MEDICAL BIOCHEMISTRY

INTEGRATED ACADEMIC STUDIES OF PHARMACY

SECOND YEAR OF STUDY

2023/2024.

Course:

MEDICAL BIOCHEMISTRY

The course is evaluated with 5 ECTS. There are 4 classes of active teaching per week (2 classes of lectures, 1 class of seminar and 1 class of work in a small group)

TEACHING STAFF:

	Name and surname	Email addresses	Title
1.	Sanja Stanković	sanjast2013@gmail.com	Assistant Professor - Course chief
2.	Marina Mitroivić	mitrovicmarina34@gmail.com	Full Professor
3.	Ivanka Zelen	ivankayelen@gmail.com	Full Professor
4.	Marijana Stanojević Pirković	marijanas14@gmail.com	Associate Professor
5.	Ivana Nikolić	angelkg2009@gmail.com	Associate Professor
6.	Milan Zarić	zaricmilan@gmail.com	Associate Professor
7.	Marija Anđelković	marijabcd@gmail.com	Associate Professor
8.	Petar Čanović	petar.c89@gmail.com	Associate Professor

COURSE STRUCTURE:

Module	Name of module	Week	Lectures weekly	Seminars weekly	Work in small group	Teacher-module supervisor
1	„Brain-to-brain loop“ for laboratory testing. Pre-preanalytical, preanalytical, analytical, postanalytical and post-postanalytical phase of laboratory processes. Good Laboratory Practice Principles. Analytical technics in medical laboratories: basic principles and applications. Examination of disorders in carbohydrate metabolism. Examination of disorders in lipid metabolism. Examination of disorders in amino acid and protein metabolism. Examination of the catalytic activity of enzymes. Clinical and biochemical analyzes in the diagnosis of hematological diseases.	7	2	1	1	Milan Zarić
2	Liver diseases: clinical and biochemical aspects. Acute and chronic kidney injury: clinical and biochemical aspects. Coronary heart disease: clinical and biochemical aspects. Rheumatic diseases and diseases of the locomotor system: clinical and biochemical aspects. Clinical and laboratory assessment of thyroid abnormalities. Clinical and laboratory profile of primary hyperparathyroidism. Polycystic ovary syndrome: clinical and laboratory evaluation. Biochemical evaluation of adrenal dysfunction: the clinical and laboratory perspective.	8	2	1	1	Ivana Nikolić

						Σ 30+15+15=60

EVALUATION:

The student overcomes the course based on the points achieved in the pre-examination activities and the final exam. The score is equivalent to the number of gained points (table). Points are earned as follows:

Activity during classes (pre-exam activities): The student can acquire up to 30 points by answering 2 exam questions during each week's class, while working in a small group and, according to the demonstrated knowledge, receives 0-2 points. If at the end of the semester the student did not aquire more than 50% of the maximum amount of points (30), they are considered to not have passed the pre-exam activity.

Module	**Module Name**	**MAXIMUM POINTS**
		Activity during classes
1.	„Brain-to-brain loop“ for laboratory testing. Pre-preanalytical, preanalytical, analytical, postanalytical and post-postanalytical phase of laboratory processes. Good Laboratory Practice Principles. Analytical technics in medical laboratories: basic principles and applications. Examination of disorders in carbohydrate metabolism. Examination of disorders in lipid metabolism. Examination of disorders in amino acid and protein metabolism. Examination of the catalytic activity of enzymes. Clinical and biochemical analyzes in the diagnosis of hematological diseases.	16
2.	Liver diseases: clinical and biochemical aspects. Acute and chronic kidney injury: clinical and biochemical aspects. Coronary heart disease: clinical and biochemical aspects. Rheumatic diseases and diseases of the locomotor system: clinical and biochemical aspects. Clinical and laboratory assessment of thyroid abnormalities. Clinical and laboratory profile of primary hyperparathyroidism. Polycystic ovary syndrome: clinical and laboratory evaluation. Biochemical evaluation of adrenal dysfunction: the clinical and laboratory perspective.	14
Σ		**30**

Final Exam: In this way, the student can acquire up to 70 points. The student takes a final exam consisting of 35 questions, testing their knowledge of all the material covered during the course. If the student does not answer more than 50% of the exam correctly, they are considered to not have passed the final exam.

The final grade is formed as follows:

In order for a student to pass the course, they must acquire a minimum of 51 points, pass the pre-exam activities in all modules, and pass the final exam (test).

The final grade will be formed according to the following table:

Number of points	**Grade**
0 - 50	**5**
51 - 60	**6**
61 - 70	**7**
71 - 80	**8**
81 - 90	**9**
91 - 100	**10**

LITERATURE:

Alberts, Bruce. Molecular biology of the cell. N.York: Garland Science. 2015.

TEXTBOOK TITLE	AUTHORS	PUBLISHER	LIBRARY
Molecular biology of the cell	Alberts, Bruce	N.York: Garland Science. 2015.	
Genetics. A Molecular approach	Peter J. Russell (editor)	San Francisco: Benjamin Cumm i tigs. 2006. .	Yes
Medical physiology: a cellular & molecular approach	Boron, Walter F (editor)	Phyladelphia:Elsevier. 2005.	Yes
PCR primer design	Yuryev, Anton (editors)	New Yersey: Humana Press. 2007.	Yes
A-Z of quantitative PCR	Bustin, Stephen. (editor)	California: International university line. 2004	Yes
. Medical Biochemistry	Baynes J, Dominiczak M (editor).	5th Edition. Elsevier Science. 2018.	Yes

All lectures can be found on the website of the Faculty of Medicine: www.medf.kg.ac.rs

THE PROGRAM

FIRST MODULE: „Brain-to-brain loop“ for laboratory testing. Pre-preanalytical, preanalytical, analytical, postanalytical and post-postanalytical phase of laboratory processes. Analytical technics in medical laboratories: basic principles and applications. Examination of disorders in carbohydrate metabolism. Examination of disorders in lipid metabolism. Examination of disorders in amino acid and protein metabolism. Examination of the catalytic activity of enzymes. Clinical and biochemical analyzes in the diagnosis of hematological diseases.

TEACHING UNIT 1 (FIRST WEEK):

„BRAIN-TO-BRAIN LOOP“ FOR LABORATORY TESTING. PRE-PREANALYTICAL, PREANALYTICAL, ANALYTICAL, POSTANALYTICAL AND POST-POSTANALYTICAL PHASE OF LABORATORY PROCESSES.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- General overview of the organization of the clinical-biochemical laboratory and recommendations for biosafety and health at work
- Total Testing Process phases
- Preanalytical and preanalytical phase
- Analytical phase
- Postanalytical and post-postanalytical phase
- Good laboratory practice

TEACHING UNIT 2 (SECOND WEEK):

ANALYTICAL TECHNICS IN MEDICAL LABORATORIES: BASIC PRINCIPLES AND APPLICATIONS.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Photometry
- Colorimetry
- Spectrophotometry
- Fluorimetry
- Electrochemical methods
- Enzyme immunoassays: ELISA, CLIA, CMIA, ECLIA, ELFA, TRACE
- Turbidimetry and nephelometry
- Electrophoresis
- Chromatography, Mass spectrometry
- PCR
- Automation in clinical-biochemical laboratory

TEACHING UNIT 3 (THIRD WEEK):

EXAMINATION OF DISORDERS IN CARBOHYDRATE METABOLISM.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Carbohydrate metabolism
- Diabetic ketoacidosis
- Hypoglicemia
- Hyperosmolar coma
- Fructose metabolism disorders

- Galactosemia
- Glycogen storage diseases
- Pyruvate metabolism disorders
- Other carbohydrate metabolism disorders
- Inherited defects affecting carbohydrate metabolism
- Determination of biomarkers in disorders in carbohydrate metabolism

TEACHING UNIT 4 (FOURTH WEEK):

EXAMINATION OF DISORDERS IN LIPID METABOLISM.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Introduction to disorders in lipid metabolism
- Disorders of lipid digestion and absorption
- Disorders of fatty acid metabolism
- Disorders of cholesterol metabolism
- Disorders of lipoprotein metabolism
- Lipid storage diseases sphingolipidoses
- Determination of lipid profile

TEACHING UNIT 5 (FIFTH WEEK):

EXAMINATION OF DISORDERS IN AMINO ACID AND PROTEIN METABOLISM.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Introduction to amino acid and protein metabolism
- Phenylketonuria
- Tyrosinemia
- Homocystinuria
- Non-ketotic hyperglycinemia
- Maple syrup urine disease
- Urea cycle defects
- Amino acid transport disorders
- Serum protein determination

TEACHING UNIT 6 (SIXTH WEEK):

EXAMINATION OF THE CATALYTIC ACTIVITY OF ENZYMES.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Regulation of enzyme activity- mechanisms of activation and inhibition.
- Allosteric enzymes,
- Clinically important enzymes, nomenclature, and classification of enzymes
- Determination of enzme activity

TEACHING UNIT 7 (SEVENTH WEEK):

CLINICAL AND BIOCHEMICAL ANALYZES IN THE DIAGNOSIS OF HEMATOLOGICAL DISEASES.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Anemia
- Hemophilia
- Blood-clotting disorders
- Leukemia, lymphoma and myeloma
- CBC determination, reticulocyte count, blood film, bone marrow examination, erythrocyte sedimentation rate, haemostasis tests

SECOND MODULE: Liver diseases: clinical and biochemical aspects. Acute and chronic kidney injury: clinical and biochemical aspects. Coronary heart disease: clinical and biochemical aspects. Rheumatic diseases and diseases of the locomotor system: clinical and biochemical aspects. Clinical and laboratory assessment of thyroid abnormalities. Clinical and laboratory profile of primary hyperparathyroidism. Polycystic ovary syndrome: clinical and laboratory evaluation. Biochemical evaluation of adrenal dysfunction: the clinical and laboratory perspective.

TEACHING UNIT 8 (EIGHTH WEEK):

LIVER DISEASES: CLINICAL AND BIOCHEMICAL ASPECTS.		
Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Introduction to liver diseases
- Non-alcoholic fatty liver disease biomarkers
- Fibrosis biomarkers
- Cirrhosis biomarkers
- Hepatocellular carcinoma biomarkers
- Hepatitis biomarkers
- Enymes determination
- Tumor markers determination
- Fibrosis biomarkers determination

TEACHING UNIT 9 (NINTH WEEK):

ACUTE KIDNEY INJURY AND CHRONIC KIDNEY DISEASE: CLINICAL AND BIOCHEMICAL ASPECTS.		
Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Introduction to acute kidney injury (AKI)
- Introduction to chronic kidney desease (CKD)
- Reccomendations/guidelines AKI/CKD biomarkers
- AKI stress markers
- AKI damage markers
- AKI functional markers
- Biomarkers of CKD (markers or renal glomerular function, markers of endothelial dysfunction, markers of tubular injury, markers of inflamation).
- Chemical examination of urine.
- Urinary sediment analysis.

TEACHING UNIT 10 (TENTH WEEK):

CORONARY HEART DISEASE: CLINICAL AND BIOCHEMICAL ASPECTS.		
Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Introduction to coronary heart disaese
- Clinical guidelines and reccomendations (acute coronary syndrome, heart failure, pulmonary embolism, etc)
- Troponin T i troponin I
- Natriuretic peptides

- Primena ESC 0/1h i 0/2h algorithm in emergency deprtment
- Heart Type Fatty Acid Binding Protein
- Soluble suppression of tumorigenicity 2
- Galectin-3
- Inflamatory biomarkers (CRP, IL-6, Lp-PLA2)
- Prognostic biomarkers of coronary heart disaese
- Determination of cardiac biomarkers (automated analyzers, POCT)

TEACHING UNIT 11 (ELEVENTH WEEK):

RHEUMATIC DISEASES AND DISEASES OF THE LOCOMOTOR SYSTEM: CLINICAL AND BIOCHEMICAL ASPECTS.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Introduction to rheumatic diseases and diseases of the locomotor system
- Rheumatoid arthritis (RA)
- Connective tissue disorders
- Systemic lupus erythematosus (SLE)
- Rheumatoid factor
- Anti-citrullinated peptide antibodies
- Antinuclear antibodies
- Inflamatory biomarkers
- Human leukocyte antigen HLA-B27 allele
- Multi-biomarker disease activity (MBDA) test
- Bone and cartilage biomarkers
- Determination of rheumatic diseaases biomarkers.

TEACHING UNIT 12 (ELEVENTH WEEK):

CLINICAL AND LABORATORY ASSESSMENT OF THYROID ABNORMALITIES.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Introduction to thyroid abnormalities
- Thyroid-stimulating hormone, free thyroxine, free triiodothyronine, thyroglobulin, thyroglobulin antibodies, thyroid peroxidase antibodies, TSH receptor antibodies, calcitonin.
- Pitfalls in thyroid function tests interpretation
- Hyperthyroidism
- Hypothyroidism
- Subclinical Thyroid Dysfunction
- Thyroid Nodules
- Thyroid Cancer
- Algorithm for the interpretation of thyroid function test results
- Determination of thyroid hormones and antibodies

TEACHING UNIT 13 (THIRTEENTH WEEK)

CLINICAL AND LABORATORY PROFILE OF HYPERPARATHYROIDISM.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Introduction to hyperparathyroidism
- Primary hyperparathyroidism
- Secondary hyperparathyroidism,
- Serum calcium, urine calcium
- Serum calcium/phosphorus ratio

- PTH and iPTH
- vitamin D
- Determination of primary hyperparathyroidism biomarkers

TEACHING UNIT 14 (FOURTEENTH WEEK)

POLYCYSTIC OVARY SYNDROME:
CLINICAL AND LABORATORY EVALUATION.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Introduction to polycystic ovary syndrome (PCOS)
- Anthropometric and clinical biomarkers
- Insulin and the insulin-like growth factor 1 system
- Anti-Müllerian hormone and gonadotropins
- Steroids
- Inflammatory and renal injury biomarkers
- Oxidative stress
- Noncoding RNAs

TEACHING UNIT 15 (FIFTEENTH WEEK)

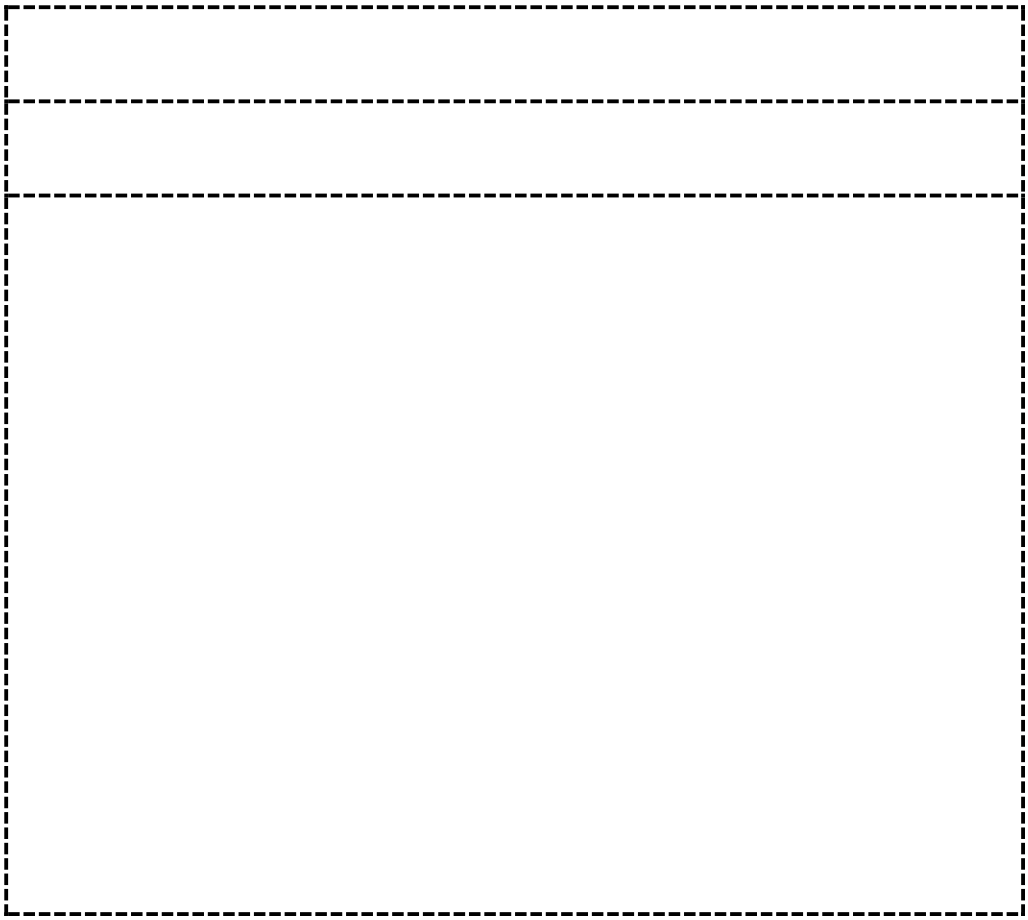
BIOCHEMICAL EVALUATION OF ADRENAL DYSFUNCTION:
THE CLINICAL AND LABORATORY PERSPECTIVE.

Lectures: 2 classes	Seminar: 1 class	Exercises: 1 class

- Introduction to adrenal insufficiency
- Primary adrenal insufficiency
- Secondary adrenal insufficiency
- Tertiary adrenal insufficiency
- Cortisol, ACTH
- The cosyntropin stimulation (short synacthen) test
- The salivary cortisol test
- 21-hydoxylase antibodies
- Biochemical screening evaluation for suspected adrenal insufficiency
- Alterations in hypothalamic–pituitary–adrenal axis in various forms of adrenal insufficiency

SCHEDULE OF LECTURES AND SEMINARS

SCHEDULE OF EXCERCISES



LESSON SCHEDULE FOR THE COURSE MEDICAL BIOCHEMISTRY

module	week	type	name of the teaching unit	teacher
1	1	**L**	„Brain-to-brain loop“ for laboratory testing. Pre-preanalytical, preanalytical, analytical, postanalytical and post-postanalytical phase of laboratory processes.	Marijana Stanojević Pirković Milan Zarić Sanja Stanković
	1	**S**	„Brain-to-brain loop“ for laboratory testing. Pre-preanalytical, preanalytical, analytical, postanalytical and post-postanalytical phase of laboratory processes.	Marijana Stanojević Pirković Milan Zarić Sanja Stanković
	1	**E**	Introduction to clinical laboratory practice and laboratory processes and documentation.	Marijana Stanojević Pirković Milan Zarić Sanja Stanković
	2	**L**	Analytical technics in medical laboratories: basic principles and applications.	Sanja Stanković Marijana Stanojević Pirković Milan Zarić
	2	**S**	Analytical technics in medical laboratories: basic principles and applications.	Sanja Stanković Marijana Stanojević Pirković Milan Zarić
	2	**E**	Clinical laboratory analyzers overview and prinicples of analitycal techniques	Sanja Stanković Marijana Stanojević Pirković Milan Zarić
	3	**L**	Examination of disorders in carbohydrate metabolism.	Ivana Nikolić Ivanka Zelen Marija Anđelković
	3	**S**	Examination of disorders in carbohydrate metabolism.	Ivana Nikolić Ivanka Zelen Marija Anđelković
	3	**E**	Determination of biomarkers in disorders in carbohydrate metabolism	Ivana Nikolić Ivanka Zelen Marija Anđelković
	4	**L**	Examination of disorders in lipid metabolism.	Marijana Stanojević Pirković Milan Zarić Sanja Stanković
	4	**S**	Examination of disorders in lipid metabolism.	Marijana Stanojević Pirković Milan Zarić Sanja Stanković
	4	**E**	Determination of lipid profile.	Marijana Stanojević Pirković Milan Zarić Sanja Stanković

LESSON SCHEDULE FOR THE COURSE MEDICAL BIOCHEMISTRY

module	week	type	name of the teaching unit	teacher
	5	**L**	Examination of disorders in amino acid and protein metabolism.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	5	**S**	Examination of disorders in amino acid and protein metabolism.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	5	**E**	Performing diagnostic tests for protein disorders.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	6	**L**	Examination of the catalytic activity of enzymes.	Marina Mitrović Ivanka Zelen Petar Čanović
	6	**S**	Examination of the catalytic activity of enzymes.	Marina Mitrović Ivanka Zelen Petar Čanović
	6	**E**	Determination of catalytic activity of clinically relevant enzymes	Marina Mitrović Ivanka Zelen Petar Čanović
	7	**L**	Clinical and biochemical analyzes in the diagnosis of hematological diseases.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	7	**S**	Clinical and biochemical analyzes in the diagnosis of hematological diseases.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	7	**E**	CBC determination, reticulocyte count, blood film, bone marrow examination, erythrocyte sedimentation rate, haemostasis tests.	Ivanka Zelen Ivana Nikolić Marija Anđelković
2	8	**L**	Liver diseases: clinical and biochemical aspects.	Marina Mitrović Petar Čanović Ivana Nikolić
	8	**S**	Liver diseases: clinical and biochemical aspects.	Marina Mitrović Petar Čanović Ivana Nikolić
	8	**E**	Determination of liver diseases biomarkers.	Marina Mitrović Petar Čanović Ivana Nikolić

LESSON SCHEDULE FOR THE COURSE MEDICAL BIOCHEMISTRY

module	week	type	name of the teaching unit	teacher
	9	**L**	Acute and chronic kidney injury: clinical and biochemical aspects.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	9	**S**	Acute and chronic kidney injury: clinical and biochemical aspects.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	9	**E**	Determination of kidney injury biomarkers. Chemical examination of urine. Urinary sediment analysis.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	10	**L**	Coronary heart disease: clinical and biochemical aspects.	Sanja Stanković Marijana Stanojević Pirković Milan Zarić
	10	**S**	Coronary heart disease: clinical and biochemical aspects.	Sanja Stanković Marijana Stanojević Pirković Milan Zarić
	10	**E**	Determination of cardiac biomarkers.	Sanja Stanković Marijana Stanojević Pirković Milan Zarić
	11	**L**	Rheumatic diseases and diseases of the locomotor system: clinical and biochemical aspects.	Marina Mitrović Petar Čanović Marijana Stanojević Pirković
	11	**S**	Rheumatic diseases and diseases of the locomotor system: clinical and biochemical aspects.	Marina Mitrović Petar Čanović Marijana Stanojević Pirković
	11	**E**	Determination of rheumatic diseaases biomarkers.	Marina Mitrović Petar Čanović Marijana Stanojević Pirković
	12	**L**	Clinical and laboratory assessment of thyroid abnormalities.	Marijana Stanojević Pirković Milan Zarić Sanja Stanković
	12	**S**	Clinical and laboratory assessment of thyroid abnormalities.	Marijana Stanojević Pirković Milan Zarić Sanja Stanković
	12	**E**	Determination of thyroid hormones and antibodies	Marijana Stanojević Pirković Milan Zarić Sanja Stanković

LESSON SCHEDULE FOR THE COURSE MEDICAL BIOCHEMISTRY

module	week	type	name of the teaching unit	teacher
	13	**L**	Clinical and laboratory profile of primary hyperparathyroidism.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	13	**S**	Clinical and laboratory profile of primary hyperparathyroidism.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	13	**E**	Determination of primary hyperparathyroidism biomarkers.	Ivanka Zelen Ivana Nikolić Marija Anđelković
	14	**L**	Polycystic ovary syndrome: clinical and laboratory evaluation.	Marina Mitrović Petar Čanović Marija Anđelković
	14	**S**	Polycystic ovary syndrome: clinical and laboratory evaluation.	Marina Mitrović Petar Čanović Marija Anđelković
	14	**E**	Determination of of polycystic ovary syndrome biomarkers	Marina Mitrović Petar Čanović Marija Anđelković
	15	**L**	Biochemical evaluation of adrenal dysfunction: the clinical and laboratory perspective.	Marina Mitrović Petar Čanović Milan Zarić
	15	**S**	Biochemical evaluation of adrenal dysfunction: the clinical and laboratory perspective.	Marina Mitrović Petar Čanović Milan Zarić
	15	**E**	Determination of adrenal dysfunction biomarkers.	Marina Mitrović Petar Čanović Milan Zarić
		FE	**FINAL EXAM**	