

# **DEPARTMENT OF BIOCHEMISTRY UNIVERSITY OF KASHMIR**



## **PhD Entrance Test Syllabus for Biochemistry (Effective from 2023)**

## **Syllabus for PhD Entrance Test in Biochemistry**

(Effective from 2023)

*(The syllabus is based on core papers in MSc Biochemistry programme in effect since 2021)*

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<b>S.No.</b>	<b>Course Name</b>
1.	Biomolecules
2.	Cell Biology
3.	Metabolism
4.	Molecular Biology
5.	Immunology
6.	Biotechnology

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# 1. Biomolecules

## Unit-1

### Carbohydrates

Definition, classification, characterization and biological importance of mono- and disaccharides  
Structure and conformation of sugars  
Stereo-and optical isomers  
Structure and function of homo and heteropolysaccharides  
Mucopolysaccharides and proteoglycans  
Chemical reactions of functional groups present in carbohydrates

## Unit-II

### Lipids

Classification of lipids  
Chemical composition and properties of Triacylglycerides  
Nomenclature and properties of saturated and unsaturated fatty acids  
Properties and functions of phospholipids and sphingolipids  
Structure and functions of steroids (Cholesterol and Bile salts).  
Prostanoids

## Unit-III

### Amino acids

Structure, classifications and physiochemical properties  
Essential and non-essential aminoacids  
Characteristics of a peptide bond  
Oligo-peptides and polypeptides  
Chemical synthesis of a peptide

### Proteins

Levels of protein structure  
Elucidation of primary structure  
Forces stabilizing the tertiary structure  
Protein denaturation and renaturation  
Structure and function of Hemoglobin and myoglobin

## Unit-IV

### Nucleic Acids

Primary, secondary and tertiary structure of DNA  
Various forms of DNA, structure polymorphism of DNA  
Properties of DNA  
Denaturation and annealing of DNA, Cot Curve  
DNA as genetic material  
Primary, secondary and tertiary structure of RNA  
Functions of various types of RNA

## **2. Cell Biology**

### **Unit-I**

Cell membrane

Chemical composition

Structure and function of membrane proteins

Membrane lipids and membrane fluidity

Movement of substances across cell membrane

Membrane potential

Mitochondria - structure and function

Golgi complex- structure and function

Introduction to vesicle transport

Lysosomes and plant vacuoles, Peroxisomes

### **Unit-II**

Introduction to endomembrane system

Approaches to study endomembrane

Endoplasmic reticulum, structure and function

Structure and function of Nucleus and nucleolus

Chromosome and chromatin structure

Structure and composition of a gene

### **Unit-III**

Cell cycle and its stages

Regulation of cell cycle

Cell cycle and cancer

Mitosis

Prophase, prometaphase, metaphase, anaphase, telophase, cytokinesis

Motor proteins and their role in cell division

Meiosis

The stages of meiosis

Genetic recombination during meiosis

### **Unit-IV**

Extracellular matrix and cell interaction

Extracellular space

Interaction of cells with extracellular material

Tight Junction- sealing the extracellular space

Cell -cell adhesion

Cell -cell communication

The cytoskeleton

Microtubules

Intermediate filaments

Microfilaments

### **3. Metabolism**

#### **Unit-I**

##### Bioenergetics

- Energy transformation by biological systems
- Concept and significance of free energy
- Phosphoryl transfer potential
- Coupled reactions
- ATP as energy currency
- ATP Cycle
- Nernst equation and redox potential

##### Structural organization of respiratory chain

- Electron flow in respiratory chain
- Inhibitors of ETC
- Oxidative phosphorylation
- Structure and function of ATP-synthase complex
- Regulation of rate of oxidative phosphorylation

#### **Unit-II**

##### Carbohydrate metabolism

- Glycolysis
- Citric acid cycle, its function in energy generation and biosynthesis of energy rich-bonds
- Pentose phosphate pathway and its regulation
- Alternate pathways of carbohydrate metabolism
- Gluconeogenesis
- Biosynthesis of glycogen and starch
- Regulation of carbohydrate metabolism -hormonal/enzymatic
- Inborn errors of carbohydrate metabolism

#### **Unit-III**

##### Lipid metabolism

- Fatty acid oxidation-  $\alpha$ ,  $\beta$ ,  $\omega$ , oxidation and lipo-oxidation.
- Fatty acid biosynthesis- Acetyl CoA carboxylase, Desaturase and elongase
- Biosynthesis of triacylglycerols, Phosphoglycerides and sphingolipids
- Biosynthetic pathways for terpenes, steroids and prostaglandins
- Ketone bodies- Formation and utilization
- Regulation of lipid metabolism -hormonal/enzymatic
- Inborn errors of lipid metabolism
- Interactions between carbohydrate and lipid metabolism
- Role of insulin and adiponectin

## **Unit-IV**

### Amino acid metabolism

- Metabolic fate of amino groups
- Pathways of amino acid catabolism
- Nitrogen excretion and urea cycle
- Biosynthesis of amino acids
- Regulation of amino acid metabolism

### Nucleic acid metabolism

- Degradation of purines and pyrimidines
- Biosynthesis and regulation of purine and pyrimidine nucleotides
- Denovo and salvage pathways
- Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides
- Structure and regulation of ribonucleotide reductase
- Inhibitors of nucleic acid biosynthesis

## **4. Molecular Biology**

### **Unit-I**

#### Replication

- Unit of replication,
- Replication Origin and Replication Fork
- Enzymes involved in replication,
- Initiation, Elongation and Termination of Replication
- Fidelity of Replication
- Recombination and repairs

### **Unit-II**

#### Transcription

- Transcription in prokaryotes and eukaryotes
- Transcriptional factors and their role
- RNA polymerases
- Formation of initiation complex
- Elongation and termination
- Inhibitors of transcription
- RNA processing, splicing, polyadenylation, capping
- Structure and function of different types of RNA's

### **Unit-III**

#### Regulation of gene expression

- Prokaryotes
- Eukaryotes
- Viruses
- Transcriptional activators and repressors
- Role of chromatin in regulating gene expression and gene silencing
- Epigenetics and its importance in regulation of gene expression

### **Unit- IV**

#### Translation

##### Genetic code

- General characteristics of genetic code
- Deciphering of genetic code
- Ribosomes as the site of protein synthesis, polysomes
- Activation of amino acids
- Chain initiation, elongation and termination in prokaryotes and eukaryotes
- Control of translation (Role of Guanine nucleotides).
- Translational fidelity, Kinetic proof reading
- Positive and negative regulation of translation
- Inhibitors of protein synthesis

## **5. Immunology**

### **Unit-I**

Historical perspective, terms associated with immunology,

Antigenicity, Features of Antigenicity, super antigens, adjuvants.

Cells of immune system: Myeloid, Mononuclear cells, T-Lymphocytes, B-Lymphocytes, NK cells

Primary and secondary lymphoid organs: Thymus, Bursa of Fabricius, Peyer's Patch, spleen, lymph nodes

Mucosal associated and cutaneous associated lymphoid tissues.

### **Unit – II**

Immunoglobulin, structure, classes and subclasses

Multigene organization of Ig gene, variable region gene rearrangements, allelic exclusion, generation of diversity of Ig, Assembly and secretion of Ig, class switch,

Regulation of Ig transcription.

Humoral and cell mediated immunity: B cell development and activation, BCR, T cell development and activation, TCR.

Regulation of system: complement cascade, Biological function and its regulation. ,

Complement fixation test.

Introduction to cytokines.

### **Unit – III**

Major histocompatibility complex: different classes, organization and biological function.

Transcription regulation of MHC

Hypersensitivity: Type I, II, III, and IV

Autoimmunity and autoimmune diseases

Single organ and systemic autoimmune diseases

Brief introduction to Primary and secondary immunodeficiencies, AIDS

Mechanisms of transplantation. Examples of organ transplantation.

Examples of immune response to Viruses, bacteria, protozoa, fungal and helminthic infection

### **Unit-IV**

Immunoblotting and diagnosis of various important diseases, only infectious and few cancerous types

Techniques – ELISA, RIA, fluorescent IA, agglutination of pathogenic bacteria,

Haemagglutination and its inhibition. Affinity, avidity

Immunoelectron microscopy

Enumeration of total T-cell numbers by sRBC, rosette technique

Determination of total number of B-lymphocytes by staining for surface IgG.

Antigen – antibody interaction and its applications.

Total hemolytic assay



## **6. Biotechnology**

### **Unit-I**

#### Recombinant DNA Technology

Vectors: Plasmids, bacteriophages, phagemids, cosmids, YACs, and BACs

Methods of creating recombinant DNA molecule

Transformation and screening of recombinant vector

Confirmation of insert

Expression strategies in different hosts, vector and host engineering

Types of restriction endonucleases

Library construction

Types of libraries

cDNA and genomic libraries

Primary, secondary and tertiary screening methods

### **Unit-II**

#### Animal Cell Culture

Primary and established cell lines

Types of various cell lines

Biology and characterization of the cultured cells

Introduction to balanced salt solutions and simple growth medium

Role of CO<sub>2</sub>, serum and supplements, Serum and serum free media, defined media and their applications, antibiotics

Immortalization and methods used to immortalize cells

Viability and cytotoxicity assays: Trypan blue, MTT, TUNEL and ELISA based assays

Concept of Plant Cell culture

### **Unit-III**

#### Blotting techniques

Western, Northern, Southern

#### Polymerase chain reaction

Overlap extension PCR

Multiplex, Gradient and Nested PCR, RT-PCR, qPCR

Principle of - RFLP, RAPD and AFLP techniques

Methods for analysis of gene expression at RNA level and protein level

Large-scale expression analysis using micro array analysis

Flow-cytometry

#### Genome Editing

Cre-Lox recombination system

Zinc Finger Nucleases (ZFNs)

TALEN system

CRISPR-Cas9 technology

#### DNA Sequencing

Next generation sequencing

Sequencing while synthesizing

Ion Torrent/semiconductor sequencing  
Pyrosequencing  
Genome wide sequencing (GWS) and Whole genome gene sequencing (WGS)  
Genome-wide association studies (GWAS)  
Transcriptome and Exome sequencing

#### **Unit- IV**

Immunobiotechnology

Development of Monoclonal Antibodies by  
Hybridoma Technology

Applications of MCA and Antibody Fragments

Vaccination: Conventional and genetically engineered vaccines

Lymphokines – production and applications