AL-ALEEM MEDICAL COLLEGE | GULAB DEVI TEACHING HOSPITAL LAHORE

Study Guide
MBBS
Biochemistry Department

DEPARTMENT OF BIOCHEMISTRY

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INTRODUCTION

"Biochemistry marches on!" More you explore more you appreciate. Understanding a harmonious balance of biochemical processes at molecular level in the body helps to comprehend the fundamentals of Medicine, the "Science of Healing".

The Department of Biochemistry at Al Aleem Medical College, attached with Gulab-Devi Trust Hospital which has the historic value, was established in 1934, is presently engaged in equipping the students with basic knowledge of Biochemistry in contextual manner. Special emphasis is given on the applied aspects to have a better command on human chemistry with relevance to common functional disturbances.

The college is affiliated with University of Health Sciences, Lahore and has been established under the guidelines of PMDC with the required infrastructure, professional and qualified faculty.

VISION

to inculcate the understanding of molecular events that govern normal physiological functions and pathological disturbances of human body in contextual manner.

MISSION

The world-class curriculum of Biochemistry aligned with the vision and mission of PMDC and the institute, has been designed to help extrapolate a blend of basic biochemical aspects, molecular and genetic information in an integrated manner, essential for developing a perspective on the function of human body in health and disease.

The program emphasizes on:

- Acquisition of knowledge of the subject in depth via various teaching/learning modalities strategies like interactive lecture sessions, team-based leaning (TBL), individual assignments, directed self-learning (DSL) and self-directed learning (SDL).
- Building attributes like cooperativity, critical thinking and problem solving skills through working within teams in practical demonstration exercises and small group discussions.
- Enhancing the professionalism, communication and leadership qualities through class presentations.

which will enable the student to evolve into future researcher, lifelong learner, community leader and off course a better health care provider.

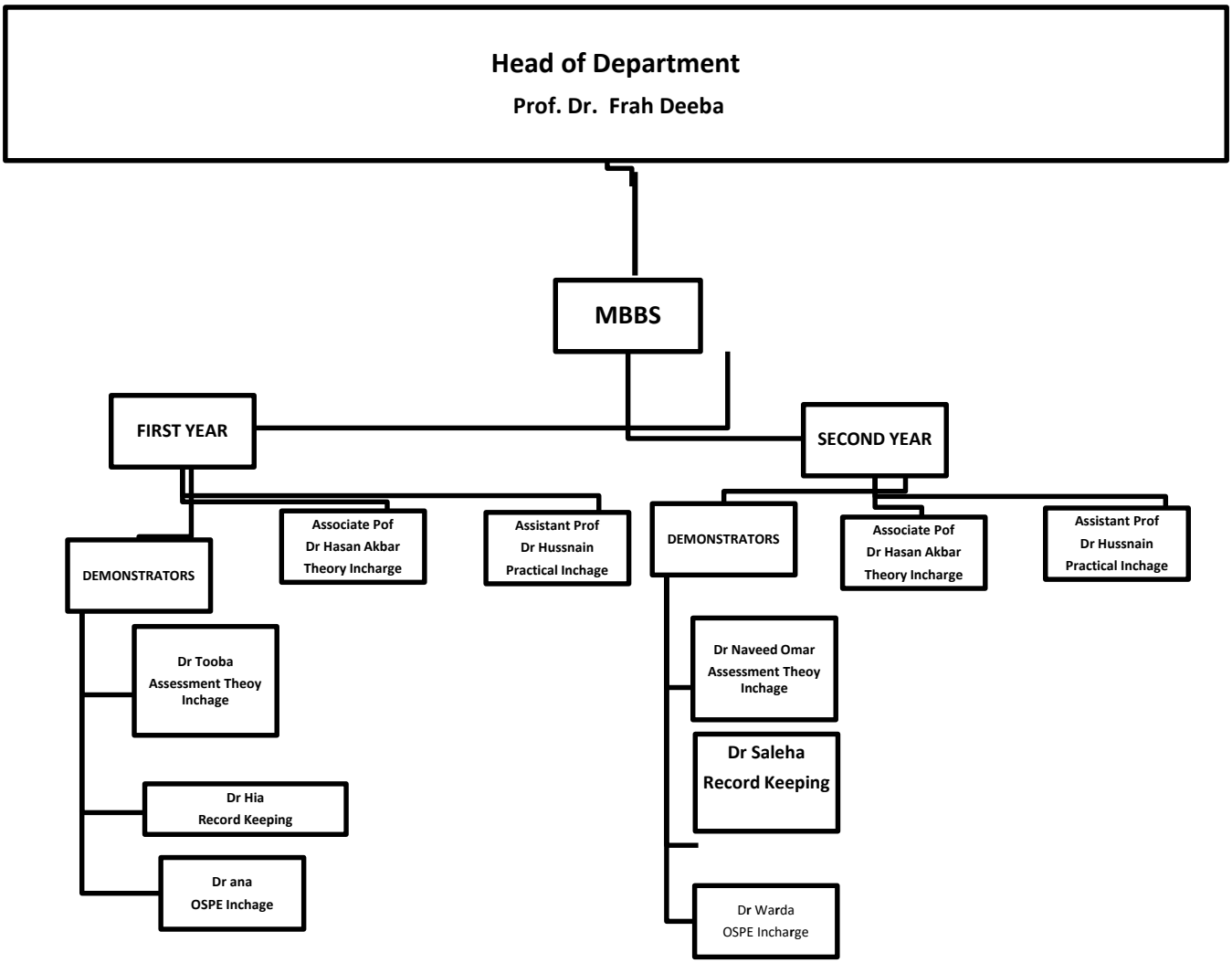
The department provides a conducive working environment for the various faculty members and the supporting staff which is based on respect, dignity, professionalism and team work.

TEACHING FACULTY

Sr. #	Name	Qualification	Designation
1	Prof. Dr. Farah Deeba	MBBS, MPhil, PhD (Biochemistry), CHPE	Head and Dean of Biochemistry
2	Dr. Hasan Akbar Khan	MBBS, MPhil, PhD Scholar	Associate Professor
3	Dr. Muhammad Hussnain	MBBS, MPhil	Assistant Professor
4	Dr. Naveed Umer Lodhi	MBBS, MPhil (Part I, II passed, Thesis pending)	Senior Demonstrator
5	Dr. Saleha Akram	MBBS, MPhil	Senior Demonstrator
6	Dr. Tooba Ali	MBBS, MPhil (Part I, II passed, Thesis pending)	Senior Demonstrator
7	Dr. Hira Saeed	MBBS, MPhil (Part I, II passed, Thesis pending)	Senior Demonstrator
8	Dr. Fizzah Iqbal	MBBS	Demonstrator
9	Dr. Warda Chaudhri	MBBS	Demonstrator

PARAMEDICAL STAFF

Sr. #	Name	Designation
1	Mr. Bashir Ahmad	Lab Technician
2	Mr. Muhammad Saqib Nadeem	Computer Operator
3	Mr. Muhammad Akmal Bashir	Store Keeper
4	Mr. Muhammad Azam Aziz	Lab Attendant


Head of Department
Prof. Dr. Frah Deeba
MBBS
FIRST YEAR
SECOND YEAR
DEMONSTRATORS
Associate Pof
Dr Hasan Akbar
Theory Incharge
Assistant Prof
Dr Hussnain
Practical Inchage
Dr Tooba
Assessment Theoy
Inchage
Dr Hia
Record Keeping
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OSPE Inchage
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Associate Pof
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Theory Incharge
Assistant Prof
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Practical Inchage
Dr Naveed Omar
Assessment Theoy
Inchage
Dr Saleha
Record Keeping
Dr Warda
OSPE Incharge

SYLLABUS MBBS FIRST PROFESSONAL

Learning Objectives

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

1. Molecular and functional organization of a cell, and sub-cellular components.
2. In-depth knowledge of structure, function and interrelationship of biomolecules and consequences of deviation from normal.
3. 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).
4. Description of mechanisms involved in maintenance of body fluid & pH and the related homeostatic processes.
5. 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.
6. Having a clear understanding of the fundamental aspects of enzymology & clinical applications along with regulation of enzyme activity.
7. 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.

1- Cell Biochemistry

a) Introduction to biochemistry: An overview of biochemistry and its significance in medicine.

b) Biochemical composition and functions of cell: Organization and composition of eukaryotic and prokaryotic cells (only biochemical aspects)

c) Cell membranes (biochemical composition)

d) 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

e) Membrane receptors and other biologically important regulatory and catalytic membrane-bound proteins like G-proteins, adenlylyl cyclase, phospholipase.

f) Basic methods to study cell biochemistry: Centrifugation, ultracentrifugation, radioimmunoassay, ELISA (enzyme-linked imnunosorbent assay); chromatography; electrophoresis, spectrophotometry, and pH metry.

2- Water, pH and buffers

a) Ionization of water; weak acids and bases

b) pH and pH scale: Concept of pH and related topics (determination of pH), and concept of pl (isoelectric pH)

c) pKa value, dissociation constant (Ka), and titration curve of weak acids

d) Determination of pH of buffer: Henderson-Hasselbalch equation and its applications (derivation not required).

e) Body buffer systems (bicarbonate, ammonia, phosphate, and proteins) and their mechanism of action.

3- Carbohydrates

a) Definition, biochemical functions and classification of carbohydrates.

b) Structure and function of biologically important monosaccharides and their important derivatives (sugar acids, sugar alcohols, sugar amines, and glycosides)

c) Isomerism in carbohydrates (types and description)

d) Biologically important disaccharides, their properties and their biomedical importance

e) Oligosaccharides, their combination with other macromolecules and their biomedical importance

f) Homopolysaccharides of biologic significance and their structural and functional characteristics

g) Structural and functional characteristics of heteropolysaccharides including details of glycosaminoglycans; proteoglycans, peptidoglycans; and mucopolysaccharidoses.

4- Amino acids and Proteins

a) Biomedical importance and classification (biologic functions; nutritional value; and overall shape of molecule) of proteins.
b) Structure, functions and properties of amino acids
c) 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.
d) Dissociation and titration of amino acids; determination of pl 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.
e) 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)
f) Important techniques for separation of proteins (electrophoresis, isoelectric focusing, chromatography, filtration, centrifugation, and dialysis).
g) Immunoglobulins; their types; structure, and biomedical significance.
h) Plasma proteins (viz, prealbumin, albumin, haptoglobin, ceruloplasmin, alpha I-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 I-acid glycoprotein, C-reactive protein).
i) Glycoproteins: components of glycoproteins (overview of linkages between proteins and carbohydrates, N- and O-linked oligosaccharides).

5- Nucleotides and nucleic acids

a) Chemistry of purines and pyrimidines; their types and structure
b) Structure and functions of nucleotides and nucleosides (EXCLUDING metabolism of nucleotides).
c) Natural and synthetic derivatives of purines and pyrimidines and their biomedical role.
d) Structure, functions and types of nucleic acids (EXCLUDING metabolism)

6- Lipids and fatty acids

a) Classification of lipids and their general biological functions.
b) 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 (trans-fats) in coronary heart disease; omega-3 and omega-6 fatty acids and the importance of their dietary use.
c) Nutritionally essential fatty acids and their functions
d) Eicosanoids and their biologic functions along with their significance in health and disease.
e) Physical and chemical properties of fats and oils (triacylglycerols); saponification, iodine number, and acid number of fats; rancidity of fats
f) Structure and biologic functions & significance of phospholipids, glycolipids, sulfolipids and gangliosides
g) Cholesterol and its related compounds such as bile acids: Structure (constituent structural components), properties and biologic role
h) Lipid peroxidation and its significance

7- Enzymes

a) Introduction, classification and nomenclature of enzymes: Definitions of enzymes and IU of enzyme activity; Enzyme Commission Classification of enzymes along with main subclasses.

b) Properties of enzymes: Chemical nature, active site, catalytic efficiency, specificity, proenzymes, and kinetic properties

c) Coenzymes and cofactors: Coenzymes derived from various vitamins along with the examples of enzymes requiring these coenzymes; and metal cofactors

d) Isozymes and their clinical significance

e) Allosteric enzymes and their biological significance

f) Factors affecting enzyme activity

g) 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.

h) Mechanism of enzyme action and kinetics of enzyme activity (Michaelis Menten and Lineweaver-Burke equations WITHOUT derivation)

i) Regulation of enzyme activity (covalent modification, allosteric regulation and regulation by gene induction, repression & de-repression of enzyme synthesis)

j) 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.

8- Porphyrins and hemoproteins

a) Chemistry and biosynthesis of heme and other porphyrins including disorders of heme biosynthesis (porphyrias)

b) Important hemoproteins found in body along with their principal biologic functions; structure and function of hemoglobin and myoglobin, and types of hemoglobin. Hemoglobin AIC

c) Oxygen binding capacity of hemoglobin, factors affecting and regulating the oxygen-binding capacity of hemoglobin. Methaemoglobin (metHb) and methaemoglobinemia.

d) Bilirubin Metabolism: Degradation of heme, synthesis, hepatic uptake, conjugation, and excretion of bilirubin and fate of bilirubin in intestine.

e) Hyperbilirubinemias: Causes of hyperbilirubinemias along with the acquired and congenital disorders leading to hyperbilirubinemias; jaundice and kernicterus.

f) Hemoglobinopathies: Sickle cell anemia (biochemical cause and its clinical manifestations), haemoglobin C disease, haemoglobin SC disease and thalassemias.

9- Vitamins and Minerals

a) General features of vitamins as essential nutrients

b) Classification of vitamins according to their physico-chemical nature and biochemical functions

c) Important dietary sources and recommended dietary allowances of vitamins.

d) Intestinal absorption, transport and storage of vitamins.

e) Mechanism of action of vitamins and their biochemical functions in body.

f) Disorders associated with vitamin deficiency and hypervitaminoses.

g) 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).

10- Nutrition

a) 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)

b) Balanced diet

c) 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).

d) 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 transfats on health, and nutritionally essential fatty acids.

e) 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).

f) Calculation of caloric requirement of a person and nutritional requirements in pregnancy, lactation, infancy, and old age.

g) Obesity and food additives (artificial sweeteners and flavor enhancers)

11- The Extracellular Matrix

a) Collagen: Types and structure of collagen; biosynthesis & degradation of collagen; collagenopathies (Ehlers-Danlos syndrome (EDS) and Osteogenesis imperfecta (01))

b) Elastin: Structural characteristics of elastins; role of alphal-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.

c) Fibrillin-l as a protein of microfibrills; Marfan syndrome; fibronectin and its role in cell adhesion and migration; laminin as a protein component of renal glomerular and other basal laminas.

d) Glycosaminoglycans (GAGs): Structure, classification, functions and distribution of GAGs; diseases associated with enzyme deficiencies of degradation of GAGs (mucopolysaccharidoses — Hunter syndrome & Hurler syndrome)

e) Structure and functions of proteoglycans

Laboratory Experiments

- Introduction to use of laboratory facilities / equipment 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; e 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.
- Writing a urine report and interpretation of results of urine analysis.

RECOMMENDED BOOKS

- Harper's Illustrated Biochemistry by Murrary RK, Granner DK 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.

REFERENCE BOOKS

- 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

Table of Specifications for Biochemistry Theory Paper

MBBS First Professional Examination

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. Heme metabolism, porphyrins, porphyrias, jaundice, hemoglobin & myoglobin, hemoglobinopahties	1.0	4
Total items	09 SEQs	45 MCQs
Total Marks (5 marks for each SEQ and 1 mark for each MCQ)	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: SEQ+ MCQ+ Internal Assessment=

45+ 45+ 10=100 Marks

Table of Specifications for Biochemistry Oral & Practical Examination

MBBS First Professional Examination

Oral and Practical Examination carries 100 marks

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 nonobserved stations; 2 marks for each station — time allowed is 2 minutes for each non-observed station.	22
E- Practical a. Principle, 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

SYLLABUS MBBS SECOND PROFESSIONAL

Learning objectives

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

1. 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.
2. Once these basic concepts are understood, it will be straightforward to understand how alterations in the basic processes can lead to a disease state.
3. 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.
4. 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.
5. 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).
6. To describe digestion assimilation of nutrients & consequences of malnutrition. Integrate the various aspects of metabolism & their regulatory pathways.
7. To explain biochemical basis of inherited disorders with their associated sequelae.
8. To outline the molecular mechanisms of gene expression, the principles of genetic engineering & their applications in medicine.
9. To outline the biochemical basis of cancer & carcinogenesis.
10. To make use of conventional techniques/instruments to perform biochemical analysis relevant to clinical screening & diagnosis. Familiarize with principles of various conventional & specialized lab investigations & instrumentation analysis & interpretation of a given data.
11. Applying basic knowledge of protein synthesis, post translational modification and targeting to its cellular destination.
12. 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

1- **Bioenergetics and Biologic Oxidation**

a) Endergonic and exergonic reactions, free energy, free energy change, ATP and other compounds as carriers of energy

b) Electron transport chain: Components and organization of electron transport chain (ETC)

c) Reactions of electron transport chain, redox potential, methods of electron transfer among the components of electron transport chain, and energy release during electron transport

d) Oxidative phosphorylation: ATP synthesis in ETC, inhibitors and uncouplers of oxidative phosphorylation, and chemiosmotic hypothesis of oxidative phosphorylation.

2- **Metabolism of Carbohydrates**

a) Glycolysis

- Reactions of aerobic and anaerobic glycolysis occurring in RBCs and other tissues
- Biomedical significance and energy yield of aerobic and anaerobic glycosis 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

b) Tricarboxylic acid (TCA) cycle

- Reactions of T CA cycle and their regulation along with energy yield.
- Importance of TCA cycle and its amphibolic role

c) 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.

d) Glycogen metabolism

- Synthesis and importance of UDP glucose
- Reactions of glycogenesis and glycogenolysis
- Regulation of glycogenic 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)

e) The hexose monophosphate pathway and other pathways of hexose metabolism

- Hexose monophosphate (HMP) pathway: Reactions of oxidative and nonoxidative 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 biologic 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

f) 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.

3- **Metabolism of lipids**

a) 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.

b) Synthesis and storage of triacylglycerols in body.

c) Mobilization of stored triacylglycerols along with its regulation

d) Oxidation of fatty acids: Activation of fatty acid, translocation of fatty acyl COA into mitochondrial matrix, reactions of ß-oxidation of saturated and unsaturated fatty acids, energy yield of ß-oxidation, fate of acetyl COA, and other types of fatty acid oxidation (alpha-oxidation, omega-oxidation, and oxidation of odd-carbon fatty acids).

e) Synthesis and utilization of ketone bodies: Reactions of hepatic ketogenesis, and utilization of ketone bodies by extrahepatic tissues.

f) Ketoacidosis and regulation of ketogenesis.

g) Synthesis of eicosanoids, their regulation and functions along with their biomedical importance.

h) 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.

i) Cholesterol metabolism: Reactions and regulation of cholesterol biosynthesis, and fate and functions of cholesterol in body.

j) Biosynthesis and fate of bile acids and their significance in health and disease.

k) 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.

l) Biochemical defects leading to fatty liver

4- **Metabolism of Proteins and Amino Acids**

a) An overview of protein turnover in human body; nitrogen balance (positive and negative).

b) Inter-organ amino acid exchange in normal post-absorptive state

c) 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.

d) An overview of amphibolic intermediates formed from the carbon skeleton of amino acids.

e) Concept 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, tyrosinemias, and albinism.

f) Metabolism of epinephrine and norepinephrine, creatine, creatinine, histamine, gamma-aminobutyrate, serotonin, melatonin, and melanin

5- **Integration and Regulation of Metabolic Pathways**

a) Fed-fast cycle and starvation.

b) Basic concepts of intermediary metabolism, introduction of anabolic and catabolic pathways.

c) An overview of regulation and integration of various metabolic pathways (role of liver, heart, brain, skeletal muscle and adipose tissue).

6- **Metabolism of Nucleotides**

a) de novo Synthesis of purines and pyrimidines; the salvage pathways of nucleotide synthesis; degradation of purine and pyrimidine nucleotides

b) Disorders associated with purine nucleotide metabolism like adenosine deaminase deficiency, purine nucleoside phosphorylase deficiency, and hyperuricemia

c) Natural and synthetic derivatives of purines and pyrimidines and their role in health and disease.

7- **Biochemical Genetics (Informational Flow in the Cell)**

a) The structural basis of cellular information

b) Organization of DNA: chromosomes, Karyotyping.

c) Replication of DNA: Reactions of DNA replication in eukaryotes and prokaryotes; types of damage to DNA and DNA repair; mutations

d) 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.

e) 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.

f) Regulation of gene expression in prokaryotes and eukaryotes

g) 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.

h) Oncogenes and their role in carcinogenesis; mechanisms of activation of proto-oncogenes; mechanism of action of oncogenes; tumour supressor genes and oncogenic viruses.

i) Genetic basis of disease

j) Important tumor markers and their clinical significance (Carcinoembryonic Antigen, Alpha fetoprotein, human chorionic gonadotropin, calcitonin and prostatic acid phosphatase).

8- **Biochemistry of Endocrine System**

a) 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

b) 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).

c) 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.

d) Calcium Requlatinq 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).

e) 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 / syndrome, secondary adrenal deficiency, Addison's disease, primary aldosteronism and secondary aldosteronism.

f) Adrenal Medullary Hormones: Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of all adrenal medullary hormones; and associated disorders like pheochromocytoma

g) 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.

h) 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

9- **Biochemistry of Digestive Tract**

a) Introduction, chemical composition, and secretion and regulation of various digestive juices of GIT such as saliva, gastric juice & HCI, pancreatic juice, bile, and succus entericus

b) Hydrolysis (digestion) of carbohydrates, lipids, proteins, and nucleic acids in gastrointestinal tract

c) Absorption of carbohydrates, lipids and amino acids.

d) Disease states associated with GIT disorders like achlorhydria, peptic ulcers, lactose intolerance, cholelithiasis and pernicious anemia, cystic fibrosis and celiac disease.

e) 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.

10- Metabolism of Xenobiotics

a) 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)

b) Phase Il metabolism of xenobiotics; types of phase Il reactions;

c) Responses to xenobiotics including pharmacologic, toxic, immunologic and carcinogenic effects

11- Water & electrolyte balance; acid-base regulation

a) 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).

b) Body buffer systems, role of lung and kidney in maintenance of acid-base balance.

c) 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.

d) Clinical interpretation of laboratory report of arterial blood gases.

Laboratory Experiments

- 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 fulids, like glucose, creatinine, urea, protein, albumin, uric acid, and calcium, total cholesterol; HDL cholesterol, and triacylglycerols; 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 phosophatase (ALP), and lactate dehydryogenase (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)

RECOMMENDED BOOKS

- Harper's Illustrated Biochemistry by Murrary RK, Granner DK 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.

REFERENCE BOOKS

- 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
- 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
- Biochemistry by Berg JM, Tymoczko JL, and Stryer L, latest edition, published by W.H. Freeman and Company
- Tietz Textbook of Clinical Chemistry by Burtis CA and Ashwood ER published by Saunders.
- Clinical Chemistry and Metabolic Medicine by Martin A. Crook, latest edition, Edward Arnold (Publishers) Ltd
- Practicals and Viva in Medical Biochemistry by Dandekar SP and Rane SA, latest edition, published by Elsevier.

Table of Specifications for Biochemistry Theory Paper

MBBS Second Professional Examination

CONTENTS	SEQs	MCQs
Bioenergetics and biologic oxidation	0.5	2
2. Carbohydrate Metabolism	1.5	6
3. Lipid metabolism	1.5	6
4. Metabolism of proteins and amino acids	1.5	6
5. Metabolism of purines, pyrimidiens, and nucleotides	0.5	2
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	0.5	3 3
8. Endocrinology	1.0	6
9. Biochemistry of digestive juices of GIT, digestion and absorption in GIT	0.5	3
10. Oncogenesis and metabolism of xenobiotics	0.5	3
11. Water & electrolyte balance; acid-base regulation	0.5	2
Total items	9 SEQs	45 MCQs
Total Marks (5 marks for each SEQ and 1 mark for each MCQ)	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: SEQ+ MCQ+ Internal Assessment=

45+ 45+ 10=100 Marks

Table of Specifications for Biochemistry Oral & Practical Examination

MBBS Second Professional Examination

Oral and Practical Examination carries 100 marks

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 nonobserved stations; 2 marks for each station — time allowed is 2 minutes for each non-observed station.	22
E- Practical a. Principle, 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

Teaching/learning Activities

The world-class curriculum of Biochemistry aligned with the vision and mission of PMDC and the institute, has been designed to help extrapolate a blend of basic biochemical aspects, molecular and genetic information in an integrated manner, essential for developing a perspective on the function of human body in health and disease.

The program emphasizes on:

- Acquisition of knowledge of the subject in depth via various teaching/learning modalities strategies like **interactive lecture sessions, team-based leaning (TBL), individual assignments, directed self-learning (DSL) and self-directed learning (SDL).**
- Building attributes like cooperativity, critical thinking and problem solving skills through working within teams in **practical demonstration exercises and small group discussions.**
- Enhancing the professionalism, communication and leadership qualities through **class presentations (Powerpoint/Poster).**

These teaching/learning activities will enable the student to evolve into future researcher, lifelong learner, community leader and off course a better health care provider.

The department is committed to provide the research opportunity to its faculty and students who intent to, in collaboration with other departments and other institutes.

ASSESSMENT PLAN

Continued Yearly Assessment

It includes continued assessment that carries weightage towards final internal assessment.

This comprises of topic tests followed by Term tests.

The Assessment is in the form of

- Written test (50% Short essay questions +50% MCQs).
- Viva
- OSPE
- Class PowerPoint/Poster Presentations

Summative Assessment

Includes:

Sendup exam is taken at the end of academic year that carries weightage towards internal assessment.

Professional Exam is held by UHS at the end of academic year.

Biochemistry Department
Al Aleem Medical College, Lahore

First Year MBBS **Academic Performa**

Roll No:

Name: **Session:**

Father's Name: **Date of Joining:**

Profession of Parents/Guardian: **Contact No. of Parents/Guardian:**

Permanent Address: **Temporary Address:**

Marks Matriculation: **FSc:**

Email ID: **Phone No:**

Theory			Practical/Viva		
Date	**Topic**	**Marks (50)**	**Date**	**Topic**	**Marks (25)**
	Cell Biochemistry & Separation Techniques			Proteins OSPE	
	Lipids			Lipids & Solution preparation OSPE	
	Protein, Amino Acids, plasma proteins & Immunoglobulins			Carbohydrate OSPE	
	Enzymes			Urine Analysis OSPE	
	Haemoglobin & Porphyrins			Viva- Protein, Amino acids, Plasma Proteins & ECM	
	Carbohydrates			Viva- Lipids	
	First term test			Viva- Carbohydrate	
	Vitamins &Minerals			Viva- Vitamins, Minerals	
	Nucleic acids and ECM			Viva- Hemoglobin & Physicochemical aspects	
	Nutrition & Physiochemical aspects, pH			Viva- Minerals, Nutrition & Nucleic Acid	
	Second term test			Final OSPE	
	Class Presentation			Class Presentation	
	Class Presentation			Class Presentation	

Attendance First Quarter: **Send Up:**

Attendance Second Quarter: **Signature:**

Biochemistry Department
Al Aleem Medical College, Lahore

MBBS 2nd Prof **Academic Performa**
Roll No. **Session:**
Name: **Date of Joining:**
Father's Name: **Contact No. of Parents/Guardian:**
Father's Profession: **Temporary Address:**
Address/Permanent: **FSc.:**
Marks Matric: **Phone No.**
Email ID:

Theory			**Practical/Viva**		
Date	**Topic**	**Marks (50)**	**Date**	**Topic**	**Marks (25)**
	Carbohydrates Metabolism I				
	Carbohydrates Metabolism II				
	Lipid Metabolism				
	Protein & Amino Acids Metabolism				
	Nucleotide Metabolism				
	Oxidative Phosphorylarion				
	Endocrinology				
	Electrolyte & Acid Base Balance				
	Genetics I				
	Genetics II			Final OSPE	

Attendance First Quarter: **Send Up:**

Attendance Second Quarter: **Signature**

AL- ALEEM MEDICAL COLLEGE LAHORE
1st Year MBBS Session 2018- 19

Day	8:00am - 09:45am (Practical/Tutorial)	09:45am - 10:40am (Lecture)	10:40am – 11:00am	11:00am - 11:55am (Lecture)	11:55am – 12:50pm (Lecture)	12:50pm - 2:35pm		2:35pm-03:30pm
						Demonstration	Practical Dissection	
						12:50pm-01:45pm	01:45pm-02:35pm	
Monday	**Batch:A(Histology)** **Batch:B(Physiology)** **Batch:C(Biochemistry)**	Physiology	**B R E A K**	General Anatomy	Biochemistry	Dissection		SDL
Tuesday	**Batch:A(Physiology)** **Batch:B(Biochemistry)** **Batch:C (Histology)**	Physiology		Embryology	**Clinical Anatomy SGD** **(Tutorial)**	Dissection		SDL
Wednesday	**Batch:A(Biochemistry)** **Batch:B(Histology)** **Batch:C(Physiology)**	Histology		Physiology	Biochemistry	Dissection		SDL
Thursday	**Clinical Physiology SGD** **(Tutorial)**	Embryology		Biochemistry	Physiology	Dissection		SDL

Friday	08:00am-09:30am (Lecture)	09:30am-10:15am (Lecture)	10:15am-11:00am Physiology (Lecture)	11:00am-11:45am (Lecture)	11:45-12:30	12:30-1:30	1:30-2:30	2:30pm-3:30pm
	Clinical Biochemistry SGD **(Tutorial)**	Clinical Lecture		Biochemistry	Islm/Pk std.	Jumma Prayer	DSL	SDL

AL- ALEEM MEDICAL COLLEGE LAHORE
2nd Year MBBS Session 2018-'19

Day	8:00am – 08:55am (Lecture)	08:55am – 09:50am (Lecture)	09:50am - 10:45am (Lecture)	10:45am - 11:05am	11:05am - 12:50pm Demonstration 11:05am-12:00pm	12:50pm - 2:35pm PRACTICAL/TUTORIAL		2:35pm-3:30pm
						Practical Dissection 12:00-12:50pm		
Monday	Anatomy	Physiology	Biochemistry	**BREAK**	Dissection	**PRACTICAL** **Batch B (Physiology)** **Batch A (Anatomy)** **Batch C (Biochemistry)**		**SDL**
Tuesday	Biochemistry	Anatomy	Physiology		Dissection	**PRACTICAL** **Batch A (Physiology)** **Batch C (Anatomy)** **Batch B (Biochemistry)**		**SDL**
Wednesday	Physiology	Embryology	**Clinical Anatomy SGD (Tutorial)**		Dissection	**PRACTICAL** **Batch C (Physiology)** **Batch B (Anatomy)** **Batch A (Biochemistry)**		**SDL**
Thursday	Clinical Lecture	Biochemistry	Physiology		Dissection	**Clinical Biochemistry SGD (Tutorial)**		**SDL**
Friday	**08:00am-09:30am (Tutorial)**	**09:30am-10:15am (Lecture)**	**10:15am-11:00am (Lecture)** Biochemistry		**11:00am-11:45am** Physiology (Lecture)	**11:45-12:30**	**12:30-1:30**	**1:30-2:30**	**Friday**
	Clinical Physiology SGD (Tutorial)	Anatomy				Islm/Pk Stds.	Jumma Prayer	DSL	