

CURRICULUM OF BIOCHEMISTRY

MBBS COURSE

Contents

S. No.	Subject	Page No.
1.	Introduction	02
2.	Educational Hours	03
3.	Learning Outcomes	04
4.	Educational Strategies	05
5.	Assessment	06
6.	Learning Resources	07
7.	Contents Modules	08
8.	Implimentation	09-11
9.	Programme Evaluation	12
10.	Table of Specification	13-17
11.	Modules	18-30

INTRODUCTION

The basic sciences subject will be covered during first and second year. Biochemistry is taught with its clinical application and use in clinical subjects. Due to nature of this subject educational strategies of diverse approaches are employed. Educational resources like videos, Biochemical Analyzer, microscopy slides, books and journals are used to learn this diverse subject. Early clinical exposure is used for clinical application of Biochemistry.

First year and second year are divided in three educational terms which conclude at with formative assessment test. End of year is University exam for summative assessment.

EDUCATIONAL HOURS

Year	Theory	Practical	Total
1st year	50 hours (25 Lecture, 25 SGD / PBL)	50 hours	100
2nd year	50 hours (25 Lecture, 25 SGD / PBL)	50 hours	100
Total	100 hours in 36 weeks/year	100 hours	200 hours
Strategy	Lectures Problem based learning Small group discussion Case based discussion	Laboratory session Clinical sessions Audio video sessions	

LEARNING OUTCOMES

At the end of curriculum student will be able to demonstrate his knowledge and understanding on the subject with following learning objectives:

- Molecular and functional organization of a cell, and sub-cellular components.
- In-depth knowledge of structure, function and interrelationship of biomolecules and consequences of deviation from normal.
- Delineating, learning and understanding the chemistry of biomolecules of biologic significance. In order to accomplish this, the student will learn the basic chemical aspects of the biomolecules (carbohydrates, lipids, amino acids, polypeptides, nucleic acids).
- Description of mechanisms involved in maintenance of body fluid & pH and the related homeostatic processes.
- Recognizing homeostatic dynamics through the concepts of human nutrition and be familiar with the biochemical role of micro- and macro-nutrients like vitamins, minerals, and electrolytes along with their clinical implications of their dietary use.
- Having a clear understanding of the fundamental aspects of enzymology & clinical applications along with regulation of enzyme activity
- To be familiar with the homeostatic mechanisms through the concepts of inter-regulation of carbohydrates, lipids and protein metabolism and its relation to hormone actions in the human body.
- Once these basic concepts are understood, it will be straightforward to understand how alterations in the basic processes can lead to a disease state.
- To have understanding and knowledge about many pathological situations where these can be related to biochemical defects, and to have some experience of biochemical techniques in order to understand the practical/clinical problems in biochemistry.
- To develop skills as a self-directed learner, recognize continuing educational needs; use appropriate learning resources and critically analyze relevant literature in order to have a comprehensive understanding and knowledge of biochemistry.
- To learn and understand the basic biochemical processes taking place in the body since these underline an understanding of normal and abnormal human metabolism. In order to accomplish this, the student should learn how large molecules are synthesized and used (DNA, RNA, and proteins), and how energy is generated, stored, and retrieved (metabolism).
- Developing skills as a self-directed learner, recognize continuing educational needs; use appropriate learning resources and critically analyze relevant literature in order to have a comprehensive understanding and knowledge of biochemistry.

EDUCATION STRATEGIES

The educational strategies in this curriculum are multiple and aligned with domain of learning and according to the desired outcome

Didactic lectures

One-third of the curriculum will be delivered in a traditional didactic format including PowerPoint presentations and case discussions. Didactic education is considered to be a one-way transmission of material from teacher to learner, we cannot overlook the possibility of meaningful interaction between experts and learners during live lectures. This type of interaction, which allows for immediate clarification of concepts and extension of knowledge, may be particularly important for novice learners who have relatively little exposure to the subject matter, such as our study population.

Problem based learning

A lot of emphasis is on case based discussion. Problem-based learning (PBL) is complex and heterogeneous. A wide variety of educational methods are referred as PBL. These include Lecture-based case, Case based lecture, Case based discussions, Problem or inquiry based and Closed loop or reiterative. Incorporation of case based discussion in teaching enhances the critical thinking and problem-solving skills. It also helps in developing a broader prospective of clinical case scenarios.

Small Group Discussion

Small group discussion provides a unique environment to achieve high standards in medical education. Activation of prior knowledge, exchange of ideas, and engagement at a higher cognitive level are assumed to result in deeper learning and better academic achievements by students.

Video sessions

Anatomy is a subject which involves visual learning and formulating concepts. Video assisted learning sessions also provides opportunities to learn gross anatomy.

Laboratory Sessions

Laboratory sessions are important as they provide opportunity for experiential learning in terms of study of slides and identification of tissues

Early clinical Exposure (ECE)

Clinical skills session are important part of curriculum to achieve psychomotor and affective outcomes. This provide opportunity for medical students in early years and will stimulate contextual learning.

ASSESSMENT

MCQ's and SEQ's

Multiple choice question and short essay question test will be used at the end of part of curriculum to assess the learning of knowledge. These all assessment exercises will be formative. The written tests like Multiple-Choice Questions (MCQs) and Short-Essay Questions (SEQs) test formats are used for the assessment of cognitive domain. The MCQs are more objective and essentially select type of item response format. MCQs have a cueing effect, which promotes guessing and leads to higher scores. In addition, writing MCQs of higher cognitive level of problem solving is challenging. On the contrary, the SEQs are more subjective and have a supply or construct type item response format, which does not have any cueing effect and can effectively assess problem solving skills.

Clinical exam and OSCE

Short case and OSCE will be used to evaluate clinical skills and procedural skills at the ward end of placement. The OSCE is a method of clinical skill assessment, and it has been reported to be appropriate for assessing learning achievement levels in the psychomotor and emotional domains, which are difficult to evaluate with written examinations.

Viva Voce

Viva voce is used for assessment of knowledge and problem solving ability of students. This method is useful evaluating cognitive domain.

Practical

Practical test are used for assessment of knowledge and psychomotor skills.

Assignments

Students of different year will be given assignment of different nature such as research and literature search and surveys

INTERNAL ASSESSMENT

- i. The weightage of internal assessment shall be 10% of totals marks.
- ii. Continuous internal assessment shall consist of evaluation at the end of each assignments, e.g. practical, class tests etc., attitudinal assessment from educational supervisors.
- iii. Assessment of knowledge, Skills and Attitude shall contribute toward internal assessment. Methods used to assess these domains shall include Multiple Choice Questions of one-best type, Short essay questions, Oral/Viva, and Practical/Clinical examinations.
- iv. The score of internal assessment shall contribute to the score in the final examination, Final university examination of each subject shall contribute 90 to total score, and the candidate shall pass in aggregate.
- v. Proper record of continuous internal assessment shall be maintained.

LEARNING RESOURCES

The department of biochemistry will require following resources for implementation resources:

- Human resource
- Instructors (faculty members)
- Curriculum coordinator curriculum secretary
- Infrastructure
- Lecture hall with AV aids
- Tutorial room with AV aids
- Biochemistry Lab
- Simulated patients and simulated manikins
- Computers

LISTS OF CONTENT RESOURCES

- Harper's Illustrated Biochemistry by Murrary RK, Granner OK and Rodwell VW, latest edition, McGraw Hill
- Lippincott's Illustrated Reviews: Biochemistry by Harvey R and Ferrier D, Latest edition, published by Lippincott Williams & Wilkins
- Marks' Basic Medical Biochemistry - A Clinical Approach, by Smith C, Marks AD, and Lieberman M. Latest edition, published by Lippincott Williams & Wilkins
- Practicals and Viva in Medical Biochemistry by Dandekar SP and Rane SA, latest edition, published by Elsevier.
- Textbook of Biochemistry with Clinical Correlations by Devlin TM , latest edition, published by Wiley-Liss
- Biochemistry by Berg JM, Tymoczko JL, and Stryer L, latest edition, published by W .H. Freeman and Company
- Clinical Chemistry and Metabolic Medicine by Martin A. Crook, latest edition , Edward Arnold (Publishers) Ltd
- Lehninger Principles of Biochemistry by David L Nelson and Michael M. Cox
- Tietz Textbook of Clinical Chemistry by Burtis CA and Ashwood ER published by Saunders.
- Fundamentals of Biochemistry Life at Molecular Level by Donald Voet, Judith G Voet and Charlotte W . Pratt

CONTENTS MODULES

S.No	Topic
1	Module 1 Cell Biochemistry
2	Module 2 Water, Buffers and pH
3	Module 3 Carbohydrates
4	Module 4 Proteins and Amino Acids
5	Module 5 Nucleotides
6	Module 6 Lipids and Fatty Acids
7	Module 7 Enzymes
8	Module 8 Porphyrins and proteins
9	Module 9 Vitamins and minerals
10	Module 10 Nutrition
11	Module 11 Extracellular matrix
12	Module 12 Practical biochemistry tests
13	Module 13 Bioenergetics and Biological Oxidation
14	Module 14 Carbohydrate Metabolism
15	Module 15 Lipid Metabolism
16	Module 16 Metabolism of proteins and amino acids
17	Module 17 Integration and Regulation of Metabolic Pathways
18	Module 18 Metabolism of Nucleotides
19	Module 19 Biochemical Genetics
20	Module 20 Biochemistry of endocrine system
21	Module 21 Biochemistry of Gastrointestinal system
22	Module 22 Metabolism of xenobiotics
23	Module 23 Water & electrolyte balance; acid-base regulation
24	Module 24 Practical special biochemistry

IMPLEMENTATION

The curriculum will be spread over 2 year with 36 working weeks each year. During this period student will be exposed to various education strategies to achieve the learning objectives.

1st Year.

In this year student will be exposed to do dissection, histology lab, Museum and early clinical exposure to develop understanding of anatomy and its applied aspects.

Theory (Lecture, SGD and PBL)	Practical (Early clinical exposure, Bio-Lab)
50 Hours (36 Weeks)	50 Hours

2nd Year.

In this year student will be exposed to do dissection, histology lab, Museum and early clinical exposure to develop understanding of anatomy and its applied aspects.

Theory (Lecture, SGD and PBL)	Practical (Early clinical exposure, Bio-Lab)
50 Hours (36 Weeks)	50 Hours

First Year			
	First term	Second term	Third term
	Module 1: Cell Biochemistry Module 2: Water, Buffers & pH Module 3: Carbohydrates Module 4: Protein & Amino Acid Module 5: Nucleotides Module 6: Lipids & Fatty Acids	Module 7: Enzymes Module 8: Porphyrins & proteins Module 9: Vitamins & minerals Module 10: Nutrition Module 11: Extracellular matrix	PBL & Case based learning with early clinical exposure related to 1. Carbohydrate 2. Protein & Aminoacids 3. Lipids 4. Vitamins & Minerals
Practical	1. Introduction to lab 2. Preparation of solution 3. Preparation of buffers 4. Methods & unit of calculation 5. Conversion of units 6. pH meter & pH measurement	1. Test on carbohydrate & protein 2. Test on monosaccharides 3. Collection, Storage & analysis of hormones	SGD, OSPE, Interpretation, VIVA related to practicals
Assessment	Tests (MCQ, SEQ) Viva of theory and practical examination At end of each module	Tests (MCQ, SEQ) Viva of theory and practical examination At end of each module	Tests (MCQ, SEQ) Viva of theory and practical examination At end of each module

Second Year			
	First term	Second term	Third term
	<p>Module 13 Bioenergetics and Biological Oxidation</p> <p>Module 14 Carbohydrate Metabolism</p> <p>Module 15 Lipid Metabolism</p> <p>Module 16 Metabolism of proteins and amino acids</p> <p>Module 17 Integration and Regulation of Metabolic Pathways</p> <p>Module 21 Biochemistry of Gastrointestinal system</p>	<p>Module 18 Metabolism of Nucleotides</p> <p>Module 19 Biochemical Genetics</p> <p>Module 20 Biochemistry of endocrine system</p> <p>Module 22 Metabolism of xenobiotics</p> <p>Module 23 Water & electrolyte balance; acid-base regulation</p>	<p>PBL & Case based learning with early clinical exposure related to</p> <ol style="list-style-type: none"> 1. Bioenergetics 2. Protein & Aminoacids 3. Lipids 4. Acid base, water & electrolytes 5. Nucleotide metabolism
Practical	<ol style="list-style-type: none"> 1. Instrumentation, Spectrophotometer, Centrifuge & Micropipette 2. Test on carbohydrates, Proteins & Lipids 	<ol style="list-style-type: none"> 1. Test on uric acid calcium, phosphate 2. Test on enzymes involve in cardiac function, liver function, pancreas & LFT 	<p>SGD, OSPE, Interpretation, VIVA related to practicals</p>
Assessment	<p>Tests (MCQ, SEQ) Viva of theory and practical examination At end of each module</p>	<p>Tests (MCQ, SEQ) Viva of theory and practical examination At end of each module</p>	<p>Tests (MCQ, SEQ) Viva of theory and practical examination At end of each module</p>

PROGRAMME EVALUATION

Purpose of Evaluation

The major goals of the evaluation are to provide information that the students can use to achieve curricular objectives and that the faculty can use to monitor quality of and improve curriculum.

Design of Evaluation

The evaluation design as only posttest.

Users of evaluation: students, curriculum faculty, Principal Office

Resources: Curriculum faculty and departmental secretaries. No additional funding

Evaluation question:

- What percentage of students achieved 75% mandatory attendance?
- What percentage of students achieved pass marks in university exam?
- What are the strengths of the curriculum? What are the weaknesses? How can the curriculum can be improved?

Because of limited resources, the evaluation was kept simple. Data Collection was integrated into the curriculum schedule. The major goals of the evaluation are to provide information that the students can use to achieve curricular objectives and that the faculty can use to monitor quality of and improve curriculum. The evaluation design as only posttest.

End of curriculum evaluation form:

This will be filled by students and faculty members for evaluation of adequacy with each content was covered, whether they would recommend the curriculum to others and written comments on curriculum strengths, weaknesses and suggestions for improvements.

Annual Report:

Based on evaluation of the educational programe report will be generated annually and submitted to Medical Educational Department.

MBBS FIRST YEAR PROFESSIONAL EXAMINATION (PART-1)

TABLE OF SPECIFICATIONS			
CONTENTS		SEQs	MCQs
1	Biochemistry of the cell, cell membrane, and membrane phenomena water, pH and buffers	0.5	3
2	Extracellular matrix	0.5	2
3	Chemistry of carbohydrates	1.0	4
4	Chemistry of lipids	1.0	5
5	Chemistry of proteins and amino acids, plasma proteins including immunoglobulins.	1.0	6
6	Chemistry of nucleotides and nucleic acids	0.5	3
7	Enzymes	1.0	5
8	Vitamins	1.5	7
9	Nutrition	0.5	2
10	Minerals and trace elements	0.5	4
11	Home metabolism, porphyrins, jaundice, hemoglobin & myoglobin, hemoglobinopathies	1.0	4
	Total items	09 SEQs	45 MCQs
	Total marks (5 marks for each SEQs and 1 mark for each MCQs)	45 marks	45 marks

25% of MCQs and SEQs should be clinically oriented or problem-based.

10% marks are allocated for "Internal Assessment"

Total Marks For Theory Paper: SEQs+ MCQs+ Internal Assessment = 45+45+10=100 marks

MBBS FIRST YEAR PROFESSIONAL EXAMINATION (PART-1)

Oral and practical examination carries 100 marks

TABLE OF SPECIFICATIONS	
Examination Component	Marks
A: Internal Assessment	10
B: Practical notebook / Manual (Internal Examiner)	05
C: Viva voce a. External examiner: 25 Marks b. Internal Examiner: 25 Marks	50
D: OSPE a. Observed stations (6 marks): There are two observed stations: 3 marks for each station – time allowed is 3 minutes for each observed station b. Non-observed stations (16 marks): There are eight non-observed stations: 2 marks for each station – time allowed is 2 minutes for each non-observed station.	22
E: Practical a. Principal supposed calculation, etc: 4 marks (External Examiner) b. Performance of the experiment: 4 marks (Internal Examiner) c. Structured table viva: 5 marks (External Examiner)	13

MBBS FIRST YEAR PROFESSIONAL EXAMINATION (PART-2)

TABLE OF SPECIFICATIONS			
CONTENTS		SEQs	MCQs
1	Bioenergetics and biologic oxidation	0.5	3
2	Carbohydrate Metabolism	0.5	2
3	Lipid metabolism	1.0	4
4	Metabolism of proteins and amino acids	1.0	5
5	Metabolism of purines, pyrimidies and nucleotides	1.0	6
6	Replication of DNA, mutations and DNA repair.	0.5	3
7	Transcription RNA processing and proteins synthesis regulation of gene expression, genetic diseases and basic techniques used in molecular genetics	1.0	5
8	Endocrinology	1.5	7
9	Biochemistry of digestive juices of GIT, digestive and absorption in GIT	0.5	2
10	Oncogenesis and metabolism of xenobiotics	0.5	4
11	Water and electrolyte balance, acid-base regulation	1.0	4
	Total items	09 SEQs	45 MCQs
	Total marks (5 marks for each SEQs and 1 mark for each MCQs)	45 marks	45 marks

25% of MCQs and SEQs should be clinically oriented or problem-based.

10% marks are allocated for "Internal Assessment"

Total Marks For Theory Paper: SEQs+ MCQs+ Internal Assessment = 45+45+10=100 marks

MBBS FIRST YEAR PROFESSIONAL EXAMINATION (PART-2)

Oral and practical examination carries 100 marks

TABLE OF SPECIFICATIONS	
Examination Component	Marks
F: Internal Assessment	10
G: Practical notebook / Manual (Internal Examiner)	05
H: Viva voce c. External examiner: 25 Marks d. Internal Examiner: 25 Marks	50
I: OSPE c. Observed stations (6 marks): There are two observed stations: 3 marks for each station – time allowed is 3 minutes for each observed station d. Non-observed stations (16 marks): There are eight non-observed stations: 2 marks for each station – time allowed is 2 minutes for each non-observed station.	22
J: Practical d. Principal supposed calculation, etc: 4 marks (External Examiner) e. Performance of the experiment: 4 marks (Internal Examiner) f. Structured table viva: 5 marks (External Examiner)	13

**Format (Practical Examination / OSPE
MBBS first year professional examination (Part-2))**

BIOCHEMISRTY (PART -11)

Total marks: 100

Total marks allocated to Oral and Practical Examination are 100

Internal Assessment: 10 Marks

General Viva (Theory Viva): 50 Marks

25 marks are allocated to internal examiner and 25 marks to external examiner

Practical Examination: 40 Marks

Practical examination comprises three components i.e. Yearly Workbook, OSPE and experiment

A: Yearly Workbook: 5 Marks (Internal Examiner)

B: OSPE: 22 Marks

OSPE comprises 10 stations (two observed stations carrying 3 marks each and 8 non-observed stations 2 marks each).

C: List of Tests for Observed Stations (3 minutes at each station)

I. Spectrophotometer.

II. Centrifuge Machine.

III. Pipettes.

IV. Blood Samples.

D: Non-Observed Stations (2 minutes for each station)

I. Test to determine the concentration of total cholesterol, HDL cholesterol and triacycerols in plasma.

II. Test to determine the concertration of total proteons, and glucose in plasma and CSF, and albumin in plasma.

III. Determination of plasma uric acid and calcium.

IV. Determination of create nine and urea in plasma, and create nine clearance.

V. Determination of activates of ALT and alkaline phosphates in plasma.

VI. Determination of activities of creatine kinase, LDH and AST.

E: Experiment: 13 marks

I. Principal/supposed calculations of the experiment: 4 marks (External Examiner)

II. Performance pf experiment: 4 Marks (Internal Examiner)

III. Table viva: 5 Marks (External Examiner)

Contents	Objectives	Domain	Strategy	Assessment
Module 1: Cell Biochemistry				
	<ul style="list-style-type: none"> Introduction to biochemistry: An overview of biochemistry and its significance in medicine. Biochemical composition and functions of cell: Organization and composition of eukaryotic and prokaryotic cells (only biochemical aspects) Cell membranes (biochemical composition). Membrane phenomena: Transport of substances across the cell membrane via active (primary and secondary active) transport; diffusion (simple and facilitated), and vesicle-mediated transport (phagocytosis, endocytosis, and exocytosis); Gibbs-Donnan equilibrium, osmosis and osmotic pressure. Membrane receptors and other biologically important regulatory and catalytic membrane-bound proteins like G-proteins, adenyl cyclase, phospholipase. Basic methods to study cell biochemistry: Centrifugation, ultracentrifugation, radioimmunoassay, ELISA (enzyme-linked immunosorbent assay); chromatography; electrophoresis, spectrophotometry, and pHmetry. 	C3 C3 C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/PBL SGD/LAB	SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ OSCE
Module 2: Water, Buffers and pH				
	<ul style="list-style-type: none"> Ionization of water; weak acids and bases pH and pH scale: Concept of pH and related topics (determination of pH), and concept of pI (isoelectric pH) pKa value, dissociation constant (Ka), and titration curve of weak acids Determination of pH of buffer: Henderson-Hasselbalch equation and its applications (derivation not required). Body buffer systems (bicarbonate, ammonia, phosphate, and proteins) and their mechanism of action. 	C3 C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/PBL	SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ
Module 3: Carbohydrates				
	<ul style="list-style-type: none"> Definition, biochemical functions and classification of carbohydrates. Structure and function of biologically important monosaccharides and their important derivatives (sugar acids, sugar alcohols, sugar amines, and glycosides) Isomerism in carbohydrates (types and description) Biologically important disaccharides, their properties and their biomedical importance Oligosaccharides, their combination with other macromolecules and their biomedical importance Homopolysaccharides of biologic significance and their structural and functional characteristics Structural and functional characteristics of heteropolysaccharides including details of glycosaminoglycans; proteoglycans, peptidoglycans; and mucopolysaccharides. 	C3 C3 C3 C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/PBL SGD/PBL SGD/PBL	SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ

Contents	Objectives	Domain	Strategy	Assessment
Module 4: Proteins and AminoAcids				
<ul style="list-style-type: none"> • Biomedical importance and classification (biologic functions ; nutritional value ;and overall shape of molecule) of proteins. • Structure, functions and properties of amino acids • Classification of standard (proteinogenic) amino acids (based upon side chain structure, polarity of side chain, nutritional , and metabolic end-products) , biologically important non-standard (non-proteinogenic) amino acids and their principal functions . • Dissociation and titration of amino acids; determination of pi of amino acids with two and three dissociable groups; importance of amino acids in the maintenance of pH; and mechanism of buffering action of proteins . • Structural organization of proteins: Details of four orders of protein structure (primary, secondary , tertiary, and quaternary); denaturation of proteins; and protein misfolding (amyloidoses and prion disease) • Important techniques for separation of proteins (electrophoresis , isoelectric focusing, chromatography, filtration, centrifugation, and dialysis) . • Immunoglobulins; their types ; structure, and biomedical significance. • Plasma proteins (viz, prealbumin, albumin, haptoglobin, ceruloplasmin, alpha1-anti-trypsin; alpha 2-macroglobulin and transferrin) and their principal biologic functions along with their clinical significance. Alpha fetoprotein and clinically important acute phase proteins (alpha 1-acid glycoprotein , C-reactive protein). • Glycoproteins : components of glycoproteins (overview of linkages between proteins and carbohydrates, N-and O-linked oligosaccharides) 	<p>C33</p> <p>C3 C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3 C3</p> <p>C3</p>	<p>SGD/LEC</p> <p>SGD/PBL SGD/LEC</p> <p>SGD/LEC</p> <p>SGD/PBL</p> <p>SGD/PBL</p> <p>SGD/PBL SGD/PBL</p> <p>SGD/PBL</p>	<p>SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ</p>	
Module 5 Nucleotides				
<ul style="list-style-type: none"> • Chemistry of purines and pyrimidines ; their types and structure • Structure and functions of nucleotides and nucleosides (EXCLUDING metabolism of nucleotides) . • Natural and synthetic derivatives of purines and pyrimidines and their biomedical role. • Structure, functions and types of nucleic acids (EXCLUDING metabolism) 	<p>C3</p> <p>C3</p> <p>C3 C3</p>	<p>SGD/LEC SGD/PBL</p> <p>SGD/LEC SGD/LEC</p>	<p>SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ</p>	

Contents	Objectives	Domain	Strategy	Assessment
Module 6: Lipids and Fatty Acids				
	<ul style="list-style-type: none"> Classification of lipids and their general biological functions. Fatty acids: Definition; nomenclature; classification ; chemical and physical properties; isomerism in fatty acids; role of saturated and unsaturated fatty acids in health and disease ; role of trans fatty acids (transfats) in coronary heart disease; omega-3 and omega-6 fatty acids and the importance of their dietary use. Nutritionally essential fatty acids and their functions Eicosanoids and their biologic functions along with their significance in health and disease Physical and chemical properties of fats and oils (triacylglycerols); saponification, iodine number, and acid number of fats; rancidity of fats Structure and biologic functions & significance of phospholipids , glycolipids , sulfolipids and gangliosides Cholesterol and its related compounds such as bile acids: Structure (constituent structural components), properties and biologic role Lipid peroxidation and its significance 	<p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p>	<p>SGD/LEC SGD/PBL</p> <p>SGD/LEC SGD/LEC SGD/LEC</p> <p>SGD/LEC</p> <p>SGD/LEC</p> <p>SGD/LEC</p>	<p>SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ SGD/MCQ SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ</p>
Module 7: Enzymes				
	<ul style="list-style-type: none"> Introduction, classification and nomenclature of enzymes: Definitions of enzymes and IU of enzyme activity; Enzyme Commission Classification of enzymes along with main subclasses. Properties of enzymes : Chemical nature, active site , catalytic efficiency , specificity, proenzymes , and kinetic properties Coenzymes and cofactors : Coenzymes derived from various vitamins along with the examples of enzymes requiring these coenzymes; and metal cofactors Isozymes and their clinical significance Allosteric enzymes and their biological significance Factors affecting enzyme activity Types of enzyme inhibitors and their biomedical importance: Effects of competitive, non-competitive and uncompetitive inhibitors on enzyme activity , effects of competitive and non-competitive inhibition on Lineweaver-Burke plot. Mechanism of enzyme action and kinetics of enzyme activity (Michaelis Menten and Lineweaver-Burke equations WITHOUT derivation) Regulation of enzyme activity (covalent modification, allosteric regulation and regulation by gene induction, repression & de-repression of enzyme synthesis) Therapeutic use of enzymes and diagnostic application of determination of enzyme activities of certain enzymes in plasma in hepatic, muscle, prostatic, pancreatic, bone and cardiac diseases. 	<p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p>	<p>SGD/LEC</p> <p>SGD/PBL</p> <p>SGD/LEC</p> <p>SGD/LEC SGD/LEC SGD/LEC SGD/LEC</p> <p>SGD/LEC</p> <p>SGD/LEC</p> <p>SGD/LEC</p>	<p>SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SGD/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p>

Contents	Objectives	Domain	Strategy	Assessment
Module 8: Porphyrins and proteins	<ul style="list-style-type: none"> Chemistry and biosynthesis of heme and other porphyrins including disorders of heme biosynthesis (porphyrias) Important hemoproteins found in body along with their principal biologic functions; structure and function of hemoglobin and myoglobin, and types of hemoglobin. Hemoglobin A 1c Oxygen binding capacity of hemoglobin, factors affecting and regulating the oxygen-binding capacity of hemoglobin. Methaemoglobin (metHb) and methaemoglobinemia Bilirubin Metabolism: Degradation of heme, synthesis, hepatic uptake, conjugation, and excretion of bilirubin and fate of bilirubin in intestine. Hyperbilirubinemias: Causes of hyperbilirubinemias along with the acquired and congenital disorders leading to hyperbilirubinemias; jaundice and kernicterus. Hemoglobinopathies: Sickle cell anemia (biochemical cause and its clinical manifestations), haemoglobin C disease, haemoglobin SC disease and thalassemias. 	C3 C3 C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/LEC SGD/LEC	SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/LEC SGD/LEC
Module 9: Vitamins and minerals	<ul style="list-style-type: none"> General features of vitamins as essential nutrients Classification of vitamins according to their physico-chemical nature and biochemical functions Important dietary sources and recommended dietary allowances of vitamins . Intestinal absorption , transport and storage of vitamins. Mechanism of action of vitamins and their biochemical functions in body. Disorders associated with vitamin deficiency and hypervitaminoses . Minerals (sodium , potassium, chloride , calcium , phosphorus , magnesium, and sulfur) and trace elements (iron, zinc , selenium, iodine, copper, chromium, manganese , cadmium and fluoride) in human nutrition and their sources, absorption, transport, storage , and biochemical functions along with their recommended dietary allowances (RDA). 	C3 C3 C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/LEC SGD/LEC	SEQ/MCQ SEQ/MCQ SEQ/MCQ SGD/MCQ SEQ/MCQ SEQ/MCQ

Contents	Objectives	Domain	Strategy	Assessment
Module 10: Nutrition				
	<ul style="list-style-type: none"> Energy metabolism: Caloric value of food , Specific dynamic action (SDA) of food , respiratory quotient , metabolic rate (determination and factors affecting metabolic rate), basal metabolic rate (BMR) (measurement , calculation, and factors affecting BMR) Balanced diet Proteins in nutrition: Obligatory nitrogen loss, nitrogen balance , nutritionally essential amino acids and their role in body growth and nitrogen equilibrium, determination of comparative nutritional efficiency and quality of dietary protein, recommended dietary allowance of protein, protein energy malnutrition (kwashiorkor and marasmus). Fats and lipids in nutrition: Fats as a source of energy, role of saturated and unsaturated fats in health and disease, effect of dietary intake of trans fats on health, and nutritionally essential fatty acids. Carbohydrates in human nutrition: Protein sparing effect of carbohydrates, dietary carbohydrates and blood glucose along with the details of glycemic index, dietary fibers (types and biomedical importance) . Calculation of caloric requirement of a person and nutritional requirements in pregnancy, lactation, infancy, and old age . Obesity and food additives (artificial sweeteners and flavor enhancers) 	<p>C3</p> <p>C3 C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p>	<p>SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ</p> <p>SGD/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p>	
Module 11 Extracellular matrix				
	<ul style="list-style-type: none"> Collagen : Types and structure of collagen ; biosynthesis & degradation of collagen ; collagenopathies (Ehlers-Danlos syndrome (EDS) and Osteogenesis imperfecta) Elastin: Structural characteristics of elastins ; role of alpha1-antitrypsin in elastin degradation ; major biochemical differences between collagen and elastin; genetic disorders associated with elastin like Williams-Beuren syndrome, supravalvular aortic stenosis, pulmonary emphysema , and aging of the skin. Fibrillin-1 as a protein of microfibrils; Marfan syndrome ; fibronectin and its role in cell adhesion and migration ; laminin as a protein component of renal glomerular and other basal laminae. Glycosaminoglycans (GAGs): Structure , classification , functions and distribution of GAGs ; diseases associated with enzyme deficiencies of degradation of GAGs (mucopolysaccharidoses - Hunter syndrome & Hurler syndrome) Structure and functions of proteoglycan 	<p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p>	<p>SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SGD/MCQ</p> <p>SGD/MCQ</p> <p>SEQ/MCQ</p>	

Contents	Objectives	Domain	Strategy	Assessment
Module 12 Practical biochemistry tests				
	<ul style="list-style-type: none"> • Introduction to use of laboratory facilities including safety measures • Preparation of solutions : Preparation of solutions (molar and normal) from various kinds of laboratory chemicals (solid and liquids); • Preparation of various kinds of buffer solutions ; • Basic methods of laboratory calculations; • Introduction and conversion of conventional and SI measuring units. • Demonstration of buffer action, and determination of pH (by using indicators and pH meter). • Qualitative analysis of carbohydrates and proteins. • Tests to detect monosaccharides of biomedical significance — glucose , fructose and Galactose (Benedict's test , Selivanoff's test , and Osazone test) • Tests to detect proteins / peptides / amino acids (Heat coagulation test , sulphosalicylic acid test , Heller's Ring test and Ninhydrin test) • Collection and storage of urine samples for laboratory analysis, and physical and chemical analysis of urine to detect normal and abnormal constituents. 	<p>C3 P2 A2 C3 P2 A2</p> <p>C3 P2 A2 C3 P2 A2 C3 P2 A2 C3 P2 A2</p> <p>C3 P2 A2 C3 P2 A2</p> <p>C3 P2 A2</p> <p>C3 P2 A2</p>	<p>SGD/LAB SGD/LAB</p> <p>SGD/LAB SGD/LAB SGD/LAB SGD/LAB</p> <p>SGD/LAB SGD/LAB</p> <p>SGD/LAB</p> <p>SGD/LAB</p>	<p>PRAC/OSCE PRAC/OSCE</p> <p>PRAC/OSCE PRAC/OSCE PRAC/OSCE PRAC/OSCE</p> <p>PRAC/OSCE PRAC/OSCE</p> <p>PRAC/OSCE</p> <p>PRAC/OSCE</p>

At the end of the Part-II course, the student should be able to demonstrate his knowledge and understanding on the subject with following learning objectives

- To be familiar with the homeostatic mechanisms through the concepts of inter-regulation of carbohydrates, lipids and protein metabolism and its relation to hormone actions in the human body.
- Once these basic concepts are understood, it will be straightforward to understand how alterations in the basic processes can lead to a disease state.
- To have understanding and knowledge about many pathological situations where these can be related to biochemical defects, and to have some experience of biochemical techniques in order to understand the practical/clinical problems in biochemistry.
- To develop skills as a self-directed learner, recognize continuing educational needs; use appropriate learning resources and critically analyze relevant literature in order to have a comprehensive understanding and knowledge of biochemistry.
- To learn and understand the basic biochemical processes taking place in the body since these underline an understanding of normal and abnormal human metabolism. In order to accomplish this, the student should learn how large molecules are synthesized and used (DNA, RNA, and proteins), and how energy is generated, stored, and retrieved (metabolism).

Contents	Objectives	Domain	Strategy	Assessment
Module 13 Bioenergetics and Biological Oxidation				
<ul style="list-style-type: none"> Endergonic and exergonic reactions, free energy, free energy change, ATP and other compounds as carriers of energy Electron transport chain: Components and organization of electron transport chain (ETC) Reactions of electron transport chain, redox potential, methods of electron transfer among the components of electron transport chain, and energy release during electron transport Oxidative phosphorylation: ATP synthesis in ETC, inhibitors and uncouplers of oxidative phosphorylation, and chemiosmotic hypothesis of oxidative phosphorylation. 	C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC	SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ	
Module 14 Carbohydrate Metabolism				
<ul style="list-style-type: none"> Glycolysis :Reactions of aerobic and anaerobic glycolysis occurring in RBCs and other tissues, Biological significance and energy yield of aerobic and anaerobic glycolysis and its significance, and substrate-level phosphorylation, Regulation of glycolytic pathway, Metabolic fates of pyruvate, Lactic acidosis; genetic deficiency of pyruvate kinase and pyruvate dehydrogenase Tricarboxylic acid (TCA) cycle: Reactions of TCA cycle and their regulation along with energy yield ,Importance of TCA cycle and its amphibolic role Gluconeogenesis: Reactions of gluconeogenesis using pyruvate and glycerol as precursors, and regulation of gluconeogenesis, Important gluconeogenic precursors: Entrance of amino acids, intermediates of TCA cycle, glycerol, and other compounds as gluconeogenic precursors, Biomedical significance of gluconeogenesis: Role of gluconeogenesis in plasma glucose level regulation, and the Cori cycle, and glucose-alanine cycle. Glycogen metabolism: Synthesis and importance of UDP glucose, Reactions of glycogenesis and glycogenolysis, Regulation of glycolytic synthase and glycogen phosphorylase, Importance of allosteric regulation of glycogen phosphorylase 'a' (a plasma glucose sensor) by plasma glucose, Disorders of glycogen metabolism (glycogen storage diseases), The hexose monophosphate pathway and other pathways of hexose metabolism, Hexose monophosphate (HMP) pathway: Reactions of oxidative and non oxidative phases of HMP pathway, importance of HMP pathway along with uses of NADPH, and glucose 6-phosphate dehydrogenase deficiency, Reactions of uronic acid pathway along with its biological importance., Metabolism of fructose: Metabolic fate of fructose in human body, sorbitol metabolism along with effect of hyperglycemia on sorbitol metabolism, essential fructosuria and hereditary fructose intolerance ,Metabolism of galactose: Metabolic fate of galactose in body and synthesis of lactose; and disorders of galactose metabolism (galactokinase deficiency and classic galactosemia), Metabolism of ethanol) Regulation of blood glucose level : Regulation of plasma glucose hormonally (insulin, glucagon, growth hormone, epinephrine, and cortisol) and non-hormonally, and the role of various metabolic pathways in blood glucose level regulation, Hypoglycemia and hyperglycemia: An overview of hypoglycemia and hyperglycemia, their important causes, and clinical manifestations, Diabetes mellitus: Types of diabetes mellitus along with its clinical manifestations, metabolic changes in type 1 and type 2 diabetes mellitus, and diagnosis of diabetes mellitus 	C3 C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/LEC	SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ	

Contents	Objectives	Domain	Strategy	Assessment
Module 15: Lipid Metabolism	<ul style="list-style-type: none"> de novo synthesis of fatty acids: Production of cytosolic acetyl CoA, fatty acid synthase multienzyme complex, reactions of cytosolic fatty acid synthesis, elongation of fatty acid chain, synthesis of polyunsaturated fatty acid, and regulation of fatty acid synthesis. Synthesis and storage of triacylglycerols in body. Mobilization of stored triacylglycerols along with its regulation Oxidation of fatty acids: Activation of fatty acid, translocation of fatty acyl CoA into mitochondrial matrix, reactions of β-oxidation of saturated and unsaturated fatty acids, energy yield of β-oxidation, fate of acetyl CoA, and other types of fatty acid oxidation (alpha-oxidation, omega-oxidation, and oxidation of odd-carbon fatty acids). Synthesis and utilization of ketone bodies: Reactions of hepatic ketogenesis, and utilization of ketone bodies by extrahepatic tissues. Ketoacidosis and regulation of ketogenesis. Synthesis of eicosanoids, their regulation and functions along with their biomedical importance. Metabolism of phospholipids and sphingolipids: Synthesis of phospholipids (phosphatidylcholine and phosphatidylethanolamine), synthesis of glycerol ether phospholipids (cardiolipin and platelet activating factor), degradation of phospholipids, deficiency of lung surfactant, metabolism of glycolipids, biosynthesis of ceramide, sphingomyelin, and gangliosides, and degradation of sphingolipids along with sphingolipidoses. Cholesterol metabolism: Reactions and regulation of cholesterol biosynthesis, and fate and functions of cholesterol in body. Biosynthesis and fate of bile acids and their significance in health and disease. Plasma lipoproteins: Synthesis, transport, and fate of chylomicrons, VLDL, IDL, LDL, and HDL; disorders associated with impairment of lipoprotein metabolism, and atherogenic effect of oxidized LDL. Biochemical defects leading to fatty liver 	<p>C3</p> <p>C3 C3 C3</p> <p>C3</p> <p>C3 C3</p> <p>C3</p> <p>C3</p> <p>C3</p> <p>C3</p>	<p>SGD/LEC</p> <p>SGD/PBL SGD/LEC SGD/LEC</p> <p>SGD/LEC</p> <p>SGD/LEC SGD/LEC</p> <p>SGD/LEC</p> <p>SGD/LEC</p> <p>SGD/LEC SGD/LEC</p> <p>SGD/LEC</p>	<p>SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ</p>
Module 16: Metabolism of proteins and amino acids	<ul style="list-style-type: none"> overview of protein turnover in human body; nitrogen balance (positive and negative). Inter-organ amino acid exchange in normal post-absorptive state Degradation of amino acids; removal of nitrogen from amino acids by transamination and deamination; sources of ammonia in body; transport of ammonia, ammonia toxicity; fate of ammonia in body, reactions and regulation of the urea cycle along with metabolic disorders of the urea cycle An overview of amphibolic intermediates formed from the carbon skeleton of amino acids of glucogenic and ketogenic amino acids; an outline of the metabolism of individual amino acids like glycine, cysteine, arginine, proline, phenylalanine, tyrosine, histidine, tryptophan, methionine amino acids; causes and salient features of important metabolic defects in amino acid metabolism like phenylketonuria, maple syrup urine disease (MSUD), histidinemia, alkaptonuria, cystathioninuria, homocystinuria, hyperprolinemia, cystinuria, cystinosis, tyrosinemia, and albinism. of epinephrine and norepinephrine, creatine, creatinine, histamine, gamma-aminobutyrate, serotonin, melatonin, and melanin 	<p>C3</p> <p>C3 C3</p> <p>C3</p> <p>C3 C3</p> <p>C3</p>	<p>SGD/LEC</p> <p>SGD/PBL SGD/LEC</p> <p>SGD/LEC SGD/LEC</p> <p>SGD/LEC</p>	<p>SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ</p>

Contents	Objectives	Domain	Strategy	Assessment
Module 17: Integration and Regulation of Metabolic Pathways				
	<ul style="list-style-type: none"> Fed-fast cycle and starvation. Basic concepts of intermediary metabolism, introduction of anabolic and catabolic pathways. An overview of regulation and integration of various metabolic pathways (role of liver, heart, brain, skeletal muscle and adipose tissue). 	C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC	SEQ/MCQ SEQ/MCQ SEQ/MCQ
Module 18 :Metabolism of Nucleotides				
	<ul style="list-style-type: none"> de novo Synthesis of purines and pyrimidines; the salvage pathways of nucleotide synthesis; degradation of purine and pyrimidine nucleotides Disorders associated with purine nucleotide metabolism like adenosine deaminase deficiency, purine nucleoside phosphorylase deficiency, and hyperuricemia Natural and synthetic derivatives of purines and pyrimidines and their role in health and disease. 	C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC	SEQ/MCQ SEQ/MCQ SEQ/MCQ
Module 19: Biochemical Genetics				
	<ul style="list-style-type: none"> The structural basis of cellular information Organization of DNA: chromosomes, Karyotyping. Replication of DNA: Reactions of DNA replication in eukaryotes and prokaryotes; types of damage to DNA and DNA repair; mutations Transcription (DNA-dependent RNA synthesis): Steps in the transcription of eukaryotic and prokaryotic genes; post-transcriptional modifications (processing) of RNA; reverse transcription in retroviruses and its relation to cancers and AIDS. Translation (protein synthesis): The genetic code; components required for protein synthesis, composition of eukaryotic and prokaryotic ribosomes; steps of protein synthesis; post-translational modifications of polypeptide chains; protein targeting. Regulation of gene expression in prokaryotes and eukaryotes Molecular biology techniques: Basic information and biomedical importance of molecular biology techniques; DNA extraction; recombinant DNA technology; DNA cloning; polymerase chain reaction (PCR); hybridization; blotting techniques . Oncogenes and their role in carcinogenesis; mechanisms of activation of proto-oncogenes; mechanism of action of oncogenes; tumour suppressor genes and oncogenic viruses. Genetic basis of disease Important tumor markers and their clinical significance (Carcinoembryonic Antigen, Alpha fetoprotein, human chorionic gonadotropin, calcitonin and prostatic acid phosphatase). 	C3 C3 C3 C3 C3 C3 C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/LEC SGD/LEC SGD/LEC	SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ

Contents	Objectives	Domain	Strategy	Assessment
Module 20: Biochemistry of endocrine system				
<ul style="list-style-type: none"> An overview of endocrine system; classification of hormones based on their mechanism of action and chemical nature; mechanisms of action of each class of hormone ; general characteristics of various types of hormone receptors ; types and actions of various kinds of G-proteins in mediating the actions of hormones; signal transduction pathways of various hormones; types and role of various kinds of second messengers Pituitary and hypothalamic hormones: Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of all hypothalamic and pituitary hormones; disorders associated with hyper- and hypo-activities of these hormones such as growth hormone deficiency (dwarfism), gigantism, acromegaly, Cushing's syndrome , Addison's disease , Diabetes insipidus, and the inappropriate secretion of ADH (SIADH). Thyroid Hormones: Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of all thyroid hormones; disorders associated with hyper- and hypo-activities of these hormones like goiter, hypothyroidism , hyperthyroidism , Graves' disease . Calcium Regulating Hormones: Structure, biosynthesis , secretion, transport, regulation, catabolism, and biologic actions of parathyroid hormone; disorders associated with hyper- and hypo-activities of these hormones like; role of parathyroid hormone, calcitriol, and calcitonin in calcium homeostasis; hypoparathyroidism, hyperparathyroidism (primary, secondary, and tertiary), pseudohypoparathyroidism, rickets, and osteomalacia). Adrenal Cortical Hormones: Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of all adrenal cortical hormones ; disorders associated with hyper- and hypo-activities of these hormones like Cushing's disease I syndrome , secondary adrenal deficiency, Addison's disease , primary aldosteronism and secondary aldosteronism . Adrenal Medullary Hormones: Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of all adrenal medullary hormones; and associated disorders like pheochromocytoma Male and Female Gonadal Hormones: Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of all male and female gonadal hormones; disorders associated with hyper- and hypo-activities of these hormones like; hypergonadism and hypogonadism in males and females. Hormones of Pancreas: Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of all pancreatic hormones (insulin, glucagon, somatostatin and pancreatic polypeptide); disorders associated with hyper- and hypo-activities of these hormones like; pathophysiology of insulin deficiency and diabetes mellitus 	C3 C3 C3 C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/LEC	SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ	

Contents	Objectives	Domain	Strategy	Assessment
Module 21: Biochemistry of Gastrointestinal system				
	<ul style="list-style-type: none"> Introduction, chemical composition, and secretion and regulation of various digestive juices of GIT such as saliva, gastric juice & HCl, pancreatic juice, bile, and succus entericus Hydrolysis (digestion) of carbohydrates, lipids, proteins, and nucleic acids in gastrointestinal tract Absorption of carbohydrates, lipids and amino acids. Disease states associated with GIT disorders like achlorhydria, peptic ulcers, lactose intolerance, cholelithiasis and pernicious anemia, cystic fibrosis and celiac disease. Site of synthesis and major actions of gastrointestinal hormones like gastrin, cholecystokinin (CCK), secretin, gastric inhibitory peptide (GIP), vasoactive intestinal polypeptide (VIP), motilin, enkephalins, substance P, neurotensin, and enteroglucagon. 	C3 C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC SGD/PBL	SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ
Module 22: Metabolism of xenobiotics				
	<ul style="list-style-type: none"> Definition and classes of important xenobiotics of medical relevance, their phases of metabolism and clinical significance (Cytochrome P450: Cytochrome P450 hydroxylase cycle in microsomes; role of cytochrome P450 in phase I metabolism of xenobiotics; induction of cytochrome P450) Phase II metabolism of xenobiotics; types of phase II reactions; Responses to xenobiotics including pharmacologic, toxic, immunologic and carcinogenic effects 	C3 C3 C3	SGD/LEC SGD/LEC SGD/LEC	SEQ/MCQ SEQ/MCQ SEQ/MCQ
Module 23: Water & electrolyte balance; acid-base regulation				
	<ul style="list-style-type: none"> Biochemical mechanisms to regulate water and electrolyte balance in body: Fluid compartments of the body; gain and loss of body water; regulation of body water balance, effect of pure water deprivation, water excess or water intoxication; and electrolytes of body fluids (sodium, potassium, magnesium and chloride). Body buffer systems, role of lung and kidney in maintenance of acid-base balance Acid-base disturbance in the body like respiratory and metabolic acidosis (lactic acidosis and ketoacidosis); respiratory and metabolic alkalosis; concept of anion gap, base excess and base deficit. Clinical interpretation of laboratory report of arterial blood gases. 	C3 C3 C3 C3	SGD/LEC SGD/PBL SGD/LEC SGD/LEC	SEQ/MCQ SEQ/MCQ SEQ/MCQ SEQ/MCQ

Contents	Objectives	Domain	Strategy	Assessment
Module 24 Practical special biochemistry				
	<ul style="list-style-type: none"> The introduction of techniques and instrumentation of clinical biochemistry like centrifugation, spectrophotometry (visible, UV, infra red and atomic absorption), pH metry, chromatography, electrophoresis, enzyme-linked immunosorbent assay (ELISA), micropipetting, flame photometry and ion selective electrode (ISE) technique Collection, preservation, and storage of blood sample Estimation of various substances in blood and other biological fluids, like glucose, creatinine, urea, protein, albumin, uric acid, and calcium, total cholesterol; HDL cholesterol, and triglycerols; demonstration of creatinine clearance; and oral glucose tolerance test (OGTT) Determination of plasma enzyme activities of alanine aminotransferase (ALT), aspartate aminotransferase (AST), amylase, creatine phosphokinase (CK), alkaline phosphatase (ALP), and lactate dehydrogenase (LDH) Clinical interpretation of common laboratory values of the compounds and enzymes as listed above Determination of amino acids in urine by paper chromatography (demonstration) 	<p>C3</p> <p>C3 C3</p> <p>C3</p> <p>C3</p> <p>C3</p>	<p>SGD/LEC</p> <p>SGD/PBL SGD/LEC</p> <p>SGD/LEC</p> <p>SGD/LEC</p> <p>SGD/LEC</p>	<p>SEQ/MCQ</p> <p>SEQ/MCQ SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p> <p>SEQ/MCQ</p>

Domain	Level
Knowledge	C1 Knowledge C2 Comprehension C3 Application C4 Analysis C5 Synthesis C6 Evaluation
Psychomotor	P1 Observe P2 Practice P3 Adjust P4 Master P5 Develop P6 Construct
Affect	A1 Receiving A2 Responding A3 Valuing A4 Organization A5 Characterization