FACULTY OF MEDICINE

STUDY PROGRAM 0912.1 MEDICINE

CHAIR OF BIOCHEMISTRY AND CLINICAL BIOCHEMISTRY

APPROVED
at the meeting of the Commission for Quality Assurance and Evaluation of the Curriculum in Medicine
Minutes No. 5 of 16.06.2022
Chairman dr. hab., associated professor
Sergiu Suman _____

APPROVED
at the Council meeting of the Faculty Medicine nr. 1
Minutes No. 6 of 21.06.2022
Dean of Faculty, dr., associated professor
Gh. Plăcintă _____

APPROVED
approved at the meeting of the Chair of Biochemistry and Clinical Biochemistry
Minutes No. 21 of 20.05.2022
Head of Chair, dr., associated professor
Silvia Stratulat _____

SYLLABUS

DISCIPLINE **CLINICAL BIOCHEMISTRY**

Integrated studies

Tipe of course: **Compulsory**

Curriculum authors:

Silvia Stratulat, Ph.D., associate professor, head of chair;
Olga Tagadiuc, dr. hab., professor;
Ala Ambros, Ph.D., associate professor;
Svetlana Protopop, Ph.D., associate professor;
Tatiana Timercan, Ph.D., associate professor.

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I. INTRODUCTION

- **General presentation of the discipline: place and role of the discipline in the formation of the specific competences of the professional / specialty training program**

Clinical Biochemistry discipline aims to provide students with fundamental theoretical knowledge and general practical skills in medical biochemistry that are indispensable to all health professionals. Students will study the biochemical bases of the existence and functioning of the human body and of individual organs and systems under physiological conditions and in some diseases. Students will gain skills of individual and team work, of problem formulation and solving, of analysis and interpretation of the results of medical investigations, application of theoretical knowledge in medical practice, integration of information from different disciplines (fundamental and clinical), etc.

- **Mission of the curriculum (aim) in professional training consists of studying:**

a) the particularities of the chemical composition of some organs/tissues and of the fundamental metabolic processes underlying their functionality under physiological conditions;

b) disturbances in the chemical composition of organs/tissues and of the fundamental metabolic processes that underly the pathogenic mechanisms of organ/tissue damage in diseases;

c) biochemical investigation methods, the systemic and rational approach of biochemical diagnosis and the formation of critical analysis skills and of correct interpretation of laboratory data.

- **Language (s) of the course**: Romanian, English, Russian and French
- **Beneficiaries**: students of the 3rd year, Integrated Studies Program 0912.1 Medicine.

II. MANAGEMENT OF THE DISCIPLINE

Code of discipline		**S.05.O.039**	
Name of the discipline		**Clinical Biochemistry**	
Person(s) in charge of the discipline		Silvia Stratulat, dr. of med, associate professor; Olga Tagadiuc, dr. hab. of med, professor; Ala Ambros, dr. of med, associate professor; Svetlana Protopop, dr. of med, associate professor; Tatiana Timercan, dr. of med, associate professor	
Year	**III**	Semester	**V**
Total number of hours, including:			**90**
Lectures	**30**	Practical/laboratory hours	**15**
Seminars	**15**	Self-training	**30**
Form of assessment	**E**	Number of credits	**3**

III. TRAINING AIMS WITHIN THE DISCIPLINE

At the end of the discipline study the student will be able to:

a) <u>at the level of knowledge and understanding:</u>

- to know the particularities of the chemical composition of vital organs and tissues;
- to know the basic metabolic processes that ensure the viability of the organs and tissues;
- to know the influence of various factors (environmental, vitamins, pharmaceuticals, toxins) on the composition and metabolism of vital organs and tissues;
- to know the molecular mechanisms of the disorders that condition the major syndromes and diseases;
- to know the main methods of biochemical laboratory diagnosis;
- to study the normal values and physiological variations of the main biochemical markers;
- to know how to prepare patients for biochemical laboratory investigations, methods of collection, storage and transport of biological material and possible causes of errors.

b) *<u>at the application level:</u>*

- assess the clinical-diagnostic utility of certain biochemical investigations in the assessment of organ and tissue disorders;
- appreciate the usefulness of certain biochemical investigations in the diagnosis of specific conditions;
- systematically and rationally designate certain biochemical laboratory investigations based on presumptive diagnosis / patient diagnosis;
- to correctly interpret the results of biochemical investigations.

c) *<u>at the integration level:</u>*

- to appreciate the importance of Clinical Biochemistry in the context of General Medicine;
- know the correlations between Clinical Biochemistry and other clinical disciplines;
- objectifying the connections and interdependence between structural, metabolic and clinical biochemistry;
- to appreciate the evolution of physiological metabolic processes and their disorders that condition various pathologies;
- to correlate the pathogenic molecular-biochemical mechanisms of some disorders with biochemical laboratory diagnosis methods useful in each particular case.

IV. PROVISIONAL TERMS AND CONDITIONS

To learn the discipline students need a thorough knowledge in the field of Chemistry and Biology, obtained in pre-university studies, as well as in the field of Anatomy, Histology, Human Physiology and Biochemistry obtained in the undergraduate studies.

Computer and Internet usage skills are also needed to identify the materials required for study and individual work, document processing, tables and presentations.

V. THEMES AND ESTIMATE ALLOCATION OF HOURS

Lectures, practical hours/ laboratory hours/seminars and self-training

No. d/o	THEME	Number of hours		
		Lectures	Practical hours	Self-training
1.	The importance of clinical biochemistry for the specialist doctor. Clinical laboratory diagnosis. Practical aspects in clinical biochemistry.	2	2	2
2.	Biochemistry of the blood. Plasma proteins. Methods of separation, assay and interpretation of serum protein variations. Basic concepts in the interpretation of pathological variations of serum enzymes.	2	2	2
3.	Metabolism of minerals and microelements. Biochemical importance.	2	2	2
4.	Primary and secondary hemostasis. Fibrinolysis. Evaluation and interpretation of indices of fluid-coagulant balance.	2	2	2
5.	Hydro electrolytic and acid-base balance.	2	2	2
6.	Pathochemistry and laboratory exploration of renal functions.	2	2	2
7.	Concluding test nr. 1. Evaluation of individual work	2	2	2
8.	Metabolism of lipoproteins. Dislipidemias.	2	2	2
9.	Pathochemistry of thyroid gland disorders.	2	2	2
10.	Pathochemistry of the adrenal cortex and the reproductive system.	2	2	2
11.	Pathochemistry and diagnosis of the gastrointestinal tract, exocrine pancreas and liver	2	2	2
12.	Calcium and phosphate homeostasis. Osteo-articular diseases.	2	2	2
13.	Biochemistry of nerve transmission	2	2	2
14.	Concluding test nr. 2. Evaluation of individual work	2	2	2
15	Final evaluation	2	2	2
Total		**30**	**30**	**30**

VI. PRACTICAL TOOLS PURCHASED AT THE END OF THE COURSE

- to assess the clinical-diagnostic utility of certain biochemical investigations in the assessment of organ and tissue disorders;
- to appreciate the usefulness of certain biochemical investigations in the diagnosis of specific conditions;
- systematically and rationally designate certain biochemical laboratory investigations based on presumptive diagnosis / patient diagnosis;
- to correctly interpret the results of biochemical investigations.

VII. OBJECTIVES AND CONTENT UNITS

Objectives	Content units
Chapter 1. The importance of clinical biochemistry for the specialist doctor. Clinical laboratory diagnosis. Practical aspects in clinical biochemistry.	
• Define the laboratory diagnosis. • Know biochemical laboratory research objects. • Identify the stages of laboratory investigations. • Determine the content and procedures specific to each stage. • Know and identify laboratory biochemical diagnosis errors and their causes. • Know and apply for themselves the standard profiles of the biochemical laboratory diagnosis. • Explain clinical and diagnostic value of biochemical markers.	1. Laboratory clinical diagnosis: purpose, objects of analysis and stages. 2. Factors that influence the results of the analyses: a) internal factors (associated with the patient) – age, sex, race, physiological state; b) external factors – collection time, food, smoking, stress, medications. 3. The pre-analytical stage of clinical laboratory diagnosis: plan and request of the investigation, preparation of the patient, sampling, processing, storing and transportation of the biological samples. 4. Analytical stage of clinical laboratory diagnosis. The main laboratory analysis methods – spectrophotometry, nephelometry, turbidimetry, luminescence, ELISA, etc. – general principles. Sensitivity, specificity and repeatability of laboratory methods – their importance. How to express and calculate results. 5. Post-analytical stage of clinical laboratory diagnosis – evaluation of the veracity of the results obtained and their validation. Clinical value of results – reference values. Interpretation of results. 6. The causes of errors at different stages of clinical laboratory diagnosis and how to prevent them.
Chapter 2. Biochemistry of the blood. Plasma proteins. Methods of separation, assay and interpretation of serum protein variations. Basic concepts in the interpretation of pathological variations of serum enzymes.	
• Know the role and main characteristics of plasma proteins. • To apply in practice the methods of protein dosage and separation. • To interpret the pathological changes of plasma proteins and the major abnormalities observed in electrophoresis • Define the acute phase proteins of inflammation • Define the proteins – tumor markers • Name the functional classification of plasma enzymes • Know the organ-specific enzymes of the liver,	1. Functions of plasma proteins. Characteristics of the main plasma proteins: albumins, fibrinogen, globulins (transferrin, ferritin, ceruloplasmin, haptoglobins, immunoglobulins). 2. Protein dosing and separation methods. Interpretation of major abnormalities observed in serum protein electrophoresis. Serum proteinogram. Pathological changes of plasma proteins 3. Acute phase proteins of inflammation 4. Proteins - tumor markers 5. Plasma enzymes. Functional classification. Secretory, indicator, excretory enzymes. 6. The clinical-diagnostic value of enzyme determination. Serum enzymes in liver, heart, GI, muscle, bone, kidney diseases 7. The value of enzymes in malignant diseases 8. Nitrogenous non-protein compounds of the blood plasma. Residual nitrogen. Its fractions in norm and pathology. Mechanisms of water retention and production of azotemia.

Objectives	Content units
myocardium, brain, kidneys, muscles, bones. • Describe the mechanism of plasma disenzynemia • To know the diagnostic value of enzyme determinations in heart, liver, GI, muscular, bone, renal, malignant diseases • To demonstrate the use of enzymes in medical practice • Know the compounds that make up residual nitrogen, its fractions in normal and pathological conditions • To differentiate the mechanisms of retention and production azotemia.	
Chapter 3. Metabolism of minerals and microelements. Biochemical importance.	
• To classify the elements of the human body. • To define macroelements, trace elements, microelements. • To determine the metabolic role, sources, daily requirement and normal values of the minerals Na, K, Cl, Ca, P, Mg, S and microelements Cr, Co, Cu, Fe, Mn, Mo, Se, Zn, F. • To interpret the clinical importance of minerals Na, K, Cl, Ca, P, Mg, S and trace elements Cr, Co, Cu, Fe, Mn, Mo, Se, Zn, F. • To integrate the metabolism of different elements of the human body	1.Classification of the elements of the human body. Macroelements, trace elements, microelements. 2.Sodium (Na). The role. Sources. Daily necessities. Hypernatremia, hyponatremia. 3. Potassium (K). The role. Sources. Hyperkalemia. Hypokalemia. 4.Chlorine (Cl). Daily necessities. Metabolism, functions. 5.Calcium (Ca). Sources. Normal values, types of plasma Ca. Hormonal regulation. Hypercalcemia. Hypocalcemia. 6.Phosphorus (P). The role. Sources. Hyperphosphatemia. Hypophosphatemia. 7. Sulphur. Sources. Sources. 8. Iron (Fe). The role. Sources. Types of Fe present in the human body (essential and storage). Ferritin. Hemosiderin, Transferrin. Pathological changes (deficiency and excess of Fe). 9. Copper (Cu). The role. Sources. Daily necessities. Manifestations of Cu deficiency. Hereditary disorders related to Cu metabolism. 10.Magnesium (Mg). The role. Sources. Normal values. Hypermagnesemia. Hypomagnesemia. 11. Fluorine (F). The role. Sources. Daily necessities. Fluorosis. 12. Zinc (Zn). The role. Sources. Clinical importance. 13. Manganese (Mn). The role. Sources. 14. Chromium (Cr). The role. Sources. 15. Cobalt (Co). The role. Sources. 16. Molybdenum (Mo). The role. Sources. Daily necessities. 17. Selenium (Se). The role. Sources. Daily necessities. Toxicity. Clinical importance.

Objectives	Content units
Chapter 4. Primary and secondary hemostasis. Fibrinolysis. Evaluation and interpretation of indices of fluid-coagulant balance.	
• To define the notions of primary and secondary hemostasis • To know the intervention of the vascular component in primary hemostasis • To know the structural, functional peculiarities and quantitative and qualitative abnormalities of platelets • To outline the extrinsic and intrinsic pathway of coagulation • To understand the principles of regulation of fluid - coagulant balance • To identify the causes, the consecutiveness of the pathogenic metabolic mechanisms and the metabolic changes that determine the development of primary and secondary hemostasis disorders • Systemically and rationally apply biochemical investigations in the assessment of fluid-coagulant balance • Correctly interpret the changes in the coagulogram • To integrate hemostatic biochemical changes depending on the clinical manifestations and the administered treatment • Solve case studies.	1. Notions of haemostasis. Its role and stages. 2. Primary haemostasis: a. the intervention of the vascular component (the role of vasoconstriction, vascular endothelium and subendothelial structures) b. the structural and functional particularities of platelets. The role of platelets in coagulation and fibrinolysis. Quantitative (thrombocytopenia, thrombocytosis and thrombocythemia) and qualitative (hereditary and acquired) abnormalities of platelets. c. Von Willebrand factor – structure, functions. Von Willebrand's disease. d. exploration of primary haemostasis: bleeding time, platelet aggregation tests and von Willebrand factor exploration 3. Secondary haemostasis: a. coagulation factors and cofactors. b. the extrinsic and intrinsic pathway of coagulation. c. coagulation exploration: prothrombin time, partially activated thromboplastin time, thrombin time, clotting time, fibrinogen dosage. d. genetic abnormalities of changes in coagulation factors 3. Anticoagulant mechanisms (antithrombin III; heparin cofactor II, tissue factor-mediated pathway inhibitors; protein Z and protein Z inhibitors); protein C system: protein C, protein S, thrombomodulin and endothelial protein C receptor) 4. Fibrinolysis: a. general diagram of the fibrinolytic system; b. plasminogen and plasmin; c. fibrinolysis activators and inhibitors; d. exploration of fibrinolysis: the lysis time of the diluted blood clot, the dosage of D-dimers. e. genetic and acquired disturbances of fibrinolysis. 5. Peculiarities of haemostasis in various physiological and pathological conditions (in haemorrhagic syndromes of newborns, haemostasis in pregnancy, in neoplasms, in kidney diseases, disseminated intravascular coagulation). Thrombosis. Laboratory exploration of thrombosis. 6. Notes on anticoagulant and antiplatelet therapy
Chapter 5. Hydro electrolytic and acid-base balance.	
• To define the notions of: diffusion, osmosis, filtration, osmolarity, osmolality,	1. Pathochemistry of quantitative and qualitative disturbances of water and electrolyte homeostasis.

Objectives	Content units
tonicity, oncotic and hydrostatic pressure. • To know the role, properties, quantity and distribution of water and electrolytes in the basic compartments, • To demonstrate the mechanisms involved in the control of water and electrolyte homeostasis. • Apply the osmolality calculation formula, osmolality gap. • To define the notions of acid-base balance, buffer system, metabolic and respiratory acidosis and alkalosis, compensated and decompensated. • To know the role and functioning mechanisms of: buffer systems, red blood cells, lungs, kidneys, liver and gastrointestinal tract. • To know the reference values and physiological variations of the acid-base balance parameters, • To define the causes and demonstrate the mechanisms involved in acid-base imbalances, • Apply the Henderson-Hasselbalch equation and the anion gap calculation formula. • To integrate laboratory and clinical results to solve case studies	1.1 The role, amount and distribution of water and electrolytes in the body. The forces that coordinate the movement of water and electrolytes between compartments. Control of water homeostasis. 1.2 Sodium homeostasis control. Disorders of water and sodium metabolism 1.3 Potassium homeostasis. Disorders of potassium metabolism (hypo and hyperkalemia. 2. Diagnosis of hydro-electrolytic disorders and the pathochemical principles of treatment. 3. Physiological and biochemical mechanisms of acid-base balance regulation. 4. Parameters of acid-base balance, their physiological and pathological variations (age, time of day, phases of digestion, state of exertion) 5. Metabolic and respiratory acidosis and alkalosis.
Chapter 6. Pathochemistry and laboratory exploration of renal functions	
• to define Clearance, reabsorption, secretion and non-ionic diffusion.	1. Elements of renal structure. Renal functions. Determinants of glomerular filtration. Pathochemistry of quantitative and qualitative disorders of the glomerular filtrate.

Objectives	Content units
• to know the structure and functions of the nephron. • to demonstrate the mechanisms of urine formation, concentration and dilution of urine. • apply the Cockroft - Gault formula for calculating the GFR necessary for differentiating renal insufficiency • define the basic nephrological syndromes: renal tubular acidosis, nephrotic syndrome, nephritic syndrome, acute and chronic renal failure, renal lithiasis and explain the causes and pathogenetic mechanisms. • to know the causes, pathogenetic mechanisms and laboratory investigations that confirm the presence of diabetic, toxic and medicinal nephropathy. • to know the laboratory investigations necessary to assess the functional state of the kidneys, the reference values and the physiological variations of the "Renal investigations" profile in blood and urine. • to demonstrate the mechanisms involved in the appearance of characteristic irregularities in renal disorders: edema, hypertension, proteinuria, haematuria, aminoaciduria, pigmenturia, pyuria, leukocyturia, etc., • to apply the laboratory results of biomarkers for the	2. Exploration of glomerular filtration: Glomerular filtration rate (GFR), creatinine, plasma urea, Cystatin C. Interpretation of laboratory results. 3. Tubular functions. Pathochemistry of tubular functional - morphological disorders. Mechanisms of water reabsorption, concentration and dilution of urine. 4. Exploring tubular functions: a. Urinary excretion of amino acids and glucose. b. Urine concentration/dilution tests. c. Urine acidification tests. 5. Proteinuria: prerenal, renal, postrenal. Causes, laboratory differentiation. 6. Pathochemistry of nephrological syndromes: 6.1 Renal tubular acidosis, Alport syndrome. to 6.2 Nephrotic syndrome 6.3 Nephritic syndrome 6.4 Acute renal failure (ARI) and chronic (CRI). 6.5 Diabetic, toxic and medicinal nephropathy. 7. Diagnosis of renal dysfunctions: "Renal investigations" profile in the blood. The chemical composition of urine. Abnormal components of urine. Urinary sediment. 8. Exploration of the endocrine-humoral and metabolic functions of the kidney 9. Renal lithiasis. Chemical composition of stones. Causes and stages of lithogenesis, precipitating factors. Laboratory exploration and principles of pathogenetic treatment. 10. The pathogenetic principles of treatment of renal dysfunctions.

Objectives	Content units
early identification of ARI and for the differentiation of the stages of CRI. • to integrate the laboratory results with the clinical ones in order to make a pathogenetic diagnosis.	
Chapter 8. Laboratory investigation of plasma lipids and lipoproteins. Primary and secondary dyslipidemias	
• To define the notions of dyslipidemia, primary and secondary hyperlipidemia. • To know the principles of classification of dyslipidemias and the corresponding classes. • To differentiate the causes that determine the development of primary and secondary hyperlipidemias. • To logically expose the consecutiveness of the pathogenic metabolic mechanisms of primary and secondary dyslipidemias. • To know the biochemical methods of diagnosis of dyslipidemias. • Systemically and rationally apply lipid metabolism investigation tests. • To correctly assess the changes in biochemical laboratory tests in some diseases accompanied by dyslipidemia. • Solve case studies.	1. Plasma lipoproteins – structure, role, separation methods. Apoproteins, proteins, enzymes and receptors involved in lipoprotein metabolism. Major lipoproteins (chylomicrons, VLDL, LDL, HDL). Minor and pathological lipoproteins (IDL, LP(a), LPX, beta – VLDL). 2. Determination of plasma lipids and lipoproteins – triglycerides, cholesterol, LDL – cholesterol, HDL – cholesterol, apoproteins. Factors that can influence lipid parameters. Isolated hypercholesterolemia (polygenic hypercholesterolemia, familial hypercholesterolemia, sitosterolaemia, autosomal dominant hypercholesterolemia). 3. Isolated hypertriglyceridemia (diabetic dyslipidaemia, familial hypertriglyceridemia, familial hyperchylomicronaemia). Combined hyperlipidaemias (combined familial hyperlipidaemia, metabolic syndrome hyperlipidaemia, hepatic lipase deficiency). 4. Hypolipidemias (α - and ß – hypobetalipoproteinaemia). 5. Decrease in HDL – cholesterol (familial hypoalphalipoproteinemia, Tangier disease, LCAT deficiency). 6. Increase in HDL – cholesterol (PTEC deficiency). 7. Biochemical principles of hyperlipidaemia treatment. 8.Atherosclerosis. The role of lipoproteins in atherosclerosis. Atherogenic dyslipidaemia.
Chapter 9. Pathochemistry of thyroid gland disorders.	
• To describe in detail the metabolism of iodine in the body. • To know the particular mechanisms of synthesis,	1. Peculiarities of the metabolism of thyroid hormones (T_3 and T_4). 2. Classification of thyroid disorders according to the level of secretion, type of glandular hypertrophy and etiology. 3. Paraclinical thyroid examination - evaluation of the functional state of the thyroid gland - thyroid autoimmunity tests

Objectives	Content units
secretion, storage, transport and inactivation of T_3 and T_4. • To identify the specific receptors of T_3 and T_4 in tissues and organs, the signaling cascades triggered and the metabolic processes subsequently modulated. • To classify thyroid function disorders depending on the level of secretion, the type of glandular hypertrophy and the etiology of the pathological condition. • To define the causes of thyroid hypo- and hyperfunction. • To describe in logical sequence the chain of metabolic disturbances in thyroid hypo- and hyperfunction and the mechanisms of organ and tissue damage. • To systematically and rationally apply the methods of laboratory investigation of thyroid function in accordance with the specific algorithms. • To correctly assess changes in biochemical laboratory tests in thyroid dysfunctions. • To solve case studies.	- special serum markers - biochemical constants in serum - radioiodine uptake (RIC) - dynamic exploration - imaging exploration of the thyroid – correlations with laboratory biochemical methods (generalities). 4. The thyroid function investigation algorithm. 5. Hyperthyroidism: definition; the causes and pathogenic mechanisms of excess production of thyroid hormones; metabolic changes and clinical manifestations of hyperthyroidism; paraclinical diagnosis of hyperthyroidism; principles of treatment 6. Hypothyroidism: definition; the causes and pathogenic mechanisms of thyroid hormone production deficiencies; metabolic changes and clinical manifestations of hypothyroidism; paraclinical diagnosis of hypothyroidism; principles of treatment 7. Thyroid cancer. Evaluation of thyroid nodules
Chapter 10. Pathochemistry of the adrenal cortex and the reproductive system.	
• To know the particular mechanisms of synthesis, secretion, storage, transport and inactivation of steroid hormones. • To identify the specific receptors of steroid hormones in tissues and organs, the signaling cascades triggered and the metabolic processes and effects subsequently modulated.	1. Steroid hormones: structure, biosynthesis, regulation of secretion, transport, mechanism of action, effects, metabolism. 2. Pathochemistry of adrenocortical insufficiency - Addison's disease: the causes and pathogenic mechanisms of the deficiency of adrenocortical hormone production, metabolic changes and clinical manifestations, paraclinical diagnosis, principles of treatment 3. Pathochemistry of Cushing's syndrome: causes and pathogenic mechanisms of excess production of adrenal cortical hormones, metabolic changes and clinical manifestations, paraclinical diagnosis, principles of treatment

Objectives	Content units
• To classify and differentiate the disorders of the secretion of steroid hormones depending on the level of secretion, the type of glandular hypertrophy and the etiology of the pathological condition • To describe in logical sequence the chain of metabolic disturbances in the hypo- and hypersecretion of adrenal cortical and sexual hormones • Interpret the biochemical mechanisms of organ and tissue damage in the pathology of adrenal cortical and sexual hormones. • Systemically and rationally indicate the investigations in the diagnosis of adrenal and sexual gland disorders • To appreciate steroid hormone disorders and metabolic changes based on laboratory biochemistry investigations • Solve case studies.	4. Performing functional tests (test with Dexamethasone, Synacthen, etc.) and interpreting their results, principles of treatment. 5. Biochemical mechanisms of polyglandular autoimmune syndromes. MEN 1 and MEN 2 syndromes. 6. Adrenogenital syndromes and the biochemical mechanisms involved in their development. 7. Pathochemistry and diagnosis of sexual gland disorders. 8. Hypogonadism – biochemical mechanisms and their clinical relevance. 9. Pathochemistry of primary and secondary infertility. 10. Early ovarian failure and metabolic changes associated with menopause. 11. Laboratory diagnosis of sexual gland disorders.
Chapter 11. Pathochemistry and diagnosis of the gastrointestinal tract, exocrine pancreas and liver	
• Define the notions of lobule, acinus and hepaton and describe their metabolic features. • Classify liver enzymes and explain the diagnostic value of classes and individual representatives. • To distinguish the physiological changes in the activity of liver enzymes of diagnostic value from those conditioned by hepatic and extrahepatic diseases. • Systemically and rationally indicate enzymatic investigations in the diagnosis of liver diseases and for their differentiation from extrahepatic diseases.	1. Pathochemistry and diagnosis of functional-morphological disorders of the stomach and intestine (malabsorption syndrome, steatorrhea, diarrhea and hemorrhage). 2. Pathochemistry and diagnosis of acute and chronic inflammatory diseases of the pancreas and pancreatic disorders in systemic diseases. 3. Liver enzymes. Classification, representatives, role and physiological variations. Mechanisms of dysenzymia in liver diseases. Pathological changes of liver enzymes in liver and extrahepatic diseases. Diagnostic, prognostic and treatment monitoring value of liver enzymes. 4. The role of the liver in the integration of metabolism and maintaining the homeostasis of the human body. Methods of investigating the integrative role of the liver and markers of metabolic, hydrosaline, acid-base, fluid-coagulant balance, etc. in liver diseases. 5. Mechanisms of bile excretion and regulation of this process. Disorders of bile excretion and associated pathologies. Methods of investigation of biliary excretion and markers of diagnostic interest.

Objectives	Content units
• To know the role of the liver in the homeostasis of the body's protein, carbohydrate and lipid metabolism. • To identify laboratory markers of homeostatic liver function. • Apply homeostatic liver function markers in the biochemical diagnosis of liver and extrahepatic diseases. • To describe the pathogenic biochemical mechanisms of gallstones and the principles of treatment based on these mechanisms. • To differentiate the types of hereditary and acquired cancers based on changes in laboratory biochemical indices. • To appreciate the detoxification/inactivation pathways of certain substances in the liver and the mechanisms of organ damage associated with these mechanisms. • To define drug-induced hepatopathy and to know the mechanisms of development of the pathological condition depending on the drug. • To know the markers of syndromes specific to liver pathologies (cytolytic, hepatopriv, inflammatory and excretobiliary) and their diagnostic value. • To be able to systemically and rationally indicate sets of markers for the investigation of liver function. • To correctly appreciate the changes in biochemical laboratory tests in some liver diseases. • To solve case studies.	6. General and hepatic detoxification mechanisms. Stages of detoxification in the liver (oxidative and conjugation). Hepatoxicity associated with detoxification mechanisms, including drug hepatotoxicity. Markers of hepatotoxicity. 7. Biochemical syndromes specific to liver diseases. Laboratory markers of each syndrome and their diagnostic value. 8. Markers of cancerous diseases of the gastrointestinal tract, pancreas and liver.
Chapter 12. Calcium and phosphate homeostasis. Osteo-articular diseases.	
• To know the mechanisms involved in calcium and phosphate homeostasis.	1. Calcium and phosphate homeostasis 2. Mechanisms involved in phospho-calcium homeostasis. Hormonal regulation.

Objectives	Content units
• To know the disorders of calcium and phosphate metabolism • To apply in practice the investigation of phospho-calcium metabolism disorders • To know the biochemistry of bone tissue - proteins, lipids, nucleic acids, organic acids, enzymes as bone component parts. • To apply in practice the use of markers of bone formation and bone resorption • To know metabolic bone diseases, including osteoporosis. • Apply in practice the classification of osteoporotic syndromes	3. Disorders of calcium and phosphate metabolism. 4. Investigation of phospho-calcium metabolism disorders. 5. Bone as a biological material. 6. Bone tissue biochemistry. Proteins, lipids, nucleic acids, organic acids, enzymes. 7. Markers of bone formation. Markers of bone resorption. 8. Metabolic bone diseases. Osteoporosis. Classification of osteoporotic syndromes.
Chapter 13 Biochemistry of nerve transmission	
• to define the notions of synapse, synaptic transmission, neurotransmitter, neuromodulator, pre- and postsynaptic action potential, ionotropic and metabotropic synaptic receptor, agonist, competitive and non-competitive antagonist. • to know the main neurotransmitter substances, their classification and structure, the mechanisms of synthesis, storage, release of neurotransmitters in the synaptic cleft, the molecular mechanisms of mediator coupling with receptors and signal transmission in postsynaptic cells. • to demonstrate the connection between hereditary and acquired defects of the molecular structures involved in synaptic transmission (channelopathies, enzymopathies, proteinopathies, receptor defects) and some neurological	1. Peculiarities of the chemical and metabolic composition of nerve cells. 2. The structure of synapses and the peculiarities of communication between nerve cells. 3. Structure and classification of neurotransmitters. Cholinergic, monoaminergic, aminoacidergic, peptidergic, purinergic neurotransmitter substances. 4. Synthesis, storage, release of neurotransmitters, removal of mediators from the synaptic cleft, synaptic receptors, biochemical mechanisms of action of neurotransmitters at the postsynaptic level. 5. Pathologies associated with disturbances in the synthesis, release or action of different neurotransmitters, or affecting their receptors (Parkinson's disease, Alzheimer's disease, schizophrenia, depression, anxiety, migraine, myasthenia gravis).

Objectives	Content units
conditions and psychiatric disorders. • to apply the knowledge gained on this subject for solving clinical cases related to the diagnosis and treatment of the corresponding diseases. • integrate the information with reference to the biochemical aspects of nerve transmission with that accumulated in other fundamental disciplines (anatomy, histology, physiology) and be able to apply it to tangential clinical disciplines (neurology, psychiatry, medical psychology).	
Evaluation of individual work	
Final evaluation	

VIII. PROFESSIONAL (SPECIFIC (SC)) AND TRANSVERSAL (TC) COMPETENCES AND STUDY FINALITIES

✓ Professional (specific) (SC) competences

- PC1. Knowledge, understanding and use of language specific to medical biochemistry.
- PC2. General knowledge of key vital chemical compounds for the human body.
- PC3. Explain the outcome of the main metabolic processes that ensure the viability of the body and the mechanisms of the most important disorders specific to major syndromes.
- PC6. Advanced knowledge of the peculiarities of the chemical composition and metabolism of organs and tissues under physiological conditions and most important diseases.

✓ Transversal competences (TC)

- TC1. Communication skills, written and oral, in the field of medicine and medical biochemistry.
- TC2. Individual and team work skills.
- TC3. The ability to effectively apply information technology to medical activity as well as to identify sources of information and continuous education in the field of activity.
- TC4. Understanding and the ability to apply the principles and values of general and professional ethics in action.

✓ Study finalities

Upon completion of the course the student will:

1. know the molecular bases of physiological metabolic processes, the biochemical mechanisms that regulate the functions of organs/tissues and the body,
2. understand the causes and pathogenesis of certain hereditary and acquired diseases,
3. prove the need for biochemical investigation and the rational and systemic use of specific markers,

4. interpret correctly the results of biochemical examination and correlate them with the clinical and functional data in order to establish the diagnosis, correct the lifestyle and prescribe the medication adapted to the biochemical mechanisms of the pathology occurrence.

IX. STUDENT'S SELF-TRAINING

No.	Expected product	Implementation strategies	Assessment criteria	Implementation terms
1.	Work with information sources	Selection of basic information and details regarding the topic questions by reading the lecture, the material from the textbook and additional informational sources on the respective topic. Full reading of text and systematization of essential content. Generalization and making conclusions regarding the importance of the theme/subject.	Level of information assimilation and volume of work	During the semester
2.	Work with on-line materials	Studying the teaching materials on the Chair and other relevant sites, completing and acquiring information on the studied subject	Level of information assimilation and volume of work	During the semester
3.	Study cases solved	Self-solving of study cases in accordance with the recommendations, with subsequent verification and discussion.	Mark from 0-0.5 for each chapter.	Each lesson
4	Self-assessment tests solved	Self-solving of the self-assessment tests in accordance with the recommendations, with subsequent verification and discussion.	Mark from 0-0.5 for each chapter.	Each lesson
5	Paper on actual topic presented at the students scientific group of the chair and at national and	Selection of basic information and details on the current topics of biochemistry from scientific sources over the last 5 years.	Mark from 0-1.0 for each paper	During the semester

	international scientific conferences.			

X. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-ASSESSMENT

- ***Teaching and learning methods used***

The Clinical Biochemistry discipline teaching is based on classical and web-based training.

The course is held in accordance with the classical model. The theoretical teaching material and course presentations are placed on the MOODLE platform and are offered for individual study.

At the practical lessons and seminars, theoretical topics are discussed according to methodical guidelines, tests and case studies are solved, interactive teaching and learning methods are applied.
To study the discipline, a number of learning methods such as observation, analysis, comparison, classification / scheme / figure design, modeling, deduction, and experiment are recommended.

- ***Applied** (specific to the discipline) **teaching strategies / technologies***

Classical didactic strategies (inductive, deductive, analogous, algorithmic and heuristic) are applied in the teaching of the Clinical Biochemistry discipline, which are achieved by several teaching-learning methods (active participation, individual study, verification and evaluation) like description and didactic conversation, work with the text-book, problem solving, case study, test solving, etc. For the implementation of the strategies and methods, a set of technical means of training are used both in the courses and practical lessons.

- ***Methods of assessment** (including the method of final mark calculation)*

Current:
At each laboratory work and seminar, several methods of current assessment are used: control works, solving case studies and tests, solving practical problems, etc. During the semester, 2 concluding tests are provided.

Final assessment – exam – computer-assisted testing in SIMU.

Method of mark rounding at different assessment stages

Intermediate marks scale (annual average, marks from the examination stages)	National Assessment System	ECTS Equivalent
1,00-3,00	**2**	**F**
3,01-4,99	**4**	**FX**
5,00	**5**	**E**
5,01-5,50	**5,5**	
5,51-6,0	**6**	

6,01-6,50	**6,5**	**D**
6,51-7,00	**7**	
7,01-7,50	**7,5**	**C**
7,51-8,00	**8**	
8,01-8,50	**8,5**	**B**
8,51-9,00	**9**	
9,01-9,50	**9,5**	**A**
9,51-10,0	**10**	

The average annual mark and the marks of all stages of final examination (computer assisted, test, oral) - are expressed in numbers according to the mark scale (according to the table), and the final mark obtained is expressed in number with two decimals, which is transferred to student's record-book.

Absence on examination without good reason is recorded as "absent" and is equivalent to 0 (zero). The student has the right to have two re-examinations in the failed exam.

XI. RECOMMENDED LITERATURE:

A. Compulsory :

1. www.e.usmf.md. (lecture course and theoretical material on the MOODLE platform).
2. https://themedicalbiochemistrypage.org/

B. Additional

1. Bhagavan N.V., Ha Chung-Eun. Essentials of Medical Biochemistry: With Clinical Cases. Academic Press; 1st edition, 2011.
2. Marshall W.J. Clinical Chemistry. 4th edition, Mosby press, UK, London, 2000