MEDICAL UNIVERSITY

"PROF. DR. PARASKEV STOYANOV" - VARNA

FACULTY OF DENTAL MEDICINE

Approved:
DEAN:
/Assoc. Prof. Georgi Papanchev, DMD, PhD/

EDUCATIONAL PROGRAMME

OF

"Biochemistry"

Specialty "DENTAL MEDICINE"
Educational-qualification degree "MASTER"
Professional qualification "PHYSICIAN IN DENTAL MEDICINE"

	Semester	Horarium weekly	Total horarium
Lectures	**II, III**	**1/2**	**45**
Exercises	**II, III**	**1/2**	**45**
Total			**90**
Monitoring and evaluation forms	**Current control**		**Exam – III semester**
Credits (ECTS)	**4+3**		**7**

Lecturers: Prof. Yoana Dimitrova Kiselova-Kaneva, PhD

Prof. Maria Atanasova Radanova, PhD

Varna, 2026

ANNOTATION:

The course builds upon prior education in chemistry and biology, shifting the focus toward the molecular foundations of vital processes. It covers the major types of macromolecules and the relationship between structure and function. Students of Dental Medicine will acquire knowledge of the principal stages of synthesis and degradation of key biomolecules, as well as the fundamental mechanisms underlying the main metabolic processes in the organism. Special attention is devoted to the interrelationships and regulatory mechanisms of the major metabolic pathways, the understanding of which is essential for comprehending the pathological consequences of their disruption. Throughout the course, students will become familiar with the mechanisms of energy extraction, storage, and utilization in the organism. The curriculum also includes topics on heme metabolism and the mechanisms of xenobiotic biotransformation - topics that bridge biochemistry with pharmacology and the clinical laboratory. Particular attention is also given to topics of relevance to dental medicine, addressing the structure and remodeling of the extracellular matrix, the specificities of metabolism and regulation in dental tissues, as well as the biochemical aspects of dental caries and periodontal diseases.

Forms of Training, Control and Assessment

- **Lectures:** multimedia presentations and virtual animations on specific topics.
- **Exercises:** a guide, specifically developed by the Department of Biochemistry for "Dental Medicine" students, is used, tailored to the specifics of the discipline. The manual contains questions, tests, and logical tasks related to individual thematic units, as well as protocols for practical exercises.

An interactive learning approach is employed, including group discussions on set questions, practice tests for self-assessment of acquired knowledge, virtual animations for visualizing the mechanisms and regulation of processes, and solving clinical cases, among others.

- **Current Control:** The current control assessment provides insight into the student's performance during the two semesters of studying the discipline. Current control is conducted through scheduled tests (attestations) upon completion of each major thematic unit. The number and scope of the tests are as follows:

  Semester II (Year I) — two tests covering: (1) proteins and enzymes; (2) signal transduction and bioenergetics.

  Semester III (Year II) — three tests covering: (1) carbohydrate metabolism; (2) lipid metabolism; (3) metabolism of amino acids, nucleotides, calcium, and heme.

  Current control consists of multiple-choice tests administered through the Blackboard e-learning platform. Each test comprises 24 questions with a single correct answer and is completed within 30 minutes. Tests are graded according to the following scale:

Number of correct answers	Grade
18	Fair 3,00
19	Fair 3,25
20	Good 3,50
21	Good 3,75
22	Good 4,00
23	Good 4,25
24	Very Good 4,50
25	Very Good 4,75
26	Very Good 5,00
27	Very Good 5,25
28	Excellent 5,50
29	Excellent 5,75
30	Excellent 6,00

The final current control grade is calculated as the arithmetic mean of the grades obtained from the five tests taken throughout the course of study in the discipline.

- **Final control:** At the end of the Biochemistry course, an examination is held consisting of the following components: examination test (administered through the Blackboard e-learning platform) comprising 36 questions to be completed within 60 minutes, and an oral examination, which contribute with different weights to the formation of the final grade, together with the averaged current control grade.

Tests are graded according to the following scale:

Number of correct answers	Grade		Number of correct answers	Grade
21	Fair 3.00		29	Very Good 4.60
22	Fair 3.20		30	Very Good 4.80
23	Fair 3.40		31	Very Good 5.00
24	Good 3.60		32	Very Good 5.20
25	Good 3.80		33	Very Good 5.40
26	Good 4.00		34	Excellent 5.60
27	Good 4.20		35	Excellent 5.80
28	Good 4.40		36	Excellent 6.00

Evaluation Criteria

The process of forming an assessment is complex. The grading is conducted according to a six-point system, and the final grade in Biochemistry is formed by:

- The student's performance during the colloquiums (referred to as Current Control, or CC);
- The result of a written examination test (referred to as Written Test, or WT);
- The result of an oral exam (referred to as Oral Exam, or OE).

The final grade is calculated using the following formula:

$$0.3 \times CC + 0.2 \times WT + 0.5 \times OE$$

Where:

CC - the average score from the current control.

WT - the score of a examination test.

OE - the score of an oral exam.

Upon completion of the Biochemistry course, students are expected to have acquired the following knowledge, skills, and competencies:

Knowledge of:

- the relationship between structure and function in the major classes of biomolecules - carbohydrates, lipids, proteins, and nucleic acids;
- the molecular mechanisms, interrelationships, and regulation of the main metabolic processes at the cellular, tissue, and organ level;
- the pathological consequences of dysregulation of the major metabolic processes in the organism;
- the mechanisms of detoxification of xenobiotics, reactive oxygen species, ammonia, and other toxic metabolic products;

- the mechanisms of energy extraction, storage, and utilization in the organism;
- the specificities of metabolism and regulation in dental tissues;
- the biochemical aspects of dental caries and periodontal diseases.

Skills for:

- orientation in the fundamental concepts and models of the functioning of living matter;
- interpretation of results from biochemical investigations related to the diagnosis and monitoring of diseases such as diabetes, hereditary enzymopathies, and others;
- evaluation of potential drug interactions based on knowledge of xenobiotic biotransformation;
- recognition of biochemical predispositions for complications during dental procedures;
- critical reading and interpretation of scientific literature in the field of biochemistry.

Competencies to understand, discuss, and analyze biochemical processes in the oral cavity in the context of the general metabolic processes in the organism.

Lectures and seminars topics

	Lectures, I Year, IInd Semester	Hours
1.	Levels of organization of protein molecules. Protein folding. Conformational diseases. Fibrillar proteins - collagen and elastin - relationship between structure and functions. Disorders in the biosynthesis of collagen.	2
2.	Globular proteins - myoglobin and hemoglobin - relationship between structure and function. Dissociation curves. R and T states of hemoglobin. Bohr effect. Hemoglobin types. Hemoglobinopathies.	2
3.	General characteristics, nomenclature and classification of enzymes. Cofactors. Water-soluble vitamins as enzyme cofactors. Mechanism of enzyme action. Active center. Enzyme kinetics. Effect of substrate concentration on enzyme reaction rate. Michaelis-Menten equation. Michaelis constant (Km) and maximum speed (Vmax). Determination of Km and Vmax by the method of Lineweaver and Burk. Effect of enzyme concentration, pH and temperature on the rate of the enzyme reaction.	2
4.	Inhibition of enzyme action. Reversible and irreversible inhibition. Kinetics of competitive and non-competitive enzyme inhibition. Regulation of enzyme activity - types of regulatory mechanisms. Allosteric enzymes - general characteristics and biological significance. Kinetics characteristics of allosteric enzymes. Isoenzymes. Enzymes used for clinical diagnosis and therapy.	2
5.	General principles of intercellular signaling and signal transduction. Mechanism of signal transduction involving membrane receptors coupled to G-proteins - adenylate cyclase and phosphoinositide signaling cascades. Signaling by membrane enzyme receptors. Signaling through intracellular receptors. NO signaling cascade.	2
6.	Metabolism - exchange of substances and energy. Biological oxidation. Central role of ATP in cellular bioenergetics. Oxidative phosphorylation. Mitochondrial respiratory chain - molecular structure, redox systems. Electron transport inhibitors. Uncoupling agents. Inhibition of the ATP synthase complex. Substrate phosphorylation.	2
7.	Free radical oxidation. Antioxidant systems of biological importance. Oxidative stress, inflammation and tissue reorganization.	1
8.	Biological significance of carbohydrates. Digestion and absorption of carbohydrates. Main metabolic pathways of carbohydrate metabolism. Anaerobic and aerobic glycolysis, regulation.	2
	Total	**15**

Lectures, II Year, III[rd] Semester		Hours
1.	Products of glycolysis and their metabolic fate. Shuttle mechanisms for transfer of NADH's hydrogen produced in anaerobic glycolysis. Oxidative decarboxylation of pyruvate. Regulation. Tricarboxylic acid cycle. Regulation. Pentose phosphate pathway of glucose degradation. Importance of oxidizing and non-oxidizing phase. Glucose-6-phosphate dehydrogenase deficiency.	3
2.	Glycogen metabolism - biological significance, mechanism. Regulation of glycogenogenesis and glycogenolysis. Gluconeogenesis - biological significance, mechanism and regulation. Blood sugar. Blood sugar regulation - hormones and metabolic pathways of carbohydrate metabolism involved. Hypo- and hyperglycemia.	3
3.	Components of the extracellular matrix. Glycoproteins, glycosaminoglycans, proteoglycans. Structure, biological functions and pathologies.	1
4.	Digestion and absorption of dietary lipids. Transport forms of lipids in the blood. Lipoprotein complexes - types, biological role, structure and composition. Role of apolipoproteins in lipoprotein complexes. Chylomicrons – transport forms of exogenous lipids – metabolic fate.	2
5.	Lipolysis in adipose tissue - mechanism, regulation. Fate of glycerol and fatty acids obtained from the degradation of triacylglycerols. Activation and transport of free fatty acids in mitochondria. β-oxidation of fatty acids. Keton bodies - definition, types and biological role. Ketogenesis and ketolysis - tissue localization and mechanism. Ketoacidosis.	3
6.	Biosynthesis of fatty acids - mechanism, export of acetyl-CoA into the cytosol, sources of NADPH. Regulation. Lipogenesis in liver, adipose tissue and intestinal mucosa. VLDL – transport forms of endogenous lipids – metabolic fate.	2
7.	Cholesterol metabolism. Role of LDL and HDL in cholesterol transport. Receptor-mediated endocytosis of LDL. Disorders in cholesterol metabolism - atherogenesis. Bile acids - biosynthesis and biological significance, enterohepatic circulation, types of bile acids.	3
8.	Phospholipids – biological significance, types, metabolism. Release of arachidonic acid from membrane phospholipids. Role of phospholipase A2. Oxidation products of arachidonic acid - eicosanoids. Inhibition of the synthesis of eicosanoids by nonsteroidal anti-inflammatory drugs.	2
9.	Digestion of dietary proteins and absorption of amino acids. Transamination. Oxidative deamination. Predeamination. Decarboxylation. Exchange of some amino acids, such as phenylalanine, tyrosine, etc.	2
10.	Ammonia toxicity. Pathways for disposal of ammonia in peripheral tissues. Role of glutamine. Glucose-alanine cycle. Pathways for the disposal of ammonia in the liver - urea biosynthesis. Regulation of the urea cycle. Hyperammonemias.	2
11.	Biosynthesis of purine and pyrimidine nucleotides – initial substrates, cofactors, key enzymes, regulation. Purine and pyrimidine nucleotides degradation – end products and clinical significance.	2

12.	Metabolism of calcium and phosphates. Hormones regulating calcium and phosphate metabolism. Calcitriol – biosynthesis, regulation. Role of vit. D and vit. K for bone tissue metabolism.	1
13.	Biosynthesis and degradation of heme. Disorders in heme biosynthesis, porphyrias. Metabolism of bile pigments, enterohepatic circulation, direct and indirect bilirubin. Disorders in bile pigments metabolism.	1
14.	Metabolism of xenobiotics - stages, mechanisms of biotransformation. Role of cyt P450, characteristics of cyt P450 relevant to medical practice - induction and inhibition of cyt P450. Ethanol metabolism.	1
15.	Organic and inorganic components of dentin and tooth enamel. Biological role of fluorine and fluorides - sources, bioavailability and homeostasis. Deficiency and excess of fluorine.	1
16.	Composition of saliva. Carioprotective properties of saliva. Cariogenic factors. Caries. Biochemical aspects of periodontitis.	1
	Total	**30**

	Seminars, I Year, IInd Semester	Hours
1.	Fibrillar proteins - collagen and elastin - relationship between structure and functions. Collagen diseases.	2
2.	Globular proteins - myoglobin and hemoglobin - relationship between structure and function. Types of hemoglobin. Hemoglobinopathies.	2
3.	Enzymes I: Chemical nature, specificity, coenzymes, vitamins, enzyme kinetics.	2
4.	Enzymes II: Regulation of enzyme activity. Inhibition of enzyme action. Application of enzymes in medicine.	2
5.	**Current control on Proteins and Enzymes**	1
6.	General principles of signal transduction - mechanism of signal transduction with the participation of membrane receptors and with the participation of intracellular receptors.	2
7.	Bioenergetics I: Biological oxidation, central role of ATP. Structure and functions of the respiratory chain - oxidative phosphorylation. Inhibitors of the electron transport. Role of uncoupling agents.	2
8.	**Current control on intracellular signaling and bioenergetics.** Free-radical oxidation. Antioxidants.	2
	Total	**15**

	Seminars, II Year, IIIrd Semester	
1.	Carbohydrate Metabolism I: Digestion of Carbohydrates. Cellular monosaccharides transports. Glycolysis in anaerobic and anaerobic conditions. Regulation of glycolysis.	2
2.	Carbohydrate metabolism II: Oxidative decarboxylation of pyruvate. Shuttle mechanisms for NADH transport in mitochondria. Krebs cycle. Pentose phosphate pathway – biological significance, regulation.	2
3.	Carbohydrate metabolism III: Glycogen metabolism - biological significance, mechanism and regulation. Gluconeogenesis - biological significance, mechanism and regulation. Blood sugar regulation. Hypo- and hyperglycemia	2
4.	**Current control on Carbohydrate Metabolism.** Carbohydrate metabolism IV: Components of the extracellular matrix. Glycoproteins, glycosaminoglycans, proteoglycans. Structure, biological functions and pathology.	2
5.	Lipid metabolism I: Digestion and resorption of lipids. Chylomicrons – transport forms of exogenous lipids – metabolic fate. Transport forms of lipids in the blood - a comparative review of structure, composition and biological role.	2
6.	Lipid metabolism II: Lipolysis in adipose tissue. Metabolic fate of glycerol and free fatty acids. Oxidation of free fatty acids with an even number of carbon atoms. Ketogenesis and ketolysis.	2
7.	Lipid metabolism III: Biosynthesis of free fatty acids and TAG. Transport of endogenous lipids in the blood by VLDL.	2
8.	Lipid metabolism IV: Biosynthesis of cholesterol and bile acids. Cholesterol transport in the blood - role of LDL and HDL.	2

9.	**Current control on lipid metabolism.** Lipid metabolism V: Phospholipids – biological importance, types. Eicosanoids – formation and biological role.	2
10.	Amino acid metabolism I: Digestion of proteins and absorption of amino acids. Intracellular metabolism of amino acids – transamination, oxidative deamination and transdeamination. Decarboxylation. Metabolism of some amino acids.	2
11.	Amino acid metabolism II: Ammonia toxicity. Ways of disposal of ammonia in liver and peripheral tissues.	2
12.	Metabolism of purine and pyrimidine nucleotides. Role of tetrahydrofolic acid in nucleotide metabolism. Hyperuricemia.	2
13.	Metabolism of calcium and phosphates. Hormones regulating calcium and phosphate metabolism - parathormone, calcitriol, calcitonin. Biosynthesis and degradation of heme. Hyperbilirubinemias.	2
14.	**Current control on amino acid, nucleotides, calcium and heme.** Metabolism of xenobiotics - stages, mechanisms of biotransformation. Role of cyt P450.	2
15.	*Practical work on the semeter's topics.* Solving sample exam tests.	2
	Total	**30**

EXAMINATION SYNOPSIS
OF BIOCHEMISTRY
FOR DENTAL MEDICAL STUDENTS

1. Fibrillar proteins. Structural characteristics of collagen and elastin. Collagen biosynthesis. Disorders in the biosynthesis of collagen.
2. Globular proteins - myoglobin and hemoglobin. Structural characteristics related to their function. Dissociation curves of myoglobin and hemoglobin. T and R states. Hemoglobin – Bohr effect. Types of hemoglobins, hemoglobinopathies.
3. Characteristics of enzymes as biocatalysts. Classification. Water-soluble vitamins as enzyme cofactors - cofactors for electron and proton transport. Water-soluble vitamins as enzyme cofactors - group transport cofactors.
4. Enzyme kinetics – speed of the enzyme reaction. Effect of substrate concentration on enzyme reaction rate. Effect of enzyme concentration on enzyme reaction rate, enzyme activity. Effect of pH and temperature on the rate of the enzyme reaction.
5. Inhibition of enzyme action. Reversible and irreversible inhibition. Competitive and non-competitive inhibition.
6. Regulation of enzyme activity - allosteric enzymes. Regulation by reversible covalent modification, limited proteolysis, induction and repression of enzyme synthesis.
7. Isoenzymes - general characteristic, biological significance. Enzymes used for clinical diagnosis and therapy.
8. General principles of intercellular signaling and signal transduction. Signaling molecules. Receptors. Types of signaling – autocrine, paracrine, endocrine, synaptic.
9. Gαβγ – protein bound membrane receptors operating with the enzyme adenylate cyclase. Effector circuit. Gαβγ – protein bound membrane receptors operating with the enzyme phospholipase C. Effector chain. NO signaling cascade.
10. Intracellular receptors. Types of ligands for intracellular receptors. Principle of signaling involving intracellular receptors, effector chain.
11. Metabolism – exchange of substances and energy.. Endergonic and exergonic processes. Coupling of endergonic and exergonic processes. Central role of ATP for cellular bioenergetics.
12. Molecular structure of the respiratory chain - redox systems and principle of their arrangement in the respiratory chain. Coupling respiration with phosphorylation – Mitchell's chemiosmotic theory.
13. Electron transport inhibitors. Uncoupling agents of oxidative phosphorylation. Inhibition of the ATP synthase complex.
14. Free radical oxidation - sources for the formation of active oxygen forms in the body, biological role. Antioxidant systems – types and biological role. Oxidative stress, inflammation and tissue reorganization.
15. Digestion and absorption of carbohydrates. Main metabolic pathways of carbohydrate metabolism.
16. Anaerobic and aerobic glycolysis. Phosphorylation of glucose in the cell. Types of hexokinases. Regulation of glycolysis.
17. Pentose phosphate pathway of glucose degradation. Biological significance. Importance of oxidizing and non-oxidizing phase. Glucose-6-phosphate dehydrogenase deficiency.
18. Fate of pyruvate in aerobic conditions – oxidative decarboxylation of pyruvate, pyruvate dehydrogenase complex. Regulation of the pyruvate dehydrogenase complex. Fate of

cytosolic NADH - shuttle mechanisms for hydrogen transfer.

19. Tricarboxylic acids cycle - biological significance, mechanism. Regulation of the tricarboxylic acid cycle. Anaplerotic reactions. Energy yield from the complete breakdown of glucose under aerobic conditions. Substrate phosphorylation reactions.
20. Glycogen - structure and biological significance. Glycogenogenesis and glycogenolysis – mechanism and regulation.
21. Gluconeogenesis - biological significance. Organ localization, mechanism, key enzymes, regulation.
22. Blood sugar. Blood sugar regulation - hormones and metabolic pathways of carbohydrate metabolism that affect blood sugar levels. Hypo- and hyperglycemias.
23. Components of the extracellular matrix. Glycoproteins, glycosaminoglycans, proteoglycans. Structure, biological functions and pathology. Matrix metalloproteinases.
24. Digestion and absorption of lipids. Enzymes involved in digestion. Role of bile acids in lipids digestion.
25. Transport forms of lipids in the blood. Lipoprotein complexes - types, composition. Role of apolipoproteins entering into the structure of lipoprotein complexes.
26. Transport of dietary lipids via chylomicrons. Chylomicron metabolism. Transport of lipids synthesized in liver via VLDL. VLDL metabolism.
27. Lipolysis in adipose tissue, regulation. Activation and transport of fatty acids in mitochondria. Mechanism of β-oxidation of long chain fatty acids with an even number of carbon atoms. Energy balance of β-oxidation.
28. Ketone bodies - definition, types, biological role. Mechanism and tissue localization of ketogenesis and ketolysis. Conditions for the occurrence of ketoacidosis.
29. Biosynthesis of fatty acids - export of acetyl-CoA in the cytosol, sources of NADPH. Acetyl-CoA carboxylase and fatty acyl synthetase complex. Regulation of fatty acid biosynthesis.
30. Lipogenesis in liver, adipose tissue and intestinal mucosa.
31. Cholesterol biosynthesis - mechanism. Regulation of cholesterol biosynthesis. Importance of LDL and HDL in the transport of cholesterol in the blood. Receptor-mediated endocytosis of LDL. Disorders in cholesterol metabolism - atherogenesis.
32. Biosynthesis of bile acids. Biological role. Enterohepatic circulation of bile acids.
33. Phospholipids - biological significance, types. Release of arachidonic acid from membrane phospholipids. Role of phospholipase A2.
34. Oxidation products of arachidonic acid. Biological significance of eicosanoids. Regulation of eicosanoid synthesis.
35. Digestion of dietary proteins. Role of hydrochloric acid. Enzymes involved in protein digestion. Absorption of amino acids. Sodium-dependent transport.
36. Mechanism of transamination of amino acids. Transaminases - role of pyridoxal cofactors. Oxidative deamination of glutamate – mechanism. Predeamination – mechanism and biological significance.
37. Exchange of phenylalanine and tyrosine – catecholamines, melanin, thyroid hormones. Disorders in phenylalanine and tyrosine metabolism.
38. Ammonia toxicity. Ways of disposal of ammonia in peripheral tissues, role of glutamine and alanine. Ammonia disposal in liver - urea biosynthesis. Regulation of the urea cycle.
39. Biosynthesis of purine nucleotides *de novo* - role of tetrahydrofolic acid. Regulation of purine nucleotide biosynthesis. Biosynthesis of purine nucleotides in the salvage pathway. Disorders in the biosynthesis of purine nucleotides.
40. Biosynthesis of pyrimidine nucleotides. Regulation of pyrimidine nucleotide biosynthesis.

41. Degradation of purine nucleotides. Hyperuricemia. Gout. Pyrimidine nucleotides degradation.
42. Heme biosynthesis - mechanism and regulation. Degradation of heme – bile dyes. Direct and indirect bilirubin. Disorders in the metabolism of bile pigments. Jaundice.
43. Calcium and phosphate metabolism. Hormones regulating calcium metabolism - parathormone, calcitonin, calcitriol - mechanism of action.
44. Calcitriol. Biosynthesis. Mechanism of action and role in calcium and phosphate metabolism and in the regulation of bone homeostasis. Hypo- and hypervitaminoses D.
45. Metabolism of xenobiotics - stages, mechanisms of biotransformation. Role of cyt P450, characteristics of cyt P450 relevant to medical practice - induction and inhibition of cyt P450. Ethanol metabolism.
46. Organic and inorganic constituents of dental tissues. Biological role of fluorine and fluorides - sources, bioavailability and homeostasis. Deficiency and excess of fluorine.
47. Composition and role of saliva as for caries prevention. Cariogenic factors. Biochemistry of dental caries - biochemical processes carried out by the microflora of dental plaque. Biochemical aspects of periodontitis.

Literature

Obligatory:

1. Lectures on the electron platform Blackboard

Recommended:

1. Ferrier D. Lippincott's illustrated reviews: Biochemistry. 8th edition, 2021 (and earlier editions)
2. Mark's Basic Medical Biochemistry – a clinical approach, 6th edition, 2022 (and earlier editions)
3. Rodwell VW, Kennelly PJ, Bender DA, Weil PA and Botham KM. Harper`s Illustrated Biochemistry. 2023; 32-th Edition; ISBN 978-1-259-83793-7. (Electronic textbook of Biochemistry from a subscription to an online resource: *Access Medicine*). https://accessmedicine.mhmedical.com/book.aspx?bookid=2386
4. Janson LW and Tischler ME. The Big Picture: Medical Biochemistry. 2018; ISBN 978-0-07-163791-6. (Electronic textbook of Biochemistry from a subscription to an online resource: Access Medicine). https://accessmedicine.mhmedical.com/book.aspx?bookid=2355

Supplementary:

1. Levine M. Topics in Dental Biochemistry. Springer Heidelberg Dordrecht London New York, 2011. ISBN 978-3-540-88115-5; e-ISBN 978-3-540-88116-2. DOI 10.1007/978-3-540-88116-2
2. Williams R.A.D., Elliot J.C. Basis and Applied Dental Biochemistry. Second edition, Edinburgh, New York, 2011. ISBN 10:0443031444.

Program worked out by:
Prof. Yoana Kiselova-Kaneva, PhD
Prof. Maria Radanova, PhD
Department of Biochemistry, Molecular Medicine and Nutrigenomics

Department's council protocol № 09/18.05.2026

PREPARED:

/PROF. YOANA KISELOVA-KANEVA, PhD/

/PROF. MARIA RADANOVA, PhD /

HEAD OF DEPARTMENT:

/ASSOC. PROF. MILKA NASHAR, PhD/