Syllabus for PhD Entrance Test-2026

Subject: Biochemistry

Syllabus

Part A: 01 to 03 Units from Research Methodology
Part B: 04 to 10 Units from Cognitive Subject- Biochemistry

Unit 01: Research Aptitude

Research- Meaning, Types, and Characteristics, Positivism and Post- positivistic approach to research. Methods of Research: Experimental, Descriptive, Historical, Qualitative and Quantitative methods. Steps of Research. Thesis and Article writing: Format and styles of referencing.

Foundations of Research- Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process

Unit 02- Data Interpretation, Information and Communication Technology (ICT)

Data Analysis- Sources, acquisition and classification of Data. Quantitative and Qualitative Data. Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Unit 03- Tools related to Research

ICT- General abbreviations and terminology. Basics of Internet, Intranet, E-mail, Audio and Video-conferencing. Digital initiatives in higher education. ICT and Governance.

Use of tools / techniques for Research- methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

Unit-04: Methods in Biology

Biophysical Method- Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry.

Microscopic techniques- Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques, freeze-etch and freeze- fracture, and image processing methods in microscopy.

Radiolabeling techniques- Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

Histochemical and Immunotechniques- Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization.

Chromatographic and Electrophoretic techniques- Principles, procedure and applications of paper, TLC, adsorption, ion exchange, gel filtration, affinity, GLC, HPLC and FPLC. Polyacrylamide gel electrophoresis, SDS-PAGE, 2D-electrophoresis, agarose gel electrophoresis, isoelectric focusing, capillary electrophoresis, isotachophoresis. Separation of proteins, lipoproteins and nucleic acids. Visualizing separated components; staining, fluorescence, PAS staining, zymogram and reverse zymogram.

Unit-05: Molecular Biology Techniques and Recombinant DNA methods

Isolation and purification of RNA, DNA (genomic and plasmid), different separation methods. Analysis of RNA and DNA by one and two dimensional gel electrophoresis.

Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors. Isolation of specific nucleic acid sequences. Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors.

In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms.

Protein sequencing methods, detection of post translation modification of proteins. DNA sequencing methods, strategies for genome sequencing.

Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques. RFLP, RAPD and AFLP techniques.

Unit-06: Biological Macromolecules

Carbohydrates- Homopolysaccharides and heteropolysaccharides- starch, cellulose, glycogen, glycosaminoglycans, chitin, xylans, bacterial cell wall polysaccharides, blood group polysaccharides. Glycoproteins: N- and O-glycosylation, lectins, carbohydrates in tissue engineering. Proteoglycans; agreecan, syndecan, and decorin.

Amino acids, Peptides and Proteins- Features of the peptide bond, naturally occurring peptides. Chemical synthesis of peptides. Determination of primary structure. Secondary structure of proteins- α, β sheet, β bend, β turn and super secondary structures. Secondary structure prediction methods- Ramachandran plot, Chou and Fasman algorithm. Tertiary and quaternary structures. Denaturation and renaturation of proteins, molten globule. 3D Structure of myoglobin and hemoglobin. Molecular Chaperons.

Lipids- Properties of fatty acids, esters of fatty acids, cholesterol, phosopholipids, glycolipids, sphingolipids, cerebrosides and gangliosides. Lipid mediators- Eicosanoids, prostaglandins, leukotrienes, prostacyclins, thrombaxanes, DAG, ceramide and PAF.

Nucleic acids- Physico-chemical properties of nucleic acids- melting of DNA, Tm; factors affecting Tm, Cot curve, classification of DNA based on cot curve. Structure of nucleic acids: Primary, secondary and tertiary structure of DNA; Watson and Crick model; B and Z DNA, other models of DNA structure. palindromic sequences, cruciforms. DNA protein interaction; zinc finger, leucine zipper, helix-turn-helix, other motifs, DNA bending and kinks. Secondary structure of tRNA and clover leaf model. Chargaff's rule.

Unit-07: Physiology and Hormone regulation

Circulatory system- Blood Composition and cells. Functions of Erythrocytes, WBCs, Platelets. Hemostasis, Mechanism of blood clotting, role of Vit K, anticoagulants, blood volume, blood pressure and their regulations. Hematopoiesis. Plasma lipoproteins and their functions. CSF; composition and function.

Respiratory System- Lungs, structure and functions, gas exchange, oxygen binding by hemoglobin, factors affecting oxygenation and acid-base balance.

Digestive secretions- Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Mechanism of HCl production in the stomach and Gastrointestinal hormones.

Hepatobiliary System- Anatomy of the liver, blood supply, cells; hepatocytes, endothelial cells and Kupffer cells, secretory and excretory function and formation of bile.

Excretory system- Formation of urine- glomerular filtration, tubular reabsorption of glucose, water and electrolytes, tubular secretion. Kidney hormones. Regulation of acid base, electrolyte and water balance. Respiratory and metabolic acidosis and alkalosis.

Endocrine System- Chemistry of hormones produced by hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenals, gonads and intestine. Structure and control of hypothalamus: Hormones produced; GRH, somatostatin, TRH, CRH, GnRH. Menstrual cycle. Regulation of hormone production and release. Regulation by feedback mechanism. Conversion of cholesterol to steroid hormone.

Mechanism of action of Hormone- Peptide hormones- General mechanisms of cell signaling by hydrophilic factors, transmembrane receptors, G protein coupled receptors, receptor tyrosine kinase, eicosanoid receptors. Second messengers: IP3, DAG, cAMP, protein kinases. Nitric oxide signaling; Steroid hormones- Steroid receptors, isolation and characterization of steroid receptors. Receptor down regulation, desensitization and up regulation. Pineal gland, Melatonin and circadian rhythm.

Unit-08: Immunology

Types of immunity- innate and adaptive. Immune reactive cells. Humoral and cell mediated immunity. Anatomy of lymphoid organs- primary lymphoid organs, secondary lymphoid organs and lymphtic system. Antigens-chemical nature, types, antigenicity, haptens, epitopes, antigenic determinants, adjuvants and super antigens. Valency of antigen, epitope analysis.

Immunoglobulins-Basic structure and functions. Antigenic determinants on immunoglobulins. Methods of raising polyclonal antibodies. Monoclonal antibodies– production and application. Antibody diversity- mechanism contributing to diversity, somatic recombination, rearrangement and generation of antibody diversity. Class switching.

Cellular Basis of Immunity- Primary and secondary immune response. Reticuloendothelial system, T, B and accessory cells. Development of T and B cells. Sub sets of T and B cells. T-helper cells, T-killer cells, T-suppressor cells. T and B cell receptors, antigen processing and presentation. T and B interaction. Cytokines and co-stimulatory molecules; lymphokines, interleukins, structure and function of IL-Iβ, IL-2, TNF-α. Suppression of immune response.

MHC- MHC gene and its polymorphism, role of MHC in immune response and transplantation. T cell and B cell receptor complexes. Antigen processing and presentation. Cytokines and co-stimulatory molecules.

Complement system- components, receptors, activation of complement pathways and its biological consequences. Major histocompatibility complex (MHC) genes and products. Role of MHC antigens in immune response, MHC antigens in transplantation.

Hyper sensitivity reactions (Type I, II, III and IV). Transplantation, Graft rejection, graft vs. host reaction. Disorders of immunity- Immunological tolerance, auto immune disorders (AIDS and SCID). Vaccines- Adjuvants, vaccines and their preparations.

Unit-09: Molecular Biology and Genetics

DNA replication, repair and recombination- Enzymes of replication, replication fork, accuracy of replication, extrachromosomal DNA, DNA mutations and lesions, repair mechanisms, homologous recombination.

Transcription- Initiation, elongation and termination mechanism, enzymes involved, RNA processing: capping, tailing, splicing and editing, RNA transport, ribozymes, riboswitches and non-coding RNA, inhibitors of Transcription.

Translation- Initiation, elongation and termination mechanism, machinery of translation, regulation, inhibitors, protein targeting, post-translation modification, protein degradation.

Chromosomal and extrachromosomal inheritance- Principles of Mendelian inheritance, codominance, incomplete dominance, genomic imprinting, linkage and crossover, sex-linked inheritance, inheritance of mitochondrial genes, maternal inheritance.

Genes and mutations- Allele, multiple alleles, pseudoalleles, complementation tests; Mutation types, causes and detection; mutant types – lethal, conditional, biochemical, loss of function, gain of function, dominant-negative; germinal versus somatic mutations. Recombination, deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Genetic analysis- Linkage maps, mapping with molecular markers in animals and bacteria, tetrad analysis, gene transfer in bacteria: transformation, conjugation, transduction, sexduction, fine structure analysis of gene.

Unit-10: Metabolism and regulation

Carbohydrate metabolism- Energetics and regulation of glycolysis Citric acid cycle and Gluconeogenesis. Cori cycle, glyoxylate cycle and glucose paradox. Biosynthesis and degradation of

starch and glycogen and its regulation. Glycogen storage disorders. HMP pathway and its regulation. Effect of insulin and glucagon on carbohydrate and lipid metabolism in different tissues.

Lipid Metabolism- Degradation of triacylglycerols, phospholipids and sphingolipids. Significance of lipase, hormone sensitive lipase, phospholipases and sphingomyelinase. Fatty acid degradation- β and ω-oxidation. Formation of ketone bodies and their oxidation. Energetics and biosynthesis of fatty acids- fatty acid synthetase complex, chain elongation and desaturation. Cholesterol metabolism and its regulations. Oxidized lipids and their metabolism. Foam cell formation. Biosynthesis of phospholipids, sphingolipids, ether lipids and glycolipids. Biosynthesis of prostaglandins, thromboxanes and leukotrienes.

Mitochondrial electron transport: Entry of reducing equivalents for oxidation; malate-aspartate shuttle, glycerol phosphate shuttle. Organization of respiratory chain complexes, structure and function of the components; Fe-S proteins, cytochromes, Q cycle, proton transfer, P/O ratio, oxidative phosphorylation, uncouplers and inhibitors, sequence of electron carriers based on redox potentials. ATP synthesis, ATP synthase complex, binding change mechanism, proton motive force, Mitchell's hypothesis.

Amino acid Metabolism-General reactions of amino acid metabolism, degradative and biosynthetic pathways of amino acids, urea cycle, amino acids as metabolic precursors. Synthesis and degradation of purine and pyrimidine nucleotides. Disorders of carbohydrates, lipids, amino acids and nucleic acid metabolism. Inborn errors of metabolism.

Enzymology- Types, properties, cofactors, mechanism of action and specificity, enzyme kinetics, various kinds of inhibition, regulation.

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Question Paper Pattern for PhD Entrance Test-2026

The question paper consists of 100 Multiple Choice Questions (MCQs).

Each question should have four options viz., A, B, C, D options.

Each question carries 1 (One) mark.

First 30 questions (Question 1 to 30) should cover Research Methadology.

Next 70 questions (Question 31 to 100) from cognitive subject I,e, Biochemistry