSO mapping matrix for BCH 307 (Practical-5)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 307.1 | 3 | 3 | 3 | 3 |
| 307.2 | 3 | 3 | 3 | 3 |
| 307.3 | 3 | 3 | 3 | 3 |
| 307.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 3 |

***Core***

**M.Sc. (Biochemistry) Semester - III**

**Paper: BCH –308**

**Practical-6 (Based on papers BCH-303 and BCH-304A&B)**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 8hrs**
**Internal Assessment: 20** **Credits: 4**

**Course outcomes**:

After the completion of the course, the students will be able to:

308.1 Appreciate and illustrate the biochemistry of plant related processes and its relation to the stressed environment

308.2 Develop skills and knowledge to conduct basic research work in the field of Plant Biochemistry.

308.3 Correlate the applications of enzymes of plant origin (β-amylases) in various industrial processes such as food, fermentation and pharmaceutical industries.

308.3 Understand and estimate few important parameters related to human physiology.

**List of experiments**

1. Estimation of phenols in plant tissues
2. Estimation of chlorophyll content in the leaves
3. Quantitative estimation of starch in the given plant tissue
4. Quantitative determination of free amino acid content in germinating moongbean seeds
5. Estimation of proline in stressed plant tissues
6. To determine the activity of malate dehydrogenase in the given plant tissue
7. Determination of β-amylase activity in germinating barley seeds
8. Estimation of ascorbic acid in lemon juice
9. To determine the activity of polyphenol oxidases
10. To estimate titrable acidity in fruits
11. Estimation of proteins in germinating seeds by Lowry's method
12. Estimation of nitrate reductase activity from plant tissue
13. Determination of ESR by Westergen method
14. Determination of chloride in the given serum sample
15. Determination of phosphorus in the given serum sample

**CO-PO mapping matrix for the course BCH–308**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-308.1 | 3 | 3 | - | 1 | 3 | 3 |
| BCH-308.2 | 3 | 3 | - | 2 | 3 | 3 |
| BCH-308.3 | 3 | 3 | - | 1 | 3 | 3 |
| BCH-308.4 | 3 | 3 | - | - | 2 | 1 |
| Average | 3 | 3 | - | 1 | 2.75 | 2.5 |

**CO-PSO mapping matrix for the course BCH–308**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-308.1 | 3 | 3 | 3 | 2 |
| BCH-308.2 | 3 | 3 | 3 | 2 |
| BCH-308.3 | 3 | 3 | 3 | 2 |
| BCH-308.4 | 3 | 3 | 3 | 2 |
| Average | 3 | 3 | 3 | 2 |

***Core***

**M.Sc. (Biochemistry) Semester - IV**

**Paper: BCH – 401**

**Biostatistics and Bioinformatics**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objective**:

- To familiarize the student with the science of biological data analysis using statistical and computational tools.

**Course outcomes**: After the completion of the course, the students will be able to:

401.1 Understand the basic statistics and know how to analyse the biological data.
401.2 Equip the students to infer their results in a better way which is essential to get scientific data published in reputed journals.
401.3 Understand the fundamentals of bioinformatics.
401.4 Know how to use biological databases, retrieve information and link the wet and dry lab knowledge for better understanding of biological phenomenons.

## SECTION - A

**Fundamentals of Statistics:** Arithmetic mean, median, mode: measures of variation: standard deviation, variance, coefficient of variation; properties; correlation: types and methods; simple, multiple, linear and non linear correlation, spearman's correlation, rank correlation; regression: linear and curvilinear regression (for X and Y only), regression lines by least square method, regression equations of X on Y and Y on X only; sample size; power of study.

## SECTION - B

**Tests of Significance:** Null hypothesis; standard error; level of significance; degrees of freedom; significance of mean for large samples; significance in means for small samples (students t-test); significance in ratio of two samples; F test (for difference between variance of two samples); chi square test; analysis of variance (ANOVA) test for one and two way classification; applications of various online tools: SPSS, Minitab, XLSTAT etc.

## SECTION - C

**Fundamentals of Bioinformatics:** Introduction to bioinformatics; concept of databases; biological databases; integration of databases; applications and problems in information retrieval from biological databases; Pairwise sequence comparisons by DOT-MATRIX and dynamic programming; Global (Needleman and Wunsch algorithm) and local (Smith and Waterman algorithm) alignments; Measures of sequence similarity (Alignment score, % sequence identity; percentage similarity; statistical scores–E, P and Z); Heuristic approaches for database searching; BLAST and FASTA; multiple sequence alignment; SP scoring; multidimensional dynamic programming; progressive sequence alignment approach.

## SECTION - D

**Applications of Bioinformatics:** Gene, ORF of a gene, promoter and regulatory elements prediction; phylogenetic analysis (phylogeny, Phylogenetic tree, construction methods of Phylogenetic tree and Phylogenetic programs); protease digestion mapping; protein structure analysis; protein secondary structure prediction; Homology modelling (principles and procedures); docking; determination of metabolic pathways.

**Suggested Readings**:


1. Statistical Methods by S P Gupta (2017), Sultan Chand and Sons. New Delhi
2. Fundamentals of Mathematical Statistics, S C Gupta and V K Kapoor (2014), Sultan Chand and Sons.
3. Essential Bioinformatics, JinXiong (2007), Cambridge University Press.
4. Bioinformatics for Dummies, Jean-Michel Claverie, Cedric Notredame (2003), John Wiley and Sons.
5. Introduction to Bioinformatics, 5th ed., Arthur M. Lesk (2019) Oxford University Press.
6. Fundamental Concepts of Bioinformatics (2003), Dan E. Krane, Michael L Raymer.


**CO-PO mapping matrix for BCH 401 (Biostatistics and Bioinformatics)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 401.1 | 3 | 2 | - | 1 | - | 2 |
| 401.2 | 3 | 2 | - | 2 | - | 3 |
| 401.3 | 3 | 2 | - | 2 | - | 2 |
| 401.4 | 3 | 2 | - | 2 | - | 3 |
| Average | 3 | 2 | - | 1.75 | - | 2.5 |

**CO-PSO mapping matrix for BCH 401 (Biostatistics and Bioinformatics)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 401.1 | 3 | 3 | 3 | 3 |
| 401.2 | 3 | 3 | 3 | 3 |
| 401.3 | 3 | 3 | 3 | 3 |
| 401.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 3 |

***Core***

**M.Sc. (Biochemistry) Semester – IV**

**Paper: BCH – 402**

**Biotechniques**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objective**:

- To introduce the student about the radioisotopic, fractionation, molecular biology, immunological and spectroscopic techniques, their principles and applications.

**Course outcomes**: After the completion of the course, the students will be able to:

402.1 Know the radio-isotopic techniques and their application in biological science research.

402.2 Understand the basic techniques of molecular biology and relate modern DNA technology for disease diagnosis and therapy.

402.3 Know the antigen antibody interactions, experimental methods of monoclonal antibody synthesis and types of vaccines.

402.4 Gain insight knowledge of the interaction of matter with electromagnetic radiations that will help to understand the chemical structure of molecules

## SECTION - A

**Radioisotope techniques:** Basic concepts (types of radioactive decay, rate of radioactive decay, radioactive isotopes and their half-lives and units of radioactivity); GM and scintillation counter; autoradiography; specific activity of a radioisotope; safety aspects; applications of radioisotopes in biological sciences. **Centrifugation:** Basic principles; different types of centrifuges; types of rotor; analytical and preparative ultracentrifugation methods.

## SECTION - B

**Molecular biology techniques:** Isolation of DNA and RNA, purification and quantification of nucleic acids;Electrophoresis of nucleic acids: agarose gel electrophoresis, pulse field electrophoresis; capillary electrophoresis; microchip electrophoresis; DNA sequence analysis methods: Sanger dideoxy method, Maxam Gilbert chemical method and Fluorescence method; Polymerase chain reaction: principles, process, design and optimization; different types of PCR: allele specific, nested, multiplex and real-time PCR; ligase chain reaction; SNP and application in molecular diagnostics; DNA fingerprinting: applications and prospects; restriction fragment length polymorphism (RFLP) and its uses.

## SECTION - C

**Immunotechniques:** Immunoprecipitation; agglutination; RIA; ELISA; ELISPOT; immunoblotting; immunofluorescence assays; cytotoxic assay; hybridoma technology for production of monoclonal antibody - principles, techniques and applications; designing chimeric and humanized antibodies; vaccines: types and their role in prevention of diseases.

## SECTION - D

**Spectroscopy:** Nature of electromagnetic radiations; principles of biophysical methods used for analysis of biopolymer structure - UV, Visible, Infrared, Raman, Fluorescence and NMR spectroscopy; ORD and CD; Atomic absorption spectroscopy.

**Suggested readings:**


1. Kuby Immunology, 7th Edition
2. Physical Biochemistry, 3rd edition, by K. E Van Holde.
3. Principles and Techniques of Practical Biochemistry, 8th edition by Keith Wilson and John Walker.
4. Physical Biochemistry, 2nd edition, by D Friefelder.
5. Biophysical Chemistry: Principles and Techniques, 3rd edition by A Upadhyay, K Upadhyay and N Nath.


**CO-PO mapping matrix for BCH 402 (Biotechniques)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 402.1 | 3 | - | 2 | 2 | - | 2 |
| 402.2 | 3 | 1 | 2 | - | - | 1 |
| 402.3 | 3 | - | 2 | 1 | 2 | 2 |
| 402.4 | 2 | 1 | 1 | 1 | - | 1 |
| Average | 2.75 | 0.5 | 1.75 | 1.0 | 0.5 | 1.5 |

**CO-PSO mapping matrix for BCH 402 (Biotechniques)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 402.1 | 3 | 3 | 2 | 1 |
| 402.2 | 3 | 2 | 3 | 2 |
| 402.3 | 2 | 3 | 3 | 2 |
| 402.4 | 3 | 2 | 2 | 2 |
| Average | 2.75 | 2.5 | 2.5 | 1.75 |

***Core***

**M.Sc. (Biochemistry) Semester - IV**

**Paper: BCH – 403**

**Genetic Engineering**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objective**:

- To provide students a basic knowledge of genetic engineering for gene transfer into bacteria, yeast, plants, and animals as well as recombinant protein production in bacteria and eukaryotic cells.

**Course outcomes**: After the completion of the course, the students will be able to:

403.1 Understand the basic of genetic engineering and steps involved in a gene cloning experiment.
403.2 Know the various methods of gene transfer into *E. coli*, yeast, plant cells and animal cell and also know how to construct a genomic/cDNA library
403.3 Gain knowledge of recombinant protein production in bacteria and eukaryotic cells.
403.4 Understand the practice the ethics in research and aware about IPR and bioethics.

## SECTION– A

**Gene cloning strategies:** Isolation and purification of nucleic acid and its quantification and analysis; Molecular tools and their applications; Restriction endonucleases; DNA modification enzymes; Site directed mutagenesis; Cloning vectors; Ligation of DNA fragments: Linkers, adapters and homopolymeric tailing; Construction of genomic library: mRNA enrichment; Reverse transcription; Synthesis of cDNA and library construction.

## SECTION- B

**Expression vectors:** Choice of expression system; Expression in bacterial, yeast, insect and mammalian cells; Baculovirus expression systems; Expression of heterologous genes; Factors affecting the expression of cloned genes; Codon bias; Vector engineering and codon optimization;

**Transgenic and gene knockout technologies:** Transgenic methodology; Transgenic animals and plants; Targeted gene replacement; chromosome engineering.

## SECTION- C

**Studying gene expression and function:** Studying the transcript of a cloned gene; Identifying protein binding sites on a DNA molecule; Identifying control sequences by deletion analysis; Identifying and studying the translation product of a cloned gene by HRT & HART. Studying protein-protein interactions (Phage display and the yeast two hybrid systems). Production of Proteins from cloned genes: Expression in *E. coli* (Vectors for expression of foreign genes in *E. coli*, promoters used in expression vectors, general problems with the production of recombinant protein in *E. coli*);Production of recombinant protein by eukaryotic cells (Recombinant protein production in yeast, insect cells and mammalian cells; Pharming- recombinant protein production from live animals and plants); Recombinant protein purification using His-tag. Importance of gene cloning in medicine for the production of recombinant pharmaceuticals

## SECTION- D

**Intellectual Property Rights:** Introduction to IPR, Types of IPR - Patents, Trademarks, Copyright and Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications. Importance of IPR - patentable and nonpatentable, IPR and WTO regime - consumer protectionand plant genetics resources. **Bioethics:** Introduction to ethics and bioethics; Ethical and socioeconomic aspects of gene therapy, germline, somatic, embryonic and adult stem cell research. Ethical implications of GM crops, GMOs, human genome project, human cloning and bio-weapons.

**Suggested Readings**:


1. Gene Cloning and DNA Analysis - An Introduction, 7th edition, by T. A. Brown (2016), Blackwell Publishing.
2. Molecular Biotechnology - Principles & applications of Recombinant DNA, 5th ed., Bernard R. Glick, Cheryl L. Patten (2017), ASM Press.
3. Principles of Gene Manipulation, 7th ed., Sandy B. Primrose, Richard Twyman (2006), Blackwell Scientific Publication.
4. Analysis of Genes and Genomes, 2004 by Richard J Reece, John Wiley & Sons, Ltd.
5. Beier F.K, Crespi R.S and Straus T. Biotechnology and Patent protection, Oxford and IBH Publishing Co. New Delhi.
6. Rajmohan Joshi (Ed.) 2006. Biosafety and Bioethics, Isha Books, Delhi


**Teaching Learning Process**

- Teaching is supported by Classroom Lectures, Power point presentations/ICT and related videos.
- Written assignments are assigned.
- Knowledge of the students is assessed through Oral test/surprise tests/ internal assessments.

**CO-PO mapping matrix for BCH 403 (Genetic Engineering)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 403.1 | 3 | 2 | 1 | 2 | - | 2 |
| 403.2 | 3 | 2 | 1 | 2 | - | 2 |
| 403.3 | 3 | 2 | 1 | 2 | - | 2 |
| 403.4 | 3 | 1 | 3 | 2 | - | 2 |
| Average | 3 | 2 | 1.5 | 2 | - | 2 |

**CO-PSO mapping matrix for BCH 403 (Genetic Engineering)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 403.1 | 3 | 3 | 3 | 3 |
| 403.2 | 3 | 3 | 3 | 3 |
| 403.3 | 3 | 3 | 3 | 3 |
| 403.4 | 2 | 2 | 3 | 3 |
| Average | 2.75 | 2.75 | 3 | 3 |

***Elective***

**M.Sc. (Biochemistry) Semester - IV**

**Paper: BCH – 404A**

**Basics of Microbiology**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives:**

- To provide the students a basic knowledge of microorganisms and their metabolic pathways.
- To focus on the importance of microbiology at industrial level and in general human welfare.

**Course outcomes:** After the completion of the course, the students will be able to:

404A.1 Describe the physical & chemical agents for the control of microorganisms for biosafety purpose.
404A.2 Explain bacterial genetics and the importance of microorganisms in food and industrial microbiology.
404A.3 Equip themselves with an appreciation of the biochemical activities of microorganisms and their role in the biodegradation process.
404A.4 Get an insight about the pathogenicity of microorganisms and antimicrobial chemotherapy among students.

## SECTION – A

Members of the microbial world; Impact of microorganisms on humans; Gram+veandGram–vebacteria;Controlofmicroorganismsby physical & chemical agents; Nutritional types of microorganisms; Culture media; Pure culture techniques; Microbial Growth curve, Continuous culture of microorganisms; influence of environmental factors on growth: solutes and water activity, pH, temperature, oxygen concentration, pressure and radiations; Biofilms

## SECTION – B

Bacterial Genetics: Transformation, Transduction &Conjugation
Fermentations: Lactic and mixed acid fermentations; Amino acid fermentation by *Clostridium* species and the Stickland reaction; fermentations without substrate level phosphorylation; Fermentors; Characteristics of large scale fermentations; Major products of industrial microbiology: Antibiotics (penicillin and tetracyclines), Alcohol and alcoholic beverages, Organic compounds (citric acid); Yeast as a food and food supplement; Microbes as products: Biosensors and Bioinsecticides
Methods of food preservation; Food born infection and intoxications (*Salmonella & Staphylococcus*)

## SECTION – C

Biochemical activities of Microorganisms: Extracellular enzymatic activities of microorganisms, Carbohydrate fermentation, Triple sugar-iron agar test, IMViC test, Hydrogen sulphide test, Urease test, Litmus milk reactions, Nitrate reduction test, Catalase test, Oxidase test, Utilization of amino acids

Acetogenesis; Methanogenesis;

Microbial Biodegradation of Petroleum and Xenobiotics; Biodegradable plastics

Virus: Structure and general characteristics; cultivation of viruses; Viroids and Prions

## SECTION – D

**Microbial diseases and their control:**

Pathogenicity of microorganisms: Host-parasite interactions; pathogenesis of viral diseases; Bacterial pathogenesis; pathogenicity islands; Toxigenicity: General characteristics of Exotoxins and Endotoxins

Antimicrobial chemotherapy: General Characteristics of antimicrobial drugs, Mechanism of action of antibacterial drugs: inhibitors of cell wall synthesis, protein synthesis inhibitors, metabolic antagonists, nucleic acid synthesis inhibitors; factors influencing antimicrobial dug effectiveness, Mechanisms of drug resistance; Mechanism of action of Antifungal drugs and Antiviral drugs

**Suggested Readings:**


1. MicrobiologybyL.M.Prescott.J.P.HarleyandD.A.Klein7th ed.WM.C.BrownPublishers.
2. Brock Biology of Microorganisms 13thed. by M.T. Madigan, J.M. Martinko, J. Parker (2000) Prentice Hall International,Inc.
3. TheMicrobialWorld,5thed. ByR.Y.Stainer,J.L.Ingraham,M.L.WheelisandP.R. Painter, Prentice-Hall of India, NewDelhi.
4. Microbiology,5thed.ByM.J.Pelczar,E.C.S.Chanetal.Mcgraw-HillBookCompany.
5. Microbiology:FundamentalandApplications,2nded.byR.M.Atlas,MaxwellMacmillan, InternationalEdition.


**Teaching Learning Process:**

- Teaching is supported by Classroom Lectures, Power point presentations/ICT and related videos.
- Written assignments are assigned.
- Knowledge of the students is assessed through Oral test/surprise tests/ internal assessments.

**CO-PO matrix for the course BCH – 404A (Basic Microbiology)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-404A.1 | 3 | 3 | 3 | 2 | 1 | 2 |
| BCH-404A.2 | 3 | 3 | - | 1 | 3 | 3 |
| BCH-404A.3 | 3 | 3 | - | 1 | 3 | 3 |
| BCH-404A.4 | 3 | 3 | 3 | 2 | 2 | 3 |
| Average | 3 | 3 | 1.5 | 1.5 | 2.25 | 2.75 |

**CO-PSO matrix for the course BCH – 404A (Basic Microbiology)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-404A.1 | 3 | 3 | 3 | 1 |
| BCH-404A.2 | 3 | 3 | 3 | 1 |
| BCH-404A.3 | 3 | 3 | 3 | 3 |
| BCH-404A.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 2 |

***Elective***

**M.Sc. (Biochemistry) Semester - IV**

**Paper: BCH – 404B**

**Genetics and Evolution**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 3 hrs**
**Internal Assessment: 20** **Credits: 4**

**Note:** The examiner will setnine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. Candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

**Objectives**:

- To review the genetic basis of heredity for both Mendelian and quantitative characters
- To review the scientific evidence for biological evolution
- To explore how selection influences the genetic composition of a population
- To review the current understanding of how species are originated and how biological diversity arises

**Course outcomes**: After the completion of the course, the students will be able to:

404B.1 Understand the mechanisms of heredity and evolution, and their consequences for population genetic structure and biodiversity
404B.2 Gain insight knowledge of transmission of hereditary characters
404B.3Understand the fundamentals of population genetics
404B.4 Get the insight knowledge of genetic and ecological processes in the biological evolution

## SECTION- A

**Inheritance:** Mendelian principles; extensions of Mendelian principles (codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance, expressivity and phenocopy); cytoplasmic inheritance; concept of gene; allele (multiple and pseudo); linkage; sex linked inheritance, mutations and recombination.

## SECTION - B

**Human Genetics:** Human karyotype: banding and nomenclature of banding and aberrant karyotypes; Common syndromes due to numerical chromosome changes (triploidy, trisomy, monosomy) and structural alterations (translocation, duplications, deletions and fragile sites); Linkage map and Pedigree analysis; Identification of human genetic diseases- positional cloning illustrated using examples- Duchenne muscular dystrophy, cystic fibrosis, Huntington's disease.

## SECTION - C

**Evolutionary Thoughts and History:** Lamarckism and Darwinism; Adaption, Struggle, Fitness and natural selection; The evolutionary synthesis; The evolutionary time scales;

Eras, periods and epoch; Origins of unicellular and multicellular organism; Major groups of plants and animals; Stages in primate evolution including Homo.

**SECTION - D**

**Molecular Evolution:** Concept of neutral evolution, origin of new genes and proteins (by gene disruption and exon shuffling); gene duplication and divergence; variation (phenotypes, chromosome structure, protein structure and nucleotide sequences); speciation, allopatry and sympatry; isolating mechanisms; convergent evolution; co-evolution; adaptive radiation. **Population Genetics:** Populations, Gene pool, Gene and allele frequency; Conservation of gene frequency; Hardy Weinberg Law; concepts of rate of change in gene frequency through natural selection; random genetic drift.

**Suggested readings:**


1. Essential genes (2006), Benzamin Lewin, Pearson education international.
2. Human Molecular Genetics (2010), 4th ed., Tom Strachan and Andrew P Read, Garland Science.
3. Molecular Biology of Gene (2008), 6th ed., Watson, Baker *et al*, Levine and Losick, Pearson education Inc.
4. Principles of Genetics (2006), 8th ed., Gardener *et al*, John Wiley, New York.
5. Essential Genetics: A Genomic Perspective (2002), 3rd ed., Hart and Jones, Jones and Bartlett.
6. Genetics: Conceptual approach (2003), Benjamin A P, W H Freeman and Company, New York.
7. Principles of Genetics (2015), 7th ed., Snustad and Simmons, Wiley


**Teaching Learning Process:**

- Teaching is supported by Classroom Lectures, Power point presentations/ICT and related videos.
- Written assignments are assigned.
- Knowledge of the students is assessed through Oral test/surprise tests/ internal assessments.

**CO-PO mapping matrix for BCH 404B (Genetics and Evolution)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 404B.1 | 3 | 3 | - | 2 | - | 1 |
| 404B.2 | 3 | 3 | - | 2 | - | 1 |
| 404B.3 | 3 | 3 | - | 2 | - | 1 |
| 404B.4 | 3 | 3 | - | 2 | - | 1 |
| Average | 3 | 3 | - | 2 | - | 1 |

**CO-PSO mapping matrix for BCH 404B (Genetics and Evolution)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 404B.1 | 3 | 3 | 3 | 3 |
| 404B.2 | 3 | 3 | 3 | 3 |
| 404B.3 | 3 | 3 | 3 | 3 |
| 404B.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 3 |

***Core***

**M.Sc. (Biochemistry) Semester - IV**

**Paper: BCH –405**
**Practical-7 (Based on papers BCH-401 and BCH-402)**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 8hrs**
**Internal Assessment: 20** **Credits: 4**

**Course outcomes**:
After the completion of the course, the students will be able to:
405.1 Demonstrate the proficiency in concepts, practical skills in bioinformatics and biotechniques
405.2 Use of computational biology to extract the information for in vitro/ in vivo experiments
405.3 An understanding of computational biology and their practical application
405.4 Develop skills in carrying out research projects in modern biological science by employing computational biology

**List of experiments**

1. Designing of primers using bioinformatics
2. Sequence alignment using ALIGN and multiple sequence alignment using bioinformatics
3. 3 D- structure determination of proteins
4. Retrieval of sequence using ENTREZ
5. To draw phylogenetic tree and its analysis
6. Western blotting
7. Two dimensional gel electrophoresis
8. Immunoprecipitation
9. Immunoblotting
10. Cytotoxicity assay

**CO-PO mapping matrix for BCH 405 (Practical-7)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH 405.1 | 2 | 2 | - | 2 | - | 3 |
| 405.2 | 2 | 2 | - | 2 | - | 3 |
| 405.3 | 3 | 2 | - | 2 | - | 3 |
| 405.4 | 3 | 2 | - | 2 | - | 3 |
| Average | 2.5 | 2 | - | 2 | - | 3 |

**CO-PSO mapping matrix for BCH 405 (Practical-7)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH 405.1 | 3 | 3 | 3 | 3 |
| 405.2 | 3 | 3 | 3 | 3 |
| 405.3 | 3 | 3 | 3 | 3 |
| 405.4 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 3 | 3 |

**Paper: BCH –406**
**Practical-8 (Based on papers BCH-403 and BCH-404A&B)**

**Total Marks: 100**
**External Marks: 80** **Time allowed: 8hrs**
**Internal Assessment: 20** **Credits: 4**

**Course outcomes:**
After the completion of the course, the students will be able to:
406.1 Understand and develop the skills in the preparation of microbial media and to get more familiar about the aseptic techniques to perform routine culture handling tasks safely and effectively.
406.2 Exhibit proficiency in the isolation of cultures by various methods (Serial dilution, Spread plate and Streak plate methods)
406.3 Demonstrate skill in taking up basic research projects and findings by employing microbiological concepts and principles.
406.4 The students will acquire detailed knowledge regarding the important methods in Molecular Biology and also understand the molecular approach used in research.

**List of experiments**

1. To study some of the routinely used equipments in microbiology laboratory
2. Storage of microorganisms
3. Preparation of solid and liquid media for growth of microorganisms
4. Isolation of bacteria from soil and maintenance of microorganisms by plating, streaking and serial dilution method
5. To perform slant and stab culture
6. To perform Gram staining in order to differentiate between gram positive and gram negative bacteria
7. To demonstrate bacterial transformation
8. Separation of poly RNA on oligo dT column
9. To perform agarose gel electrophoresis
10. Determination of molecular weight of DNA fragments on agarose gel electrophoresis
11. To perform PCR /RFLP using restriction enzymes
12. To demonstrate Southern blotting and Northern blotting

**CO-PO mapping matrix for the course BCH–406 (Practical-8)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| BCH-406.1 | 3 | 3 | 3 | - | 3 | 3 |
| BCH-406.2 | 3 | 3 | 3 | - | 3 | 3 |
| BCH-406.3 | 3 | 3 | 1 | 2 | 3 | 3 |
| BCH-406.4 | 3 | 3 | 1 | - | 2 | 3 |
| Average | 3 | 3 | 0.75 | 0.75 | 2.75 | 2.5 |

**CO-PO mapping matrix for the course BCH–406 (Practical-8)**

| COs | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|
| BCH-406.1 | 3 | 2 | 3 | 3 |
| BCH-406.2 | 3 | 2 | 3 | 3 |
| BCH-406.3 | 3 | 2 | 3 | 3 |
| BCH-406.4 | 3 | 2 | 3 | 3 |
| Average | 3 | 2 | 3 | 3 |

**CO-PO-PSO Mapping Matrix for all the courses of M.Sc. Biochemistry**

| Course Code | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|
| BCH-101 | 3 | 3 | - | 2 | - | 2 | 3 | 3 | 3 | 3 |
| 102 | 3 | 3 | - | 1.25 | 3 | 2.25 | 3 | 3 | 3 | 1.5 |
| 103 | 2.75 | 1 | 1.25 | 2 | - | 1 | 2.5 | 2.75 | 2.5 | 2.25 |
| 104 | 3 | 3 | - | 2.25 | 1 | 1.5 | 3 | 3 | 3 | 2 |
| 105 | 3 | 2.25 | 0.75 | 0.5 | 1.5 | 2.5 | 3 | 3 | 2 | 1.25 |
| 106 | 3 | 3 | 2 | 2 | - | 2 | 3 | 3 | 3 | 3 |
| 201 | 3 | 3 | - | 2 | - | 2 | 3 | 3 | 3 | 3 |
| 202 | 3 | 3 | 0.5 | 2 | 1.75 | 2.5 | 3 | 3 | 3 | 2 |
| 203 | 2.5 | 2.25 | 0.5 | 0.75 | 0.5 | 0.75 | 2.75 | 2.75 | 2.5 | 2.5 |
| 204 | 1.5 | 2.75 | 0.25 | 1.25 | 1 | - | 2.5 | 2.75 | 2.75 | 2.75 |
| 205 | 3 | 3 | 2.66 | 2.66 | 1.66 | - | 3 | 3 | 2 | 2.33 |
| 206 | 3 | 3 | 0.5 | - | 3 | - | 3 | 3 | 3 | 1 |
| 207 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 2 |
| 208 | 3 | 2 | 2 | 3 | - | 3 | 3 | 3 | 3 | 3 |
| 301 | 1.75 | 2.25 | 0.25 | 0.75 | 0.5 | 0.75 | 2.75 | 2.5 | 2.5 | 2.25 |
| 302 | 1.5 | 2.75 | - | 1.25 | 0.75 | 0.5 | 2.75 | 2.75 | 2.25 | 2.25 |
| 303 | 3 | 3 | - | 1.25 | 1.25 | 1.5 | 3 | 3 | 3 | 1.5 |
| 304A | 3 | 1.25 | 0.75 | - | 1.5 | 1.5 | 3 | 3 | 2.5 | 1.75 |
| 304B | 3 | 3 | - | 3 | - | 2 | 3 | 3 | 3 | 2 |
| 305 | 3 | 3 | 2.66 | 2.66 | 1.66 | - | 3 | 3 | 2 | 2.33 |
| 306 | 3 | 3 | - | 2 | 1.25 | 2 | 2 | 3 | 2 | 2 |
| 306A | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| 307 | 3 | 3 | 2 | 3 | - | 3 | 3 | 3 | 3 | 3 |
| 308 | 3 | 3 | - | 0.75 | 2.75 | 2.5 | 3 | 3 | 3 | 2 |
| 401 | 3 | 2 | - | 1.75 | - | 2.5 | 3 | 3 | 3 | 3 |
| 402 | 2.75 | 0.5 | 1.75 | 1 | 0.5 | 1.5 | 2.75 | 2.5 | 2.5 | 1.75 |
| 403 | 3 | 2 | 1.5 | 2 | - | 2 | 2.75 | 2.75 | 3 | 3 |
| 404A | 3 | 3 | 1.5 | 1.5 | 2.25 | 2.75 | 3 | 3 | 3 | 2 |
| 404B | 3 | 3 | - | 2 | - | 1 | 3 | 3 | 3 | 3 |
| 405 | 2.5 | 2 | - | 2 | - | 3 | 3 | 3 | 3 | 3 |
| 406 | 3 | 3 | 0.75 | 0.75 | 2.75 | 2.5 | 3 | 2 | 3 | 3 |
| | | | | | | | | | | |