CURRICULUM

Master of Philosophy Biochemistry

(M.Phil)

(Two Years Programme)

The King Edward Medical University, Lahore

2016

CONTENTS

Introduction to programme

Biochemistry is the study of the chemistry related to biological organisms. It forms a bridge between biology and chemistry by studying how complex chemical reactions and chemical structures give rise to life and life's processes. Biochemistry also deals with chemical transformations that take place inside of living organisms, but the truth is that the study of biochemistry should generally be considered neither fully "biology" nor fully "chemistry" in nature. Biochemistry incorporates everything in size between a molecule and a cell and all the interactions between them. The aim of this programme is to make postgraduate students able to describe in molecular terms structure and function of cellular components (such as enzymes and cellular organelles) and the processes carried out both on and by organic macromolecules - especially proteins, carbohydrates, lipids, nucleic acids, and other biomolecules. Biochemists have isolated numerous biomolecules found in cells to determine their structures and to analyze how they function. Biochemical studies have illuminated many aspects of disease that have opened up new therapeutic approaches. This programme has been designed keeping in consideration the study of structural elucidation and the determination of mode of action of biomolecules, identification of disease mechanisms, study of in born errors of metabolism, study of oncogenes in cancer cells, the relationship of biochemistry with Genetics, Physiology, Immunology, Pharmacology, Toxicology etc.

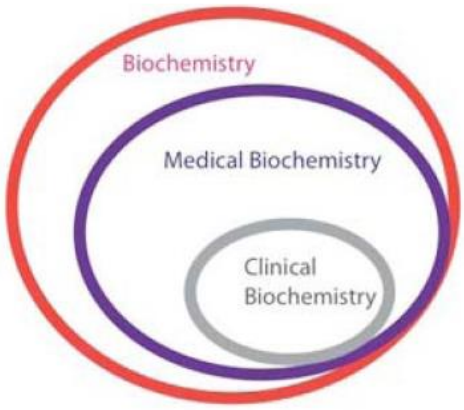

Figure 1. Biochemistry, medical biochemistry and clinical biochemistry.

Scope of Biochemistry

Many newer disciplines have been emerged from Biochemistry such as Enzymology (study of enzymes), Endocrinology (study of hormones) Clinical Biochemistry (study of diseases), and Molecular Biochemistry (Study of Biomolecules and their functions). Along with these branches certain other specialties have also come up such as Agricultural Biochemistry, Pharmacological Biochemistry etc. Medical Biochemistry seeks to advance the understanding of chemical structures and processes that constitute health and disease, and underlie transformations between these two states. Clinical Biochemistry is an important applied sub-discipline of Medical Biochemistry, also known under the names of clinical Chemistry, Pathological Biochemistry or Chemical Pathology Clinical Biochemistry is concerned with methodology and interpretation of biochemical tests performed on body fluids and tissues, to support diagnosis, treatment and monitoring of disease. Clinical Biochemistry is driven by the discovery of biomarkers, and the availability of appropriate measurement methods. Therefore, its scope constantly changes. It has become an autonomous discipline. Those who acquire a sound knowledge of Biochemistry can tackle the two central concerns of the biomedical sciences.

(1) The understanding and maintenance of health

(2) The understanding and treatment of diseases.

Phases of training in M.Phil Biochemistry Programme:

<table>
<tr><td rowspan="5">Year 1</td><td colspan="3">Semester 1
(18 weeks)</td><td colspan="2">Semester 2
(09weeks)</td><td rowspan="5">Rotation in Medicine
(12 weeks)</td></tr>
<tr><td rowspan="2">Teaching/ Learning sessions
(16 weeks)</td><td colspan="2">Semester Evaluation
(02 weeks)</td><td rowspan="4">Teaching/ Learning sessions
(08 weeks)</td><td rowspan="4">Mid semester internal assessment
(01 weeks)</td></tr>
<tr><td>Mid semester internal assessment
(01 week)</td><td>End semester internal assessment
(01 week)</td></tr>
<tr><td colspan="3">Synopsis writing and submission</td></tr>
<tr><td colspan="3">Four mandatory workshops completion</td></tr>
<tr><td rowspan="4">Year 2</td><td colspan="3">Research & Dissertation (Lab. Work)</td><td colspan="2">Remaining Semester 2
(09weeks)</td></tr>
<tr><td colspan="3">Research project & Thesis Writing</td><td>Teaching/ Learning sessions
(08 weeks)</td><td>Mid semester internal assessment
(01 weeks)</td></tr>
<tr><td colspan="5">Thesis Submission 12 weeks before Final Examination</td></tr>
<tr><td colspan="5">Thesis evaluation(within 6-8 weeks before final exam)</td></tr>
<tr><td colspan="6">Final Examination(at the end of training)</td></tr>
</table>

List of Courses

1st semester courses (12 credit hours):

Module –1

- Course code (001): Basic Biochemistry **- 3 credit hours**
- Course code (002): Metabolism & Bioenergetics **- 3 credit hours**

Module --2

- Course code (003): Metabolic Disorders **- 3 credit hours**
- Course code (004): Analytical Techniques **- 3 credit hours**

2nd Semester courses (12 credit hours)

Module –3

- 005: Clinical Chemistry (1) **- 3 credit hours**
- 006: Clinical Chemistry (2)**- 3 credit hours**

Module –4

- 007:Molecular Biology (1) **- 3 credit hours**
- 008: Molecular Biology (2) **- 3credit hours**

GENERAL SCHEDULE OF THE WEEK IN EACH SEMESTER

Days	9-11am	11:30am-1:30pm	1:30 -2:30pm
Mon	Lecture	Assignment for the week will be given and discussed	Self study
Tues	Lecture	Practical/ lab work	Assignment: Library/Internet
Wed	Interactive Discussion	Assignment discussion	Assignment: Library/Internet
Thurs	Final submission of assignment	Practical Training /lab work	Self study
Fri	Journal Club (9-12)- Presentations and discussion		
Sat	Detailed feedback on assignment	Interactive Discussion	Self study

Course code (001)

Basic Biochemistry

CreditHours: 3

Introduction:

Our undergraduate medical curriculum does not allow sufficient exposure of medical students to the basic Biochemistry. On the other hand M.Phil students are expected to demonstrate their understanding of the concepts and principles of General Biochemistry. This course has been designed to bridge the gap between the point where the medical post graduate is currently standing and the point from where they can comfortably pursue higher level of understanding. The course seeks to lay down the foundation to make doctors more comfortable with advanced biochemistry in this curriculum.

LearningGoal:

Theoverallgoalofthiscourse isto enable M.Phil students of medical background to get familiar with Basic Biochemistry, structural and functional hierarchy of biomolecules and their inter relationship.

LearningObjectives:

By the end ofthe course, the M.Phil students should beableto:

1. Discuss the concept of body buffers and their role in pH regulation.
2. Identify the mechanism of regulation of body pH, role of lungs & kidney in acid –base homeostasis.

3. Classify enzymes, their regulation, and various inhibitors along with their biomedical importance.
4. Describe properties, functions of enzymes, coenzymes, cofactors and isoenzymes.
5. Identify factors affecting enzyme activity and their relation to Michaelis-Menten equation
6. Explain the classification, structure, function and biomedical importance of various types of carbohydrates
7. Discuss the structure, properties, importance, and basis of classification of amino acids
8. Explain biochemical importance of proteins on the basis of their classification, structure, and function.
9. Describe various types of plasma proteins &immunoglobulins along with their biochemical & clinical significance.
10. Discuss structure, functions ,types of haemoglobin and their related disorders
11. Explain the synthesis and degradation of heme and its relation to hyperbilirubinemia.
12. Classify various types of lipids and fatty acids along with their biomedical importance.
13. Describe types of eicosanoids, their synthesis and biochemical significance.
14. Draw general structures of steroid /cholesterol and their biomedical importance.
15. Define role of lipid peroxidation in health and disease.

16. Describe classification of vitamins, their structure, types, RDA, deficiency manifestations, and their biochemical functions
17. Enumerate various types of minerals & trace elements, their sources, RDA, and their related disorders.
18. Explain types, structure and functions of nucleosides & nucleotides
19. Describe structure, functions, chemistry, types & derivatives of purines and pyrimidines along with their role in health and disease

Contents:

Buffers

- Ionization of water
- Henderson – Hasselbach equation
- Body buffers and their mechanism of action,Acid base balance regulation in human body
- Acids produced in the body, mechanisms of regulation of pH, role of lungs and kidney in buffering mechanism
- Disorders of acid base metabolism

Enzymes

- Classification/nomenclature,Properties of enzymes and catalysts, regulation of enzyme activity
- Functions of enzymes and catalysts, Co-enzymes and co-factors
- Isozymes and their clinical importance,Therapeutic use and application of enzymes in clinical diagnosis
- Enzyme kinetics, Factors affecting enzyme activity (Michaelis – Menten and Lineweaverburk equations)

- Classification of enzyme inhibitors and their biochemical importance

Carbohydrates

- Definition, biochemical function and classification of carbohydrates,Structure and functions of monosaccharides and their derivatives
- Disaccharides and their important examples, Oligosaccharides and their combination with other macromolecules, Polysaccharides and their biochemical rolealong with important examples,Biochemical importance of carbohydrates

Proteins

- Definitions, biochemical importance and classification of proteins based on physiochemical properties,Structure of proteins and their significance in pH maintenance
- Amino acids and their structure, properties, functions, Classification and nutritional significance of amino acids, Dissociation, titration and importance of amino acids
- Immunoglobulins and their biomedical significance
- Plasma proteins and their clinical significance

Porphyrins and Haemoglobin

- Chemistry and biosynthesis of porphyrins and related disorders
- Structures, functions and types of haemoglobin,Oxygen binding capacity of haemoglobin, factors affecting and regulating the oxygen binding capacity

of haemoglobin, Haemoglobinopathies (Sickle cell disease, Thalassaemia etc.) and their biochemical causes

- Degradation of haem, formation of bile pigments, its types, transport and excretion
- Hyperbilirubinimia, biochemical causes and differentiation

Lipids and Fatty Acids

- Classification of lipids and their biochemical functions, Structure and biochemical function of neutral lipids phospholipids, glycolipids andsphingolipids
- Classification of fatty acids and their biochemical functions, Functions of essential fatty acids,Identification of fats and oils (saponification, acid number)
- Eicosanoids and their function in health and disease (overview)
- Steroids and their biochemical role,Cholesterol, its structure, chemistry and functions
- Bile acids and bile salts
- Lipid peroxidation and its significance

Vitamins and Minerals

- Vitamins and their different types, Classification of vitamins, their chemical structure and biochemical function,Absorption of vitamins and minerals
- Daily requirements, sources of water and fat soluble vitamins
- Effects of vitamin deficiency, Role of vitamins as co-enzymes,Hypo- and hyper-vitaminosis

- Minerals in human nutrition, sources, biochemical actions and recommended daily allowance (RDA), Sodium, potassium, chloride, calcium, phosphorus, magnesium, sulfur, iodine, fluoride,Trace elements:Iron, Zinc, Selenium, Iodine, Copper, Chromium, Cadmium, Manganese (Fe, Zn, Se, I, Cu, Cr, Cd and Mn)

Nucleotides and Nucleic Acids

- Chemistry of purines and pyrimidines, their types, structure and function,Derivatives of purines and pyrimidines, their role in health and disease
- Chemistry and structure of nucleoside and nucleotide and their biochemical role,Nucleic acids (DNA & RNA) their types, structure and functions

Practical work:

1. Preparation of buffer solutions
2. Qualitative analysis of unknown carbohydrate & protein.

TeachingMethodologies:

1. Didactic classroom instruction on multimedia and white board
2. Interactive discussions
3. Practical laboratory work
4. Assignment: Library/Internet
5. Journal Club

Assessment Plan

Quarterly basis internal assessment based on criteria mentioned in Proforma

1. Ongoing formative assessment through class participation and interactive discussion

Recommended Books:

1. Principles of Biochemistry. Ed **Lehninger**, Nelson and Cox.CBS publishers and distributors.

2. **Biochemistrys**Ed **LubertStryer.** W.H. Freeman and Company, New York.

3. Harper's Biochemistry. Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell.Appleton and Lange, Stamford, Connecticut.

4.Biochemistry. Ed Donald **Voet** and Judith G. Voet.John Wiley & sons, Inc.

5.Textbook of Biochemstry with Clinical Correlations. Ed. Thomas M. **Devlin**.Wiley-Liss Publishers.

6.Principles and Techniques of **Practical Biochemistry**. Ed .**Keith Wilson** and John Walker.CambridgeUniversity Press.

Course Instructors

- Prof. Dr. Nakhshab Choudhry(MBBS,DCP,M.Phil,PhD), Chairman Deptt. Of Biochemistry),KEMU Lahore
- Dr. Shakil Ahmed (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry, KEMU Lahore
- Dr. Syed Faisal Hassan Shah (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry, KEMU Lahore
- Dr. Noor-ul-ainWaheed (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry, KEMU Lahore

COURSE/ MODULE: Course code (001): Basic Biochemistry

DURATION 24days (4 weeks)

CONTACT HOURS Total **48** contact hours in **4weeks**
12 contact hours / week ---
(**18** hours for **Lectures**, **4x3** contact hours for **Practical**, **13** hours for **Interactive Discussion** and **13** hours for**Seminars/Oral Assignments/ Journal Club**)

CREDIT HOURS 3

TEACHING METHODOLOGIES Lectures/ Interactive Discussions/Seminars or Oral Assignments/ Practical Training

Sr. No.	TOPICS	CONTENTS	Days	Total Contact Hours	Lecture	Interactive Discussion	Seminars/ Oral Assignment/ Journal Club	Practical
1.	**Buffers**	Ionization of water,Body buffers and their mechanism of action, Henderson – Hasselbach equation,Acid base balance regulation in human body, Acids produced in the body, Mechanisms of regulation of pH, Role of lungs and kidneys in buffering mechanism, Acid Base disorders	2	4	1	1	1	3
2.	**Enzymes**	Classification/Nomenclature, Properties of enzymes and catalysts, Regulation of enzyme	3	6	3	2	1	--

		activity, Functions of enzymes and catalysts, Co-enzymes and co-factors,Isozymes and their clinical importance, Factors affecting enzyme activity (Michaelis – Menten and Lineweaverburk equations), Classification of enzyme inhibitors and their biochemical importance						
3.	**Carbohydrates**	Definition, biochemical functions, classification, Structure and functions of Monosaccharides and their derivatives, Disaccharides and their importance, Oligosaccharides and their combination with other macromolecules,Polysaccharides and their importance, biochemical role.Biochemical importance of different carbohydrates.	2.5	5	2	1	1	3
4.	**Proteins**	Definitions, biochemical importance and classification of proteins based on their physiochemical properties, Amino acids and their structure, properties and functions, Classification and nutritional significance of	4	8	2	2	2	6

		amino acids ,Dissociation, titration and importance of amino acids, Structure of proteins and their significance in pH maintenance,Techniques for separation of proteins e.g. salting out, electrophoresis, chromatography, centrifugation.						
5.	**Porphyrins and Haemoglobin**	Chemistry and biosynthesis of porphyrins and related disorders. Structures, functions and types of haemoglobin. Oxygen binding capacity of haemoglobin & factors affecting, regulating the oxygen binding capacity of haemoglobin. Degradation of haem, formation of bile pigments, its types, transport and excretion. Hyperbilirubinemia, types & biochemical causes. Haemoglobinopathies (Hb-S, Thalassaemia etc.) and their biochemical causes.	2	4	2	1	1	--

6.	**Lipids and Fatty Acids**	Classification of lipids and their biochemical functions. Structure and biochemical function of phospholipids, glycolipids and sphingolipids, Classification of fatty acids and their biochemical functions, Functions of essential fatty acids. Identification of fats and oils (saponification, acid number), Eicosanoids, their function in health and disease (overview), Steroids and their biochemical role. Cholesterol, its structure, chemistry and functions. Lipid peroxidation and its significance.	2.5	5	2	1	2	--
7.	**Vitamins and Minerals**	Vitamins , their different types, Classification , their chemical structure and biochemical function, Absorption of vitamins and minerals,Daily requirements, sources of water/fat soluble vitamins, Effects of vitamin deficiency, Role of vitamins as co-enzymes, Hypo- and hypervitaminosis, Minerals Sodium, potassium, chloride, calcium, phosphorus, magnesium, sulfur, iodine, fluoride, Trace	5	10	4	3	3	--

		elements (Fe, Zn, Se, I, Cu, Cr, Cd and Mn)in human nutrition, sources, biochemical actions and their recommended daily allowance (RDA).						
8.	**Nucleotides and Nucleic Acids**	Chemistry of purines and pyrimidines, their types, structure and function, Chemistry and structure of nucleoside and nucleotide and their biochemical role, Derivatives of purines and pyrimidines, their role in health and disease, Nucleic acids (DNA & RNA) their types, structure and functions.	3	6	2	2	2	--

Course code (002)

Metabolism & Bioenergetics

CreditHours: 3

Introduction:

This includes molecular motif of a living cell, Principles of bioenergetics, electron transport chain and oxidative Phosphorylation, energy transformation and its association with metabolism of carbohydrates, lipids, proteins, amino acids, porphyrins, purines, pyrimidines, their regulation, dysregulation andtheir inter-relationships in the context of metabolic homeostasis.

LearningGoal:

The course aims to teach M.Phil students the principles and details of Bioenergetics, Electron Transport Chain and its relation to generation of ATP. It would help to understand energy transformations in various metabolic reactions and their role in the synthesis of biological molecules. This would also include digestion, breakdown and reutilization of various bio molecules formed during the course of metabolism along with their regulation for the purpose of homeostasis. At the end of this course students will be able to correlate the role of above mentioned biochemical processes in integration of metabolism.

LearningObjectives:

By the end of the course, the M.Phil students should be able to:

1. Discuss the concept of redox reactions, redox couples, along with enzymes and coenzymes of biological oxidation and reduction.
2. Describe the process of respiratory chain, its components, role of electron flow in oxidative Phosphorylation, ATP Synthasein synthesis of ATP along with their inhibitors&uncouplers.
3. Illustrate the processes & energetic of glycolysis, gluconeogenesis along with their reversible, irreversible steps catalyzed by specific enzymes and regulation of blood glucose level.
4. Explain the Reactions of Citric acid cycle, Cori's cycle, glycogenesis and glycogenolysis, Hexose Mono Phosphate (HMP) shunt, Uronic acid pathway.
5. Discuss digestion, absorption of carbohydrates and metabolism of Monosaccharides, Disaccharides.
6. Describe Mobilization, transport, synthesis, oxidation & regulation, of fatty acids, TAGs, sterols, phospholipids& glycolipids.
7. Enumerate ketone bodies, eicosanoids, plasma lipoproteins, their various types, synthesis, degradation and utilization.
8. Illustrate steps of cholesterol synthesis, its fate, functions, regulation and associated disorders.
9. Explain steps of amino acid oxidation, their metabolic fate, including various processes of nitrogen transfer, nitrogen excretion, ammonia intoxication, urea formation, Urea cycle and its regulation along with genetic defects of urea cycle.

10. Describe the functions, pathways of amino acid degradation and genetic disorders of individual amino acids
11. De novo synthesis of purines, pyrimidines, their recycling , degradation and related disorders
12. Draw the concept map showing the integration of metabolic pathways in different tissues

Contents:

The contents of the course in this module are:

Bioenergetics and Biological Oxidation:

- Endergonic and exergonic reactions, coupling through ATP
- Oxidation and reduction, methods of electron transfer, redox potential, enzymes and coenzymes of biologic oxidation and reduction
- Respiratory chain and oxidative phosphorylation, components of respiratory chain, electron carriers
- ATP synthesis coupled with electron flow
- ADP coupled to electron transfer
- ATP synthase- relation to proton pump, PMF, and active transport
- Uncouplers and inhibitors of oxidative Phosphorylation

Metabolism of Carbohydrates

- Glycolysis, Phases and reactions of glycolysis
- Energetics of aerobic and anaerobic gylcolysis and theirimportance, Regulation of glycolysis
- Cori's cycle,The fate of pyruvate
- Citric Acid Cycle, Reactions, energetics and regulation and importance of citricacid cycle

- Amphibolic nature of citric acid cycle (tricarboxylic acid cycle –TCA or the Kreb's cycle)
- Anpoleratic reactions and regulations of TCA cycle
- Gluconeogenesis
- Important three by-pass reactions of gluconeogenesis
- Entrance of amino acids and intermediates of TCA cycle andother nutrients as gluconeogenic substrates
- Significance of gluconeogenesis
- Glycogen metabolism
- Reactions of glycogenesis and glycogenolysis
- Importance of UDP-Glucose
- Regulation of glycogen synthase and glycogenphosphorylase
- Glycogen phosphorylase A and the blood glucose sensor
- Disorders of glycogen metabolism (glycogen storage diseases)
- Secondary pathways of carbohydrate metabolism
- Hexose Mono Phosphate (HMP) shunt, its reactions andimportance
- Glucuronic acid pathway, its reactions and importance
- Metabolism of fructose, galactose and lactose
- Regulation of Blood Glucose level
- Hyperglycemia, hypoglycemia and their regulating factors
- Biochemistry of Diabetes Mellitus, its laboratory findings anddiagnosis

Metabolism of Lipids:

- Mobilization and transport of fatty acids, tricylglycerol andsterols
- Oxidation of fatty acids
- Activation and transport of fatty acid in the mitochondria

- β-oxidation, fate of acetyl CoA, regulation of β-oxidation
- Other types of oxidation, i.e. αoxidation, ω-oxidation, peroxisome oxidation, oxidation of odd number carbon-containing fatty acidsand unsaturated fatty acids etc.
- Ketogenesis
- Mechanism and utilization of ketone bodies and significance
- Ketosis and its mechanism
- Biosynthesis of fatty acids
- Eicosanoids, synthesis from arachidonic acid, their mechanismand biochemical functions
- Triacylgycerol synthesis and regulation
- Synthesis and degradation of phospholipids and their metabolic Disorders
- Cholesterol synthesis, regulation, functions, fate of intermediates of Cholesterol synthesis, hypercholesterolemia, atherosclerosis
- Plasma lipoproteins, VLDL, LDL, HDL, and chylomicrons, theirtransport, functions and importance in health and disease
- Glycolipid metabolism and abnormalities

Metabolism of Proteins and Amino acids:

- Amino acid oxidation, metabolic fates of amino acid, transamination, deamination decarboxylation, deamidation and transamination
- Transport of amino group, role of pyridoxal phosphate,glutamate, glutamine, alanine
- Ammonia intoxication, nitrogen excretion and urea formation,
- Urea cycle and its regulation, genetic defects of urea cycle

- Functions, pathways of amino acid degradation and geneticdisorders of individual amino acids

Metabolism of Nucleotides:

- De novo purine synthesis
- Synthesis of pyrimidine
- Recycling of purine and pyrimidine bases (Salvage pathway)
- Degradation of purine, formation of uric acid
- Disorders of purine nucleotide metabolism

Integration and regulation of metabolic pathways in different tissues

Practical/Lab Work:

- Estimation of glucose , Glucose Tolerance Test
- Estimation of Cholesterol, TAGs
- Estimation of Uric Acid
- Estimation of Urea, Creatinine

TeachingMethodology:

1. Didacticclassroominstructiononmultimedia andwhiteboard
2. Interactive discussions
3. Practical work: demonstration and hands on practice
4. Assignment: Library/Internet, Journal Club

Recommended Readings:

1. Principles of Biochemistry. Ed Lehninger, Nelson and Cox, CBS publishers and distributors

2. **Biochemistrys**Ed **LubertStryer.** W.H. Freeman and Company, New York.

3. Harper's Biochemistry.Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W Rodwell.Appleton and Lange, Stamford, Connecticut

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6. Principles and Techniques of **Practical Biochemistry**. Ed .**Keith Wilson** and John Walker.CambridgeUniversity Press

Assessment Plan

1. Quarterly basis internal assessmentbased on criteria mentioned in Proforma
2. Ongoing formative assessment through class participation and interactive discussion

Instructors

- Dr. Nakhshab Choudhry (MBBS, DCP, M.Phil, PhD), Chairman Deptt. Of Biochemistry) KEMU Lahore
- Dr. Shakil Ahmed (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry, KEMU Lahore
- Dr. Syed Faisal Hassan Shah (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry, KEMU Lahore
- Dr. Noor-ul-ain Waheed (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry, KEMU Lahore

COURSE/ MODULE: **Course code (002): Bioenergetics & Metabolism**

DURATION: 24 days (4 weeks)

CONTACT HOURS: Total **48** contact hours in **4 weeks**
12 contact hours /week ---
(**14** hours for **Lectures**, **11x3** contact hours for **Practical**, **12**hours for **Interactive Discussion** and **11**hours for**Seminars/Oral Assignments/Journal Club**)

CREDIT HOURS: **3**

TEACHING METHODOLOGIES: Lectures/ Interactive Discussions/Seminars, Oral Assignments, Journal Club/ Practical Training

SR. No.	TOPICS	CONTENTS	DAYS	TOTAL CONTACT HOURS	LECTURES	INTERACTIVE DISCUSSION	SEMINARS/ ORAL ASSIGNMENTS/JOURNAL CLUB	PRACTICAL
1.	**Bioenergetics and Biological Oxidation**	Endergonic and exergonic reactions, coupling through ATP.Oxidation and reduction, methods of electron transfer, redox potential, enzymes and coenzymes of biologic oxidation and reduction.Respiratory chain and oxidative phosphorylation, components of respiratory chain, electron carriersATP synthesis coupled	3	6	2	2	2	--

		with electron flow. ADP coupled to electron transferATP synthase- relation to proton pump, PMF and active transport, Uncouplers and inhibitors of oxidative Phosphorylation.						
2.	**Metabolism of Carbohydrates**	Glycolysis, Phases and reactions of glycolysis, Energetics of aerobic and anaerobic gylcolysis and theirimportance, Regulation of glycolysis, Cori's cycle. The fate of pyruvate, Citric Acid Cycle, Reactions, energetics and regulation and importance of citricacid cycle, Amphibolic nature of citric acid cycle (tricarboxylic acid cycle –TCA or the Kreb's cycle), Anaplerotic reactions and regulations of TCA cycle. Gluconeogenesis, Important three by-pass reactions of gluconeogenesis, Entrance of amino acids and intermediates of TCA cycle andother nutrients as gluconeogenicsubstrates, Significance of gluconeogenesis, Glycogen metabolism, Reactions of glycogenesis and glycogenolysis, Importance of UDP-Glucose,	5	10	3	2	2	3

		Regulation of glycogen synthase and glycogenphosphorylase, Glycogen phosphorylase A and the blood glucose sensor. Disorders of glycogen metabolism (glycogen storage diseases), Secondary pathways of carbohydrate metabolism, Hexose Mono Phosphate (HMP) shunt, its reactions andimportance, Glucuronic acid pathway, its reactions and importance, Metabolism of fructose, galactose and lactose, Regulation of Blood Glucose level, Hyperglycemia, hypoglycemia and their regulating factors. Biochemistry of Diabetes Mellitus, its laboratory findings anddiagnosis.						
3.	**Metabolism of Lipids**	Mobilization and transport of fatty acids, tricylglycerol and sterols, Oxidation of fatty acids, Activation and transport of fatty acid in the mitochondria, β-oxidation, fate of acetyl CoA, regulation of β-oxidation, Other types of oxidation, i.e. α-oxidation, ω-oxidation,	5	10	2	2	2	4

		peroxisome oxidation, oxidation of odd number carbon-containing fatty acidsand unsaturated fatty acids etc.Ketogenesis, mechanism and utilization of ketone bodies and significance, Ketosis and its mechanism, Biosynthesis of fatty acids, Eicosanoids, synthesis from arachidonic acid, their mechanismand biochemical functions, Triacylgycerol synthesis and regulation, Synthesis and degradation of phospholipids and their metabolicDisorders, Cholesterol synthesis, regulation, functions, fate of intermediates of Cholesterol synthesis, hypercholesterolemia, atherosclerosis, Plasma lipoproteins, VLDL, LDL, HDL, and chylomicrons, theirtransport, functions and importance in health and disease, Glycolipid metabolism and abnormalities.						
4.	**Metabolism of Proteins and Amino acids**	Amino acid oxidation, metabolic fates of amino acid, transamination, deamination decarboxylation, deamidation and	5	10	4	2	2	2

		transamination, Transport of amino group, role of pyridoxal phosphate, glutamate, glutamine, alanine. Ammonia intoxication, nitrogen excretion and urea formation. Urea cycle and its regulation, genetic defects of urea cycle. Functions, pathways of amino acid degradation and geneticdisorders of individual amino acids.						
5.	**Metabolism of Nucleotides**	De novo purine synthesis, Synthesis of pyrimidine, Recycling of purine and pyrimidine bases (Salvage pathway), Degradation of purine, formation of uric acid, Disorders of purine nucleotide metabolism.	4	8	2	2	2	2
6.	**Integration and regulation of metabolic pathways in different tissues**		2	4	1	2	1	--

Course code (003)

Metabolic Disorders

Credit Hours: 3

Introduction:

A comprehensive knowledge of metabolic disorders is paramount for clinicians as well as researchers and scholars in basic sciences as it facilitates to bridge the gap between clinical sciences and basic sciences. The course will help to develop a link between basic knowledge of biochemistry and metabolic disorders.

Learning Goal:

The overall goal of this course is to facilitate M.Phil students to have a grasp on the basic concepts of metabolic disorders, their manifestations, and role of biochemical investigations in diagnosis of metabolic disorders.

Learning Objectives:

By the end of the course, the M.Phil students should be able to:

1. Discuss disorders related to monosaccharide, disaccharide metabolism along with their diagnosis on the basis of biochemical tests & their complications.
2. Classify glycogen storage diseases on the basis of enzyme deficiency, their related metabolic pathways, clinical manifestations, complications.
3. Describe disorders related to fatty acid oxidation, triglyceride & ketone bodies synthesis, cholesterol & lipoprotein metabolism.
4. Illustrate the pathway involved in congenital adrenal hyperplasia.

5. Discuss disorders related to urea synthesis, ammonia disposal, and amino acid metabolism.
6. Describedisorders related to Purine & Pyrimidine metabolism.
7. Classify disorders related to breakdown of heme.
8. Differentiate between various vitamins deficiency disorders on the basis of clinical features and biochemical tests.

Contents:

1. **Metabolic disorders related to Carbohydrate Metabolism**

- Diabetes Mellitus& its complications
- All types of Glycosuria
- Classical Galactossemia
- Hereditary fructose intolerance
- Essential Fructosuria
- Essential Pentosuria
- G-6 PD deficiency
- Hyperosmolar Nonketotic Diabetic Coma
- Glycogen Storage Diseases
- Hypoglycemia
- Lactose intolerance

2. **Metabolic disorders related to Lipid Metabolism**

- Lipid Storage Diseases
- Ketosis and Ketonuria including Diabetic Ketoacidosis
- Respiratory Distress Syndrome
- Hypercholesterolemia

- All types of Hyperlipidemia including hyperlipoproteinemia
- Hypolipoproteinemia
- Atherosclerosis,CVA,CHD
- Steatorrhea
- Chyluria
- Cholelithiasis/Obstructive Jaundice
- Congenital Adrenal Hyperplasia
- Carnitine Deficiency
- Fatty liver
- Obesity/Metabolic Syndrome
- Disorders related to oxidation of Fatty Acids (Refsum's Disease, Zellweger syndrome,Methyl MalonicAcidemia,SIDS)

3. Metabolic disorders related to Protein Metabolism

- All types of Uremia
- Hepatic Encephalopathy
- Hyperammonemia
- Argininosuccinicaciduria
- Citrullinemia
- Isovaleric academia
- Glycinuria /Hyperoxaluria
- Cystinuria / Cystinosis
- Phenylketonuria/Albinism
- Tyrosinemia
- Alkaptonuria

- Homocystinuria
- Hartnups disease
- Maple Syrup Urine Disease
- Histidinemia
- Creatinuria
- Carcinoid syndrome

4. Metabolic disorders related to Nucleotides and Nucleic Acids Metabolism

- Hyperuricemia &Hypouricemia
- Gout
- Lesch-Nyhan Syndrome
- Severe Combined Immunodeficiency Disease(SCID)
- Oroticaciduria
- Purine Nucleoside Phosphorylase Deficiency

5. Metabolic disorders related to heme metabolism

- Porphyrias
- Hyperbilirubinemia
- Jaundice

6. Disorders related to Vitamins and Minerals

- Vitamin DeficiencyDiseases
- Minerals & Trace elements Deficiency Diseases

Practical work:

- Interpretationof Liver Function Tests including estimation of activity of AST, ALT, ALP, GGT in serum
- Estimation of serum Albumin, Bilirubin.
- Estimation of serum Calcium,Iron, TIBC, Ferritin

Teaching Methodologies:

1. Didactic classroom instructions on multimedia and whiteboard
2. Interactive discussions
3. Practical laboratory work
4. Assignment: Library/Internet
5. Journal Club

Assessment Plan

- Quarterly basis internal assessment based on criteria mentioned in Proforma
- Ongoing formative assessment through class participation and interactive discussion

Recommended Books:

1. Principles of Biochemistry. Ed **Lehninger**, Nelson and Cox.CBS publishers and distributors

2. **Biochemistrys**Ed **LubertStryer.** W.H. Freeman and Company, New York.

3. Harper's Biochemistry. Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W Rodwell.Appleton and Lange, Stamford, Connecticut

4. Biochemistry. Ed Donald **Voet** and Judith G. Voet.John Wiley & sons, Inc

5. Textbook of Biochemistry with Clinical Correlations. Ed. Thomas M. **Devlin**.Wiley-Liss Publishers

6. Principles and Techniques of **Practical Biochemistry**. Ed. **Keith Wilson** and John Walker.Cambridge University Press

7. **Tietz textbook of clinical** chemistry and molecular diagnostics. Editors Burtis CA, Ashwood ER, Bruns DE. 4thed. Elsevier; 2006

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Course Instructors

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- Dr. Shakil Ahmed (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry, KEMU Lahore
- Dr. Syed Faisal Hassan Shah (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry, KEMU Lahore
- Dr. Noor-ul-ain Waheed (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry, KEMU Lahore

COURSE/ MODULE: Course code (003): Metabolic Disorders

DURATION 24 days (4 weeks)

CONTACT HOURS Total **48** contact hours in **4 weeks**
12 contact hours /week ---
(**10** hours for **Lectures**, **4x3** contact hours for **Practical**, **19** hours for **Interactive Discussion** and **15** hours for **Seminars/Oral Assignments/Journal Club**)

CREDIT HOURS 3

TEACHING METHODOLOGIES Lectures/ Interactive Discussions/Seminars or Oral Assignments/ Practical Training

Sr. No.	TOPICS	CONTENTS	Days	Total Contact Hours	Lecture	Interactive Discussion	Seminars/ Oral Assignment/ Journal Club	Practical
1.	**Metabolic disorders related to Carbohydrate Metabolism**	Diabetes Mellitus & its complications, All types of Glycosuria, Classical Galactossemia, Hereditary fructose intolerance, Essential Fructosuria, Essential Pentosuria, G-6 PD deficiency, Hyperosmolar Nonketotic Diabetic Coma, Glycogen Storage Diseases, Hypoglycemia, Lactose intolerance	5	10	2	4	4	--

2.	**Metabolic disorders related to Lipid Metabolism**	Lipid Storage Diseases, Ketosis and Ketonuriaincluding Diabetic Ketoacidosis, Respiratory Distress Syndrome, Hypercholesterolemia, All types of Hyperlipidemia including hyperlipoproteinemia, Hypolipoproteinemia, Atherosclerosis, CVA, CHD, Steatorrhea, Chyluria, Cholelithiasis/ Obstructive Jaundice, Congenital Adrenal Hyperplasia, Carnitine Deficiency, Fatty liver, Obesity/Metabolic Syndrome, Disorders related to oxidation of Fatty Acids (Refsum's Disease, Zellweger syndrome, Methyl MalonicAcidemia, SIDS)	5	10	2	4	4	--
3.	**Metabolic disorders related to Protein Metabolism**	All types of Uremia, Hepatic Encephalopathy, Hyperammonemia, Argininosuccinicaciduria, Citrullinemia, Isovaleric academia, Glycinuria/ Hyperoxaluria, Cystinuria/ Cystinosis, Phenylketonuria/Albinism,Tyrosinemia,Alkaptonuria, Homocystinuria, Hartnups disease, Maple Syrup Urine Disease, Histidinemia, Creatinuria, Carcinoid syndrome	5	10	2	4	2	6

4.	**Metabolic disorders related to Nucleotides and Nucleic Acid Metabolism**	Hyperuricemia &Hypouricemia, Gout, Lesch-Nyhan Syndrome, Severe Combined Immunodeficiency Disease(SCID), Oroticaciduria,Purine Nucleoside Phosphorylase Deficiency	4	8	2	4	2	--
5.	**Metabolic disorders related to HemeMetabolism**	Porphyrias, Hyperbilirubinemia, Jaundice	2	4	1	1	1	3
6.	**Disorders related to Vitamins and Minerals**	Vitamin Deficiency Diseases, Minerals & Trace elements Deficiency Diseases	3	6	1	2	2	3

Course code (004)

Analytical Techniques

Credit Hours: 3

Introduction:

M.Phil students are expected toconduct Biochemical laboratory investigations and experimentation relevant to clinicalmanagement and biomedical research.They must be able toanalyze, interpret and evaluate the data.Therefore, this course has been designed to instill basic knowledge, methodology, and application of analytical techniques which is part and parcel of their training in the field of Biochemistry.

Learning Goal:

Tomake students capable of performing experiments, employing analytical techniques and interpretation of results in clinical management and experimental research

Learning Objectives:

By the end of the course, the M.Phil students should be able to:

1. Identify different parts of pH meter, their working on the principle of pH metery along withitsapplications.
2. Classify different types of chromatography, their methodology, uses in clinical field and Biochemistry laboratory.

3. Perform detection of amino acids in urine by paper chromatography.
4. Describe different types of electrophoresis, their methodology, uses in clinical field and Biochemistry laboratory.
5. Discuss immunoassays, their types, principle, specifications and uses in clinical Biochemistry laboratory.
6. Explain Spectrophotometery, Photometery, Flame photometery, Flow Cytometery, Chemiluminiscence,Turbidimetery &Nephelometery, Atomic Absorption Spectrometery, Fluorometery,Mass Spectrophotometery on the basis of their specifications, principle, methodology, types, applications and uses.
7. Perform Spectrophotometery for quantitative estimation of analytes in biological specimens.
8. Differentiate between Centrifugation & Ultracentrifugation, their specifications, uses and applications.
9. Perform centrifugation for processing biological specimens.
10. Explain Osmometery&Freezing point osmometer.
11. Discuss Clinical Chemistry automation and detailof steps involved in automated analysis.

Contents:

pH metery

- Principle of pH metery
- Components and working of pH meter
- Applications of pH metery in Biochemistry laboratory
-

Electrophoresis

- Paper electrophoresis
- Cellulose acetate electrophoresis
- Gel electrophoresis
    - PolyacrylamideGel Electrophoresis
- Immune electrophoresis
- Ion selective electrodes (ISE)
- Two-dimensional electrophoresis
- Capillary electrophoresis

Chromatography

- Paper Chromatography
- Partition Chromatography
- Affinity Chromatography
- Column Chromatography
    a. Gas-Liquid Chromatography
    b. Gas Chromatography
    c. High Performance Liquid Chromatography
- Ion Exchange Chromatography
- Adsorption
- Thin Layer Chromatography
- Exclusion Size Chromatography
- Gel Filteration Chromatography

Immunoassays

- Unlabelled immunoassays

- Labeled immunoassays
    - Radio Immunoassay
    - Enzyme Immunoassay
    - Chemiluminescent assay
    - Fluorescent Immunoassay

Centrifugation

- Principle of Centrifugation
- Types of centrifuge machines
- Ultracentrifugation
- Uses in Biochemistry lab

Spectrophotometery and Photometery

- Spectrophotometery
- Flame photometery
- Flow Cytometery
- Chemiluminiscence
- Turbidometry&Nephelometery
- Atomic Absorption Spectrometery
- Fluorometery

- **Mass Spectrometery**
    - Mass analyzer
    - Detector
    - Applications in Clinical Laboratory
- **Osmometery**
    - Freezingpoint osmometer

- **Clinical Chemistry Automation**
  - Basic Approaches to Automation
  - Steps in Automated analysis

Practical work:

- Detection of amino acids in urine by paper chromatography
- Centrifugation for processing biological specimens
- Spectrophotometery for quantitative estimation of analytes in biological specimens
- Working of clinical chemistry autoanalyzer
- Identification of proteins by gel electrophoresis
- Determination of pH of solution by pH meter
- Working of ELISA

Teaching Methodologies:

1. Didactic classroom instruction on multimedia and whiteboard
2. Interactive discussions
3. Practical laboratory work
4. Assignment: Library/Internet
5. Journal Club

Assessment Plan

Quarterly basis internal assessment based on criteria mentioned in Proforma

Ongoing formative assessment through class participation and interactive discussion

Recommended Books:

1. Principles of Biochemistry. Ed **Lehninger**, Nelson and Cox.CBS publishers and distributors

2. **Biochemistrys**Ed **LubertStryer.** W.H. Freeman and Company, New York.

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- Dr. Noor-ul-ainWaheed (MBBS, M.Phil) Assistant Professor, Deptt. of Biochemistry

COURSE/ MODULE:Course code (004): Analytical Techniques

DURATION 24 days (4 weeks)

CONTACT HOURS Total **48** contact hours in **4 weeks**
12 contact hours /week ---
(**16** hours for **Lectures**, **10x3** contact hours for **Practical**, **13** hours for **Interactive Discussion** and **9** hours for **Seminars/Oral Assignments/Journal Club**)

CREDIT HOURS 3

TEACHING METHODOLOGIES Lectures/ Interactive Discussions/Seminars or Oral Assignments/ Practical Training

Sr. No.	TOPICS	Contents	Days	Total Contact Hours	Lecture	Interactive Discussion	Seminars/ Oral Assignment/ Journal Club	Practical
1.	**pH metery**	Principle of pH metery, Components and working of pH meter, Applications of pH metery in Biochemistry laboratory	2	4	1	1	1	3

2.	**Electrophoresis**	Paper electrophoresis, Cellulose acetate electrophoresis, Gel electrophoresis, Polyacrylamide Gel Electrophoresis, Immune electrophoresis, Ion selective electrodes (ISE), Two-dimensional electrophoresis, Capillary electrophoresis	4	8	3	2	1	6
3.	**Chromatography**	Paper Chromatography, Partition Chromatography, Affinity Chromatography, Column Chromatography, Gas-Liquid Chromatography, Gas Chromatography, High Performance Liquid Chromatography, Ion	5	10	4	2	2	6

		Exchange Chromatography, Adsorption, Thin Layer Chromatography, Exclusion Size Chromatography,GelFilteration Chromatography						
4.	**Immunoassays**	Unlabelled immunoassays, Labeled immunoassays, Radio Immunoassay, Enzyme Immunoassay ,Chemiluminescent assay, Fluorescent Immunoassay	3	6	2	2	1	3
5.	**Centrifugation**	Principle of Centrifugation, Types of centrifuge machines, Ultracentrifugation, Uses in Biochemistry lab	2	4	1	1	1	3

6.	**Spectrophotometery and Photometery**	Spectrophotometery, Flame photometery, Flow Cytometery, Chemiluminiscence, Turbidimetry&Nephelometery, Atomic Absorption Spectrometery, Fluorometery	4	8	3	2	1	6
7.	**Mass Spectrometery&Osmometery**	Mass analyzer, Detector, Applications in Clinical Laboratory, Freezing point osmometer	2	4	1	2	1	--
9.	**Clinical Chemistry Automation**	Basic Approaches to Automation, Steps in Automated analysis.	2	4	1	1	1	3

Course code (005)

Clinical Chemistry I

Credit Hours: 3

Introduction:

Post-graduate M. Phil traineesare considered to be familiar with understanding of the Biochemistry from clinical perspective in diagnosis as well as treatment strategies of diseased conditions.Keeping in view these requirements of the course it has been designed so.

Learning Goal:

The overall goal of this course is to make M.Phil students able to get benefit of their understanding aboutclinical Biochemistryfor interpretation of diagnosis & complications of diseases which in turn help themcarrying out basic research in clinical field.

Learning Objectives:

By the end of the course, the M.Phil students should be able to:

1. Discuss various electrolytes in humans, clinical significance of blood gases analysis, acid-base regulation along with compensatory mechanisms, acid-base disorders, Osmolal gap &Anion Gap, Water & Electrolytes balance

2. Classify Renal Function Tests and estimation of Nitrogen metabolites along with their interpretation in acute & chronic Renal failure
3. Explain urinalysis, albuminuria,urine osmolality & its significance
4. Describe hormonal regulation of calcium & phosphate metabolism, their related disordersand analytical methods for analysis of ionized and total calcium, inorganic phosphate, and vitamin D_3
5. Differentiate Liver Function Tests in Clinical Chemistry Laboratory and their interpretation
6. Discuss Gastric Function Tests and disorders related to pancreas and intestine
7. Explain Clinical Enzymology in detail along with application of various isoenzymes in the field of medicine
8. Enumerate Factors altering nutrition requirements in different conditions and discuss diseases related to nutrition in detail

Contents:

1. Electrolytes, Blood Gases, and Acid-Base Balance

- Sodium, Potassium, Chloride, Bicarbonate, Phosphate, Magnesium, Calcium, Lactate
- Blood gases analysis, their relationship and clinical significance
- Acid-base regulation, compensatory mechanisms involving lungs & kidneys
- Acid-base disorders

- Osmolal gap, Anion Gap
- Water & Electrolytes Imbalance

2. Nitrogen metabolites & renal function

- Functions of kidneys, Renal Function Tests
- Nitrogen metabolites (Urea, Creatinine, Uric Acid)
- Albuminuria
- Urinalysis
- Renal failure(Acute, Chronic)
- Urine Osmolality & its significance

3. Calcium and Phosphate Metabolism

- Hormonal regulation of calcium & phosphate metabolism
- Their related disorders
- Analytical methods for analysis of ionized and total calcium, inorganic phosphate, and vitamin D_3

4. Liver function

- Synthetic, Secretory, Excretory, Detoxification and Drug Metabolism of Liver
- Liver Function Tests in Clinical Chemistry Laboratory and their interpretation

- Tests for evaluation of synthetic, metabolic, and detoxification functions of liver & their use in diagnosis & management of liver disease

5. Gastric, Pancreatic, and Intestinal Function

- Enzymes of GIT
- Gastric Function Tests
- Tests for assessment of exocrine functions of pancreas
- Gastric, Pancreatic, and Intestinal diseases including
    a. Gastric & Duodenal Ulcer
    b. Acute & Chronic Pancreatitis
    c. Malabsorption Syndrome, Coeliac disease

6. Clinical Enzymology

- Principles of Diagnostic Enzymology
- Isoenzymes and their role in clinical diagnosis
- Types of various enzymes in human body
- Functional & Non-Functional Enzymes
- Enzymes used as reagents and drugs

7. Clinical Nutrition

- Factors altering nutrition requirements in different conditions
- Nutritional assessment and support in health & convalescence
- Diseases that produce nutrition problems
- Protein Energy Malnutrition (PEM)

Practical work:

- Estimation of electrolytes in clinical chemistry laboratory
- Estimation of parameters that are included in LFTs and RFTs (in clinical chemistry laboratory)
- Estimation of cardiac enzymes in clinical chemistry laboratory

Teaching Methodologies:

1. Didactic classroom instruction on multimedia and whiteboard
2. Interactive discussions
3. Practical laboratory work in Clinical Chemistry (Chemical Pathology) laboratory
4. Assignment: Library/Internet
5. Journal Club

Assessment Plan

1. Quarterly basis internal assessment based on criteria mentioned in Proforma
2. Ongoing formative assessment through class participation and interactive discussion

Recommended Books:

1. Principles of Biochemistry. Ed **Lehninger**, Nelson and Cox. CBS publishers and distributors.
2. Biochemistrys Ed **Lubert Stryer**. W.H. Freeman and Company, New York.
3. **Harper**'s Biochemistry. Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell. Appleton and Lange, Stamford, Connecticut.
4. Biochemistry. Ed Donald **Voet** and Judith G. Voet. John Wiley & sons, Inc.
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- Dr. Syed Faisal Hassan Shah (MBBS, M.Phil) Assistant Professor, Deptt. of Biochemistry
- Dr. Noor-ul-ainWaheed (MBBS, M.Phil) Assistant Professor, Deptt.of Biochemistry

COURSE/ MODULE: Course code (005): Clinical Chemistry I

DURATION 24 days (4 weeks)

CONTACT HOURS Total **48** contact hours in **4 weeks**

12 contact hours /week ---

(**14** hours for **Lectures**, **7x3** contact hours for **Practical**, **16** hours for **Interactive Discussion** and **11** hours for **Seminars/Oral Assignments/Journal Club**)

CREDIT HOURS 3

TEACHING METHODOLOGIES Lectures/ Interactive Discussions/Seminars or Oral Assignments/ Practical Training

Sr. No.	TOPICS	Contents	Days	Total Contact Hours	Lecture	Interactive Discussion	Seminars/ Oral Assignment/ Journal Club	Practical
1.	**Electrolytes, Blood Gases, and Acid-Base Balance**	Sodium, Potassium, Chloride, Bicarbonate, Phosphate, Magnesium, Calcium, Lactate ,Blood gases analysis, their relationship and clinical	4	8	3	2	2	3

		significance, Acid-base regulation, compensatory mechanisms involving lungs & kidneys,Acid-base disorders, Osmolal gap, Anion Gap, Water & Electrolytes Imbalance						
2.	**Nitrogen metabolites & renal function**	Functions of kidneys, RFTs,Nitrogen metabolites (Urea, Creatinine, Uric Acid)Microalbuminuria,Urinalysis,Renal failure (Acute, Chronic),Urine osmolality & its significance	3	6	1	2	1	6
3.	**Calcium and Phosphate Metabolism**	Hormonal regulation of calcium & phosphate metabolism,Their related disorders, Analytical methods for analysis of ionized and total calcium, inorganic phosphate, and vitamin D_3	3	6	2	2	1	3

4.	**Liver function**	Synthetic, Secretory, Excretory, Detoxification and Drug Metabolism of Liver , LFTs in Clinical Chemistry Laboratory and their interpretation, Tests for evaluation of synthetic, metabolic, and detoxification functions of liver & their use in diagnosis & management of liver disease	5	10	3	3	2	6
5.	**Gastric, Pancreatic, and Intestinal Function**	Enzymes of GIT, Gastric Function Tests, Tests for assessment of exocrinefunctions of pancreas, Gastric, Pancreatic, and Intestinal diseases including Gastric & Duodenal Ulcer Acute & Chronic PancreatitisMalabsorption Syndrome, Coeliac disease	3	6	2	2	2	--

6.	**Clinical Enzymology**	Principles of Diagnostic Enzymology, Isoenzymes and their role in clinical diagnosis, Types of various enzymes in human body, Functional & Non-Functional Enzymes, Enzymes used as reagents and drugs	4	8	2	3	2	3
7.	**Clinical Nutrition**	Factors altering nutrition requirements in different conditions, Nutritional assessment and support in health & convalescence, Diseases that produce nutrition problems, Protein Energy Malnutrition (PEM)	2	4	1	2	1	--

Course code (006)

Clinical Chemistry II

Credit Hours: 3

Introduction:

This course has been designed to enable students to learn all the working related to processing and handling of biological specimens and quality assurance of laboratory. This will also inculcate high level of understanding among postgraduate studentsin the field of endocrinology and oncology in relation to Biochemistry.

Learning Goal:

The overall goal of this course is to enable M.Phil students to have specialized training in Clinical Biochemistry including learning about sample collection, quality control methods, setting up of a Clinical Biochemistry laboratory, specialized assays,statistical analysis of data and its interpretation and understanding of endocrinological disorders.

Learning Objectives:

By the end of the course, the M.Phil students should be able to:

1. Identify tumor markers and study their relevance in differentialdiagnosisof tumors.

2. Perform specimen collection & processing and differentiate sources of biological variation
3. Perform tests for determination of hematological parameters
4. Describe analytical goals and clinical relevance of laboratory procedures
5. Explain establishment and use of reference values
6. Discuss all aspects of quality assurance in detail
7. Describe synthesis, secretion, mechanism of action, effects on target tissues, regulation, and related disorders of hormones of endocrine glands.

Contents:

1. Tumor Markers

2. Specimen Collection & Processing; Sources of Biological Variation

- Sources & composition of blood specimen
- Types of blood specimen & equipment
- Venipuncture, skin puncture, arterial puncture, anticoagulants & preservatives of blood, hemolysed sample
- Preanalytical considerations
- Capillary specimen collection
- Specimen handling & processing for testing

- Collection of urine, faeces, spinal fluid, other fluids for analysis

3. Biochemical aspects of Hematology

- Methods for determination of Glucose-6-Phosphate Dehydrogenase (G-6 PD), Pyruvate Kinase, Glutathione,2,3 Bisphosphoglycerate
- Electrophoretic separation of hemoglobin
- Determination of serum Iron, Ferritin, Total Iron Binding Capacity (TIBC)

4. Analytical goals and clinical relevance of laboratory procedures

- Analytical accuracy,precision, performance in comparison with analytical goals
- Predictive value of laboratory test in clinical diagnosis
- Evaluation of test result by the laboratory

5. Establishment and use of reference values

- Introduction to statistical terms & techniques
- Use of reference values

6. Quality assurance

- Elements of quality assurance
- Control of pre-analytical & analytical variables along with quality control
- Control materials

- General principles of Lewy-Jennings Chart, Westgard Rules
- External quality assurance
- Internal quality assurance
- Identification of sources of analytical errors

7. Endocrinology

- Introduction of hormones, mechanism of hormone action, classification of hormones
- Endocrine hormones of human body

  (Synthesis, Secretion, Mechanism of Action, effects on target tissues, regulation, related disorders)

Including:

a. Anterior Pituitary Hormones
b. Posterior Pituitary Hormones
c. Hormones of Adrenal Cortex, Adrenal Medulla
d. Sex Hormones of male & female reproductive system
e. Hormones of thyroid gland
f. Parathyroid Hormone
g. Endocrine portion of Pancreas

Practical work:

1. Performance of human specimen collection & processing
2. Determination of hematological parameters including G-6 PD, Pyruvate Kinase, Glutathione 2,3 Bisphosphoglycerate
3. Quantitative determination of tumor markers
4. Running of control material for internal quality control in Clinical Chemistry Lab.

Teaching Methodologies:

1. Didactic classroom instruction on multimedia and whiteboard
2. Interactive discussions
3. Practical laboratory work
4. Assignment: Library/Internet
5. Journal Club

Assessment Plan

1. Quarterly basis internal assessment based on criteria mentioned in Proforma

2. Ongoing formative assessment through class participation and interactive discussion

Recommended Books:

1. Principles of Biochemistry. Ed **Lehninger**, Nelson and Cox.CBS publishers and distributors.

2. **Biochemistrys**Ed **LubertStryer.** W.H. Freeman and Company, New York.

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Course Instructors

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- Dr. Syed Faisal Hassan Shah (MBBS, M.Phil) Assistant Professor, Deptt. of Biochemistry
- Dr. Noor-ul-ainWaheed (MBBS, M.Phil) Assistant Professor, Deptt. of Biochemistry

COURSE/ MODULE:Course code (006): Clinical Chemistry II

DURATION 24 days (4 weeks)

CONTACT HOURS Total **48** contact hours in **4 weeks**
12 contact hours /week ---
(**17** hours for **Lectures**, 5**x3** contact hours for **Practical**, **15** hours for **Interactive Discussion** and **11** hours for **Seminars/Oral Assignments/Journal Club**)

CREDIT HOURS 3

TEACHING METHODOLOGIES Lectures/ Interactive Discussions/Seminars or Oral Assignments/ Practical Training

Sr. No.	TOPICS	Contents	Days	Total Contact Hours	Lecture	Interactive Discussion	Seminars/ Oral Assignment/ Journal Club	Practical
1.	**Tumor Markers**		2	4	1	1	1	3

2.	**Specimen Collection & Processing; Sources of Biological Variation**	Sources & composition of blood specimen,Types of blood specimen & equipment Venipuncture, skin puncture, arterial puncture anticoagulants & preservatives of blood, hemolysed sample Preanalytical considerations**,** Capillary specimen collection**,** Specimen handling & processing for testing**,** Collection of urine, faeces, spinal fluid, other fluids for analysis	4	8	2	3	1	6
3.	**Biochemical aspects of Hematology**	Methods for determination of G-6 PD, Pyruvate Kinase, Glutathione, 2,3 Bisphosphoglycerate Electrophoretic separation of hemoglobin	2	4	1	1	1	3

		Determination of serum Iron, Ferritin, TIBC						
4.	**Analytical goals and clinical relevance of laboratory procedures**	Analytical accuracy,precision, performance in comparison with analytical goals Predictive value of laboratory test in clinical diagnosis Evaluation of test result by the laboratory	3	6	2	2	2	-
5.	**Establishment and use of reference values**	Introduction to statistical terms & techniques, Use of reference values	2	4	1	2	1	-

6.	**Quality assurance**	Elements of quality assurance , Control of pre-analytical & analytical variables along with quality control Control materials, General principles of Lewy-Jennings Chart, Westgard Rules, External quality assurance,Internal quality assurance ,Identification of sources of analytical errors	5	10	4	3	2	3
7.	**Endocrinology**	Introduction of hormones, mechanism of hormone action, classification of hormones Endocrine hormones of human body (Synthesis, Secretion, Mechanism of Action, effects on target tissues, regulation, related disorders) Including:Anterior Pituitary	6	12	6	3	3	-

		Hormones,Posterior Pituitary Hormones, Hormones of Adrenal Cortex, Adrenal Medulla, Sex Hormones of male & female reproductive system, Hormones of thyroid gland, Parathyroid Hormone, Endocrine portion of Pancreas						

Course code (007)

Molecular Biology

Credit Hours: 3

Introduction:

Molecular Biology is a key science in understanding biochemical processes of the human body as well as the molecular basis of disease. This course is aimed at teaching the M.Phil students essentials of Molecular biology which will also facilitate them to increase their perception of the genetic basis of disease necessary for research and treatment.

Learning Goal :

The course aims to teach postgraduate students the essential elements of genetic molecular biology to lay the grounds for increasing their understanding of intricate processes of molecular biology.

Learning Objectives:

By the end of the course, the M.Phil students should be able to:

1. Discuss the basic pathways of biosignalling
2. Describe genes & chromosomes

3. Explain DNA and RNA metabolism
4. Discuss regulation of gene expression
5. Analyze protein sequences, identify proteins, and retrieve protein structures from databases. View and interpret these structures. Understand Proteinmodeling and computational drug design
6. Manipulate DNA and protein sequences using stand-alone PC programs and programs available on the WWW

Contents:

1. Biosignalling

- G-ProteinCoupled Receptor
- Second Messengers
- Tyrosine Kinase Receptor
- Role of cGMP
- Multivalent Adaptor Proteins and Membrane Rafts
- Gated Ion Channels
- Bidirectional Cell-Adhesion Receptors
- Regulation of Transcription by Nuclear Hormone Receptor
- Regulation of Cell Cycle by Protein Kinases
- Oncogenes, Tumor Suppressor Genes, Programmed Cell Death

2. Genes & Chromosomes

- Chromosomal elements
- DNA supercoiling
- Structure of chromosomes
- Genetic Mutations

3. DNA Metabolism

- DNA structure
- DNA replication
- DNA damage and repair mechanism
- DNA recombination

4. RNA Metabolism

- DNA dependent synthesis of RNA
- RNA processing
- RNA dependent synthesis of RNA & DNA
- HIV Reverse Transcriptase
- Methods for generating RNA polymers

5. Regulation of Gene Expression

- Principles of gene regulation
- Process of Transcription, Post-Transcriptional Modification
- Regulation of gene expression in bacteria/eukaryotes
- Genetic code
- Process of Translation, Post-Translational Modification

6. Biological Sequence Analysis

- Pairwise alignment
- Multiple sequence alignment introduction,
- BLAST algorithm
- Expasy server
- Protein analysis (Prosite, Pfam, PRINTS, BLOCKS etc)
- Bioinformatics resources for primer designing

7. Structural Bioinformatics and Systems Biology

- Bioinformatics Structural databases
- Protein data bank repository
- Introduction to applied structural bioinformatics
- Molecular docking (Autodock)

- CADD (computer aided drug designing)
- Biological networks review and resources

Teaching Methodologies:

1. Didactic classroom instruction on multimedia and whiteboard
2. Interactive discussions
3. Assignment: Library/Internet
4. Journal Club
5. Presentations by students

Assessment Plan

2. Quarterly basis internal assessment based on criteria mentioned in Proforma
3. Ongoing formative assessment through class participation and interactive discussion

Recommended Books:

1. Principles of Biochemistry. Ed **Lehninger**, Nelson and Cox.CBS publishers and distributors.

2. **Biochemistrys**Ed **LubertStryer.** W.H. Freeman and Company, New York.

3. Harper's Biochemistry. Ed. R.K.Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell.Appleton and Lange, Stamford, Connecticut.

4.Biochemistry. Ed Donald **Voet** and Judith G. Voet.John Wiley & sons, Inc.

5.Textbook of Biochemstry with Clinical Correlations. Ed. Thomas M. **Devlin**.Wiley-Liss Publishers.

6.Principles and Techniques of **Practical Biochemistry**. Ed .**Keith Wilson** and John Walker.Cambridge University Press.

Course Instructors

- Prof. Dr. Nakhshab Choudhry (MBBS, DCP, M.Phil, PhD), Chairman Deptt. Of Biochemistry)
- Dr. Shakil Ahmed (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry
- Dr. Syed Faisal Hassan Shah (MBBS, M.Phil) Assistant Professor, Deptt. of Biochemistry
- Dr. Noor-ul-ainWaheed (MBBS, M.Phil) Assistant Professor, Deptt. of Biochemistry

COURSE/ MODULE: Course code (007): Molecular Biology

DURATION	24 days (4 weeks)
CONTACT HOURS	Total **48** contact hours in **4 weeks** **12** contact hours /week --- (**17** hours for **Lectures**, **18** hours for **Interactive Discussion** and **13** hours for **Seminars/Oral Assignments/Journal Club**)
CREDIT HOURS	**3**
TEACHING METHODOLOGIES	Lectures/ Interactive Discussions/Seminars or Oral Assignments/ Practical Training

Sr. No.	TOPICS	Contents	Days	Total Contact Hours	Lecture	Interactive Discussion	Seminars/ Oral Assignment/ Journal Club	Practical
1.	**Biosignalling**	G-Protein Coupled Receptor, Second Messengers,Tyrosine Kinase Receptor, Role of cyclic nucleotides, Multivalent Adaptor Proteins and Membrane Rafts, Gated Ion Channels, Bidirectional Cell-	4	8	2	4	2	-

		Adhesion Receptors, Regulation of Transcription by Nuclear Hormone Receptor, Regulation of Cell Cycle by Protein Kinases, Oncogenes, Tumor Suppressor Genes, Programmed Cell Death,						
2.	**Genes & Chromosomes**	Chromosomal elements, DNA supercoiling, Structure of chromosomes, Genetic Mutations						
3.	**DNA Metabolism**	DNA structure, DNA replication, DNA damage and repair mechanism, DNA recombination	3	6	2	2	2	-
4.	**RNA Metabolism**	DNA dependent synthesis of RNA, RNA processing, RNA dependent synthesis of RNA & DNA, HIV Reverse Transcriptase, Methods for generating RNA polymers	5	10	4	3	3	-

5.	**Regulation of Gene Expression**	Principles of gene regulation, Process of Transcription, Post-Transcriptional Modification, Regulation of gene expression in bacteria/eukaryotes, Genetic code, Process of Translation, Post-Translational Modification	4	8	4	2	2	-
6.	**Biological Sequence Analysis**	Pairwise alignment, Multiple sequence alignment introduction, BLAST algorithm, Expasy server, Protein analysis (Prosite, Pfam, PRINTS, BLOCKS etc), Bioinformatics resources for primer designing.	4	8	2	4	2	-
7.	**Structural**	Bioinformatics Structural databases, Protein data bank	3	6	2	2	2	-

	Bioinformatics and Systems Biology	repository, Introduction to applied structural bioinformatics, Molecular docking (Autodock), CADD (computer aided drug designing), Biological networks review and resources						

Course code (008)

Medical Genetics & Biotechnology

Credit Hours: 3

Introduction:

To distinguish the basis of genetic disorders is important for postgraduate students.The knowledge of Biotechnology and Molecular Biology techniques are indispensible in life sciences and medical sciences research. Keeping in view their significance the course has been designed.

Learning Goal:

The overall goal of this course is to enable the students to understand working of Molecular Biology techniques so that they may be able enough to do research employing these techniques and to differentiate genetic disorders.

Learning Objectives:

By the end of the course, the M.Phil students should be able to:

1. Discusssingle-gene disorders

2. Explain cytogenetics
3. Describe genetics of common diseases
4. DiscussGene Mapping
5. Identifydifferent types of dna polymorphism
6. Explaingenetic diagnosis
7. Describe recombinant DNA technology
8. Explain nucleic acid hybridization

Contents:

Single-Gene Disorders:

Major Modes of Inheritance (Autosomal Dominant, Autosomal Recessive, X-Linked Recessive)

Cytogenetics:

- *Numerical chromosome abnormalities:*

Euploidy, Aneuploidy

- *Structural chromosome abnormalities:*

Translocations, deletions

- *Other chromosomal abnormalities:*

Inversions, Ring Chromosome, Isochromosome, UniparentalDisomy

- *Advances in molecular cytogenetics:*

Fluorescence in situ hybridization (FISH), Spectral Karyotyping

Genetics of Common Diseases

Multifactorial inheritance

Gene Mapping

- **Different types of DNA Polymorphism**
- Restriction Fragment Length Polymorphisms(RFLPs)
- Variable Number of Tandem Repeats(VNTRs)
- Short Tandem Repeat Polymorphisms(STRPs)
- Single Nucleotide Polymorphisms(SNPs)
- **Gene Mapping: Linkage Analysis**

Genetic Diagnosis

Recombinant DNA Technology

- Isolation of DNA from Blood
- Isolation of DNA from tissues
- RNA isolation from blood and tissues
- Restriction enzymes

- **Nucleic acid hybridization**

Southern blotting technique

Northern blotting technique

Miscellaneous Topics

- DNA Cloning-----its applications in medicine
- DNA Library
- Probes
- Transgenic animals
- DNA sequencing
- Gene therapy
- Role of genetics in Prenatal Diagnosis
- Polymerase Chain Reaction (PCR)
- Analysis of Gene Expression

Teaching Methodologies:

1. Didactic classroom instruction on multimedia and whiteboard
2. Interactive discussions
3. Practical laboratory work

4. Assignment: Library/Internet

5. Journal Club

6. Presentations by students

Assessment Plan

Quarterly basis internal assessment based on criteria mentioned in Proforma

Ongoing formative assessment through class participation and interactive discussion

Recommended Books:

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4. **Biochemistry**. Ed Donald **Voet** and Judith G. Voet. John Wiley & sons, Inc.
5. **Textbook of Biochemstry with Clinical Correlations**. Ed. Thomas M. **Devlin**.Wiley-Liss Publishers.
6. Principles and Techniques of **Practical Biochemistry**. Ed .**Keith Wilson** and John Walker. Cambridge University Press.

7. **Tietz Textbook of Clinical Chemistry** Ed.Burtis and Ashwood. W.B. Saunders Company.
8. **Molecular Cell Biology,** H. **Lodish**, A. Berk, S.L.Zipursky, P. Matsudira, D. Baltimore, J. Darnell.

Course Instructors

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- Dr. Shakil Ahmed (MBBS, M.Phil) Assistant Professor, Deptt. Of Biochemistry
- Dr. Syed Faisal Hassan Shah (MBBS, M.Phil) Assistant Professor, Deptt. of Biochemistry
- Dr. Noor-ul-ainWaheed (MBBS, M.Phil) Assistant Professor, Deptt. of Biochemistry

COURSE/ MODULE	**Course code (008): Medical Genetics & Biotechnology**
DURATION	24 days (4 weeks)
CONTACT HOURS	Total **48** contact hours in **4 weeks** **12** contact hours /week --- (**20** hours for **Lectures**, **14** hours for **Interactive Discussion** and **14** hours for **Seminars/Oral Assignments/Journal Club**)
CREDIT HOURS	**3**
TEACHING METHODOLOGIES	Lectures/ Interactive Discussions/Seminars or Oral Assignments/ Practical Training

Sr. No.	TOPICS	Contents	Days	Total Contact Hours	Lecture	Interactive Discussion	Seminars/ Oral Assignment/ Journal Club	Practical
1.	**Single-Gene Disorders:**	Major Modes of Inheritance (Autosomal Dominant, Autosomal Recessive, X-Linked Recessive)	2	4	1	2	1	-

2.	**Cytogenetics:**	*Numerical chromosome abnormalities:* Euploidy, Aneuploidy *Structural chromosome abnormalities:* Translocations, deletions *Other chromosomal abnormalities:* Inversions, Ring Chromosome, Isochromosome, UniparentalDisomy *Advances in molecular cytogenetics:* Fluorescence in situ hybridization (FISH), Spectral Karyotyping	4	8	4	2	2	-
3.	**Genetics of Common Diseases**	Multifactorial inheritance	4	8	3	2	3	-
	Gene Mapping	Restriction Fragment Length	4	8	4	2	2	-

4.	**&different types of DNA Polymorphism**	Polymorphisms(RFLPs) , Variable VariableNumber of Tandem Repeats(VNTRs) ,Short Tandem Repeat Polymorphisms(STRPs),Single Nucleotide Polymorphisms(SNPs) Gene Mapping: Linkage Analysis						
5.	**Recombinant DNA Technology**	Isolation of DNA from Blood Isolation of DNA from tissues RNA isolation from blood and tissues, Restriction enzymes	3	6	2	2	2	--
6.	**Nucleic acid hybridization**	Southern blotting technique Northern blotting technique	3	6	2	2	2	--
7.	**Miscellaneous Topics**	DNA Cloning-----its applications in Medicine , DNA Library, Probes, Transgenic animals,DNA sequencing, Gene therapy, Role of genetics in Prenatal Diagnosis,	4	8	4	2	2	--

		Polymerase Chain Reaction (PCR), Analysis of Gene Expression						