UNIVERSITY OF DIYALA
COLLEGE OF MEDICINE
DEPT. OF CHEMISTRY
AND BIOCHEMISTRY

SYLLABUS OF

Biochemistry and Metabolism

THEORY

2nd stage

2023-2024

INDEX

contents **page number**

Vision, message and objectives of the branch:

Vision:

1. Actively contribute to medical progress through education and prepare qualified doctors to provide the best medical services and continue scientific research in all medical fields.
2. The preparation of doctors with competence and scientific experience enhanced by understanding the biochemical foundations of vital processes that occur within the human body in normal and pathological cases.

Message:

1. Excellence in the innovation and follow-up of advanced scientific methods in the conduct of pathological analyses and the preparation of medical scientific research that contributes to the service of the community.
2. Establishing sober relationships with researchers at international universities.

Goals:

1. Keeping up with the scientific development in the development of education programs and using the latest programs developed for medical education in accordance with the modern academic curriculum.
2. Contribute to providing the community with scientifically distinguished doctors with experience in the scientific foundations adopted to conduct all clinical biochemistry analyses.
3. Lectures for graduate students at university colleges as well as supervising their research projects.

Credit hours :

Theory hours of the year : 90

Theory hours of the course : 45

Practical hours of the year : 60

Practical hours of the course : 30

Theory Exam :

Mid year exam : is a 2 hrs .

Final year exam : is a 3 hrs .

Practical Exam :

Mid year exam : is a 2 hr .

Final year exam : is a 3 hrs .

Learning units :

Units of teaching of the year : 8

Units of teaching of the course / Theoey : 6

Units of teaching of the course / Practical : 2

First Semester

Total weeks of the course : 15

Theory hours of the course : 45

Theory hours / week : 3

Units of teaching: 3

First Week **(3 hours)**

Introduction to Carbohydrate metabolism

Objectives

1. Identify the major saccharides found in the human body and diet.

2. What is the process of carbohydrate metabolism.

3. Draw diagram of how glucose transported across intestinal epithelial cells and into the blood stream and describe the protein involved.

Second Week **(3 hours)**

Glycolysis

Objectives

1. Describe the overall purpose of glycolysis, its cellular reactants and products, its cellular localization and its tissue distribution.

2. Differentiate the roles of hexokinase and glucokinase in blood glucose regulation .

3. Describe the purpose of the reaction catalyzed by LDH.

4. Predict the results of a CBC in a person with PK deficiency who is in hemolytic crisis.

5. Explain the biochemical basis of the hemolytic anemia observed in deficiency of erythrocyte pymvate kinase .

Third Week **(3 hours)**

TCA Cycle

Objectivses

1. Describe the overall purpose of the TCA cycle , its reactants and products ,its cellular localization and its tissue distribution.

2. Explain the effect of the ATP and citrate on the activity of the TCA cycle.

3. Describe the role of the TCA Cycle intermediates as sources of reactants for biosynthetic pathways.

Fourth Week **(3 hours)**

Gluconeogenesis

Objectives

1. Differentiate the enzymes involved in glycolysis and gluconeogenesis.

2. Explain the contribution of gluconeogenesis to blood glucose regulation.

3. Evaluate the relative importance of different precursors for gluconeogenesis in feeding, fasting and exercise.

4. Describe the overall purpose of gluconeogenesis, its reactants and products, its cellular localization, and its tissue distribution.

Fifth Week (3 hours)

Glycogen metabolism

Objectives

1. Describe the overall purpose of gluconeogenesis and glycogenolysis, their reactants and products, their cellular localization and their tissue distribution.

2. Explain how glycogen synthesis and glycogenolysis are regulated by insulin, glucagon and catecholamine's.

3. Select laboratory tests that would contribute to the diagnosis of glycogen storage disease.

Sixth Week **(3 hours)**

Pentose phosphate pathway

Objectives

1. Describe the overall purpose of the PPP, its reactants and products and its cellular localization.

2. Describe the role of reduced glutathione in the body.

3. Explain the biochemical basis of the drug induced hemolytic anemia observed in G6PD deficiency.

4. Select laboratory tests used to diagnose G6PD deficiency.

Seventh Week **(3 hours)**

Diabetes Mellitus

Objectives

1. Compare and contrast type 1 and type 2 diabetes mellitus with respect to incidence, age of onset and distinguishing characteristics.

2. Describe abnormalities in blood glucose homeostasis in patients with type 1 diabetes.

3. Recognize the clinical presentation of type 1 diabetes mellitus.

4. Discuss how lifestyle factors impact the development of type 2 diabetes.

Eigth Week **(3 hours)**

Ethanol metabolism

Objectives

1. Identify the metabolic products of ethanol metabolism including acetyl CoA .

2. Evaluate the metabolic effects and clinical significance of ethanol and its metabolites.

3. Explain the biochemical basis for the effects of alcohol ingestion on gluconeogenesis.

4. Generate aproblem list with potential biochemical causes of hypoglycemia , hepatomegaly or lactic acidosis.

Ninth Week **(3 hours)**

G6PD Deficiency

Objectives

1. Describe the characteristics feature of hemolytic anemia.
2. Identify G6PD genetic variant.
3. Recognize the clinical manifestation of G6PD deficiency.
4. Describe diagnosis of G6PD deficiency.
5. Discuss the treatment of G6PD deficiency.

Tenth Week (3 hours)

Inborn errors of metabolism

Objectives

1. Definition of inborn error of metabolism.
2. Sample collection procedure.
3. Molecular basis of urea cycle disorders.
4. Genetic basis of phenylketonuria.

Eleventh Week **(3 hours)**

Digestion and absorption of protein

Objectives

1. Identify types of protein.
2. Describe digestion of protein by gastric secretion.
3. Illustrate the action of rennin.
4. Discuss the intestinal secretion of protein.

Twelfth Week (3 hours)

Mineral metabolism

Objectives

1. Definition of minerals.
2. Definition of trace element.
3. Illustrate factors that promote calcium absorption.
4. Describe function of calcium.
5. Discuss causes of hypercalcemia.

Thirteenth Week (3 hours)

Lipid metabolism

Objectives

1. Differentiate the contribution of diet and endogenous synthesis to lipid levels.

2. Describe the pathway of fatty acid synthesis.

3. Describe the synthesis of triglycerides.

4. Distinguish the composition of different sphingolipids.

Fourteenth Week **(3 hours)**

Fatty acid synthesis

Objectives

1. Describe the pathway of fatty acid synthesis.

2. Distinguish the effect of the feeding, fasting, exercise and hormonal regulation on body lipid.

3. Describe endocrine function of adipose tissue.

Fifteenth Week **(3 hours)**

Beta -oxidation , cholesterol and ketone bodys

Objectives

1. Describe the mechanism for activation and transport of fatty acids into mitochondria for catabolism.

2. Outline the sequence of reactions involved in oxidation of fatty acids in mitochondria.

3. Explain the mechanism for the formation of KBs and identify the physiological and pathological roles of those molecules.

4. Distinguish the mechanisms by which cholesterol biosynthesis is regulated by hormones and food intake.

Second Semester

Total weeks of the course : 15

Theory hours of the course : 45

Theory hours / week : 3

Units of teaching: 3

First Week **(3 hours)**

Amino acids and protein

Objectives

1. Describe factors affecting nitrogen balance in health and disease.
2. Describe the biosynthesis of melanin and catecholamine's hormones from essential amino acids.
3. Describe the biosynthesis of EAAs and NEAAs from intermediates of glycolytic pathway and TCA cycle.
4. Describe the role of folic acid.
5. Compare and contrast dopamine levels in Parkinson's disease.
6. Describe the role of tyrosinase in albinism.

Second Week **(3 hours)**

Urea cycle

Objectives

1. Describe the reactions of the urea cycle.

2. List the causes of hyperammonemia and treatments to reduce blood ammonia levels.

3. Identify the connections and common intermediates between the urea cycle and TCA cycle.

Third Week **(3 hours)**

Porphyrias

Objectives

1. Describe porphyrin and heme synthesis.
2. Describe the difference between total, direct and indirect bilirubin.
3. Describe heme catabolism.

Fourth Week (3 hours)

Vitamins

Objectives

1. Definition of vitamins.
2. Describe the common classification of vitamins.
3. Describe the role of vitamin A.
4. Identify the common problems associated with vitamin A deficiency.

Fifth Week **(3 hours)**

Water soluble vitamins

Objectives

1. List the water soluble vitamins.
2. Discuss the problems associated with vitamin B deficiency.
3. List the causes of vitamin B deficiency.

Sixth Week **(3 hours)**

Disorders of the hypothalamus and pituitary

Objectives

1. Introduction to endocrinology.
2. Identify the common factors which regulate the release of anterior pituitary hormone.
3. Describe the hormones that release from the anterior pituitary gland.
4. Identify clinical problems associated with growth hormone deficiency.

Seventh Week (3 hours)

Thyroid gland

Objectives

1. Describe the physiology of thyroid gland.
2. Illustrate the hormones that regulate thyroid hormone secretion.
3. Discuss thyroid function test.

Eigth Week (3 hours)

Thyroid gland disease

Objectives

1. Definition of hypothyroidism.
2. Describe symptoms of hypothyroidism.
3. Identify the pathophysiology of hypothyroidism.
4. Diagnosis of hypothyroidism.
5. Describe factors contribute to hypothyroidism.
6. Identify the causes of hyperthyroidism.
7. Pathophysiology of hyperthyroidism.
8. Describe laboratory investigation of hyperthyroidism.
9. Describe the treatment of hyperthyroidism.

Ninth Week **(3 hours)**

Biological membrane and transport

Objectives

1. Describe the function of cell membrane.
2. Meaning of transport function.
3. Types of transport mechanisms.
4. Describe the factors that influence diffusion rates.
5. Describe osmolarity and tonicity.

Tenth Week (3 hours)

Liver

Objectives

1. Describe major function of the liver.
2. Identify the substance that are excreted by the liver.
3. Describe how jaundice occur.
4. Describe why unconjugated bilirubin occur.
5. Identify the disease of the liver.

Eleventh Week (3 hours)

Kidney

Objectives

1. General description of kidney.
2. Describe the function of kidney.
3. Identify the causes of impaired renal function.

Twelfth Week **(3 hours)**

Renal Failure

Objectives

1. Definition of acute kidney injury.
2. Identify the diagnostic feature of acute kidney injury.
3. Describe the phases of acute kidney injury.
4. Identify the investigation of low urinary output.
5. Describe the classification of chronic kidney injury.

Thirteenth Week **(3 hours)**

Cancer and its consequences

Objectives

1. General definition of cancer.
2. Describe how tumor growth effect on body organs.
3. Illustrate the symptoms of tumor.
4. Describe why renal failure occure in patient with tumor.
5. Identify cancer treatment and its consequences.

Fourteenth Week **(3 hours)**

Tumor marker

Objectives

1. Definition of tumor marker.
2. Illustrate uses of tumor marker.
3. Identify types of tumor marker.

Fifteenth Week **(3 hours)**

Nutrition

Objectives

1. Definition of nutrition .
2. Illustrate how trauma and sepsis effect on nutrition of individual .
3. Definition of starvation and under nutrition .
4. Describe nutrintional assessment .

Teaching and learning methods :

1. Method of givin lectures .
2. Student groups .
3. Workshops .
4. Reports & Research

Teaching Tools :

1. Screen LCD .
2. Data show .
3. For experimental part **:**
    a. Spectrophotometer .
    b. Centrifuge .
    c. Water bath .
    d. Incubator .
    e. Test tubes .
    f. Syringes .

Students assessment methods:

1. Examination .
2. Reports preparation .

Questions include:

1-MCQs.√

2-Single choice questions. √

3-Matching. √

4-(Modified)Essay questions√

5-etc……

Marks of theory , practical :

Total marks

- Theory : 75 %
- Practical : 25 %

First course Examination

- Theory : 15
- Practical : 5

Second course Examination

- Theory : 15
- practical : 5

Final Examination

- Theory : 45
- Practical : 15

Reference :

- Lippincott Illustrated Reviews : Biochemistry , Seventh Edition , 2018 .

- Harper's Biochemistry , 31 ST Edition , 2018 .

- Lehninger Principle of Biochemistry , 4 th Edition , 2005 .

- Essentials of Medical Biochemistry with clinical cases , 3 rd Edition , 2022 . By N.V. Bhagavan and chury – Eun Ha .

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First Semester

Total weeks of the course : 15

Practical hours of the course : 30

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Units of teaching: 1

First Week **(2 hours)**

Laboratory safety

Objectives

1- To make the students aware about the possible safety issue.

2- To describe the ideal appearance and attitude of the student during the lab time.

3- To describe the proper costume that the students should ware during the lab time.

4- To lean the students what they should do in case of accident .

Second Week **(2 hours)**

Collection and handling of blood samples

Objectives

1- To Describe how to obtain blood samples.

2- To demonstrate blood draw.

3- To identify the ideal blood draw sites.

4- To learn the student what are the blood collection tubes available and which one they should use for each group of tests.

5- To teach the students what is the anti-coagulant tubes and how does it work.

Third Week **(2 hours)**

Collection and handling of urine samples

Objectives

1- To describe what is the properties of the urine.

2- To make the student appreciated the importance of urine analysis.

3- To learn the student the procedure followed to analyse urine sample.

4- What is the basic types of clinically used urine samples?

Fourth Week **(2 hours)**

Analytical techniques and instrumentation

Objectives

1- To demonstrate what kind of instrument we used in clinical biochemistry lab.

2- The explain the principles of each device.

3- Explain the basic concepts of each device.

4- Explain the possible mistake in using in these devices.

Fifth Week **(2 hours)**

Glucose

Objectives

1- Explain the importance of Glucose test.

2- Describe the principles of glucose test.

3- The types of glucose test and the reference range .

4- The clinical significance of glucose test .

5- Cause and consequence of hyper- and hypo-glycemia.

Sixth Week **(2 hours)**

HbA1c

Objectives

1- Explain the importance of AbA1c test and what is the result means .

2- Describe the principles of HbA1c test.

3- Learn the student what is the HbA1c reference range and the interpretations the result for diabetes and non-diabetes patients .

4- The clinical significance of HbA1c test .

Seventh Week **(2 hours)**

Glucose tolerance test (GTT)

Objectives

1- Explain the importance of GTT test and what is the result means.

2- Explain in which health conditions the test should order.

3- Describe the principles of GGT test.

4- Learn the student what is the GGT reference range and the interpretations the result for diabetes and non-diabetes patients.

5- The clinical significance of GGT test .

6- what is the pre-test preparations.

Eigth Week **(2 hours)**

Insulin and Glucagon

Objectives

1- Explain the importance of Insulin and Glucagon test and what is the result means.

2- Explain why the doctor's order Insulin and Glucagon test.

3- Describe the principles of Insulin and Glucagon test .

4- Learn the student what is the Insulin and Glucagon reference range and the interpretations the result for diabetes and non-diabetes patients .

5- The clinical significance of Insulin and Glucagon test.

6- what is the pre-test preparations.

Ninth Week **(2 hours)**

C-peptide

Objectives

1- Explain the importance of C-peptide test and what is the result means.

2- Explain why the doctor's order C-peptide test.

3- Describe the principles of C-peptide test.

4- Learn the student what is the C-peptide reference range and the interpretations the result for diabetes and non-diabetes patients.

5- The clinical significance of C-peptide test.

6- What is the pre-test preparations.

Tenth Week **(2 hours)**

Plasma lipids and lipoproteins (Cholesterol and Triglyceride)

Objectives

1- Explain the importance of Cholesterol and Triglyceride test and what is the result means.

2- Explain why the doctor's order Cholesterol and Triglyceride test.

3- Describe the principles of Cholesterol and Triglyceride test.

4- Learn the student what is the Cholesterol and Triglyceride reference range.

5- The clinical significance of Cholesterol and Triglyceride test.

6- What is the pre-test preparations.

Eleventh Week (2 hours)

Plasma lipids and lipoproteins (HDL, LDL, and VLDL)

Objectives

1- Explain the importance of HDL, LDL, and VLDL test and what is the result means.

2- Explain why the doctor's order HDL, LDL, and VLDL test.

3- Describe the principles of HDL, LDL, and VLDL test.

4- Learn the student what is the HDL, LDL, and VLDL reference range.

5- The clinical significance of HDL, LDL, and VLDL test.

6- What is the pre-test preparations.

Twelfth Week **(2 hours)**

Protein and albumin

Objectives

1- Explain the importance of Protein and albumin test and what is the result means.

2- Explain why the doctor's order Protein and albumin test.

3- Describe the principles of Protein and albumin test.

4- Learn the student what is the Protein and albumin reference range.

5- The clinical significance of Protein and albumin test.

Thirteenth Week (2 hours)

G6PDH

Objectives

1- Explain the importance of G6PDH test and what is the result means.

2- Explain why the doctor's order G6PDH test.

3- Describe the principles of G6PDH test .

4- Learn the student what is the G6PDH reference range.

5- The clinical significance of G6PDH test.

Fourteenth Week **(2 hours)**

Kidney function test (Urea Test)

Objectives

1- Explain the importance of Urea test and what is the result means.

2- Explain why the doctor's order Urea test.

3- Describe the principles of Urea test.

4- Learn the student what is the Urea reference range.

5- The clinical significance of Urea test.

Fifteenth Week **(2 hours)**

Kidney function test (Creatinine Test)

Objectives

1- Explain the importance of Creatinine test and what is the result means.

2- Explain why the doctor's order Creatinine test.

3- Describe the principles of Creatinine test.

4- Learn the student what is the Creatinine reference range.

5- The clinical significance of Creatinine test.

Second Semester

Total weeks of the course : 15

Practical hours of the course : 30

Practical hours / week : 2

Units of teaching: 1

First Week **(2 hours)**

Gout (Uric acid Test)

Objectives

1- Explain the importance of Uric acid test and what is the result means.

2- Explain why the doctor's order Uric acid test.

3- Describe the principles of Uric acid test.

4- Learn the student what is the Uric acid reference range.

5- The clinical significance of Uric acid test.

Second Week **(2 hours)**

Liver function test LFT (Protein synthesis (albumin))

Objectives

1- Explain the importance of albumin test in LFT and what is the result means.

2- Explain why the doctor's order albumin test for patient has liver disease.

3- Describe the principles of albumin test.

4- Learn the student what is the albumin reference range.

5- The clinical significance of albumin test for patient has liver disease.

Third Week **(2 hours)**

Liver function test
(Hepatic anion transport (bilirubin))

Objectives

1- Explain the importance of bilirubin test in LFT and what is the result means.

2- Explain why the doctor's order bilirubin test for patient has liver disease.

3- Describe the principles of bilirubin test.

4- What is the difference between direct and in direct bilirubin?

5- Learn the student what is the bilirubin reference range.

6- The clinical significance of bilirubin test for patient has liver disease.

7- How testing direct and indirect bilirubin are important for distinguish between different types of liver disease.

Fourth Week **(2 hours)**

Liver function test (Hepatocellular integrity (GOT and GPT))

Objectives

1- Explain the importance of GOT and GPT test in LFT and what is the result means.

2- Explain why the doctor's order GOT and GPT test for patient has liver disease.

3- Describe the principles of GOT and GPT test.

4- Learn the student what is the GOT and GPT reference range.

5- The clinical significance of GOT and GPT test for patient has liver disease.

Fifth Week **(2 hours)**

Liver function test (Presence of cholestasis (alkaline phosphatase ALP))

Objectives

1- Explain the importance of ALP test in LFT and what is the result means.

2- Explain why the doctor's order ALP test for patient has liver disease.

3- Describe the principles of ALP test.

4- Learn the student what is the ALP reference range.

5- The clinical significance of ALP test for patient has liver disease.

Sixth Week **(2 hours)**

Vitamin (Vitamin D3 Test)

Objectives

1- Explain the importance of Vitamin D3 test and what is the result means.

2- Explain why the doctor's order Vitamin D3.

3- Describe the principles of Vitamin D3 test .

4- Learn the student what is the Vitamin D3 reference range.

5- The clinical significance of Vitamin D3 test.

Seventh Week **(2 hours)**

Trace elements and metals

Objectives

1- Explain the importance of Trace elements and metals test and what is the result means.

2- Explain why the doctor's order Trace elements and metals test.

3- Describe the principles of Trace elements and metals test.

4- Learn the student what is the Trace elements and metals test reference range.

5- The clinical significance of Trace elements and metals test.

Eigth Week **(2 hours)**

Electrolytes (Calcium)

Objectives

1- Explain the importance of Calcium test and what is the result means.

2- Explain why the doctor's order Calcium test.

3- Describe the principles of Calcium test.

4- Learn the student what is the Calcium test reference range.

5- The clinical significance of Calcium test.

Ninth Week **(2 hours)**

Electrolytes (Sodium)

Objectives

1- Explain the importance of Sodium test and what is the result means.

2- Explain why the doctor's order Sodium test.

3- Describe the principles of Sodium test.

4- Learn the student what is the Sodium test reference range.

5- The clinical significance of Sodium test.

Tenth Week **(2 hours)**

Electrolytes (Potassium)

Objectives

1- Explain the importance of Potassium test and what is the result means.

2- Explain why the doctor's order Potassium test.

3- Describe the principles of Potassium test.

4- Learn the student what is the Potassium test reference range.

5- The clinical significance of Potassium test.

Eleventh Week **(2 hours)**

Electrolytes (Chloride)

Objectives

1- Explain the importance of Chloride test and what is the result means.

2- Explain why the doctor's order Chloride test.

3- Describe the principles of Chloride test.

4- Learn the student what is the Chloride test reference range.

5- The clinical significance of Chloride test.

Twelfth Week **(2 hours)**

Thyroid Function test
T3, T4 and TSH

Objectives

1- Explain the importance of T3, T4 and TSH test and what is the result means.

2- Explain why the doctor's order T3, T4 and TSH test.

3- Describe the principles of T3, T4 and TSH test .

4- Learn the student what is the T3, T4 and TSH test reference range.

5- The clinical significance of T3, T4 and TSH test.

Thirteenth Week **(2 hours)**

Lipase and Amylase

Objectives

1- Explain the importance of Lipase and Amylase test and what is the result means.

2- Explain why the doctor's order Lipase and Amylase test.

3- Describe the principles of Lipase and Amylase test .

4- Learn the student what is the Lipase and Amylase test reference range.

5- The clinical significance of Lipase and Amylase test.

Fourteenth Week **(2 hours)**

Cardiac marker (CPK)

Objectives

1- Explain the importance of CPK test and what is the result means.

2- Explain why the doctor's order CPK test.

3- Describe the principles of CPK test.

4- Learn the student what is the CPK test reference range.

5- The clinical significance of CPK test.

Fifteenth Week **(2 hours)**

Cardiac marker (Troponin)

Objectives

1- Explain the importance of Troponin test and what is the result means.

2- Explain why the doctor's order Troponin test.

3- Describe the principles of Troponin test.

4- Learn the student what is the Troponin test reference range.

5- The clinical significance of Troponin test.

Teaching and learning methods :

1. Method of givin lectures .
2. Student groups .
3. Workshops .
4. Reports & Research

Teaching Tools :

1. Screen LCD .
2. Data show .
3. For experimental part **:**
    a. Spectrophotometer .
    b. Centrifuge .
    c. Water bath .
    d. Incuvate .
    e. Test tubes .
    f. Syringes .

Students assessment methods:

1. Examination .
2. Reports preparation .

Questions include:

1-MCQs.√

2-Single choice questions. √

3-Matching. √

4-(Modified)Essay questions√

5-etc……

Marks of theory , practical :

Total marks

- Theory : **75 %**
- Practical : **25 %**

First course Examination

- Theory : **15**
- Practical : **5**

Second course Examination

- Theory : **15**
- practical : **5**

Final Examination

- Theory : **45**
- Practical : **15**

Reference :

- Lippincott Illustrated Reviews : Biochemistry , Seventh Edition , 2018 .

- Harper’s Biochemistry , 31 ST Edition , 2018 .

- Lehninger Principle of Biochemistry , 4 th Edition , 2005 .

- Essentials of Medical Biochemistry with clinical cases , 3 rd Edition , 2022 . By N.V. Bhagavan and chury – Eun Ha .

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