BIOCHEMISTRY

(INCLUDING MEDICAL PHYSICS AND MOLECULAR BIOLOGY)

I) GOAL

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

II) OBJECTIVES

(A) Knowledge: At the end of the course, the student shall be able to;

(a) Describe the molecular and functional organization of a cell and lists its sub cellular components.

(b) Delineate structure, function and inter-relationship of bimolecular and consequences of deviation from normal.

(c) Summarize the basic and clinical aspects of Enzymology with emphasis on diagnostic enzymes.

(d) Describe digestion & assimilation of nutrients and consequences of malnutrition

(e) Integrate the various aspects of metabolism and their regulatory pathways

(f) Explain the biochemical basis of inherited disorders with their associated consequence

(g) Describe mechanisms involved in maintenance of body fluid, and pH homeostasis

(h) Outline the molecular mechanisms of gene expression and regulations, the principles of genetic engineering and their application in medicine.

(i) Summarize the molecular concept of defenses and their application in medicine.

(j) Outline the biochemical basis of environmental health hazards, biochemical basis of cancer and carcinogenesis

(k) Familiarize with the principles of various conventional and specialized laboratory investigations, instrumentation analysis and interpretation of a given data.

(l) Suggest experiments to support theoretical concepts and clinical diagnosis.

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(B) Skills At the end of the course, the student shall be able to

1. Make use of conventional techniques and instruments to perform biochemical analysis relevant to clinical screening and diagnosis

2. Analyze and interpret investigative data

3. Demonstrate the skills of solving scientific and clinical problems and decision making

(C) Integration: The knowledge acquired in Medical Biochemistry shall help the students to integrate molecular events with structure and function of the human body in health and diseases.

DURATION

Duration of the course: 2 semesters

Total number of hours: 240 (Lectures: 160 Hours & Practicals and Innovative sessions: 80Hrs) Innovative sessions include projects, seminars, structured discussion, integrated teaching, formative evaluation and revision

DETAILED SYLLABUS DETAILS OF COURSE BIOCHEMISTRY:

- Essays must be framed from topics with three stars.
- Five and three marks questions must be framed from topics with three stars or two stars.

[THEORY: 160Hrs]

PAPER 1 (90Hrs)

S NO	TOPICS	Hrs
1	**CELL**	**(2Hrs)**
1.1	**Structure and Functions of cell and cellular organelles	1Hr
1.2	** Diseases associated withorganelle. Fractionation of organelles (in brief) and their marker enzymes	1Hr
2	**BIOMOLECULES**	**(15Hr**

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2.1	**PROTEINS:** ** Classification of aminoacids based on structure, metabolic fate, nutritive value	1Hr
2.2	**Properties of amino acids: Ionic properties of amino acids, Isoelectric pH and its importance; Buffering action of aminoacids and proteins	1Hr
2.3	**Peptide bonds; Biologically important peptides; ***Structural organization of proteins Primary Structure of insulin	1Hr
2.4	**Secondary structure	1 Hr
2.5	**Tertiary and Quaternary structure ; Myoglobin, Collagen and hemoglobin; Protein folding in brief, Prion Diseases	1Hr
2.6	*Proteins: Classification based on composition & solubility, shape, function and nutritional value, limiting aminoacids and mutual supplementation	1Hr
2.7	**Denaturation, Coagulation; Precipitation of protein –Isoelectric precipitation , precipitation using salts ,heavy metals and organic solvents	1Hr
2.8	**CARBOHYDRATES:**Classification,**Isomerism	1Hr
2.9	*Reactions: Reducing property ,Oxidation, Reduction, Dehydration and Condensation (Details of reactions along with practicals)	1Hr
2.10	*Glycosidic bonds – N linked & O linked with examples *Amino sugars, deoxy sugars with examples *Disaccharides – reducing & nonreducing , Highlight clinical importance of lactulose	1Hr
2.11	**Polysaccharides : Homopolysaccharides , Heteropolysaccharides **Glycosaminoglycans – composition, distribution and function * mucopolysaccharidosis – Types ,common features & enzyme deficiency	1 Hr
2.12	*Blood group antigens – Basic composition &Types **Dietary fibre – Definition, types function & clinical significance	1Hr

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2.13	**LIPIDS: **** Definition, Classificationwith examples * Fatty acids: Definition, Alpha and omega numbering system, Classification ; Clinical significance of MUFA & PUFA; Essential fatty acids;Trans fatty acids	1 Hr
2.14	*Cholesterol : Structure, Biologically important compounds derived *TAG : Composition & Function **Phospholipids – Composition & Functions *Phospholipases- Clinical highlights: Viper venom ,Respiratory distress syndrome	1 Hr
2.15	** Membranes : Structure & Composition (Functions will be dealt in Physiology classes) *Micelle & Liposomes	1Hr
3	**ENZYMES**	**(7Hrs)**
3.1	**Definition, IUBMB classification with examples, Coenzymes & Cofactors	1Hr
3.2	**Concept of active site, Specificity of enzymes ;Factors affecting enzyme activity , Km value and its significance	1Hr
3.3	***Enzyme inhibition : Competitive, noncompetitive, uncompetitive with examples	1 Hr
3.4	***Suicidal inhibition, Allosteric inhibition and feedback inhibition with examples (High light : Enzyme inhibition and drug designing)	1 Hr
3.5	*** Enzyme regulation in biological systems – Compartmentalization,allosteric regulation, covalent modification, zymogen activation, induction , repression & Derepression	1Hr
3.6	** Clinical enzymology: Diagnostic importance of enzymes ; Functional &non functional enzymes; **Iso-enzymes : Definition, Separation and examples – CPK & LDH	1 Hr
3.7	**Other enzymes of diagnostic importance: Transaminases(AST,ALT), ALP,GGT,NTP,ACP,Amylase,Lipase,Choline esterase,Enolase	1Hr

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	*Therapeutic enzymes *Enzymes used in laboratory techniques	
4	**DIGESTION AND ABSORPTION**	**(4)**
4.1	**CARBOHYDRATES: ****Digestion, Absorption, Glucose transporters (mechanism not needed) (Emphasize the relation of salt in the diet & ORS) ** Significance of dietary fibre *Glycemic index: Definition & Clinical significance *Malabsorption: Lactose intolerance	1Hr
4.2	**LIPIDS:** ***Digestion ,Role of bile salts & micelle *Absorption of lipids ; *Malabsorption: Steatorrhea	2 Hr
4.3	**PROTEINS: ***Digestion & Absorption, Meister cycle	1Hr
4.4	*Nitrogen balance, PEM, Definition of balanced diet, Limiting amino acids, BMR	1Hr
5	**METABOLISM OF CARBOHYDRATES**	**(19)**
5.1	***Glycolysis ; Definition,reactions,energetics,rate limiting step,Regulation	2Hrs
5.2	**Rappaport Lubering pathway, Significance of 2,3 BPG, Cori's cycle	
5.3	**Fate of pyruvate,PDHreaction,lactic acidosis with two examples	1Hr
5.4	***Gluconeogenesis ; Definition, substrates, reactions & key enzymes,	2 Hrs
5.5	Regulation, Significance, *,Glucose alanine cycle	
5.6	**Glycogenesis	3Hrs
5.7	Glycogenolysis; Regulation in brief	
5.8	*Glycogen storage disorders – Von Gierke' s disease in detail	
5.9	**HMP shunt pathway; Tissues operating , Oxidative phase in detail & mention the products of non oxidative phase,	2Hrs

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5.10	**Significance of HMP shunt pathway,G6PD,Transketolase	
5.11	**Minor sugars; Galactose metabolism & disorders ; Fructose metabolism & disorders	1Hr
5.12	*Uronic acid pathway in brief, Significance of the pathway,Pentosuria;Polyol pathway and its importance	1Hr
5.13	***Regulation of blood glucose : Fed & fasting state; Organs, Glucose transporters, Hormones, Enzymes involved	1Hr
5.14	**Insulin : Receptor ,mechanism of action, insulin release , Actions of insulin related to metabolism in brief	1Hr
5.15	***Diabetes Mellitus: Definition ,Types & etiology ,Diagnostic criteria, Metabolic derangements	1Hr
5.16	***Acute & chronic complications (Biochemical basis)	2Hrs
5.17	***Laboratory diagnosis and monitoring of glycemic control and complications	
5.18	**GTT: Indications, Procedure, Interpretation .Types of GTT curves. Mini GTT,Extended GTT,IV GTT & GCT in brief	1 Hr
5.19	**Hypoglycemia:Definition,causes,clinical features ,biochemical basis of Management, Glycosurias and reducing substances	1 Hr
6	**METABOLISM OF LIPIDS**	**(18Hrs)**
6.1	**Fatty acid biosynthesis: Fatty acid Synthase complex, reactions ; Regulation ;	2 Hrs
6.2	*Elongation and desaturation of fatty acids	
6.3 6.4	Fatty acid oxidation:*** Beta oxidation ; Definition, Fatty acid transport &carnitine,steps.	2 Hrs

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	Energetics ,regulation & disorders	
6.5 6.6	**Oxidation of odd chain fatty acid & fate of propionylcoA *Oxidation of unsaturated fatty acid & very long chain fatty acid *Alpha & Omega oxidation of fatty acid; in brief ; * In born errors associated	2Hrs
6.7	***Ketone bodies : Formation & utilization	1Hr
6.8	***Metabolic background of ketoacidosis in DM and starvation and differential diagnosis by laboratory	1Hr
6.9	**Adipose tissue : Types, Liver adipose tissue axis , Adipokines ; Hormone sensitive lipase	1Hr
6.10	**Fatty liver: Causes, Lipotropic factors, fate of fatty liver	1Hr
6.11	**Cholesterol : Synthesis up to mevalonate in detail and mention the intermediates of important reactions up to cholesterol, Regulation	1 Hr
6.12	**Metabolic fate: Formation of bile salts and its significance , Mention other biologically compounds derived from cholesterol	1Hr
6.13 6.14	**Lipoproteins : Definition, General structure of lipoproteins, classification, separation; ***Metabolism of chylomicrons	2Hrs
6.15	***Metabolism of VLDL & LDL	1 Hr
6.16	***Metabolism of HDL **Different types of HDL &Lp(a) and their significance	1Hr
6.17	*Lipid profile; Dyslipidemia; Dietary management & role of statins Lipid storage disorders : NiemannPick,Taysach';s,Gaucher's,Fabry'sdisease in brief	1Hr
6.18	Eicosanoids : ** Prostaglandins &Thromboxanes ; Major steps of formation;**Biochemical actions & therapeutic uses*Mention Leukotrienes&Lipoxins	1Hr
7	**METABOLISM OF AMINOACIDS**	**(20Hrs)**

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7.1	*Dynamic state of body proteins, Body aminoacid pool; Inter organ transport ofamino acids,* Nitrogen balance and PEM	1 Hr
7.2	**Reactions; Transdeamination (transamination + Oxidative deamination); Non oxidative deamination	1Hr
7.3 7.4	***Formation and detoxification of ammonia (urea Cycle) Regulation, Energetics, Hyperammonemia ,Biochemical basis of management of hyperammonemia	2Hrs
7.5	**One carbon metabolism	1Hr
7.6	***Metabolism of glycine:, Compounds synthesized and inborn errors	2 Hrs
7.7	**metabolism of serine, role as a component of proteins	1Hrs
7.8	**Metabolism of Sulfur containing amino acids: Metabolism of Cysteine	2Hrs
7.9	Glutathione,Taurine,Transulfuration,PAPS ;*Excretion of Sulfur	
7.10	**Metabolism of Methionine,Transmethylation	2Hrs
7.11	Inborn errors associated with metabolism of S containing amino acids	
7.12	***Metabolism of aromatic amino acids: Phenyl alanine and tyrosine; Compounds	3Hrs
7.13	synthesized, Inborn errors associated	
7.14	**Catabolism of catecholamines ,VMA formation & excretion and its significance	
7.15	**Metabolism of Tryptophan and compounds (niacin melatonin, serotonin,	2Hrs
7.16	indoxyl) formed in brief **Hartnup disease and its diagnosis** Effect of PLP on Tryptophan metabolism *Formation and excretion of 5HIAA and its clinical significance	
7.17	* Histidine metabolism & Inborn error associated**FIGLU excretion test	1Hr
	*Glutamic acid ,GABA; Glutamine ; *Aspartic acid ,Asparagine	
7.18	*Metabolism of Arginine, NO, Polyamines.	3Hrs
7.19	*Branched chain aminoacid metabolism (1st two steps only required) &MSUD	
7.20	*Biologically important amines ; *Amino acids and amino acid derivatives acting as neurotransmitters ; *Organic acidurias	
8	**TRICARBOXYLIC ACID (TCA) CYCLE & ELECTRON TRANSPORT CHAIN (ETC)**	**(4Hrs)**

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8.1 8.2	***TCA Cycle: Final Common oxidativePathway of metabolism Reactions,regulation,energetics& inhibitors; Anaplerotic reactions;Amphibolic role	2 Hrs
8.3 8.4 8.5	**High energy compounds: definition and examples ***ETC : Components and sites of ATP synthesis; Mechanism of oxidative phosphorylation; ATP synthase Inhibitors **Brown adipose tissue ** integration of metabolism, Adaptations in starvation: Life style diseases, BMI obesity, Metabolic syndrome(Mention NASH, PCOS) Atherosclerosis	2Hrs 2 Hrs
PAPER 2 (70Hrs)		
9	**METABOLISM OF HEME**	**(8 Hrs)**
9.1 9.2	***Heme synthesis : Heme synthetic pathway ,regulation &effects of lead poisoning	2Hrs
9.3	**Porphyrias: Types,Enzyme defects,manifestions and investigations of blood & urine (Acute intermittent Porpyria in detail and others in brief)	1Hr
9.4	***Heme catabolism: Formation & fate of bilirubin (uptake, conjugation, secretion) ;Formation & Fate of urobilinogen&stercobilinogen	1Hr
9.5 9.6	***Serum bilirubin: Types, Blood levels in healthy subjects ; Properties; ***Jaundice: Definition, Classification , Causes &differential diagnosis by biochemical tests	2Hrs
9.7	*Neonatal hyperbilirubinemia ,Kernicterus & biochemical basis of treatment in brief	1Hr
9.8	*Haemoglobinopathies : Different types and Hbs in detail(Hb electrophoresis ,Sickling test)*Thalassemias : Alpha and beta thalassemia in brief	1Hr
10	**FAT SOLUBLE VITAMINS**	**(5Hrs)**
10.1 10.2	***Vitamin A :** Different chemical forms, dietary sources, RDA Vitamin A; Absorption ,transport and storage; Functions of vitamin A ,Wald's visual cycle	2Hrs
	Deficiency manifestations and its prevention ; Hyper vitaminosis	

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10.3 10.4	***Vitamin D :** Chemical nature , dietary sources, RDA Vitamin D; Active form of vitamin D – its formation and actions Deficiency manifestations in children and adults and its prevention	2Hrs
10.5	**Vitamin K:** Chemical forms, dietary sources, biochemical Functions ,RDA and deficiency manifestations Highlight: Vitamin K administration to preterm babies &Vitamin K and Prothrombin time **Vitamin E:** Chemical forms, Biochemical Functions (focus lipid peroxidation and antioxidant function in brief) and deficiency manifestations	1Hr
11	**WATER SOLUBLE VITAMINS**	**(6Hrs)**
11.1	**Thiamine:** Chemical nature, dietary sources, RDA,coenzyme form, biochemical functions , deficiency manifestations High light : Transketolase assay to detect deficiency	1Hr
11.2	***Riboflavin, Pyridoxine:** Chemical nature, dietary sources,RDA, coenzyme form, biochemical functions , deficiency manifestations	1Hr
11.3	***Pantothenic acid, Niacin, Biotin**: Chemical nature, dietary sources, RDA, Coenzyme form, biochemical functions , deficiency manifestations	1Hr
11.4	***Folic acid:** Chemical nature, dietary sources, RDA,coenzyme form, biochemical functions , deficiency manifestations (One carbon metabolism along with amino acid metabolism)	1Hr
11.5 11.6	**Vitamin B_{12}, Vitamin C**: Chemical nature, dietary sources, RDA, role as coenzymes Biochemical functions, deficiency manifestations ; *Antivitamins	2Hrs
12	**MINERALS**	**(6Hrs)**
12.1 12.2	*Classification of minerals based on RDA **Calcium:** Dietary sources, biochemical functions, RDA, Blood levels in healthy subjects, regulation of blood calcium level, Hypocalcaemia, Hypocalcaemia.	2Hrs
12.3	**Phosphorus, Magnesium, Copper:** Dietary sources, biochemical functions ,RDA,	1Hr

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	Disorders related.	
12.4 12.5	***Iron:** Dietary sources, RDA,; Absorption ,transport &storage; Causes of iron deficiency & Iron deficiency Anemia ; Hereditary Hemochromatosis.	2Hrs
12.6	*Iodine,Potassium,Sodium,Chloride,Zinc,Selenium,Fluoride,Manganese,Magne siu m : in brief	1Hr
13	**HOMEOSTATIC MECHANISMS IN THE BODY**	**(5Hrs)**
13.1 13.2	**Acid base balance**: *Acids, bases, pH, pK, Buffers,HendersonHasselbalch equation ***Body buffers , respiratory & renal regulation of blood pH	2hrs
13.3 13.5	**Disorders of acid base balance ; *Anion gap Assessment of acid base balance by blood gas parameters	2Hrs
13.6	**Fluid and electrolyte balance:** *Regulation of osmolality and maintenance of fluids in the various body compartments and related disorders	1Hr
14	**MOLECULAR BIOLOGY**	**(22Hrs)**
14.1	***Nucleotide chemistry :** Structure of purine &pyrimidine bases, nucleosides, nucleotides	1Hr
14.2	**Purine synthesis and catabolism:** *Purine synthesis: Synthetic pathway in brief – Source of constituent atoms ,rate limiting steps ,first nucleotide formed and the formation of other nucleotides from IMP	1 Hr
14.3	***Purine catabolism: Pathway ,Hyperuricemia,Gout,Biochemical principles of treatment of Gout ; *LeschNyhansyndrome,Hypouricemia	1 Hr
14.4 14.5	*Pyrimidine synthesis and degradation,Oroticaciduria *Synthesis of dNTPs (deoxy nucleotide triphosphates) *Nucleotide analogues & Folic acid antagonists	2Hrs

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14.6 14.7	****Nucleic acids:** Structure and organization of DNA; Different types of DNA, Different types of RNA ,difference between DNA & RNA ;*Mitochondrial DNA	2Hrs
14.8 14.9	***Cell cycle** and ****Replication:** Process of replication (prokaryotes); DNA polymerase(prokaryotes & eukaryotes); Inhibitors	2Hrs
14.10	**DNA repair mechanisms, Examples of DNA repair defects,*Telomerase	1Hr
14.11	***Transcription:** Process of transcription(prokaryotes and differences in eukaryotes); RNA polymerases(prokaryotes & eukaryotes); Inhibitors	2Hr
14.12	**Post transcriptional modifications (hnRNA& primary tRNA transcript) *RNA editing with an example (apo B_{48}&apo B_{100});*Reverse transcriptase ; * Ribozyme	1Hr
14.13	**Genetic code , **t RNA ; *Ribosomes &Polysomes	1Hr
14.14 14.15	****Translation:** Different phases of translation(eukaryotes differences in prokaryotes);**Post translational modifications; Inhibitors protein targeting	2Hrs
14.16 14.17	*Regulation of gene expression (lac operon model, gene amplification, gene rearrangement)	2Hrs
14.18	**DNA based techniques: **Recombinant DNA technology** Applications in clinical medicine	1Hr
14.19	**Applications in clinical medicine; Gene therapy ,RFLP ,DNA finger printing	1Hr
14.20	**Blotting techniques (Southern, Northern & Western) ; ** PCR*Antisense therapy	1Hr
14.21	*Biochemical basis of inherited disorders & screening of genetic disorders; Mode of inheritance	1Hr
14.22	***Mutations: Definition ,types with examples ; Mutagens ,Ame's test	1Hr
15	**IMMUNOGLOBULINS**	**(3hrs)**
15.1	**Immunoglobulin: Types, Structure (general structure and structure of IgM& IgA);	2Hrs

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15.2	&Functions ; *Hypergammaglobulinemia ; * Hypergammaglobulinemia	
15.3	*AIDS (Structure of HIV virus ,major genes & antigens), Natural course of HIV infection Immunology of AIDS, Laboratory diagnosis &monitoring, Biochemical basis of retroviral therapy	1Hr
16	**BIOCHEMISTRY OF CANCER**	**(3Hrs)**
16.1 16.2	****Biochemistry of cancer**: Cell cycle, Cyclins and apoptosis. Etiology of cancer; Carcinogensesis: Oncogenic virus; Oncogenes ;Tumor suppressor genes,	2Hrs
16.3	**Tumor markers ; *Anticancer drugs * Monoclonal antibodies	1Hr
17	**CLINICAL BIOCHEMISTRY**	**(7Hrs)**
17.1	****Plasma proteins:** Types ; Functions ; Separation ; Abnormal patterns in clinical diseases ; A G ratio; Acute phase proteins	1Hr
17.2	****Electrophoresis** of serum proteins ;Multiple myeloma &Bence Jones proteins ****Chromatography** and diagnosis of inherited disorders of metabolism (Example: Aminoaciduria)	1Hr
17.3	***Colorimetry *ELISA** (Principle, Procedure ,Applications),*Radio immune assay (**RIA)**	1Hr
17.4	** **Cardiac markers** ***Liver function tests** and interpretation	1Hr
17.5	***Thyroid function tests** and interpretation	1Hr
17.6	****Renal function tests** and interpretation	1Hr
17.7	***Radioactivity** :Radioactive isotopes used in Medicine ;Diagnostic, therapeutic and research applications; Radiation hazards	1Hr
18	**XENOBIOTICS**	**(2Hrs)**
18.1 18.2	**Detoxification and Biotransformation of xenobiotics: Different phases *Metabolism of alcohol, brief mention of environmental toxins	2Hrs
19	**FREE RADICALS AND ANTIOXIDANTS**	**(1Hr)**
19.1	**Free radicals:** Generation, Types, lipid peroxidation. **Antioxidants:** Different types	

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PRACTICAL SYLLABUS [TOTAL: 80Hrs]

QUALITATIVE EXPERIMENTS	
Topics	**2 Hr Sessions**
Reactions of Carbohydrates : Glucose ,Fructose,Lactose,Sucrose	4 (8hrs)
Proteins : Precipitation of Proteins	1 (2Hrs)
Proteins: Color reactions	1(2Hrs)
Reactions of Albumin	1(2Hrs)
Reactions of Urea,Uric acid &Creatinine	1(2Hrs)
Identification of biologically important substance in given solution	1(2Hrs)
Normal constituents of urine – Inorganic & Organic constituents	2(4Hrs)
Abnormal constituents of urine	2(4Hrs)
Demonstration of electrophoresis of serum proteins & interpretation	1(2Hrs)
Demonstration of paper chromatography/TLC urinary aminoacids& interpretation	1(2Hrs)
Hemin crystal preparation and microscopic examination	1(2Hrs)
QUANTIATIVE EXPERIMENTS	
Introduction to clinical chemistry: Collection of blood samples, Anticoagulants , Collection of 24 hour urine sample and Urine preservatives Principles of colorimetry	1(2Hrs)
Estimations of levels of glucose, urea, creatinine, total protein and albumin in blood	5(10Hrs)
CHART DISCUSSION Clinical cases along with biochemical test results for interpretation and discussion	
Jaundice – Hepatic ,Hemolytic and Obstructive jaundice	1(2Hrs)
Diabetes mellitus - Cases based on diabetes mellitus, Diabetic ketoacidosis, Hyper	1(2Hrs)

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osmolar nonketotic coma, Hypoglycemia ,IGT,IFG	
GTT curves – Normoglycemia, Diabetes mellitus, IFG, IGT, Alimentary glycosuria, Renal glycosuria ,Hypoglycemia	1(2Hrs)
Charts based on HbA1C &Micro albuminuria	
Myocardial infarction : Markers	1(2Hrs)
Pancreatitis : Markers	
Prostate Cancer : Markers	
Nephrotic syndrome, Glomerulonephritis	
Charts based on alcoholism, atherosclerosis, lipid profile, fatty liver	1(2Hrs)
Charts based on acid base parameters related to Metabolic acidosis, Metabolic alkalosis, Respiratory acidosis and Respiratory alkalosis (Only uncompensated cases)	
Charts based on TFT related to Hypothyroidism & Hyperthyroidism	1(2Hrs)
Charts based on Metabolic syndrome ,Gout	
Charts based on inborn errors of metabolism (Lactose intolerance , Galactosemia, Fructosuria, vonGierke's disease, PKU, MSUD,Hartnup's disease, Alkaptonuria ,Albinism, Pheochromcytoma Carcinoid syndrome, Lesch Nyhan syndrome	
Charts based on Vitamins: Vit A ,D ,K, Thiamine,Niacin,Ascorbicacid,Pyridoxine,Folic acid	1(2Hrs)
Charts based on Minerals: Hypocalcaemia, Hyperkalemia, Hypokalemia, Hyponatremia, Hyponatremia, Fluorosis ,Iron deficiency anaemia, Haemochromatosis, Wilson's disease	
Charts on replication fork, Xeroderma pigmentosum , HNPCC , HIV major genes & antigens	1(2Hrs)

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Charts based on enzyme inhibition: Competitive Non competitive, Suicidal inhibition	
OBJECTIVE STRUCTURED PRACTICAL EXAMINATION (OSPE) Practice sessions	2 (4Hrs)
SPOTTERS: Based on tests, instruments, charts, microscopic slides, graphs, nutrition, reference ranges of routine parameters, major concepts, reagents, Indicators.	1 (2Hrs)
Seminars : (Guide lines for evaluation.(Colleges can make their own marking scheme) • Allot 10 topics for a day. • Assign a single topic for a student for presentation lasting for 10 minutes • All the students should learn all the 10 topics. Those who present topic will be evaluated based on the presentation; others will be evaluated either by MCQ based post test or assignments based on the topic presented. (10 MCQs just after the presentation part of the session or assignment submitted within a week) • Marks: 10 marks for presentation & 10 marks for MCQ • Consider 10 % of this mark for internal assessment	7 (12Hrs)

Distribution of marks for practical session

Items	**Marks**
Qualitative experiment	**10 marks**. • **The questions may be reworded so that the application of the experiment is highlighted**. • **Question cards may be used to elicit more information** *Sample questions are provided below which are only for guidance. Colleges can prepare their own question bank.*
Quantitative experiment	**10 marks The questions may be reworded so that the application of the experiment is highlighted** *Sample questions are provided below*

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	which are only for guidance. Colleges can prepare their own question bank

Chart discussion	**10marks**
Spotters	**5 marks** -10 spotters **– 10x0.5=5 marks**
OSPE	**5 marks. Two OSPE stations with 2.5 marks each. One performance station and one writing station using suitable question cards. Sample questions and grading sheets provided for guidance only**
Record	*[Assessment of record keeping should be done along with internal assessment. But submission of record during University Practical Examination is compulsory , to meet the requirement of attending practical examination]*

Sample questions for QUALITATIVE EXPERIMENT

I. i) Identify whether the sugar solution contains a monosaccharide or disaccharide?

[By doing relevant tests (Benedict's test, Barfoed's test/ Alkali destruction test , it is to be identified and reported).

ii) Related questions (2 or 3 questions may be kept on the seat as a question card) some examples related to the above question are given below

1. Name 2 reducing disaccharides. What are their components?

2. What is the type of linkage between the monosaccharides in these sugars?

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3. What is the shape of the osazone?

4. Name a condition where a disaccharide is excreted in urine

5. Name the dietary source for any of these disaccharides

6. Which enzyme can hydrolyze it in the GIT?

7. What will happen if this enzyme is deficient?

Q II.i) Observe the results of these tests and suggest the identity of the sugar. Do you need any other test to confirm the nature of the sugar? If so perform the test and confirm

Q III.i) How will you identify the monosaccharide supplied in the solution? **Glucose or fructose**

Some questions related to the above question are given below Q II &Q III

1. Give 2 differences between these sugars

2. Name the dietary source

3.Name a disaccharide containing this sugar

4. Name a homopolysaccharide containing this sugar

Q IV.With the help of a test explain the reducing property of glucose

1. What is the clinical use of this test?
2.Is this test specific for glucose?, if not name two non carbohydrate and two carbohydrate substances giving this test positive?
3. Name a test that specifically detects glucose.

Q V. The urine sample from a 6 year old boy gave a positive Benedict's test. Mother complains that the child is losing weight in spite of increased appetite

Identify the sugar (performance of tests)

1. Enumerate the causes of Glycosurias

2. Give two inherited causes of Glycosurias

3. Name a non sugar reducing compound

4. Is there an indication for performing plasma glucose estimation in this patient? If so explain.

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Sample questions for QUANTITATIVE EXPERIMENT

Q I. A retired school teacher aged 62 yrs complaining of increased thirst, hunger, passing urine more frequently and losing weight. Urine showed glucose oxidase based strip test positive.

1. What is the blood test required to diagnose diabetes mellitus and Do it & furnish the result. ***[The examiner can discuss the value obtained, method used and possible causes of an abnormal result at the end.]***
2. Give the diagnostic criteria of diabetes mellitus
3. What are IFG and IGT?
4. Name a blood test that reveals mean glucose level over the previous 12 weeks. What is the level of this parameter suggestive of normal glycemic status?
5. Name one test used as a early marker of diabetic nephropathy and retinopathy

Q II. A 5 year old admitted to pediatric ward due to severe diarrhea vomiting and reduced urine output. He is dehydrated. A sample of blood is sent for investigations to assess the renal function.

1.Name two blood test useful to assess renal function
2. Name the analyte which is elevated in dehydration and also in renal disease. Do the estimation of it and submit the report.

3.What is the current Gold standard test to detect renal function

OSPE General Guidelines:

- OSPE questions prepared for experiments should be observable and structured and should be completed within five minutes.

In addition to experiment, the questions kept at the writing station will help to derive the concealed concepts related to the experiment eg: inference /clinical correlations/reference range etc.

A few model OSPE questions are furnished below along with check list for structuredobservations.

A set of common laboratory reagents and lab ware should be arranged at the station. Sothat students can select the required reagents according to the OSPE questions.

Advantages OSPE:

- practising OSPE questions will sharpen the skills

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Sample OSPE questions

1. Glucose solution is provided in a numbered beaker/test tube. Show that it is an aldose by doing one test

Steps	Observations	Marks
1	Selection of a test to show glucose is an aldose : Seliwanoff's test/ Rapid Furfural test	0.5
2	Step-1	0.5
3	Step-2	0.5
4	Write down the observation and inference	0.5
5	Overall performance of the student in terms of choice of proper glassware, Cleanliness , handling of reagent bottles ,accuracy and precision.	0.5

2. Demonstrate the amino acid Tyrosine/Tryptophane, in the given protein solution.
3. Test to distinguish monosachharides from disacharides
4. Test to demonstrate the presence of ketone bodies / bile salts in urine
5. Test to detect the presence of uric acid/creatinine in a solution

Note: Appropriate question cards with a minimum of 3 questions, may be used at the writing station.

MARKS

University examination	Marks
Theory paper I & II (50+50)	100
Theory - Internal assessment	20
Viva	20
Practical	40
Practical - Internal assessment	20
Total	**200**

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SUGGESTED BOOKS IN BIOCHEMISTRY

Books for study:

1. Text of Biochemistry for Medical students by Vasudevan & Sreekumari
2. Harper's review of Biochemistry- latest edition
3. Text of Biochemistry for Medical students R Text of Biochemistry for Medical students Rafi M.D
4. Lippincott's Illustrated Review of Biochemistry -latest edition
5. Practical Biochemistry for Medical students by Vasudevan
6. Practical Biochemistry by Geetha Damodaran K
7. Manual of Practical Biochemistry by S K Gupta,Veena Singh Chalaut&Anju Jain

Books for Reference:

1. Principles of Biochemistry by Lehninger
2. Biochemistry with Clinical Correlations by Thomas. M. Devlin
3. Biochemistry by Stryer
4. Biochemistry-A case oriented Approach by Montgomery

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