SYLLABUS FOR PHD ENTRANCE – BIOCHEMISTRY

I. History and Evolution of Biochemistry

- 1. Historical milestones in the development of biochemistry.
- 2. Discovery of enzymes , vitamins, hormones, nucleic acids
- 3. Birth of molecular biology and its integration into biochemistry
- 4. Key experiments that shaped biochemical understanding (e.g. urea synthesis), central dogma, Meselson- Stahl Experiment)
- 5. Development of clinical biochemistry as a discipline
- 6. Nobel Prize contribution in biochemistry

II. Biomolecules and Structural Biochemistry

- 1. Structure and function properties of carbohydrates, lipids, proteins, and nucleic acids.
- 2. Primary , secondary , tertiary and quaternary structure of proteins
- 3. Physical and chemical properties of biomolecules
- 4. Role of water ,pH, buffers and electrolytes in biological systems
- 5. Biological oxidation and reduction reactions
- 6. Thermodynamics and bioenergetics in biological system
- 7. Properties of biological membranes and membranes transport mechanism

III. Enzymology

- 1. Classification and nomenclature of enzymes
- 2. Mechanism of enzyme action and active site structure
- 3. Enzyme kinetics including Michaelis-Menten and Lineweaver Burk analysis
- 4. Regulation of enzyme active: allosteric regulation , feedback inhibition
- 5. Enzyme inhibition: competitive , non-competitive , uncompetitive
- 6. Isoenzymes and their clinical significance
- 7. Enzyme assays and enzyme immobilization

IV. Metabolism and Bioenergetics

1. Metabolism of carbohydrates, lipids, amino acid, and nucleotides

- 2. Integration and regulation of metabolic pathways in different nutritional states.
- 3. Metabolism of phosphorylation, purines, pyrimidines, and heme.
- 4. Hormonal regulation of metabolism
- 5. Oxidative phosphorylation and mitochondrial function
- 6. Intermediary metabolism and energy balance
- 7. Metabolism adaptations in physiological and conditions

V. Molecular Biology and Genetic Biochemistry

- 1. Structure and function of deoxyribonucleic acid and ribonucleic acid
- 2. DNA replication , repair mechanisms , and recombination
- 3. Transcription and post-transcription modification
- 4. Genetic code and protein synthesis including post-translation modifications
- 5. Gene expression and regulation in prokaryotes and eukaryotes
- 6. Techniques in molecular biology such as polymerase chain reaction , blotting techniques , and DNA sequencing
- 7. Chromatin structure and epigenetic mechanisms
- 8. Gene silencing , gene editing using clustered regularly interspaced short palindromic repeats and associated proteins
- 9. Functional genomics and transcriptomics

VI. Nutritional and Hormonal Biochemistry

- 1. Macronutrients and micronutrients: structure, function and dietary sources
- 2. Nutritional assessment: anthropometry, biochemical markers, and dietary surveys.
- 3. Role of vitamins and minerals in metabolism and their deficiencies
- 4. Endocrine glands and classification of of hormones
- 5. Mechanism of hormone action via receptor-mediated pathways
- 6. Signal transduction pathways including cyclic adenosine monophosphate , inositol triphosphate , tyrosine , kinase pathways
- 7. Hormonal regulation of metabolism and physiological functions

VII. Clinical and Diagnostic Biochemistry

- 1. Biochemical basic and interpretation of organ function tests (liver, kidney, endocrine glands
- 2. Analysis and interpretation of blood, urine, cerebrospinal fluid , and other body fluids
- 3. Acid –base balance and its disorders
- 4. Biochemical markers in health and disease
- 5. Clinical enzymology and hormonal assays
- 6. Quality assurance , quality control , and standardization in clinical biochemistry laboratories
- 7. Laboratory accreditation standards and good laboratory practices

VIII. Analytical Techniques on Biochemistry

- 1. Spectrophotometry, colorimetry, and fluorimetry
- Chromatography : thin-layer chromatography , chromatography , gas chromatography, high-performance liquid chromatography , ion-exchange chromatography
- 3. Electrophoresis: paper , gel, capillary electrophoresis
- 4. Mass spectrometry : matrix-assisted laser desorption ionization-time flight, electrospray ionization
- 5. Nuclear magnetic resonance spectroscope and magnetic resonance imaging-based biochemical analysis
- 6. Flow cytometry and cell sorting
- 7. Western blotting, Northern blotting, Southern bolting
- 8. Enzyme-linked immunosorbent assay and radioimmunoassay
- 9. Isotope techniques and autoradiography
- 10. Microarray technology and single nucleotide polymorphism genotyping
- 11. Surface Plasmon resonance and isothermal titration calorimetry
- 12. Biosensors and lab-on-chip diagnostic devices
- 13.Application of artificial intelligence and machine learning in biochemical diagnostics

IX. Bioinformatics and Computational Biochemistry

- 1. Introduction to biological databases
- 2. Sequence alignment and analysis
- 3. Structure predication and molecular docking
- 4. Molecular dynamics simulations
- 5. System biology and network analysis
- 6. Big data analytics in biochemistry
- 7. Use of computational tools for research , publication, and data visualization

X. Modern and Emerging Areas in Biochemistry

- 1. Omics sciences: genomics, transcriptomics, proteomics, metabolism, lipidomic
- 2. Precision medicine and personalized nutrition
- 3. Stem cell biochemistry and regenerative medicine
- 4. Nanotechnology in biotechnical applications
- 5. Metabolism fingerprint and real-time diagnostics
- 6. Synthetic biology and biotechnical innovations
- 7. Application of artificial intelligence in laboratory automation
- 8. Integration of biochemistry with digital health and wearable technologies
