



**BHARATH INSTITUTE OF HIGHER EDUCATION  
AND RESEARCH**

# **PROGRAMME MD BIOCHEMISTRY**

**(Revised with effect from 2019-2020 onwards)**

**PAPER I – GENERAL BIOCHEMISTRY AND TECHNIQUES (Course Code: U15MDBC01)**

**Introductory Biochemistry and Molecular Biochemistry- cell, transport mechanisms, central dogma, gene expression, mutation, molecular techniques**

CO1: Describe the structure and functions of cell at molecular level

CO2: Describe central dogma

CO3: Describe regulation of gene expression, mutation and molecular techniques

**1. Methods of qualitative analysis of biomolecules :**

Principle , experimental procedure and applications of chromatography: Paper, thin layer, ion exchange, affinity, gel filtration, gas- liquid and HPLC. Principle, procedures and application of Electro phoresis: Paper, polyacrylamide gel, agarose gel, and cellulose acetate Ultracentrifugation, Ultrafiltration.

**2. Quantitative methods:**

Principle and applications of Photometry, spectrophotometry, Fluorometry, ion selective procedures and flame photometry.

3. Principles of Biophysical methods used for analysis of biopolymer structure X-ray diffraction, fluorescence, UV, ORD/CD, visible, NMR and ESR spectroscopy, Hydrodynamic methods, Atomic absorption and plasma emission spectroscopy.

4. Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, cytophotometry and flow cytometry, fixation and staining.

**5. Isotopes :**

Detection and measurement of radioactive isotopes. Principles and application of tracer techniques in biology; Radiation desitometry. Application of isotopes in research and clinical biochemistry. Effect of radiation on biological system; Autoradiography, Cerenkov radiation, Liquid Scintillation spectrometry.

6. Concept of pH and buffers. Henderson – Hasselbalch equation and its clinical application.

Principle and procedures of determination of pH. Physiological buffers.

7. Diffusion, Osmosis, Osmotic Pressure, Surface tension, Adsorption, Hydrotrophy, viscosity, Colloids. Surface tension and surfactants

8. Amino acids and proteins. Structure and properties of Amino acids, Protein structure and conformation, determination of amino acid Sequence of proteins, chemistry of conjugated proteins, nucleoproteins, lipoproteins, Immunoglobulins, glycoproteins. Structure, functional relationship of proteins: hemoglobin, myoglobin and collagen. Protein - protein interaction. Prions, beta amyloid.

9. Chemistry of carbohydrate:

Monosaccharides, Disaccharides, Homopolysaccharides,

Heteropolysaccharides, Enantiomer, Diastereomer, Mutarotation, Anomer, Epimers.

10. Chemistry of lipids: Classification, Fatty acids, PUFA, Compound lipids, Cholesterol. Triglycerides, Phospholipids, Gangliosides

11. Nucleic acid: Chemistry and structure of bases, Nucleosides, Nucleotides, RNA and DNA .DNA sequence determination. Properties of Nucleic acid. Nucleic acid metabolism and its clinical correlation

12. Bioenergetics and biological oxidation: concept of free energy change, High energy compounds, ATP generation, redox potential, electron transport chain, oxidative phosphorylation, inhibitors, uncouplers, ionophores.

13. Cell fractionation, biochemical activities of different fractions marker enzymes.

14. Enzymes: Classification, nomenclature, enzyme specificity, enzyme kinetics, coenzymes, cofactors, factors regulating enzyme activity, isozymes, proenzymes, multienzyme complexes, tandem enzymes, covalent modification, Active site of enzymes, methods of locating the amino acids residues in the active site of enzymes. Mechanism of enzyme action.

Enzyme inhibition: competitive, non-competitive, Allosteric and suicidal inhibition.

15. Purification of enzymes from cells, characterization and criterion of purity. Purification of proteins.

16. Membranes: Chemical composition, structure, biological properties, functions, membrane transport systems, ion-channels, endocytosis, exocytosis, defects.

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## **PAPER II INTERMEDIARY METABOLISM (Course Code: U15MDBC02)**

**U15MDBC02 Biochemistry of body metabolism--metabolism of carbohydrates, aminoacids, lipids, Hb, nucleic acids and their related inborn errors**

CO1: Describe the metabolism of carbohydrates and lipids

CO2: Describe the metabolism of protein and Hb

CO3: Describe the metabolism of nucleic acids

CO4: Describe the various inborn errors of metabolism

**1. Methods of investigation of metabolic pathways, primary, secondary and tertiary metabolisms.**

2. Carbohydrate metabolism: Carbohydrate digestion and absorption. Details of metabolic pathways involving carbohydrates in mammals. Embden-Meyerhof pathway, hexosemonophosphate shunt, gluconeogenesis other minor pathways, fructose and Galactose metabolisms. Inborn errors of metabolism. Blood glucose homeostasis, Hormones influencing carbohydrate utilization -insulin, glucagons, glucocorticoids, epinephrine, and glucose tolerance test, Diabetes Mellitus. Carbohydrate metabolism and brain

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3. Amino acid metabolisms: Protein digestion and absorption of amino acid metabolism of individual amino acids, one carbon units, polyamines, nitric oxide, plasma proteins, transport

proteins. Inborn errors of metabolism. Types of aminoaciduria and its clinical manifestations.

4. Lipid metabolism: Digestion and absorption, transport and storage, fatty acid synthesis, fatty acid oxidation pathways. Biosynthesis of phospholipids glycolipids. Cholesterol metabolism plasma lipoprotein metabolism. Role of adipose tissue and liver in lipid metabolism. Hormonal regulation of lipid metabolism. Prostaglandins, prostacyclins, leukotriens, thromboxanes and very long chain fatty acids. Inborn errors.

5. Regulation of metabolism: TCA Cycle, integration of metabolisms, common terminal pathway, regulation, amphibolic role. Hormonal regulations of metabolic pathways, Cori's cycle, Alanine cycle, adaptation during starvation. Electron transport chain(ETC) and its clinical and pathological correlation.

6. Purine and Pyrimidine metabolisms: Synthesis and degradation of bases and nucleotides, regulation, gout, Lesch- Nyhan syndrome.

7. Antibiotics and other chemotherapeutic agents-Inhibition of cell-wall synthesis, nucleic acid and protein synthesis, specific enzyme system, Damage to cytoplasmic membrane. Antifungal antibiotics, Anitviral chemotherapeutic agents, Mechanism of action of anticancer drugs. Drug resistance, Assay of antibiotics. Susceptibility to chemotherapeutic agents.

8. Host-microbeinteraction: The process of infection, toxins, Diphtheria toxin, Botulinum toxin, tetanus toxin, Cholera toxin, SLO and SLS, virulence factors.

9. Pituitary and Hypothalamic hormones, Thyroid hormones. Hormones that regulate calcium metabolism, Hormones of adrenal cortex, adrenal medulla, gonads, pancreas and GI.

10. Toxicity studies, Drug assays.

11. Structure & function, Neurochemical basis, Synthesis, storage, release & metabolism of neurotransmitters, Adrenergic and cholinergic systems, pharmacological manipulation of the ANS.

Neurotransmitter: Types, location, function & role in disorders of the CNS, receptors & Nomenclature, Major diseases of the CNS-Epilepsy, Parkinsonism, Alzheimer's Disease, stroke

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and their pharmacotherapy, GABA-sedative & hypnotics, Biological basis of anaesthesia, Pain & analgesia- role of opioids, Biological basis of Psychiatric disorders, CNS depressants-alcohol.

CNS stimulants including drug dependence.

12. Biochemistry of muscle contraction.

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**PAPER III MOLECULAR BIOLOGY AND IMMUNOLOGY (Course Code: U15MDBC03)**

**U19MDBC03 Biochemistry of tissues- biochemistry of vitamins, enzymes, minerals, hormones, nutrition, TCA cycle, ETC**

CO1: Describe the biochemistry of vitamins and minerals

CO2: Describe the biochemistry of enzymes and hormones

CO3: Describe the biochemical basis of nutritional deficiency disorders

CO4: Describe energy metabolism- steps and regulatory mechanisms of TCA cycle and ETC

1. DNA: Replication, DNA damage and repair processes, mutations, amplification of genes, somatic recombination, Telomeres, inhibitors of replication.

2. Fine structure of gene, Eukaryotic genomic organization (structure of chromatin, coding and non coding sequences, satellite DNA)

3. Transcription: Details of transcription. Transcriptional control of gene expression, Operon concept, promoters, enhancers, silencers, hormone responsive elements, transcription factors, post-transcriptional modifications of RNA, exons, introns, splicing, Ribozymes, inhibitors of transcription.

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4. Translation: Genetic code, tRNA, ribosomes, protein biosynthesis, post translational

modifications, inhibitors of translation, signal sequences, chaperones and heat shock proteins, anticancer drugs.

5. Lysogeny and lytic cycle of bacteriophages, Bacterial transformation, Host cell restriction, Transduction, complementation. Molecular recombination, DNA ligases, Topoisomerases, Gyrases, Methylases, Nucleases, Restriction endonucleases, plasmids and bacteriophages based vectors for cDNA and genomic libraries.

#### **6. Principles and methods of genetic engineering and gene targeting, Application in health.**

7. **Recombinant DNA technique.** Cloning procedures, vectors, plasmids, phages, Cosmids, Restriction map, PCR technique. Southern, Northern, Western blotting procedures. Restriction fragment polymorphism. In-situ hybridization. Genomic library and cDNA library, Mutations, mutagens, carcinogens, in-vitro mutagenesis. Transgenic animals and micro injection technique. Genetherapy. Protein degradation. Cathepsins, proteosomes, Caspases, Apoptosis.

8. **Biochemistry and molecular biology of cancer,** oncogenes, Chemical carcinogenesis, Genetic and metabolic disorders, Hormonal imbalances, Drug metabolism and detoxification. Genetic load and genetic counseling.

9. Basic concepts of immunology: Chemistry of immunoglobulins, primary and secondary immune responses, auto immune responses, auto immune phenomenon, Anaphylaxis, clonal selection, B cells, T cells, helper T cells, NK cells, macrophages, Interleukins, cytokines, HLA antigens, monoclonal antibodies, Hybridoma technology, Immunodiffusion, Immuno electrophoresis, radio immuno assay (RIA), enzyme linked immunosorbent assay (ELISA), Fluorescent in situ hybridization (FISH) techniques.

10. Humoral and cell mediated immunity, MHC Mechanism of immune response and generation of immunological diversity, Genetic Control immune response. Effector mechanism.

11. Hypersensitivity reactions, Delayed type hypersensitivity: T-cell mediated immunity Autoimmunity, Transfusion immunology, Transplantation immunology.

12. Allergy & inflammation: Histamine, 5HT, Prostaglandins, PAF, Bradykinin, Adenosine- role in allergy & inflammation, pharmacological manipulation, Non-steroidal anti-inflammatory drugs, Pathogenesis of asthma & principles of therapy.

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**PAPER IV–CLINICAL BIOCHEMISTRY AND NUTRITION(Course Code: U15MDBC04)**

**U15MDBC04 Practical and recent advances in Biochemistry-routine blood chemistry, LFT,RFT, PFT, analysis of body fluids, special tests-ELISA, Chemiluminence techniques, immunoflurimetry, biosensors, biochemistry and immunolgy of cancer, AIDS, organ transplantation, Gene therapy Biostatistics and biomedical intrumentation, cytogenetics,**

CO1: Perform routine biochemical investigations like LFT, RFT, TFT

CO2: Perform specialised biochemical investigations like ELISA,Chemiluminence techniques,immunoflurimetry,biosensors

CO3: Describe the biochemistry and immunology of cancer,AIDS and organ transplantation

CO4: Describe Gene therapy and cytogenetics

CO5: Apply biostatistical tools in medical research

1. Vitamins: Fat soluble and water soluble vitamins, chemistry, absorption, metabolism, biochemical roles, requirement, deficiency manifestations.

2. Mineral metabolism: Macrominerals, sodium, potassium chloride, magnesium, calcium, phosphorus.

Trace elements: iron, copper, manganese, zinc, cobalt, molybdenum, selenium, iodine and fluoride.

3. Nutritional requirements: Energy requirements, balanced diet, nutritional disorders, obesity, starvation, PUFA, dietary fibres, Cholesterol.
4. Protein requirements: Nitrogen balance, nutritive value, biological value, chemical score, protein energy malnutrition, Kwashiorkor and Marasmus.
5. Endocrinology: Mechanism of action of hormones, hormone receptors, signal transduction, G-proteins, second messengers, cyclic AMP, cyclic GMP, calcium, inositol triphosphate, diacyl glycerol, nitric oxide, Biosynthesis of adrenal and thyroid hormones, metabolic regulation by hormones, hormonal regulation of gene expression , hormonal disorders, biochemical investigation of endocrine disorders, thyroid and adrenal function tests.
6. Erythrocytes: Chemical make up, metabolic pathways, haemoglobin, hemoglobinopathies, porphyrias, heme synthesis and degradation, bilirubin - metabolism, jaundice, laboratory findings in jaundices. Composition of blood plasma in health and diseases, normal values.
7. Acid base balance , water balance and electrolyte balance, related disorders.
8. **Clinical Pharmacokinetics, Clinical Trials, Adverse drug reactions including interactions, pharmacoepidemiology, pharmacogenetics.**
9. Pathogenesis of hypertension, angina pectoris, myocardial infarction, congestive cardiac failure, cardiac arrhythmias, shock and hyperlipidaemias, Principles of their pharmacotherapy, Diuretics.
10. Principles of use of anticoagulants, antiplatelet drugs, fibrinolytic agents and drugs for treatment of anaemia.
11. Biochemical investigation of liver, kidney and gastric functions, Malabsorption disorders, inherited metabolic disorders.
12. Cell biology: Cell cycle, check points, regulation, Oncogenes, tumour suppressor genes, tumour markers.

13. Reactive oxygen species and defence mechanisms, antioxidants, and enzyme systems.
14. Diagnostic enzymology: LDH, CPK, AST, ALT, ALP, ACP, GGT, Amylase, 5' nucleotidase, etc.
15. Acute phase proteins: Alpha-1, anti-trypsin, Alpha-2, macroglobulin, Haptoglobin, Ceruloplasmin etc.
16. Tumor markers
17. AIDS; HIV, genes and gene products, diagnosis, precautions. Alzheimer's disease, Prions, beta amyloid.
18. Laboratory management: Precision, accuracy, specificity, sensitivity, percentage error, quality control, precautions in handling hazardous materials pre-analytical variations.

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### **SOFT SKILLS (Course Code:U15MDBC05)**

- 1: Proficiency in research methodology.
- 2: Ability to handle classes.
- 3: Competency in departmental administration
- 4: Ability to present topic in a proper manner in venues such as seminars and CMEs.
- 5: Competency to manage a lab independently
- 6: Organisational skills - such as for CME programmes.

### **Practical syllabus**

### **MD BIOCHEMISTRY)**

### **PAPER I – Biomedical Techniques, Biomolecules and Statistics**

### **GENERAL**

Preparation of reagents  
Standardization of methods  
Preparation of buffers  
General care and maintenance of equipment and glassware  
Precautions and handling laboratory hazards  
Familiarity with equipment: microbalance, pH meter, spectrophotometer, fluorimeter, centrifuges, incubators, freezers, fraction collectors, electrophoresis, homogenizer etc.  
Paper chromatography of amino acids.  
Thin layer chromatography of amino acids.  
Thin layer chromatography of carbohydrates.  
Ion exchange chromatography  
Gel filtration chromatography (Sephadex) of proteins, molecular weight determination.  
Affinity chromatography, Blue Sepharose and albumin.  
Demonstration of HPLC  
Paper electrophoresis, Agarose gel  
Electrophoresis of serum proteins  
Polyacrylamide gel electrophoresis, molecular weight determination.  
Amylase, effect of substrate, pH and chloride.  
Trypsin or chymotrypsin, caseinolytic method, effect of pH, effect of temperature, and  $K_m$  value.  
Study of proteinase inhibitor.  
Enzyme purification: Amylase or Urease.  
Assay of enzyme,  $K_m$  value  
Cell fractionation  
Estimation of amino acid, Ninhydrin (colorimetric) method.  
Protein estimation by Lowry's method.  
Estimation of proteins by Folin's method  
Estimation of protein by dye binding method.  
Estimation of nitrogen content of protein by Kjeldahl method.  
Titration of amino acid, formol titration and pK values.  
Absorption spectra of Phenylalanine, Tyrosine and Tryptophan.

Absorption spectra of Purines and pyrimidines.

Estimation of total sugars, by Phenol- sulfuric acid method.

Estimation of reducing sugars – Arsenomolybdate method.

Estimation of ketohexoses (fructose) – Resorcinol method.

Estimation of Aldohexoses (glucose) – Iodometric method.

Periodate oxidation of sugars.

Estimation of amino sugars.

Graphical representation of data, correlation and regression analysis, students “t” test, “chi-square’ test, analysis of variance.

### **PAPER II - INTERMEDIARY METABOLISM**

Estimation of glucose by Glucose oxidase method.

Estimation of glucose by ortho toluidine method.

Estimation of glucose by Nelson-Somogyi method.

Glucose tolerance test

Blood urea estimation

Blood creatinine estimation

Serum creatinine.

Cholesterol and HDL cholesterol, Abell’s and Ferric chloride methods.

Flame photometry, Sodium and Potassium.

Lipid profile

Plasma chloride, bicarbonate, pH and pCO<sub>2</sub>.

CSF analysis, protein, sugar and chloride.

TC, DC, ESR, Hb, BT, CT, Prothrombin time

Inborn errors of metabolism, urine screening

### **PAPER III – Molecular Biology, Applied Genetics, and Immunology**

Isolation of DNA from animal tissue, check its purity by 260/280 nm absorption.

Isolation of plasmid / bacteriophage DNA.  
Restriction digestion and agarose gel electrophoresis.  
Southern blotting.  
Isolation of mitochondria from animal tissue.  
Isolation of RNA  
Estimation of succinate dehydrogenate activity.  
Study of mitosis, karyotyping  
Ame's test  
Immunodiffusion  
Radial immunodiffusion.  
Hemagglutination  
Latex agglutination  
Widal test  
Complement fixation test  
Immunoelectrophoresis.  
ELISA: Tumor markers, T3, T4, TSH.  
Radio immuno assay  
Lymphocyte culture  
Purification of IgG from human sere.  
Raise anti IgG and purify it.  
Conjugation with ALP or HRP.  
FITC conjugation of antibody  
Western blotting.  
Blood grouping and cross matching  
C reactive protein, haptoglobins, ceruloplasmin  
Diagnosis of HIV

#### **PAPER IV - CLNICAL BIOCHEMISTRY AND NUTRITION**

Specimen collection, handling and storage.

Estimation of Albumin, total proteins and Albumin globulin ratio in serum. Biuret and dye binding method.

Serum calcium estimation.

Serum bilirubin estimation.

Serum Alkaline phosphatase.

Serum Acid phosphatase.

SGOT (AST).

SGPT (ALT).

Total LDL and iso-enzymes.

Serum amylase, Somogyi method.

Serum iron and iron binding capacity.

Electrophoresis, Lipoproteins and serum proteins

Electrophoresis, normal and abnormal hemoglobins.

Glycated hemoglobin, by affinity chromatography.

Serum triglycerides, enzymatic.

Creatinine clearance.

Urea clearance.

Protein estimation in urine and microproteinuria.

Serum GGT.

Serum lipase.

Serum inorganic phosphorus.

Estimation of Vitamin C, titration, and colorimetric method.

Estimation of iron, transferring

Estimation of T3, T4, TSH, thyroglobulin

Estimation of cortisol, VMA

Physical and chemical analysis of urine, pH, specific gravity, reducing substances, protein, ketone bodies, blood, bile salts, bile pigments

Urinary aminogram

Urine urea, creatine, creatinine, uric acid, calcium, phosphorus

Autoanalyser (demonstration).

Quality control, internal and external, analysis of variance

