

CURRICULUM
M.B.B.S

BIOCHEMISTRY

Programme Goal

The broad goal of the teaching of undergraduate students in biochemistry is to make them understand the scientific basis of the life processes at the molecular level and to orient them towards the application of the knowledge acquired solving clinical problems.

Objectives

(A) Knowledge

At the end of the course the student shall be able to demonstrate his knowledge and understanding on the

- (a) Molecular and functional organization of a cell and sub-cellular components.
- (b) Structure, function and interrelationship of biomolecules and consequences of deviation from normal.
- (c) Summarize the basic and clinical aspects of enzymology and regulation of enzymatic activity.
- (d) Understand and describe of diagnostic importance of digestion and assimilation of nutrients and consequences of malnutrition.
- (e) Integration of the various aspects of metabolism and their regulatory pathways.
- (f) Biochemical basis of inborn errors of metabolism and their associated sequelae.
- (g) Mechanisms involved in maintenance of body fluids and pH homeostasis.
- (h) Molecular mechanisms of gene expression and regulation, principles of genetic engineering and their application in medicine.
- (i) Molecular aspects of body defence and their application in medicine.
- (j) Biochemical basis of cancer and carcinogenesis, principles of metabolism and detoxification of xenobiotics.
- (k) Principles of various conventional and specialized laboratory investigations and instrumentation, analysis and interpretation of a given data; the ability to suggest experiments to support theoretical concepts and clinical diagnosis.

(B) Skills :

At the end of the course the student shall be able to:

(a) Make use of conventional techniques/instruments to perform biochemical analysis relevant to clinical screenings and diagnosis.

a. Analyze and interpret investigative data.

b. Demonstrate the skills of solving clinical problems and decision making.

(C) Integration

The knowledge acquired in biochemistry should help the students to integrate molecular events with structure and function of the human body in health and disease.

Specific learning objectives

1. While emphasizing the basic concepts, every effort should be made to correlate the clinical/ applied aspects .
2. Tutorial/small group teaching should be undertaken at the end of related group of topics to encourage students to question clear doubts etc.
3. Horizontal integration may be followed in the areas of endocrines, acid base, specialized tissues in close co-operation with department of anatomy and physiology.
4. To. make the subject more interesting and applied demonstration of clinical cases/case discussion with clinical colleagues- vertical integration.
5. Student seminars/ projects by students(review) should be encouraged as means of self learning, use of library etc.
6. Use of molecular models, video films, Cat to strengthen and illustrate basic concepts.

Course content

PAPER-I

Time(3 hrs)

1 .Chemistry, biomedical importance of biomolecules `

- (a) Carbohydrates (monosaccharides, + their derivatives-amino sugar, uronic acids, glycosides, disaccharides, polysaccharides,,starch, glycogen, cellulose, glycosaminoglycans, sialic acids etc.)
- (b) Lipids(fatty acids, triacylglycerol, phospholipids, glycolipids, sulfolipids, steroids)
- (c) Amino acids, biologically active peptides.
- (d) Proteins-three dimensional structure/conformation- four levels of architecture structure in relation to biological functions with specific examples viz Hb, collagen etc in health and disease.

(e) Separation of proteins

Clinical correlation:

- (a) Mucopolysaccharidoses
- (b) Lipid storage diseases
- (c) Sickle cell anemia

2.Enzymes-

1. Introduction, classification,
2. Coenzymes, isoenzymes,
3. Properties- kinetics, enzyme assay
4. Mechanism of enzyme action
5. Inhibition or enzyme activity
6. Regulation of enzyme activity.

Clinical correlations:

1. Drugs as enzyme inhibitors in antibacterial antiviral & antitumor therapy.
2. Diagnostic significance of isoenzymes e.g. LDH, CPK

3. **Metabolism- overview**

a. Metabolism of carbohydrates

Digestion- absorption, glycolysis TCA cycle – regulation, Glycogen metabolism and its regulation, Cori cycle,. Gluconeogenesis and control of blood glucose, metabolism of fructose, galactose, metabolism of ethanol. Significance of pentose phosphate pathway & uronic acid pathway.

Clinical correlation:

- a) Glycogen storage diseases
- b) Essential fructosuria, galactosemia
- c) Lactic acidosis
- d) G6PD deficiency
- e) Alcoholism – Methanol poisoning

b. **Metabolism of Lipids**

Digestion, absorption – role of bile salts. Storage and mobilisation of fats, biosynthesis and oxidation of fatty acids, ketone bodies- formation, utilisation. Regulation of ketogenesis- ketosis. Metabolism of unsaturated fatty acids and eicosanoids- prostaglandins, leukotrienes. Lipids transport -structure. metabolism and functions of different classes of lipoproteins. Role of liver. Separation of lipoprotein classes. Cholesterol, synthesis, transport and excretion. Bile acids formation. Role of cholesterol in the development of atherosclerosis -relationship of hypercholesterolemia- and dietary fat intake.

Clinical correlation:

1. Obesity
2. ketoacidosis
3. fatty liver
4. Hyperlipidemias
5. Atherosclerosis

c. **Biological oxidations**

Role of oxido-reductases

Cytochrome P450 system

Free radicals formation, scavenging oxygen free radicals. Antioxidants. Role in diseases.

Respiratory chain and oxidative phosphorylation, components of respiratory chain control, site specific inhibitors, uncouplers.

High energy phosphate compounds

Clinical correlations:

1. Cyanide poisoning
2. Hypoxic injury

d. Metabolism of amino acids

Digestion and absorption, pathways of amino acid degradation, transamination oxidative deamination. Metabolism of ammonia-urea cycle. Catabolism of C skeletons. Synthesis of biologically important compounds from amino acids.

Clinical correlations:

1. Inborn errors of metabolism associated with various amino-acids viz PKU, Hartnup disease, Maple syrup, urine disease etc.

e. Integration and hormonal regulation of mammalian metabolism. Inter conversion of major foodstuffs, tissue specific metabolism- liver, muscle, erythrocytes, heart, adipose tissue, brain etc.

Clinical correlations:

1. Starvation
2. Uncontrolled diabetes mellitus
3. Metabolic response to stress, injury
4. Haemolysis, erythrocyte membrane stability.

f. Endocrine biochemistry

1. General mechanisms of hormone action assay
2. Hormones of pituitary, releasing factors
3. Thyroid and parathyroids
4. Hormones of adrenal cortex
5. Adrenal medullary hormones

6. Sex hormones- biochemistry of contraception
7. Hormones of pancreas and GI tract.

g. Nutrition

Biochemical role, sources, deficiency, requirement of vitamins Role of carbohydrates- fiber in the diet. Fats- unsaturated fatty acids, Proteins , Biological value, SDA.

Minerals- Ca, P, Mg, Na, K, Cl

Trace elements- Fe ,Cu ,Se, I etc.

Clinical correlations:

1. Deficiency states of vitamins.
2. Protein- energy malnutrition
3. malabsorption syndromes
4. Iron deficiency anemia
5. Wilson's disease
6. Tetany
7. PUFA and risk factors for IHD
8. Cholera/ gastroenteritis

1. Haem Metabolism:-

Formation and catabolism of haem, bile pigments. Tests for liver function

Clinical correlations:

1. Porphyrrias
2. Jaundice

i. Metabolism of Xenobiotics

Cytochrome P450 system

Conjugation and other reactions- glucuronidation.

PAPER-II

Time(3 hrs)

Molecular biology

- a. Molecular logic of life- chemical unity underlies biological diversity.
- b. Molecular cell biology- chemical composition, current concepts of the structure of eukaryotic cell membrane, Membrane assembly- features, targeting proteins to their destinations by signal sequences- signal hypothesis, molecular chaperones, specialized functions- transfer of material and information across membranes-Diffusion, active transport, Endocytosis, exocytosis channels, pores cell surface receptors- signal transduction, signal internalization. Intercellular contact and communication, Micelles, Liposomes.

Clinical correlations:

1. Familial hypercholesterolemia
 2. Achondroplasia
 3. Metastasis
- c. **Extracellular matrix**- structural proteins, specialized proteins, glycosaminoglycans. Molecular biology of bone and cartilage cell adhesion and migration- fibronectin, renal glomerular membrane- basal lamina- laminin

Clinical correlations:

- a. Osteoporosis
 - b. Chondrodysplasia
 - c. Osteogenesis imperfecta
 - d. Marfan syndrome
- d. **Glycoproteins**- functions, structure, three major classes- O linked, N linked, GPI linked. Mucins, Glucosylation of glycoproteins- factors affecting molecules involved in leukocyte endothelial cell interactions.

Clinical correlations:

1. Influenza
2. Rheumatoid arthritis
3. α - mannosidosis

e.- Chemistry and metabolism of purines and pyrimidines.

Nucleosides and nucleotides. Analogues of purines and pyrimidines- application in medicine.

Clinical correlations:

- i- Gout
- ii- Orolic aciduria
- iii- Xanthinurias

f. Molecular basis of heredity, eukaryotic chromosomes-

DNA, histones, nucleosomes, nonhistone proteins. Chemistry, Structure of nucleic acids DNA organization and replication. Molecular basis of mutation- DNA repair Gene rearrangements.

Mammalian cell cycle- cyclins. RNA synthesis, processing and metabolism, post transcriptional modification, reverse transcription protein synthesis- post translational modification. Inhibitors of protein synthesis.

Protein targeting, regulation of gene expression in eukaryotes-tissue specific expression, molecular machines that control genes, Human Genome Project

Clinical correlations:

- a) Xeroderma pigmentosum
- b) Thalassemias
- c) Antibiotics and toxins targeting RNA polymerase
- d) Staphylococcal resistance to erythromycin

g. Recombinant DNA and medical biotechnology-

Isolation and manipulation of DNA chimeric DNA sequencing. Phage and cosmid vectors, Recombinant DNA and cloning Genomic, cDNA libraries, Gene Probes, Blotting & hybridization, selection of specific cloned DNA in libraries. Detection of recombinant DNA, PCR application in medicine.

h. Molecular basis of inherited diseases-

molecular analysis of inborn errors of metabolism with examples from different metabolic pathways biochemical diagnosis neonatal screening, prenatal

diagnosis. DNA analysis, RFLP, detection of mutation DNA cloning- PCR probes, southern blotting cues to the diagnosis of and inborn error. Major laboratory tests used in the diagnosis of genetic diseases: Gene therapy.

i Molecular mechanisms in specialized tissues

1. Molecular basis of muscle, contraction - molecular motors, molecular basis of neuronal transmission, nervous tissue, molecular mechanisms of vision, neuropeptides- endorphins and enkephalins.

Clinical correlations:

1. Myasthenia gravis
2. Parkinsonism
3. Night blindness
4. Cataract

2. Molecular mechanisms of cell deaths and aging.

j. Molecular basis of immunology

1. Overview of immune system- basic concepts
2. Antigens- epitopes, haptens viral, bacterial mitogens.
3. Immunodermical techniques
4. Immune response, T-cell mediated immunity, Humoral immune response
5. Antigen antibody reactions
6. Antigen processing and presentation, complement , cytokines
7. Hybridomas, monoclonal antibodies
8. Immune system in health and disease- immunodeficiency, hypersensitivity, autoimmunity.
9. Immunoprophylaxis
10. Major histocompatibility complex- transplantation of organs immunosuppressants.
11. Mononuclear phagocytes- macrophages.

k. Molecular biology of cancer

Biochemical characteristics of cancer

Morphological & biochemical changes occurring upon malignant transformation

Carcinogenesis- carcinogens physical chemical and biologic

Oncogenes, polypeptide growth factors

Molecular basis of metastasis molecular alterations occurring at the surface of malignant cells, cell adhesions inter cell communications. Tumor markers- biochemical basis of drugs used in cancer chemotherapy.

l. Molecular basis of differentiation

m. Clinical chemistry

Acid- base homeostasis- buffers in blood- Hb, plasma buffers.

Role of lungs, kidneys

Plasma proteins- functions, separation alterations in disease

Environmental biochemistry

Biochemical basis of human diseases and laboratory approach

Evaluation

Theory- Two papers of 50 marks each
(one applied question of 10 marks in each paper) 100 marks

Oral (viva) 20 marks

Practical 40 marks

Internal assessment 40 marks

(Theory-20; practical-20)

Total 200 marks

Pass: in each of the subjects, a candidate must obtain 50% aggregate with a minimum of 50% theory including oral and minimum of 50% in practicals.