

**DEPARTMENT OF BIOCHEMISTRY  
UNIVERSITY OF KASHMIR**

**Syllabus 3-year integrated Ph.D Entrance Test in  
Biochemistry 2016**

<b>Section</b>	<b>Title</b>
<b>1</b>	<b>Biomolecules, Bioenergetics, Intermediary Metabolism and Advanced Enzymology</b>
<b>2</b>	<b>Cell Biology and Molecular Biology</b>
<b>3</b>	<b>Biochemical Techniques and Biotechnology</b>
<b>4</b>	<b>Immunology</b>

## **SECTION 1**

### **Biomolecules, Bioenergetics, Intermediary Metabolism and Advanced Enzymology**

#### **Carbohydrates**

Definition, classification, characterization and biological importance of mono- and disaccharides.

Structure and conformation of sugars

Stereo- and optical isomerisms

Structure and function of homo- and heteropolysaccharides

Glycoproteins, Mucopolysaccharides and proteoglycans

Chemical reactions of functional groups present in the carbohydrates

#### **Lipids**

Classification of lipids

Chemical composition and properties of triglycerides

Nomenclature and properties of saturated and unsaturated fatty acids

Properties and functions of phosphoglycerides, and sphingolipids

Structure and functions of steroids (cholesterol and bile acids)

Prostanoids

Amino acids

Structure, classification and physiochemical properties

Essential and non-essential amino acids

Characteristics of a peptide bond

Oligo – and polypeptides

Chemical synthesis of peptide

#### **Proteins**

Levels of protein structure

Elucidation of primary structure

Prediction of secondary structure, Ramachandran plot

Forces stabilizing the tertiary structure

Mechanism of protein folding

Protein denaturation and renaturation

#### **Nucleic Acid**

Primary, secondary and tertiary structure of DNA

Various forms of DNA, structural polymorphism of DNA

#### **Properties of DNA**

Denaturation and reannealing of DNA, Cot Curve

DNA as a genetic material

Extra chromosomal DNA

Organelle genome

Primary, secondary and tertiary structure of RNA

Functions of various types of RNA

Concept of small RNA's

#### **Bioenergetics**

Energy transformation by biological systems

Concept and significance of free energy

Phosphoryl transfer potential

Coupled reactions

ATP as energy currency

Oxidative phosphorylation

Structural organization of respiratory chain

Metabolite transport across mitochondrial membrane

Electron flow in respiratory chain

Coupling of oxidation and phosphorylation

Structure and function of ATP-synthesis complex

Short-circuiting of proton gradient

Regulation of rate of oxidative phosphorylation

Intermediary metabolism

Approach for studying metabolism

Carbohydrates 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, starch and oligosaccharides

Regulation of blood glucose homeostasis

Lipids metabolism

Fatty acids biosynthesis

Acetyl CoA carboxylase

Fatty acids synthesis

Desaturase and elongase

Fatty acids oxidation

$\alpha$ ,  $\beta$ ,  $\omega$ , oxidation and lipo-oxidation.

**Lipid biosynthesis**  
Biosynthesis of triacylglycerols  
Phosphoglycerides and sphingolipids  
Biosynthetic pathways for terpenes  
Steroids and prostaglandins  
Ketone bodies  
Formation and utilization

**Amino acids metabolism**  
Biosynthesis and degradation of amino acids and their regulation  
Specific aspects of amino acid metabolism  
Urea cycle and its regulation  
In-born errors of amino acids metabolism  
Nucleic Acids metabolism  
Biosynthesis of purines and pyrimidines  
Degradation of purines and pyrimidine  
Structure and regulation of ribonucleotide reductase  
Biosynthesis of ribonucleotides, deoxy ribonucleotides and polynucleotide  
Inhibitors of nucleic acid biosynthesis  
**Enzymology**  
Enzyme classification and Nomenclature  
Methods of examining enzyme – substrate complexes  
Enzyme kinetics  
An introduction, factors influencing enzyme reaction velocity  
Enzyme assay  
Review of unisubstrate enzyme kinetics  
Henri and Michealis Menten equation, Briggs-Haldene modification  
Significance of Michealis Menten constant  
Transformation of Michealis Menten equation, Various straight line forms and logarithmic forms.  
Derivation of rate expression for Ping Pong and ordered Bi Bi reaction mechanism  
Enzyme inhibition  
Reversible inhibition, its types  
Determination of inhibitor constants  
Irreversible inhibition  
Ligand binding  
Cooperativity phenomenon  
Positive homotropic cooperativity and Hill equation.  
The Adair equation

**Allosteric enzymes**  
Sigmoidal kinetics and their physiological significance  
Symmetric and sequential modes for action of allosteric enzymes and their significance  
Immobilization of enzymes  
Immobilized enzymes and their industrial applications. Different methods utilized for immobilization of enzymes viz, Adsorption, gel entrapment , covalent binding, cross linking, cross linking etc.  
Effect of partition on kinetics and performance with particular emphasis on changes in pH and hydrophobicity  
Mechanism of catalysis of serine proteases, lysozyme and triose phosphate isomerases  
Enzyme regulation  
General mechanism of enzyme regulation  
Feed back inhibition and feed forward stimulation  
Enzyme repression, induction and degradation  
Control of enzymatic activity by products and substrates  
Reversible and irreversible covalent modifications of enzymes  
Extraction and purification of enzymes by using different techniques Viz. Salt fractionation, organic solvent fractionation, ion exchange chromatography, gel permeation chromatography affinity chromatography etc

## **SECTION 2**

### **Cell Biology and Molecular Biology**

Detailed structural organization and functions of:  
Cell membrane, endoplasmic reticulum, microbodies, golgi bodies, nucleus, nucleolus, lysosome and plant vacuoles  
Transport across cell membrane  
Detailed structural organization, biogenesis and functions of:  
Chloroplast, mitochondria, cell wall, peroxysomes

**Cytoskeleton: structure and function of Cell**  
 – cell interaction and adhesion.  
**Extracellular matrix of epithelium and non epithelial tissue.**  
**Cell signaling:**  
**Signaling molecules and their receptors.**  
**Functions of G-protein- coupled receptors, protein tyrosine kinase and cytokine receptors**  
**Pathways of intra cellular signal transduction, signal transduction and cytoskeleton.**  
**Signalling in development and differentiation.**  
**Molecular intake and its impacts.**  
**Introduction of cell specialization and differentiation.**  
**Cell cycle**  
**Detailed molecular events in cell cycle.**  
**Regulation of cell cycle, cell proliferation in development and differentiation.**  
**Cell death/ Apoptosis and its regulation**  
**Cancer biology**  
**Hall marks of cancer**  
**Genetic and epigenetic basis of cancer**  
**Role of Carcinogens and DNA repair in Cancer**  
**Tumor viruses, oncogenes and tumour suppressor genes**  
**Replication**  
**Unit of Replication,**  
**Enzymes Involved in replication,**  
**Replication Origin and Replication Fork, Initiation, Progression and Termination of Replication**  
**Fidelity of Replication,**  
**Extra chromosomal Replication,**  
**DNA Damage and Repair Mechanisms**  
**Recombination**  
**Transcription**  
**Transcription factors and machinery,**  
**Formation of initiation complex,**  
**Transcription activators and repressors,**  
**RNA polymerases,**  
**Capping,**  
**Elongation and termination,**  
**RNA processing, RNA editing, splicing, polyadenylation,**

**Structure and function of different types of RNA, RNA transport.**  
**Inhibitors of transcription**  
**Translation**  
**Protein synthesis and 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**  
**Brief description of post translational processing of polypeptide chains and associated signals for localization, trafficking and targeting**  
**Protein degradation by proteasomes**  
  
**Regulation of Gene expression in Phages, viruses, prokaryotes and eukaryotes**  
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**Role of chromatin in regulating gene expression and gene silencing**  
**Concept of epigenetics and its importance in regulation of gene expression**  
**Small RNA and their roles**  
**Gene silencing**  
**Micro RNA**  
**RNA caging**  
**RNA interference**  
**Gene knockout**  
**Concept and significance of polymorphism**

### **SECTION 3**

**Biochemical Techniques and Biotechnology**  
**Centrifugation**  
**Basic principle of centrifugation**  
**Factors affecting sedimentation**  
**Types of centrifugation including differential, density gradient and ultracentrifugation**  
**Analytical and preparative centrifugation**  
**Applications of centrifugation**

Chromatographic techniques  
Basic principle and application and applications of  
Gel filtration chromatography  
Affinity chromatography  
Gas chromatography  
High pressure liquid chromatography  
Electrophoresis and related Techniques  
Factors affecting electrophoretic mobility  
Types of electrophoresis  
Application in molecular and protein biology  
Isoelectric focusing  
Polymerase chain reaction;  
Principle, Requirement, Variants and Applications  
Purification of PCR product  
RFLP, RAPD and AFLP techniques  
Single strand conformation polymorphism and heteroduplex analysis  
Gel retardation assays  
DNA Sequencing

Different blotting techniques  
Detection of molecules using ELISA, RIA, immunoprecipitation, flowcytometry and immunofluorescence microscopy  
Detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.  
Methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques;  
Coimmunoprecipitation and Chromatin immunoprecipitation  
DNA profiling, DNA foot printing  
Recombinant DNA Technology  
Vectors: Plasmids, bacteriophages, phagemids, cosmids, YACs, and BACS vectors  
Methods of creating recombinant DNA molecule  
Transformation and screening of recombinant vector  
Confirmation of insert  
Expression strategies in different hosts, vector and host engineering

Properties of restriction endonucleases and their mode of action and usefulness in genetic engineering and polymorphism studies  
Library construction and screening  
cDNA and genomic libraries  
Primary, secondary and tertiary screening methods  
Identification of gene  
Protein production in bacteria

Immunobiotechnology  
Development of Monoclonal Antibodies by: Hybridoma Technology  
Recombinant DNA technology  
Applications of MCA and Antibody Fragments.  
Vaccination: Conventional and genetically engineered Vaccines.  
Lymphokines – production and applications  
Different media and their composition  
Introduction of plant tissue culture and cell suspension culture,  
Physico –Chemical conditions for propagation of plant cells and tissues .  
Composition of media, nutrient and hormone requirement  
Continuous culture, somatic cell culture, somaclonal variations, somatic cell hybridization, protoplast isolation protoplast fusion, protoplast culture  
Transfer of nucleic acids to plant cell.  
Direct transformation by electroporation and particle gun bombardment  
Agro bacterium , T1 plasmid vector  
Theory and techniques for the development of new genetic traits , conferring resistance to herbicide, pesticide, plant pathogens,  
Production of secondary metabolites.  
Primary and established Cell lines.  
Biology and characterizations 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 defined media and their applications.  
Measuring parameters of growth.  
Properties of transformed cells.

Immortalization and methods used to immortalize cells.

Measurements of viability and cytotoxicity assay: Trypan blue, MTT, TUNNEL and ELISA based assays.

Application of Animal cell culture.

## **SECTION 4**

### **Immunology**

Historical perspective, terms associated with immunology,

Antigenicity, Features of Antigenicity, super antigen, adjuvants.

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

Primary and secondary lymphoid organs: Thymus, Bursa of fabricus, Peyers Patch, spleen, lymph nodes, mucosal associated and cutaneous associated lymphoid tissues. 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: compliment cascade, its regulation. Biological functions, complement fixation test.

Introduction to cytokines.

Major histo-compatibility 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

Immunotechniques

Types of immunodiffusion and immunoelectrophoretic procedures, isoelectric focusing, affinity chromatographic methods and separation of immunoglobulin from serum

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

Techniques – ELISA, RIA, florescent IA, agglutination of pathogenic bacteria, Haemagglutination and its inhibition. Affinity, avidity

Immunoelecton microscopy

Enumeration of total T-cell numbers by sRBC, resetting

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

Antigen – antibody interaction and its applications.

Total hemolytic assay