Choice Based Credit System (CBCS)

UNIVERSITY OF DELHI

FACULTY OF INTER-DISCIPLINARY & APPLIED SCIENCES

UNDERGRADUATE PROGRAMME
(Courses effective from Academic Year 2015-16)

SYLLABUS OF COURSES TO BE OFFERED
Core Courses, Elective Courses & Ability Enhancement Courses

Disclaimer: The CBCS syllabus is uploaded as given by the Faculty concerned to the Academic Council. The same has been approved as it is by the Academic Council on 13.7.2015 and Executive Council on 14.7.2015. Any query may kindly be addressed to the concerned Faculty.

Undergraduate Programme Secretariat
Preamble

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by universities towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching-learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students. Presently the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades.

The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.
CHOICE BASED CREDIT SYSTEM (CBCS):
The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student’s performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. **Core Course**: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. **Elective Course**: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate’s proficiency/skill is called an Elective Course.
   2.1 **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).
   2.2 **Dissertation/Project**: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.
   2.3 **Generic Elective (GE) Course**: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

3. **Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course**: The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). “AECC” courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.
   3.1 **AE Compulsory Course (AECC)**: Environmental Science, English Communication/MIL Communication.
   3.2 **AE Elective Course (AEEC)**: These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

**Project work/Dissertation** is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.
### Details of courses under B.A (Honors), B.Com (Honors) & B.Sc. (Honors)

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td><strong>Theory+ Practical</strong></td>
<td><strong>Theory + Tutorial</strong></td>
</tr>
<tr>
<td><strong>I. Core Course</strong></td>
<td></td>
</tr>
<tr>
<td>(14 Papers)</td>
<td>14X4= 56</td>
</tr>
<tr>
<td>Core Course Practical / Tutorial*</td>
<td>14X5=70</td>
</tr>
<tr>
<td>(14 Papers)</td>
<td>14X2=28</td>
</tr>
<tr>
<td>Core Course Practical / Tutorial*</td>
<td>14X1=14</td>
</tr>
<tr>
<td><strong>II. Elective Course</strong></td>
<td></td>
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<tr>
<td>(8 Papers)</td>
<td></td>
</tr>
<tr>
<td>A.1. Discipline Specific Elective</td>
<td>4X4=16</td>
</tr>
<tr>
<td>(4 Papers)</td>
<td>4X5=20</td>
</tr>
<tr>
<td>A.2. Discipline Specific Elective Practical/ Tutorial*</td>
<td>4 X 2=8</td>
</tr>
<tr>
<td>(4 Papers)</td>
<td>4X1=4</td>
</tr>
<tr>
<td>B.1. Generic Elective/ Interdisciplinary</td>
<td>4X4=16</td>
</tr>
<tr>
<td>(4 Papers)</td>
<td>4X5=20</td>
</tr>
<tr>
<td>B.2. Generic Elective</td>
<td>4 X 2=8</td>
</tr>
<tr>
<td>(4 Papers)</td>
<td>4X1=4</td>
</tr>
<tr>
<td>• Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester</td>
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<tr>
<td><strong>III. Ability Enhancement Courses</strong></td>
<td></td>
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<tr>
<td>1. Ability Enhancement Compulsory</td>
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<tr>
<td>(2 Papers of 2 credit each)</td>
<td>2 X 2=4</td>
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<tr>
<td>Environmental Science</td>
<td>2 X 2=4</td>
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<tr>
<td>English/MIL Communication</td>
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<tr>
<td>2. Ability Enhancement Elective (Skill Based)</td>
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<tr>
<td>(Minimum 2)</td>
<td>2 X 2=4</td>
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<tr>
<td>(2 Papers of 2 credit each)</td>
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<tr>
<td>Institute should evolve a system/policy about ECA/ General Interest/Hobby/Sports/NCC/NSS/related courses on its own.</td>
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<tr>
<td>* wherever there is a practical there will be no tutorial and vice-versa</td>
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Structure of B.Sc. (Honours) Biochemistry under CBCS

Core Course
BCH C-1: Molecules of Life
BCH C-2: Cell Biology
BCH C-3: Proteins
BCH C-4: Enzymes
BCH C-5: Metabolism of Carbohydrates and Lipids
BCH C-6: Membrane Biology and Bioenergetics
BCH C-7: Hormone: Biochemistry and Function
BCH C-8: Human Physiology
BCH C-9: Gene Organization, Replication and Repair
BCH C-10: Metabolism of Amino Acids and Nucleotides
BCH C-11: Concepts in Genetics
BCH C-12: Gene Expression and Regulation
BCH C-13: Genetic Engineering and Biotechnology
BCH C-14: Immunology

Discipline Specific Elective (Any four)
BCH DSE-1: Nutritional Biochemistry
BCH DSE-2: Research Methodology
BCH DSE-3: Molecular basis of non-infectious human diseases
BCH DSE-4: Molecular basis of infectious diseases
BCH DSE-5: Research Project
BCH DSE-6: Advanced cell biology
BCH DSE-7: Plant Biochemistry
BCH DSE-8: Basic Microbiology

Generic Elective (Any four)
BCH GE-1: Biochemistry of Cell
BCH GE-2: Proteins and Enzymes
BCH GE-3: Intermediary Metabolism
BCH GE-4: Gene Organization, Expression and Regulation
BCH GE-5: Fundamentals of Cell Biology and Immunology
BCH GE-6: Fundamentals of Genetic Engineering
BCH GE-7: Biochemical Correlations in Diseases

Ability Enhancement Compulsory Course
AECC-1: English communication
AECC-2: Environmental science

Skill Enhancement Elective Course (Any two)
BCH SEC-1: Tools and Techniques in Biochemistry
BCH SEC-2: Protein Purification Techniques
BCH SEC-3: Clinical Biochemistry
BCH SEC-4: Bioinformatics
BCH SEC-5: Recombinant DNA Technology
# COURSE STRUCTURE of B.Sc. (Honours) Biochemistry under CBCS

<table>
<thead>
<tr>
<th>SEMESTER I</th>
<th>SEMESTER II</th>
</tr>
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<tbody>
<tr>
<td>C1</td>
<td>Molecules of Life</td>
</tr>
<tr>
<td>C2</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>AECC1</td>
<td>English/MIL Communication or EVS</td>
</tr>
<tr>
<td>GE1</td>
<td>Generic Elective</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SEMESTER III</th>
<th>SEMESTER IV</th>
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<tbody>
<tr>
<td>C5</td>
<td>Metabolism of Carbohydrates and Lipids</td>
</tr>
<tr>
<td>C6</td>
<td>Membrane Biology and Bioenergetics</td>
</tr>
<tr>
<td>C7</td>
<td>Hormone: Biochemistry and Function</td>
</tr>
<tr>
<td>SEC1</td>
<td>Skill Enhancement Course</td>
</tr>
<tr>
<td>GE3</td>
<td>Generic Elective</td>
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<tr>
<th>SEMESTER V</th>
<th>SEMESTER VI</th>
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</thead>
<tbody>
<tr>
<td>C11</td>
<td>Concepts in Genetics</td>
</tr>
<tr>
<td>C12</td>
<td>Gene Expression and Regulation</td>
</tr>
<tr>
<td>DSE1</td>
<td>Discipline Specific Elective</td>
</tr>
<tr>
<td>DSE2</td>
<td>Discipline Specific Elective</td>
</tr>
</tbody>
</table>

C: Core Courses; GE: Generic Elective; AECC: Ability Enhancement Compulsory Course; SEC: Skill Enhancement Courses; DSE: Discipline Specific Elective

**Generic Elective** (any one per semester in semesters I-IV)
- BCH GE-1: Biochemistry of Cell
- BCH GE-2: Proteins and Enzymes
- BCH GE-3: Intermediary Metabolism
- BCH GE-4: Gene Organization, Expression and Regulation
- BCH GE-5: Fundamentals of Cell Biology and Immunology
- BCH GE-6: Fundamentals of Genetic Engineering
- BCH GE-7: Biochemical Correlations in Diseases

**Skill Enhancement Course** (any one per semester in semesters III-IV)
- BCH SEC-1: Tools and Techniques in Biochemistry
- BCH SEC-2: Protein Purification Techniques
- BCH SEC-3: Clinical Biochemistry
- BCH SEC-4: Bioinformatics
- BCH SEC-5: Recombinant DNA Technology

**Discipline Specific Elective** (any two per semester in semesters V-VI)
- BCH DSE-1: Nutritional Biochemistry
- BCH DSE-2: Research Methodology
- BCH DSE-3: Molecular basis of non-infectious human diseases
- BCH DSE-4: Molecular basis of infectious diseases
- BCH DSE-5: Research Project
- BCH DSE-6: Advanced cell biology
- BCH DSE-7: Plant Biochemistry
- BCH DSE-8: Basic Microbiology
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-1: MOLECULES OF LIFE (THEORY)
SEMESTER - I

TOTAL HOURS: 60 CREDITS: 4

Unit 1 The foundations of biochemistry
Cellular and chemical foundations of life
No. of Hours: 2

Unit 2 Water
Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.
No. of Hours: 4

Unit 3 Carbohydrates and Glycobiology
Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non-reducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates
No. of Hours: 16

Unit 4 Lipids
No. of Hours: 14

Unit 5 Amino acids
Structure and classification, physical, chemical and optical properties of amino acids
No. of HOURS: 8

Unit 6 Nucleic acids
Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.
No. of HOURS: 10

Unit 7 Vitamins
Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis
No. of Hours: 6
TOTAL HOURS: 60                    CREDITS: 2

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

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)  
BCH C-2: CELL BIOLOGY (THEORY)  
SEMESTER - I  

TOTAL HOURS: 60  
CREDITS: 4  

Unit 1  Introduction to cell biology  
No. of Hours: 5  
Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells), cells as experimental models.  

Unit 2  Tools of cell biology  
No. of Hours: 10  
Light microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, FACS. Centrifugation for subcellular fractionation.  

Unit 3  Structure of different cell organelles  
No. of Hours: 15  

Unit 4  Cytoskeletal proteins  
No. of Hours: 10  
Introduction to cytoskeletal proteins. Organization of cytoskeletal protein RBC and smooth muscle and skeletal muscles. Structure of cilia and flagella.  

Unit 5  Cell wall and extracellular matrix  
No. of Hours: 10  
Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata.  

Unit 6  Cell cycle, cell death and cell renewal  
No. of Hours: 10  

BCH C-2: CELL BIOLOGY (PRACTICALS)  
SEMESTER - I  

TOTAL HOURS: 60  
CREDITS: 2  

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


B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-3: PROTEINS (THEORY)
SEMESTER - II

TOTAL HOURS: 60
CREDITS: 4

Unit 1 Introduction to amino acids, peptides and proteins

Unit 2 Extraction of proteins for downstream processing
Solubilization of proteins from their cellular and extracellular locations. Use of simple grinding methods, homogenization, ultrasonication, French press and centrifugation.

Unit 3 Separation techniques
Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization. Ion-exchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography, HPLC and FPLC

Unit 4 Characterization of proteins
Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF, SDS-PAGE and 2-D electrophoresis.

Unit 5 Covalent structure of proteins

Unit 6 Three dimensional structures of proteins

Unit 7 Protein folding and conformational diseases
Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamics of folding and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases -Alzheimer’s and Prion based.

Unit 8 Introduction to protein structure databases
Protein sequence and structure databases (PDB). Use of sequence and domain information. Viewing protein structures using in silico tools.

Unit 9 Myoglobin and haemoglobin
Oxygen binding curves, influence of 2,3-BPG, CO₂ and Cl⁻. Hill plot. Cooperativity between subunits and models to explain the phenomena - concerted and sequential models. Haemoglobin disorders.
Unit 10  Specialized proteins - antibodies and actin-myosin motors  No. of Hours: 4
Antibody structure and binding to antigens. ATP activated actin - myosin contractions.

Unit 11  Membrane proteins  No. of Hours: 2

BCH C-3: PROTEINS (PRACTICALS)
SEMESTER – II

TOTAL HOURS: 60  CREDITS: 2

1. Estimation of proteins using UV absorbance and Biuret method.
3. Isoelectric pH of casein.
5. Separation of albumin from serum using anion-exchange chromatography.
6. SDS-PAGE analysis of proteins.

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-4: ENZYMES (THEORY)
SEMESTER – II

TOTAL HOURS: 60
CREDITS: 4

Unit 1 Introduction to enzymes
No. of Hours: 2

Unit 2 Features of enzyme catalysis
No. of Hours: 6
Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Fischer’s lock and key hypothesis, Koshland’s induced fit hypothesis.

Unit 3 Enzyme kinetics
No. of Hours: 10
Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions. Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. $K_m$ and $V_{max}$, $K_{cat}$ and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme.

Unit 4 Bisubstrate reactions
No. of Hours: 2
Types of bi bi reactions (sequential – ordered and random, ping pong reactions). Differentiating bi substrate mechanisms (diagnostic plots, isotope exchange).

Unit 5 Enzyme inhibition
No. of Hours: 8
Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors.

Unit 6 Mechanism of action of enzymes
No. of Hours: 8
General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues.

Unit 7 Regulation of enzyme activity
No. of Hours: 8
Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbamoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage- zymogen. Multienzyme complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase) Isoenzymes - properties and physiological significance (lactate dehydrogenase).

Unit 8 Involvement of coenzymes in enzyme catalysed reactions
No. of Hours: 6
TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid.

Unit 9 Applications of enzymes
No. of Hours: 10
Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes.
BCH C-4: ENZYMES (PRACTICALS)
SEMESTER – II

TOTAL HOURS: 60        CREDITS: 2

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

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-5: METABOLISM OF CARBOHYDRATES AND LIPIDS
(THEORY)
SEMESTER - III

TOTAL HOURS: 60
CREDITS: 4

Unit 1 Basic design of metabolism
No. of Hours: 4
Autotrophs, heterotrophs, metabolic pathways, catabolism, anabolism, ATP as energy currency, reducing power of the cell.

Unit 2 Glycolysis
No. of Hours: 4
Glycolysis - a universal pathway, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis, galactosemia.

Unit 3 Gluconeogenesis and pentose phosphate pathway
No. of Hours: 4
Synthesis of glucose from non-carbohydrate sources, reciprocal regulation of glycolysis and gluconeogenesis, pentose phosphate pathway and its importance.

Unit 4 Glycogen metabolism
No. of Hours: 4
Glycogenesis and glycogenolysis, regulation of glycogen metabolism, glycogen storage diseases.

Unit 5 Citric acid cycle
No. of Hours: 6
Production of acetyl CoA, reactions of citric acid cycle, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxalate pathway, coordinated regulation of glyoxalate and citric acid pathways.

Unit 6 Synthesis of carbohydrates
No. of Hours: 8
Calvin cycle, regulation of calvin cycle, regulated synthesis of starch and sucrose, photorespiration, C4 and CAM pathways, synthesis of cell wall polysaccharides, integration of carbohydrate metabolism in plant cell.

Unit 7 Fatty acid oxidation
No. of Hours: 10
Digestion, mobilisation and transport of cholesterol and triacyl glycerols, fatty acid transport to mitochondria, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal oxidation, ω oxidation, ketone bodies metabolism, ketoacidosis.

Unit 8 Fatty acid synthesis
No. of Hours: 6
Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation.

Unit 9 Biosynthesis of eicosanoids, cholesterol, steroids and isoprenoids
No. of Hours: 6

Unit 10 Biosynthesis of membrane lipids
No. of Hours: 4
Synthesis of membrane phospholipids in prokaryotes and eukaryotes, respiratory distress
syndrome, biosynthesis of triacylglycerol, biosynthesis of plasmalogens, sphingolipids and glycolipids, lipid storage diseases.

**Unit 11 Starve-feed cycle**  
No. of Hours: 4  
Well-fed state, early fasting state, fasting state, early re-fed state, energy requirements, reserves and caloric homeostasis, five phases of glucose homeostasis.

**BCH C-5: METABOLISM OF CARBOHYDRATES AND LIPIDS (PRACTICALS)**  
**SEMESTER - III**

**TOTAL HOURS: 60**  
**CREDITS: 2**

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

**SUGGESTED READINGS**

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-6: MEMBRANE BIOLOGY AND BIOENERGETICS (THEORY)
SEMESTER - III

TOTAL HOURS: 60
CREDITS: 4

Unit 1  Introduction to biomembranes
No. of Hours: 4

Unit 2  Membrane structures
No. of Hours: 6

Unit 3  Membrane dynamics
No. of Hours: 6
Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics - FRAP, TNBS labeling etc. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.

Unit 4  Membrane transport
No. of Hours: 10

Unit 5  Vesicular transport and membrane fusion
No. of Hours: 6

Unit 6  Introduction to bioenergetics
No. of Hours: 6
Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, PEP, 13 BPG and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

Unit 7  Oxidative phosphorylation
No. of Hours: 12

Unit 8  Photophosphorylation
No. of Hours: 10

**BCH C-6: MEMBRANE BIOLOGY AND BIOENERGETICS (PRACTICALS)**

**SEMESTER - III**

**TOTAL HOURS: 60**

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. RBC ghost cell preparation and to study the effect of detergents on membranes.
4. Separation of photosynthetic pigments by TLC.
5. Isolation of mitochondria from liver and assay of marker enzyme SDH.
6. Study photosynthetic O2 evolution in hydrilla plant.
7. Isolation of chloroplast from spinach leaves, estimation of chlorophyll and photosynthetic activity.

**SUGGESTED READINGS**

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-7: HORMONE: BIOCHEMISTRY AND FUNCTION (THEORY)
SEMESTER – III

TOTAL HOURS: 60  CREDITS: 4

Unit 1 Introduction to endocrinology  No. of HOURS: 6

Unit 2 Hormone mediated signaling  No. of HOURS: 16

Unit 3 Hypothalamic and pituitary hormones  No. of HOURS: 8

Unit 4 Thyroid hormone  No. of HOURS: 4
Thyroid gland. Biosynthesis of thyroid hormone and its regulation; its physiological and biochemical action. Pathophysiology - Goiter, Graves disease, cretinism, myxedema, Hashimato’s disease.

Unit 5 Hormones regulating Ca2+ homeostasis  No. of HOURS: 6
PTH, Vitamin D and calcitonin. Mechanism of Ca2+ regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

Unit 6 Pancreatic and GI tract hormones  No. of HOURS: 6
Regulation of release of insulin, glucagon, gastrin, secretin, CCK, GIP, adipoeclin, leptin and ghrelin. Summary of hormone metabolite control of GI function. Physiological and biochemical action. Pathophysiology - diabetes type I and type II.

Unit 7 Hormones of adrenals  No. of HOURS: 6
Aldosterone, renin angiotensin system, cortisol, epinephrine and norepinephrine. Fight or flight response, stress response. Pathophysiology – Addison’s disease, Conn’s syndrome, Cushing syndrome.

Unit 8 Reproductive hormones  No. of HOURS: 6
Male and female sex hormones. Interplay of hormones during reproductive cycle, pregnancy, parturition and lactation. Hormone based contraception.
Unit 9  Growth factors
PDGF, EGF, IGF-II, and erythropoietin.

BCH C-7: HORMONE: BIOCHEMISTRY AND FUNCTION (PRACTICALS)
SEMESTER – III

TOTAL HOURS: 60  CREDITS: 2

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

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-8: HUMAN PHYSIOLOGY (THEORY)
SEMESTER - IV

TOTAL HOURS: 60 CREDITS: 4

Unit 1 Homeostasis and the organization of body fluid compartments

Unit 2 Cardiovascular physiology
Pressure, flow and resistance. Anatomy of heart. Physiology of the cardiac muscle, automatcity of the cardiac muscle contraction, excitation contraction coupling, relationship between cardiac cycle, heart sound, ventricular volumes and the ECG, control of cardiac function and output. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues. Portal circulations. Arterial pressure and its regulation. Hypertension, congestive heart disease, atherosclerosis and myocardial infarction.

Unit 3 Respiration

Unit 4 Renal physiology

Unit 5 Gastrointestinal and hepatic physiology
Histology of the gastrointestinal tract. Propulsion and motility of food and digested material. Enteric reflexes, secretory functions of the gastrointestinal tract, digestion and absorption of macro and micronutrients. Peptic ulcer, Sprue, celiac disease, IBD, regurgitation, diarrhoea and constipation. Anatomy of the hepatic lobule and blood flow into the liver. Formation and secretion of bile. enterohepatic cycle, reticuloendothelial system, metabolic importance of liver. Liver function tests. Jaundice, liver cirrhosis and fatty liver.

Unit 6 Musculosketetal system
Bone structure and formation. Physiology of muscle contraction in striated and non-striated muscle.
Unit 7 Reproductive physiology


Unit 8 Neurochemistry and neurophysiology


BCH C-8: HUMAN PHYSIOLOGY (PRACTICALS)
SEMESTER - IV

TOTAL HOURS: 60 CREDITS: 2

1. Hematology.
   a. RBC and WBC counting
   b. Differential leuocyte count.
   c. Clotting time.
2. Estimation of haemoglobin.
4. Determination of total iron binding capacity.
5. Pulmonary function tests, spirometry and measurement of blood pressure.
7. Histology of connective tissue, liver and brain permanent slides.
8. Case studies (Renal clearance, GFR, ECG).

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-9: GENE ORGANIZATION, REPLICATION AND REPAIR
(THEORY)
SEMESTER - IV

TOTAL HOURS: 60  CREDITS: 4

Unit 1 Structure of DNA
No. of HOURS: 6
DNA structure, features of the double helix, various forms of DNA, denaturation and reassociation of DNA.

Unit 2 Genes and genomic organization
No. of HOURS: 10
Genome sequence and chromosome diversity, definition of a gene, organization of genes in viruses, bacteria, animals and plants. Nucleosome structure and packaging of DNA into higher order structures.

Unit 3 Replication of DNA
No. of HOURS: 20
The chemistry of DNA synthesis, DNA polymerase, the replication fork, origin of replication, enzymes and proteins in DNA replication, various modes of replication, stages of replication of E. coli chromosome, relationship between replication and cell division, replication in eukaryotes. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine. Supercoiling of DNA and its importance, topoisomerases, critical role of topoisomerases in cell, topoisomerase inhibitors and their application in medicine.

Unit 4 Recombination and transposition of DNA
No. of HOURS: 12
Homologous recombination, proteins and enzymes in recombination, site-specific recombination, serine and tyrosine recombinases, biological roles of site-specific recombination, transposition, three classes of transposable elements, importance of transposable elements in horizontal transfer of genes and evolution.

Unit 5 Molecular basis of mutations
No. of HOURS: 4
Importance of mutations in evolution of species. Types of mutations - transition, transversions, frame shift mutations, mutations induced by chemicals, radiation, transposable elements, Ames test.

Unit 6 Various modes of DNA repair
No. of HOURS: 8
Replication errors and mismatch repair system, repair of DNA damage, direct repair, base excision repair, nucleotide excision repair, recombination repair, translesion DNA synthesis.

BCH C-9 : GENE ORGANIZATION, REPLICATION AND REPAIR (PRACTICALS)
SEMESTER - IV

TOTAL HOURS: 60  CREDITS: 2

1. Verification of Chargaff’s rule by paper chromatography.
2. Ultraviolet absorption spectrum of DNA and RNA.
3. Determination of DNA and RNA concentration by A_{260nm}.
4. Determination of the melting temperature and GC content of DNA.
5. Isolation of chromosomal DNA from E. coli cells.
SUGGESTED READINGS


B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-10: METABOLISM OF AMINO ACIDS AND NUCLEOTIDES
(THEORY)
SEMESTER - IV

TOTAL HOURS: 60 CREDITS: 4

Unit 1 Overview of amino acid metabolism

Unit 2 Catabolism of amino acids

Unit 3 Biosynthesis of amino acids
Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation.

Unit 4 Precursor functions of amino acids
Biosynthesis of creatine and creatinine, polyamines (putresine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.

Unit 5 Biosynthesis of purine and pyrimidine nucleotides
De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways.

Unit 6 Deoxyribonucleotides and synthesis of nucleotide triphosphate
Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides.

Unit 7 Degradation of purine and pyrimidine nucleotides
Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.

Unit 8 Integration of metabolism
Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).
BCH C-10 : METABOLISM OF AMINO ACIDS AND NUCLEOTIDES (PRACTICAL)  
SEMESTER - IV

TOTAL HOURS: 60  
CREDITS: 2

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

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-11: CONCEPTS IN GENETICS (THEORY)
SEMESTER - V

TOTAL HOURS: 60
CREDITS: 4

Unit 1 Introduction to model organisms and Mendelism
No. of HOURS: 3
Model organisms: Escherichia coli, Saccharomyces cerevisiae, Drosophila melanogaster, Caenorhabditis elegans, Danio rerio and Arabidopsis thaliana, Basic principles of heredity.

Unit 2 Applications of Mendel’s principles & chromosomal basis of heredity
No. of HOURS: 6
Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences.

Unit 3 Extensions of Mendelism
No. of HOURS: 4
Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropy gene interaction - epistatic and non epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy.

Unit 4 Genetic definition of a gene
No. of HOURS: 4
Complementation test, limitations of cis-trans test, intragenic complementation, rII locus of phage T₄ and concept of cistron

Unit 5 Genetics of bacteria and viruses
No. of HOURS: 6

Unit 6 Linkage, crossing over and mapping techniques
No. of HOURS: 6
Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in Drosophila, detection of linked loci by pedigree analysis in humans and somatic cell hybridization for positioning genes on chromosomes.

Unit 7 Human pedigree analysis
No. of HOURS: 6
Pedigree conventions, characteristics of dominant and recessive inheritance. Applications of pedigree analysis.

Unit 8 The genetic control of development and sex determination
No. of HOURS: 6
Model organism for genetic analysis, Drosophila development, maternal effect genes, morphogens and zygotic gene activity in development, sex chromosomes and sex determination, dosage compensation of X-linked genes.

Unit 9 Organelle heredity and epigenetics
No. of HOURS: 6
Extra nuclear inheritance, tests for organelle heredity and maternal effect, epigenetic mechanisms of transcriptional regulation & genomic imprinting.
Unit 10 Chromosomal aberrations  No. of HOURS: 4
Variations in chromosome number- monosomy and trisomy of sex chromosome and autosomes.
Variations in chromosome structure - inversions, deletions, duplications and translocations.

Unit 11 Inheritance of complex traits & population genetics  No. of HOURS: 5
Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability,
quantitative trait loci (QTL) and their identification. Hardy-Weinberg law, predicting allele and
genotype frequencies and exceptions to Hardy-Weinberg principle.

Evolutionary genetics  No. of HOURS: 4
Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies,
homologous sequences, phenotypic evolution and speciation.

BCH C-11: CONCEPTS IN GENETICS (PRACTICALS)
SEMESTER - V

TOTAL HOURS: 60  CREDITS: 2

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

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-12: GENE EXPRESSION AND REGULATION (THEORY)
SEMESTER - V

TOTAL HOURS: 60  CREDITS: 4

Unit 1 Biosynthesis of RNA in prokaryotes  No. of HOURS: 8
RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, the three stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Inhibitors of transcription and applications as anti-microbial drugs.

Unit 2 Biosynthesis of RNA in eukaryotes  No. of HOURS: 8
Comparison between prokaryotic and eukaryotic transcription. Transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, various types of RNA processing, transcription by RNA polymerase I and III. Inhibitors of eukaryotic transcription and their applications. Comparison of fidelity of transcription and replication.

Unit 3 RNA splicing  No. of HOURS: 6
Chemistry of RNA splicing, the spliceosome machinery, splicing pathways, group I and group II introns, alternative splicing, exon shuffling, RNA editing.

Unit 4 The genetic code  No. of HOURS: 4
Degeneracy of the genetic code, wobble in the anticodon, features of the genetic code, nearly universal code.

Unit 5 Biosynthesis of proteins  No. of HOURS: 10
Messenger RNA, transfer RNA, attachment of amino acids to tRNA, the ribosome - initiation, elongation and termination of translation, regulation of translation. Comparison of prokaryotic and eukaryotic protein synthesis. Use of antibiotics in understanding protein synthesis and applications in medicine.

Unit 6 Protein targeting and degradation  No. of HOURS: 6
Post translational modifications, glycosylation, signal sequences for nuclear transport, bacterial signal sequences, import of proteins by receptor mediated endocytosis, specialized systems for protein degradation.

Unit 7 Regulation of gene expression in prokaryotes  No. of HOURS: 8
Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon, induction of SOS response, synthesis of ribosomal proteins, regulation by genetic recombination, transcriptional regulation in λ bacteriophage.

Unit 8 Regulation of gene expression in eukaryotes  No. of HOURS: 10
Heterochromatin, euchromatin, chromatin remodeling, regulation of galactose metabolism in yeast, regulation by phosphorylation of nuclear transcription factors, regulatory RNAs, riboswitches, RNA interference, synthesis and function of miRNA molecules, phosphorylation of nuclear transcription factors.
BCH C-12: GENE EXPRESSION AND REGULATION (PRACTICALS)
SEMESTER - V

TOTAL HOURS: 60  CREDITS: 2

1. Estimation of RNA by Orcinol Method
2. Extraction of total nucleic acids from plant tissue.
3. Diauxic growth curve effect.
4. Isolation of Total RNA from bacteria/yeast.
5. Effect of inhibitors on protein synthesis.

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-13: GENETIC ENGINEERING AND BIOTECHNOLOGY
(THEORY)
SEMESTER - VI

TOTAL HOURS: 60
CREDITS: 4

Unit 1 Introduction to recombinant DNA technology
Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules, separation of DNA by gel electrophoresis. Extraction and purification of plasmid and bacteriophage DNA.

Unit 2 Cloning vectors for prokaryotes and eukaryotes
Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on E. coli plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. Vectors for yeast, higher plants and animals.

Unit 3 Joining of DNA fragments
Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters. Synthetic oligonucleotides, synthesis and use.

Unit 4 Introduction of DNA into cells and selection for recombinants

Unit 5 Methods for clone identification

Unit 6 Polymerase chain reaction
Fundamentals of polymerase chain reaction, designing primers for PCR. Studying PCR products. Cloning PCR products. Real time PCR.

Unit 7 DNA sequencing
DNA sequencing by Sanger’s method, modifications based on Sanger’s method. Automated DNA sequencing. Pyrosequencing.

Unit 8 Expression of cloned genes
Vectors for expression of foreign genes in E. coli, cassettes and gene fusions. Challenges in producing recombinant protein in E. coli. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

Unit 9 Applications of genetic engineering in Biotechnology
Site-directed mutagenesis and protein engineering. Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant

**BCH C-13: GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICALS)**
**SEMESTER - VI**

**TOTAL HOURS: 60**  
**CREDITS: 2**

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

**SUGGESTED READINGS**

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH C-14: IMMUNOLOGY (THEORY)
SEMESTER - VI

TOTAL HOURS: 60  CREDITS: 4

Unit 1  Cells and organs of the immune system  No. of HOURS: 4
Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT).

Unit 2  Innate immunity and leukocyte extravasation  No. of HOURS: 6
Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response.

Unit 3  Immunogens and antigens  No. of HOURS: 4
Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes.

Unit 4  Antibody structure and function  No. of HOURS: 4
Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family.

Unit 5  Generation of receptor diversity  No. of HOURS: 4
Dreyer-Bennett hypothesis, multigene organization of Ig locus, mechanism of V region DNA rearrangement, ways of antibody diversification.

Unit 6  Biology of the B lymphocyte  No. of HOURS: 6
Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response, anatomical distribution of B cell populations.

Unit 7  Complement system  No. of HOURS: 4
Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies.

Unit 8  MHC complex and antigen presentation  No. of HOURS: 4
General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, linkage disequilibrium, pathways of antigen processing and presentation.

Unit 9  Biology of the T lymphocyte  No. of HOURS: 4
Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation.

Unit 10  Cell mediated cytotoxic responses  No. of HOURS: 4
General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC).

Unit 11  Tolerance, autoimmunity and hypersensitivity  No. of HOURS: 8
Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody
mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity.

Unit 12 Transplantation immunology and vaccines

No. of HOURS: 8

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

BCH C-14: IMMUNOLOGY (PRACTICALS)

SEMESTER - VI

TOTAL HOURS: 60

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

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
DISCIPLINE SPECIFIC ELECTIVES
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH DSE-1: NUTRITIONAL BIOCHEMISTRY (THEORY)
SEMESTER – V/VI

TOTAL HOURS: 60  CREDITS: 4

Unit 1 Introduction to Nutrition and Energy Metabolism
Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. Physiological energy value of foods, SDA. Measurement of energy expenditure. Basal and Resting metabolism, physical activity, factors affecting energy input - hunger, appetite, energy balance. Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

No. of HOURS: 8

Unit 2 Dietary carbohydrates and health
Review functions of carbohydrates. Digestion, absorption, utilization and storage, hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates, Dietary fiber, role of fibre in lipid metabolism, colon function, blood glucose level and GI tract functions.

No. of HOURS: 8

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

No. of HOURS: 8

Unit 4 Dietary Proteins and health

No. of HOURS: 8

Unit 5 Fat and water soluble Vitamins
Vitamin A, D, E, K Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion(ADME), Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis. Vitamin C role as cofactor in amino acid modifications. Niacin- Metabolic interrelation between tryptophan, Niacin and NAD/ NADP. Vitamin B6-Dietary source, RDA, conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms. Vitamin B12 and folate; Dietary source, RDA, absorption, metabolic role Biochemical basis for deficiency symptoms.

No. of HOURS: 8

Unit 6 Minerals
Calcium, Phosphorus and Iron - Distribution in the body digestion, Absorption, Utilization, Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA. Iodine, Fluoride, Mg, Cu, Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Physiology, Function, deficiency, Toxicity and Sources

No. of HOURS: 12
Unit 7 Assessment of Nutritional status

Unit 8 Food and drug interactions and Nutriceuticals
Nutrient interactions affecting ADME of drugs, Alcohol and nutrient deficiency, Anti-depressants, psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition. Food as medicine.

BCH DSE-1: NUTRITIONAL BIOCHEMISTRY (PRACTICALS)
SEMESTER – V/VI

TOTAL HOURS: 60 CREDITS: 2

2. Serum/ urine MMA estimation.
3. Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
5. Vitamin A/E estimation in serum.
6. Case studies.

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH DSE-2: RESEARCH METHODOLOGY
SEMESTER – V/VI

Total HOURS: 20 hrs Theory and 140 hrs Practical     CREDITS: 6

Unit 1 Introduction to Research Methodology    No. of HOURS: 4
Objectives and motivation in research.

Unit 2 Defining the Research Problem       No. of HOURS: 4
Selecting and defining a research problem, Reviewing and conducting literature search,
Developing a research plan.

Unit 3 Designing of Experiment       No. of HOURS: 4
Different experimental designs – single and multifactorial design, Making measurements and
sources of error in measurements, Methods of data collection and record keeping.

Unit 4 Data Processing and Statistical Analysis    No. of HOURS: 8
Processing operations, tabulation, and graphical representation, Statistics in research: Concepts
of sample and population, Measure of central tendency, dispersion, asymmetry (skewness,
kurtosis), Normal distribution (p-value), Statistical tests and hypothesis (Standard error, t-test,
chi-square test), and regression analysis, Report writing, Writing a research paper - abstract,
introduction, methodology, results and discussion.

Based on the teaching above, each student will undertake the following exercises.

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

SUGGESTED READINGS

2. At the Bench: A Laboratory Navigator (2005) Barker, K., Cold Spring Harbor Laboratory
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH DSE-3 : MOLECULAR BASIS OF NON-INFECTIONOUS HUMAN DISEASES (THEORY)
SEMESTER – V/VI

Total HOURS: 60  CREDITS: 4

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

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

Unit 3  Multifactorial complex disorders and Cancer  No. of HOURS: 20
Understanding the definition of multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic makeup in the onset of diseases.
Cancer: characteristics of a transformed cell, causes and stages of Cancer, molecular basis for neoplastic growth and metastasis, Proto-oncogenes and tumor suppressor genes; Cancer causing mutations; Tumor viruses; Biochemical analysis of cancer; Molecular approaches to cancer treatment.
Disorders of mood : Schizophrenia, dementia and anxiety disorders.
Polycystic ovarian syndrome, Parkinson’s disease, ALS.

Unit 4  Diseases due to misfolded proteins  No. of HOURS: 8
Introduction to protein folding and proteosome removal of misfolded proteins; etiology and molecular basis for Alzheimer's, Prion diseases, Huntington's Chorea, sickle cell anemia, Thalassemia.

Unit 5  Monogenic diseases  No. of HOURS: 10
In born errors in metabolism: PKU, Alkaptonuria, Maple syrup urine disease; Receptor and transport defects: Cystic fibrosis, Long QT syndrome, familial hypercholesterolemia, Achondroplasia. Hemoglobinopathies and clotting disorders.
BCH DSE-3 : MOLECULAR BASIS OF NON-INFECTIONOUS HUMAN DISEASES (PRACTICALS)
SEMESTER – V/VI

Total HOURS: 60 CREDITS: 2

1. Anthropometric measurements for normal and high risk individuals and identifications for Kwashiorkor, Marasmus and Obesity
2. Estimation of homocysteine levels in serum
3. Estimation of glycosylated hemoglobin
4. Permanent slides for different types of cancer
5. Diagnostic profile for assessment of CVS and Diabetes mellitus using case studies.
6. Case Studies

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH DSE-4 : MOLECULAR BASIS OF INFECTIOUS DISEASES
(THEORY)
SEMESTER – V/VI

Total Hours: 60 CREDITS: 4

Unit 1 Classification of infectious agents No. of HOURS: 12

Unit 2 Overview of diseases caused by bacteria No. of HOURS: 18
Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including Typhoid, Diphtheria, Pertussis, Tetanus, Typhoid and Pneumonia.

Unit 3 Overview of diseases caused by Viruses No. of HOURS: 12
Detailed study of AIDS, history, causative agent, pathogenesis, Diagnostics, Drugs and inhibitors. Other viral diseases including hepatitis, influenza, rabies, chikungunya and polio.

Unit 4 Overview of diseases caused by Parasites No. of HOURS: 8
Detailed study of Malaria, history, causative agents, Vectors, life cycle, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development. Other diseases including leishmaniasis, amoebiasis.

Unit 5 Overview of diseases caused by other organisms No. of HOURS: 10
Fungal diseases, General characteristics. Medical importance of major groups, pathogenesis, treatment.

BCH DSE-4 : MOLECULAR BASIS OF INFECTIOUS DISEASES (PRACTICALS)
SEMESTER – V/VI

Total HOURS: 60 CREDITS: 2

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

SUGGESTED READINGS


B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH DSE-5 : RESEARCH PROJECT
SEMESTER – V/VI

Total HOURS: 180
6

This paper would focus on the project work / dissertation to be carried out by the students in the supervision of the teachers in the colleges. The topic of the project would be selected by each student in consultation with the teacher (Advisor). This would train the student to retrieve the literature and collate the information sufficient to make a presentation, the collated literature would also prepare the base for initiating the research. The student would carry out experiments to achieve the planned objectives, collation and analysis of data, presentation of the result in the form of a Dissertation. The grading would be based on continuous evaluation that would include punctuality, hard work, record keeping, intellectual inputs, data presentation, interpretation etc.
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH DSE-6: ADVANCED CELL BIOLOGY (THEORY)
SEMESTER – V/VI

Total HOURS: 60 
CREDITS: 4

Unit 1  Plasma Membrane and Nuclear Transport 
No. of HOURS: 4
Properties and Composition of Cell Membrane; Structure of Nuclear Envelope; Nuclear Pore Complex; Transport Across Nuclear Envelope; Regulation of Nuclear Protein Import and Export.

Unit 2  
Protein Sorting and Secretory Pathway 
No. of HOURS: 12
Overview of The Endomembrane System; Targeting, modification and sorting of Proteins From And Into Endoplasmic Reticulum; Synthesis And Targeting Mitochondrial Protein; Chloroplast ProteinsAnd Peroxisomal Proteins; Mechanism Of Vesicular Transport; Coat Proteins And Vesicle Budding; Vesicle Fusion; Targeting Of Proteins To Membranes; Receptor Mediated Endocytosis.

Unit 3  
Cytoskeleton and Cell Motility 
No. of HOURS: 10
Function and origin of The Cytoskeleton; Organization and Assembly of Actin Filaments And Myosin; Assembly and Dynamics of Microtubules And Intermediate Filaments; Assembly and organization of Cilia and Flagella, Muscle Contractility; Cell Polarization And migration.

Unit 4  Cell-Cell Interaction 
No. of HOURS: 8
Cell-Cell Interactions and Cell-Matrix Interactions; Components of Extracellular Matrix: Collagen and Non-Collagen Components; Role Of Cell Interaction In Development.

Unit 5  Cell Cycle and Programmed Cell Death 
No. of HOURS: 10
Overview of The Cell Cycle; Eukaryotic Cell Cycle; Events Of Mitotic Phase; Cytokinesis; Events Of Meiosis And Fertilization; Regulation Of Cell Division And Cell Growth; Apoptosis And Necrosis, Stem Cells And Maintenance of Adult Tissues, Hematopoiesis, Embryonic Stem Cells and Therapeutic Cloning.

Unit 4  Cancer Biology 
No. of HOURS: 10
Development and causes Of Cancer; Genetic Basis of Cancer; Oncogenes, Tumor Viruses; Molecular Approach to Cancer Treatment.

Unit 5  Advanced Methods in Cell Biology 
No. of HOURS: 6
BCH DSE-6 : ADVANCED CELL BIOLOGY (PRACTICALS)  
SEMESTER – V/VI

Total HOURS: 60  
CREDITS: 2

1. Isolation of organelles by sub-cellular fractionation.
2. Study of cell viability /death assay by use of trypan blue and MTT assay.
4. Identification and study of cancerous cells using permanent slides and photomicrographs.

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH DSE-7: PLANT BIOCHEMISTRY (THEORY)
SEMESTER – V/VI

Total HOURS: 60  CREDITS: 4

Unit 1  Introduction to Plant cell structure  No. of HOURS: 4
Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes.

Unit 2  Photosynthesis and Carbon assimilation  No. of HOURS: 14
Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration.

Unit 3  Respiration  No. of HOURS:12
Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.

Unit 4  Nitrogen metabolism  No. of HOURS: 14

Unit 5  Regulation of plant growth  No. of HOURS: 4
Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light.

Unit 6  Secondary metabolites  No. of HOURS: 8
Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.

Unit 6  Plant tissue culture  No. of HOURS: 4
Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclinal variation.
BCH DSE-7: PLANT BIOCHEMISTRY (PRACTICALS)
SEMESTER – V/VI

Total HOURS: 60
CREDITS: 2

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

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH DSE-8: BASIC MICROBIOLOGY (THEORY)
SEMESTER – V/VI

Total HOURS: 60
CREDITS: 4

Unit 1 History of Development of Microbiology
No. of Hours: 12
Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2 Diversity of Microbial world
No. of Hours: 12
Binomial Nomenclature, Whittaker’s five kingdom and Carl Woese’s three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaea, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Unit 3 Viruses, viroids and prions
No. of Hours: 10
An introduction to viruses with special reference to the structure and replication of the following: Poxvirus, Poliovirus, HIV, T4 and λ phage, lytic and lysogenic cycles.

Unit 4 Bacteria
No. of Hours: 10
An account of typical eubacteria, chlamydiae & rickettsiae (obligate intracellular parasites), mycoplasma, and Archaea. Applications of bacteria and Archaea in industry, environment and food.

Unit 5 Algae
No. of Hours: 6
History of phycology; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Applications of Algae in agriculture, industry, environment and food.

Unit 6 Fungi
No. of Hours: 6
Historical developments in the field of Mycology, significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic Importance of Fungi in Agriculture, environment, Industry, medicine, food, biodeterioration, mycotoxins

Unit 7 Protozoa
No. of Hours: 4
General characteristics with special reference to Amoeba
2. Microbiology Laboratory Practices and Biosafety.
3. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter)
4. Preparation and sterilization of culture media for bacterial cultivation
5. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs
6. Staining of bacteria using Gram stain
7. Isolation of pure cultures of bacteria by streaking method.
8. Estimation of CFU.

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)  
GENERIC ELECTIVES
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH GE-1 : BIOCHEMISTRY OF CELL (THEORY)

TOTAL HOURS: 60 CREDITS: 4

Unit 1 Biomolecules in their cellular environment

Unit 2 Amino acids and peptides
Types of amino acids and their chemistry, derivatives of amino acids and their biological role. Introduction to biologically important peptides.

Unit 3 Sugars and polysaccharides
Basic chemistry of sugars, optical activity. Disaccharides, trisaccharides and polysaccharides - their distribution and biological role.

Unit 4 Nucleosides, nucleotides and nucleic acids
Structures and chemistry, DNA structures and their importance, different types of RNA. Unusual DNA structures, other functions of nucleotides.

Unit 5 Lipids
Various classes of lipids and their distribution, storage lipids, structural lipids in membranes, lipids as signals, cofactors and pigments.

Unit 6 Vitamins, coenzymes and metal ions
Occurrence and nutritional role. Coenzymes and their role in metabolism. Metal ion containing biomolecules - heme, porphyrins and cyanocobalamin; their biological significance.

Unit 7 Signalling molecules
Second messengers - cAMP, cGMP, IP₃, diacyl glycerol, Ca²⁺, NO. Brief account of their importance and role in signalling and signal transduction.

BCH GE-1 : BIOCHEMISTRY OF CELL (PRACTICALS)

TOTAL HOURS: 60 CREDITS: 2

2. Qualitative tests for biomolecules - carbohydrates, lipids, amino acids, proteins, bases and nucleic acids.
5. Estimation of ascorbic acid in fruit juices.
SUGGESTED READINGS


# B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
## BCH GE-2 : PROTEINS AND ENZYMES (THEORY)

<table>
<thead>
<tr>
<th>Unit</th>
<th>No. of HOURS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Introduction to proteins</td>
<td>4</td>
<td>Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function.</td>
</tr>
<tr>
<td>2 Isolation and analysis of proteins</td>
<td>12</td>
<td>Techniques to isolate and analyze proteins- salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, IEF. Protein primary structure - sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides. Synthesis of peptides using Merrifield method.</td>
</tr>
<tr>
<td>4 Myoglobin and haemoglobin - structure and function</td>
<td>4</td>
<td>Oxygen binding curves, cooperativity models for haemoglobin.</td>
</tr>
<tr>
<td>5 Introduction to enzyme catalysis</td>
<td>8</td>
<td>Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature.</td>
</tr>
<tr>
<td>8 Enzymes in medicine and industry</td>
<td>6</td>
<td>Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry.</td>
</tr>
</tbody>
</table>
10. Protein estimation by UV absorbance and Biuret method.
11. Protein micro assay by Lowry/Bradford method.
12. Ammonium sulphate fractionation of crude homogenate from germinated mung bean.
13. Setting up assay for acid phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).
14. Determination of $K_m$ and $V_{max}$ of enzyme enriched fraction.
15. Inhibition of acid phosphatase activity by inorganic phosphate.

SUGGESTED READINGS

Total HOURS: 60  
CREDITS: 4

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

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

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

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

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

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

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

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

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

Unit 10 Integration of metabolism
No. of HOURS: 6
Brief role of hormones - catecholamines, insulin, glucagon; metabolic shifts to provide fuel to brain during fasting and starvation, role of cortisol in signalling stress - increase in gluconeogenesis and muscle protein breakdown.
BCH GE-3: INTERMEDIARY METABOLISM (PRACTICALS)

Total HOURS: 60
CREDITS: 2

1. Alcohol fermentation by yeast.
2. H₂S production, indole production and ammonia production by bacteria.
3. Urea estimation.
4. Uric acid estimation.

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH GE-4 : GENE ORGANIZATION, EXPRESSION AND REGULATION (THEORY)

Total HOURS: 60  CREDITS: 4

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

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

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

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

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

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

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

Unit 8 Regulation of gene expression  No. of HOURS: 6
Regulation of transcription in prokaryotes, concept of operons. Lac operon - control by negative and positive regulatory proteins, Trp operon - control by attenuation. Regulation of transcription in eukaryotes, regulatory sequences - enhancers, silencers response elements, nucleosome alterations, DNA-protein interactions and RNA interference.
**BCH GE-4 : GENE ORGANIZATION, EXPRESSION AND REGULATION**  
**PRACTICALS**

**Total HOURS: 60**  
**CREDITS: 2**

1. Quantitative determination of DNA and RNA by absorbance at 260 nm and using $A_{260}/A_{280}$ ratio to distinguish between them.  
2. Estimation of DNA by DPA method.  
3. Estimation of RNA by Orcinol.  
4. Isolation of chromosomal DNA from *E. coli*.  
5. Isolation of total RNA from yeast cells.

**SUGGESTED READINGS**

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH GE-5 : FUNDAMENTALS OF CELL BIOLOGY AND IMMUNOLOGY (THEORY)

Total HOURS: 60

CREDITS: 4

Unit 1 Cells and organelles
Prokaryotic and eukaryotic cells. Plasma membrane, the nucleus, intracellular membranes and organelles, mitochondria, chloroplast, endoplasmic reticulum, Golgi complex, lysosome, peroxisome, cytoskeleton, extracellular matrix, cell wall. Mitosis and meiosis.

No. of HOURS: 6

Unit 2 Membrane structure and function
Composition of membranes, membrane lipids, membrane proteins, isolation and characterization. Integral, peripheral and lipid anchored protein. Transport across membranes, simple and facilitated diffusion, active transport.

No. of HOURS: 8

Unit 3 Endoplasmic reticulum and Golgi complex
The two types of endoplasmic reticulum, rough and smooth. The Golgi complex. Role of Golgi in protein glycosylation and protein trafficking.

No. of HOURS: 6

Unit 4 Signalling mechanisms, messengers and receptors
Chemical signals and cellular receptors. G-protein linked receptors, protein kinase associated receptors. Hormonal signalling, cell signals and apoptosis.

No. of HOURS: 8

Unit 5 Cell cycle and its regulation
Overview of the cell cycle. Regulation of the cell cycle, cyclin dependent kinases.

No. of HOURS: 4

Unit 6 Overview of the immune system

No. of HOURS: 4

Unit 7 Innate immunity

No. of HOURS: 8

Unit 8 Humoral B cell response
Structure of antibodies, types of immunoglobulins, generation of antibody diversity. B cell activation, theory of clonal selection, formation of plasma and memory cells; T-independent B-response; antigens, haptens carriers and adjuvants.

No. of HOURS: 8

Unit 9 Cell mediated immunity

No. of HOURS: 8
BCH GE-5 : FUNDAMENTALS OF CELL BIOLOGY AND IMMUNOLOGY (PRACTICALS)

Total HOURS: 60

CREDITS: 2

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

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH GE-6 : FUNDAMENTALS OF GENETIC ENGINEERING (THEORY)

Total HOURS: 60
CREDITS: 4

Unit 1 Introduction to recombinant DNA technology
Overview of recombinant DNA technology. Plasmids and bacteriophage DNA as cloning vectors, pBR322, pUC8. Purification of plasmid and bacteriophage DNA. Enzymes used in manipulating DNA, separation by electrophoresis.

Unit 2 Cloning vectors for prokaryotes and eukaryotes
Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on E. coli plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. Vectors for yeast, higher plants and animals.

Unit 3 Construction, selection and identification of recombinants

Unit 4 Polymerase chain reaction and DNA sequencing
Fundamentals of polymerase chain reaction, designing primers for PCR. Analysis of PCR products. DNA sequencing by Sanger’s method and automated DNA sequencing.

Unit 5 Expression of cloned genes
Vectors for expression of foreign genes in E. coli, cassettes and gene fusions. Challenges in producing recombinant protein in E. coli. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

Unit 6 Applications of genetic engineering in biotechnology
Expression of cloned genes. Vectors for expression of foreign genes in E coli, cassettes and gene fusions. Production of recombinant pharmaceuticals such as insulin. Gene therapy. Genetically modified plants such as herbicide resistant crops.
BCH GE-6 : FUNDAMENTALS OF GENETIC ENGINEERING (PRACTICALS)

Total HOURS: 60  
CREDITS: 2

1. Ultraviolet absorption spectrum of DNA and RNA.
2. Isolation of plasmid DNA and restriction digestion.
3. Amplification of a DNA fragment by PCR
4. Virtual lab exercise on recombinant DNA techniques.

SUGGESTED READINGS

B.SC. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH GE-7 : BIOCHEMICAL CORRELATIONS IN DISEASES (THEORY)

Total HOURS: 60 CREDITS: 4

Unit 1 Inborn errors of metabolism No. of HOURS: 8
Alkaptonuria, Phenylketonuria, Glycogen and Lipid storage diseases, SCID, Clotting disorders.

Unit 2 Nutritional deficiency based diseases No. of HOURS: 8

Unit 3 Life style diseases No. of HOURS: 8
Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes mellitus-II. Inflammatory Bowel Disease (IBD).

Unit 4 Hormonal Imbalances No. of HOURS: 8
Outline of hormone action and imbalances leading to disease - precocious puberty, hyper and hypopituitarism. Hyper and hypothyroidism.

Unit 5 Autoimmune diseases No. of HOURS: 6
Concepts in immune recognition - self and non self discrimination, organ specific autoimmune diseases – Hashimoto’s thyroiditis, Grave’s disease, Myasthenia Gravis; Systemic diseases - SLE, rheumatoid arthritis; Diabetes Mellitus-I.

Unit 6 Diseases caused due to misfolded proteins No. of HOURS: 8
Alzheimer’s, Huntington’s disease, Kuru, Creutzfeldt-Jakob disease, Sickle cell anaemia, Thalessemia.

Unit 7 Infectious diseases No. of HOURS: 16
Viral infection (polio, measles, mumps, influenza, HIV); Bacterial infections (tetanus, diphtheria, tuberculosis, typhoid, cholera); Protozoan (Plasmodium and Trypanosoma) and parasitic infections. Vaccines against diseases. General strategies in the design and development of vaccines.

BCH GE-7 : BIOCHEMICAL CORRELATIONS IN DISEASES (PRACTICALS)

Total HOURS: 60 CREDITS: 2

1. Glucose tolerance test.
2. Lipid profile: triglycerides and total cholesterol.
3. Obesity parameters; BMI.
4. RBC counting and haemoglobin estimation.
5. Blood pressure measurements.
6. Calcium estimation
SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
SKILL ENHANCEMENT COURSES
(Three hours class with one hour theory and two hours practical)
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH SEC-1 : TOOLS AND TECHNIQUES IN BIOCHEMISTRY
SEMESTER – III/IV

TOTAL HOURS: 15 hrs theory + 30 hrs practical  CREDITS : 2

Unit 1 Biochemical reagents and solutions  No. of Hours: 5 + 10

Exercise
• Preparation of a buffer of given pH and molarity.

Unit 2 Spectrophotometric techniques  No. of HOURS: 9 + 18
Principle and instrumentation of UV-visible and fluorescence spectroscopy.

Exercises
• Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule).
• Determination of concentration of a protein solution by Lowry/BCA method.

Unit 3 Introduction and importance of virtual labs in biochemistry  No. of Hours: 1 + 2

SUGGESTED READINGS

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH SEC-2 : PROTEIN PURIFICATION TECHNIQUES
SEMESTER – III/IV

TOTAL HOURS: 15 hrs theory + 30 hrs practical
CREDITS: 2

Unit 1  Purification and characterization of a protein from a complex mixture (native or heterologously expressed) involving the following methods/techniques
No. of HOURS: 13 + 26

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

Unit 2  Demonstration of High Performance Liquid Chromatography (HPLC)
No. of HOURS: 2 + 4

SUGGESTED READINGS

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

BCH SEC-3 : CLINICAL BIOCHEMISTRY

SEMESTER – III/IV

TOTAL HOURS: 15 hrs theory + 30 hrs practical

CREDITS: 2

Unit 1 Introduction

No. of Hours: 1 + 2


Exercises

• Separation and storage of serum.

Unit 2 Evaluation of biochemical changes in diseases

No. of Hours: 5 + 10


Assessment of glucose metabolism in blood

Clinical significance of variations in blood glucose. Diabetes mellitus.

Exercises

• Estimation of blood glucose by glucose oxidase peroxidase method.

Lipid profile

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

Exercises

• Estimation of triglycerides.

Unit 3 Liver and kidney function tests

No. of HOURS: 5 + 10

Exercises

• Estimation of bilirubin (direct and indirect).

Renal function tests and urine analysis

Use of urine strip / dipstick method for urine analysis.

Exercises

• Quantitative determination of serum creatinine and urea.

Unit 4 Tests for cardiovascular diseases

No. of HOURS: 4 + 8

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

Exercises

• Estimation of creatine kinase MB.
SUGGESTED READINGS


B.Sc. (HONS) BIOCHEMISTRY (CBCS STRUCTURE)
BCH SEC-4 : BIOINFORMATICS
SEMESTER – III/IV

TOTAL HOURS: 15 hrs theory + 30 hrs practical  CREDITS: 2

Unit 1 Introduction to bioinformatics  No. of HOURS: 1 + 2
Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - genomics, proteomics, computer aided drug design (structure based and ligand based approaches) and Systems Biology. Applications of bioinformatics.

Unit 2 Biological databases and data retrieval  No. of HOURS: 4 + 8
Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (Ras Mol, J mol), file formats.

Exercises

- Sequence retrieval (protein and gene) from NCBI.
- Structure download (protein and DNA) from PDB.
- Molecular file formats - FASTA, GenBank, Genpept, GCG, CLUSTAL, Swiss-Prot, FIR.
- Molecular viewer by visualization software.

Unit 3 Sequence alignment  No. of HOURS: 2 + 3
Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTALW.

Exercises

- BLAST suite of tools for pairwise alignment.
- Multiple sequence alignment using CLUSTALW.

Unit 4 Phylogenetic analysis  No. of HOURS: 2 + 3
Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees - maximum parsimony, maximum likelihood and distance methods.

Exercise

- Generating phylogenetic tree using PHYLIP.

Unit 5 Protein structure prediction and analysis  No. of HOURS: 4 + 8
Levels of protein structure. Protein tertiary structure prediction methods - homology modeling, fold recognition and \textit{ab-initio} methods. Significance of Ramachandran map.

Exercises

- Primary sequence analyses (Protparam).
• Secondary structure prediction (GOR, nnPredict).
• Tertiary structure prediction (SWISSMODEL).
• Protein structure evaluation - Ramachandran map (PROCHECK).

Unit 6 Genomics No. of HOURS: 2+6
Introduction to genomics, comparative and functional genomics, gene structure in prokaryotes and eukaryotes, gene prediction methods and tools.

Exercise

• Gene prediction using GENSCAN and GLIMMER.

SUGGESTED READINGS

B.Sc. (HONS) BIOCHEMISTRY (CBCS STRUCTURE)  
BCH SEC-5: RECOMBINANT DNA TECHNOLOGY  
SEMESTER – III/IV

TOTAL HOURS: 15 hrs theory + 30 hrs practical  
CREDITS: 2

Unit 1  Work flow for in silico cloning  
No. of HOURS: 1 + 2

Unit 2  Preparation of media, antibiotic solution, culturing of E. coli, isolation of single colonies  
No. of HOURS: 3 + 6

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

Unit 3  Overview of plasmid vectors and methods of isolation  
No. of HOURS: 4 + 8

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

Unit 4  Characterization of plasmid by gel electrophoresis  
No. of HOURS: 2 + 4

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

Unit 5  Cloning of a gene in a vector and functional analysis  
No. of HOURS: 5 + 10

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

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

SUGGESTED READINGS