COURSE OF STUDIES

for

Doctor of Philosophy

in

<BIOCHEMISTRY>

UNIVERSITY OF HEALTH SCIENCES, LAHORE PAKISTAN

Mission Statement.

To advance scientific understanding in the field of biochemistry through rigorous research, innovative methodologies, and interdisciplinary collaboration. We are committed to fostering a supportive and inclusive academic environment that nurtures the intellectual and professional growth of our students, equipping them to address complex biological challenges and contribute to the advancement of science and society.

Vision Statement:

To be a leading global center for biochemistry research and education, recognized for our groundbreaking discoveries, excellence in teaching, and dedication to solving pressing health and environmental issues. We aspire to cultivate a community of scholars who push the boundaries of knowledge and drive progress in the biochemical sciences, ultimately improving human health and well-being.

Program Educational Objectives:

The objective of the PhD course in Biochemistry is to provide in-depth knowledge and understanding of various aspects of metabolism of biomolecules and related disorders. The course covers topics such as disorders of neurotransmitters, clinical endocrinology, reproductive biochemistry, cancer, AIDS, and obesity. Through this course, students will gain a comprehensive understanding of these areas and their implications in the field of biochemistry.

Program Learning Outcomes:

By the end of the PhD course students will be able to understand the fundamental principles of biochemical pathways involved in the metabolism of biomolecules, analyze the molecular mechanisms underlying the pathogenesis of disorders related to neurotransmitters, clinical endocrinology, reproductive biochemistry, cancer, AIDS, and obesity, evaluate the current research trends in the field of biochemistry and their implications in the diagnosis, treatment and prevention of metabolic disorders and develop critical thinking and problem-solving skills through experimental design, data analysis and interpretation.

SCHEME OF STUDIES (3-Year) PhD: Biochemistry

Semester #	Course code	Course title	Credit hours		
			Theory	Practical	Total
1	BCH-804	Research Methodology	2	0	02
		Advance Biostatistics	2	0	02
		Metabolism of Biomolecules and Related Disorders			02
	BCH-805	Nucleotide Metabolism & related diseases.			02
	BCH-806	Biochemistry and Related Disorders of Neurotransmitters			02
2		Advanced Laboratory Techniques			02
	BCH-807	Clinical Endocrinology			02
	BCH-808	Biochemical Aspects of Reproductive System Diseases			02
	BCH-809	Contemporary Biochemistry			02
3	Research (thesis)		30		30
Total Credit Hours: 48					

Course Title

Metabolism of biomolecules and related disorders (BCH-804)

Contact Hours:	Credit Hours: 03
Theory =	Theory =o3
Practical =	Practical = 01
Total =	Total =3

Course Objective:

This course provide understanding with basic metabolic pathway, control and integration of metabolism and diseases related to these biomolecules.

Learning Outcome:

Students will acquire a good understanding of biochemical basis of diseases related to inherited metabolic disorders and Inborn errors of metabolism.

Course Outline:

A. Metabolism of Carbohydrates

1- **Glycolysis**

- Reactions, biomedical significance, energy yield, regulation, and significance of aerobic and anaerobic glycolysis
- Substrate-level phosphorylation & metabolic fates of pyruvate.
- Lactic acidosis. Genetic deficiency of pyruvate kinase and pyruvate dehydrogenase

2- **Tricarboxylic acid (TCA) cycle**

Amphibolic role, reactions, energy yield, regulation, and importance of TCA cycle

3- **Gluconeogenesis**

- Important gluconeogenic precursors and their entrance in TCA cycle.
- Reactions, regulation, and biomedical significance of gluconeogenesis.
- Role of gluconeogenesis in plasma glucose level regulation, and the Cori cycle, and glucose-alanine cycle.

4- **Glycogen metabolism**

- Synthesis and importance of UDP glucose
- Reactions and regulation of glycogenesis and glycogenolysis
- Importance of allosteric regulation of glycogen phosphorylase
- Glycogen storage diseases

5- **Hexose monophosphate (HMP) pathway**:

- Reactions, and importance of oxidative and non-oxidative phases of HMP pathway.
- Uses of NADPH, and glucose 6-phosphate dehydrogenase deficiency.

6- Reactions and biologic importance of uronic acid pathway

7- Metabolism and metabolic fate of fructose and galactose, sorbitol, and ethanol in human body.

Essential fructosuria and hereditary fructose intolerance. Disorders of galactose metabolism. galactokinase deficiency and classic galactosemia

8- 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
- An overview, causes, and clinical manifestations of hypoglycemia and hyperglycemia:
- Types, clinical manifestations, metabolic changes and diagnosis of type 1 and type 2 diabetes mellitus.
- All related congenital & acquired diseases.

B. Metabolism of lipids

1- Fatty acids synthesis

- Fatty acid synthase multienzyme complex. De novo synthesis, elongation, unsaturation, and regulation of fatty acids synthesis.
- Synthesis, storage, and mobilization of stored triacylglycerols along with its regulation of triacylglycerols in body.

2- Oxidation of fatty acids

- Translocation of fatty acyl CoA into mitochondrial matrix, reactions, energy yield of saturated and unsaturated fatty acids.
- Fate of acetyl CoA, and fatty acid oxidation (alpha-oxidation, beta oxidation, omega-oxidation, and oxidation of odd-carbon fatty acids).

Synthesis and utilization of ketone bodies

Reactions of hepatic ketogenesis, and utilization of ketone bodies by extrahepatic tissues. Ketoacidosis and regulation of ketogenesis.

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

Metabolism of phospholipids, glycolipids, **and sphingolipids**:

Synthesis and degradation of phospholipids, glycerol ether phospholipids. Deficiency of lung surfactant,

Degradation of sphingolipids along with sphingolipidoses.

Cholesterol metabolism:

Reactions and regulation of cholesterol biosynthesis, and fate and functions of cholesterol in body.

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

Plasma lipoproteins:

Synthesis, transport, and fate of chylomicrons, VLDL, IDL, LDL, and HDL

Disorders associated with impairment of lipoprotein metabolism, and atherogenic effect of oxidized LDL.

Fatty liver

- All related congenital & acquired diseases.

C- Metabolism of Proteins and Amino Acids

- Protein turnover, nitrogen balance, Inter-organ amino acid exchange in normal post-absorptive state
- Degradation of amino acids; removal of nitrogen from amino acids by transamination and deamination.
- Sources of ammonia in body; transport of ammonia, ammonia toxicity; fate of ammonia in body,
- Urea cycle, metabolic disorders of the urea cycle.
- Amphibolic intermediates formed from the carbon skeleton of amino acids.
- Glucogenic and ketogenic amino acids
- Metabolism of individual amino

- Causes and salient features of important metabolic defects in amino acid metabolism with special emphasis on phenylketonuria, maple syrup urine disease (MSUD), histidinemia, alkaptonuria, cystathioninuria, homocystinuria, hyperprolinemia, cystinuria, cystinosis, tyrosinemias, and albinism
- Absorption of carbohydrates, lipids and amino acids Disease states associated with GIT disorders like achlorhydria, peptic ulcers, lactose intolerance, cholelithiasis and pernicious anemia, cystic fibrosis and celiac disease.
- Integration and Regulation of Metabolic Pathways
- Fed-fast cycle and starvation.
- All related congenital & acquired diseases.

Recommended Books.

Harper's 31 Edition, Rodwell Et.al

Lippencott, Biochemistry Eight Edition

Course Title

Nucleotide Metabolism & related diseases. **(BCH-805)**

Contact Hours:	Credit Hours: 02
Theory =	Theory =o2
Practical =	Practical = 0
Total =	Total =2

Course Objective:

This course will deliver introduction, structure, function, synthesis and degradation of nucleotide and disorder of nucleotide metabolism.

Learning Outcome:

After completion of course Student will be able to understand that how disturbance in nucleotide metabolism led different type of disorder.

- De novo Synthesis of purines and pyrimidines
- The salvage pathways of nucleotide synthesis
- Degradation of purine and pyrimidine nucleotides
- Genetic diseases of nucleotide metabolism.
    - Lesch Nyan s.
    - orotic aciduria
    - Increased activity of Phosphoribosyl Pirophosphate Synthetase
    - Adenylosuccinase Deficiency
    - Severe Combined Immunodeficiency Disease (SCID)
    - Purine Nucleoside Phosphorylase Deficiency
    - Pyrimidine 5' Nucleotidase Deficiency
    - Dihydropyrimidine Dehydrogenase Deficiency

Recommended Books:

Molecular biology of THE CELL ,6th edition

Harper's 31 Edition, Rodwell Et.al

Lippencott, Biochemistry Eight Edition

Course Title

Biochemistry and related disorders of Neurotransmitters (BCH-806)

Contact Hours:	Credit Hours: 02
Theory =	Theory =o2
Practical =	Practical = 0
Total =	Total =2

Course Objective:

The course will give function and mode of action of excitatory and inhibitory neurotransmitter**.**

Learning Outcome:

After completion of this course student will be able to understand, how the neurotransmitter contribute in normal functions of body and imbalance of neurotransmitter can develop certain health condition like depression, anxiety Alzheimer and Parkinson.

Course Outline

Overview, definition, and classification of neurotransmitters

- Mechanism of action of excitatory and inhibitory neurotransmitters
- Metabolism of epinephrine and norepinephrine, dopamine, gamma-aminobutyrate, serotonin, melatonin, and melanin
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- Role of neurotransmitters in Alzheimer's, epilepsy, and Parkinson's disease, depression, anxiety, and obsessive-compulsive disorder.

Molecular biology of THE CELL ,6th edition

Harper's 31 Edition, Rodwell Et.al

Lippencott, Biochemistry Eight Edition

Course Title

Clinical Endocrinology (BCH-807)

Contact Hours:	Credit Hours: 02
Theory =	Theory =o2
Practical =	Practical = 0
Total =	Total =2

Course Objective:

This course will provide knowledge to understand synthesis, regulation and related disorder.

Learning Outcome:

Student will be able to understand how the endocrine system works. Course explores the organs and glands that produce essential hormones and how hormones can act on our bodies, and the main mechanisms that regulate them. The role of hormone balance in diseases.

Course Outline:

Biochemistry of Endocrine System

- Classification of hormones
- Chemical nature of each class of hormones
- Mechanisms of action of each class of hormone.
- Hormone receptors
- Types and actions of various kinds of G-proteins in mediating the actions of hormones
- Signal transduction pathways of various hormones
- Types and role of various kinds of second messengers

Pituitary and hypothalamic hormones:

- Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of all hypothalamic and pituitary hormones
- Disorders associated with hyper- and hypo-activities of these hormones. Special emphasis on dwarfism, gigantism, acromegaly, Cushing's syndrome, Addison's disease, Diabetes insipidus, and the inappropriate secretion of ADH.

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
- Special emphasis on goiter, hypothyroidism, hyperthyroidism, Graves' disease.

Calcium Regulating Hormones

- Parathyroid hormone calcitriol, and calcitonin:
- Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic role in calcium homeostasis
- hypoparathyroidism, hyperparathyroidism (primary, secondary, and tertiary), pseudohypoparathyroidism, rickets, and osteomalacia

Adrenal Cortical Hormones

- Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of all adrenal cortical hormones
- Cushing's syndrome, secondary adrenal deficiency, Addison's disease, primary aldosteronism and secondary aldosteronism.

Adrenal Medullary Hormones

- Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of adrenal medullary hormones
- Pheochromocytoma

Gonadal Hormones

- Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions
- Hypergonadism and hypogonadism

Hormones of Pancreas

- Structure, biosynthesis, secretion, transport, regulation, catabolism, and biologic actions of all pancreatic hormones (insulin, glucagon, somatostatin, and pancreatic polypeptide)
- Insulin deficiency and diabetes mellitus

Gastrointestinal hormones

- Gastrin, cholecystokinin (CCK), secretin, gastric inhibitory peptide (GIP), vasoactive intestinal polypeptide (VIP), motilin, enkephalins, substance P, neurotensin, and enteroglucagon.

Clinical Chemistry, Ninth Edition, International Edition, Willam Marshall

Harper's 31 Edition, Rodwell Et.al

Course Title

Biochemistry and clinical aspects of reproductive diseases (BCH-808)

Contact Hours:	Credit Hours: 02
Theory =	Theory =o2
Practical =	Practical = 00
Total =	Total =2

Course Objective:

This course will discuss the bases of different diseases of reproductive organ in male and female.

Learning Outcome:

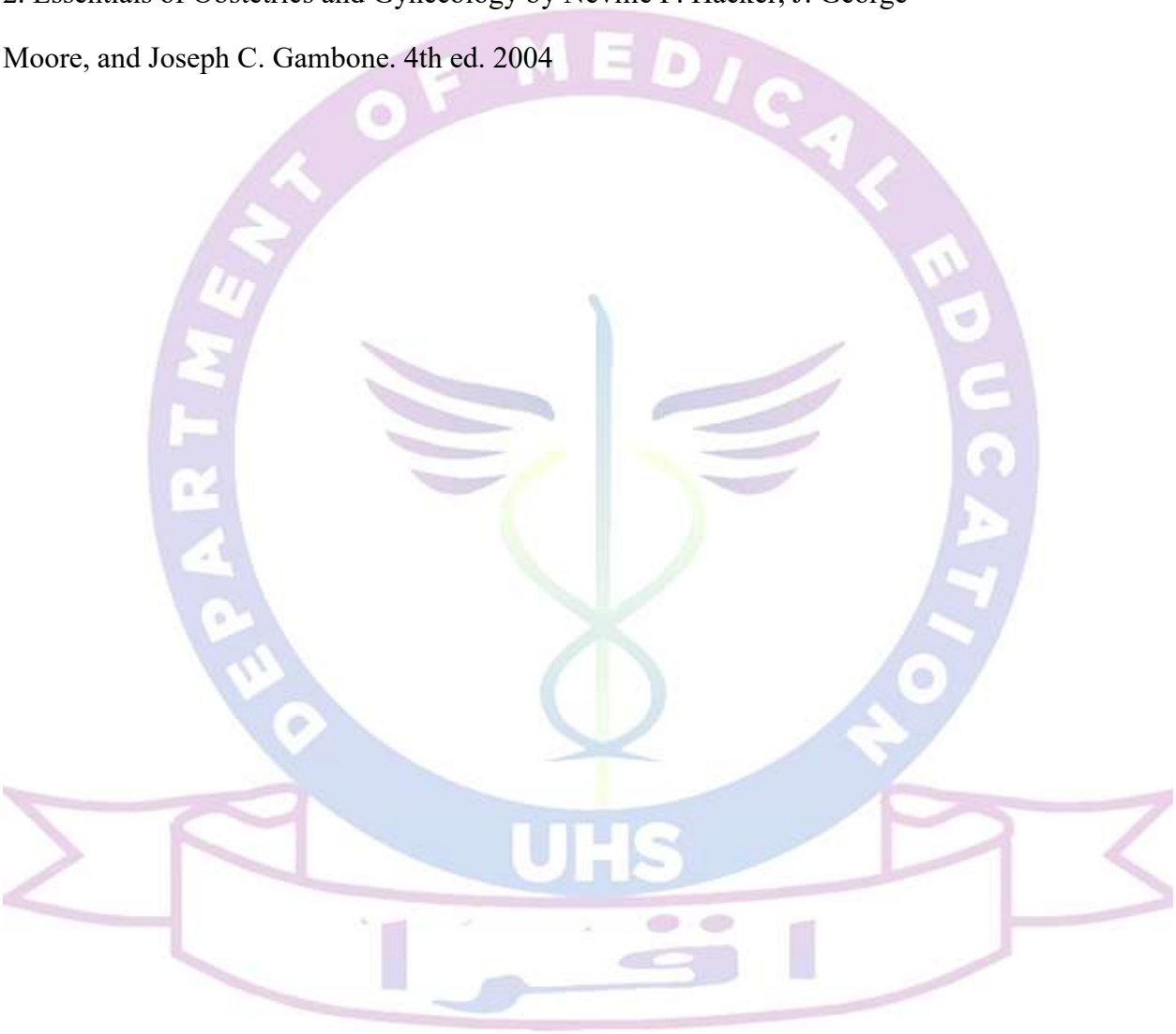
After completion of this course student will be able to understand the biochemical bases of reproductive diseases.

- Hormones of reproductive glands: estrogen and progesterone, testosterone.
- Hormones of pituitary hormones: luteinizing hormone (LH) and follicle stimulating hormone (FSH).
- Precocious and delayed puberty
- Ovarian insufficiency
- Polycystic ovary syndrome
- Hypogonadism
- Biochemistry of infertility

All related congenital & acquired diseases.

1. Gynaecology by Ten Teachers by Stanley G. Clayton and Ash Monga 2006.

2. Essentials of Obstetrics and Gynecology by Neville F. Hacker, J. George Moore, and Joseph C. Gambone. 4th ed. 2004



Course Title

Contemporary Biochemistry (BCH-809)

Contact Hours:	Credit Hours: 02
Theory =	Theory =o2
Practical =	Practical = 0
Total =	Total =2

Course Objective:

Learning Outcome:

This course will provide the up-to-date knowledge, concept and review about disease and related affaires.

- Cancers
- AIDS
- Obesity
- Management of Diabetes mellitus and asthma
- Environmental Biochemistry

Recommended Books.

There is no specific textbook for this paper. Examples are drawn from current research literature.

Teitz fundamentals of clinical chemistry

Lippincott's biochemistry

Text book of biochemistry with clinical correlations by Thomas Devlin

Harpers biochemistry

Compulsory Teaching Skills

For a thorough evaluation of students' understanding and critical thinking abilities, all PhD students in their respective disciplines will;

1. Design a comprehensive set of 50 Multiple Choice Questions (MCQs) and 25 Short Essay Questions (SEQs) for M. Phil students.

2. Plan 20 observed lectures focusing on key topics.

These assessments will provide Ph.D. students valuable experience in educational design and delivery. These will also enhance their interactive learning with the provision of real-time feedback.