# DEPARTMENT OF BIOCHEMISTRY
# UNIVERSITY OF KASHMIR

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

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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
Amio 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 Cure
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
α, β, ω, 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, deoxyribonucleotides 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
Immobiled 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
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 o plant tissue caulture 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, soaclonal varionations, 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 CO2, 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 Antigeneticiy, super antigen, adjuvants.
Cells of immune system: Myloid , 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.