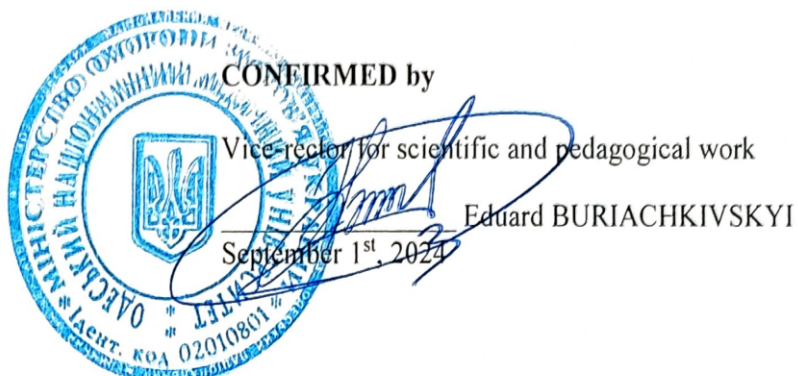


MINISTRY OF HEALTH OF UKRAINE  
ODESA NATIONAL MEDICAL UNIVERSITY

Department of Medical Biology and Chemistry



WORKING PROGRAM IN THE DISCIPLINE  
«BIOCHEMISTRY OF ESSENTIAL NUTRIENTS»

**Level of higher education:** second (master's degree)

**Field of knowledge:** 22 «Health care»

**Specialty:** 226 «Pharmacy, industrial pharmacy»

**Educational and professional program:** Pharmacy, industrial pharmacy

The working program is compiled on the basis of the educational and professional program "Pharmacy, industrial pharmacy" for the training of specialists of the second (master's) level of higher education in the specialty 226 "Pharmacy, industrial pharmacy" of the field of knowledge 22 "Health care", approved by the Academic Council of ONMedU (minutes No. 10 dated 27.06.2024).

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The working program is approved at the meeting of the Department of Medical Biology and Chemistry  
Minutes No. 1 dated 26.08 2024.

Head of the department

 Hennadii STEPANOV


Approved by the guarantor of  
the educational and professional program

 Liana UNHURIAN

Approved by the subject-cycle methodological commission for pharmaceutical disciplines of  
ONMedU

Minutes No. 1 dated 30.08.2024

Head of the subject-cycle methodological commission for pharmaceutical disciplines of ONMedU

 Natalia FIZOR

Revised and approved at the meeting of \_\_\_\_\_  
Minutes No. \_\_ dated \_\_\_\_\_

Head of the department \_\_\_\_\_

Revised and approved at the meeting of \_\_\_\_\_  
Minutes No. \_\_ dated \_\_\_\_\_

Head of the department \_\_\_\_\_

Revised and approved at the meeting of \_\_\_\_\_  
Minutes No. \_\_ dated \_\_\_\_\_

Head of the department \_\_\_\_\_

## 1. Description of the discipline:

2.

Name of indicators	Field of knowledge, specialty, specialization, level of higher education	Characteristics of the academic discipline
Total number:	Field of knowledge 22 "Health care"	<i>Full-time education</i> <i>Compulsory discipline</i>
Credits of ECTS: 3	Specialty 226 "Pharmacy, industrial pharmacy"	<i>Year of training: 4</i>
Hours: 90		<i>Semesters: VIII</i>
Content modules: 1	Level of higher education second (master's)	<i>Lectures (0 hours)</i>
		<i>Seminars (0 hours)</i>
		<i>Practical classes (30 hours)</i>
		<i>Laboratory (0 hours)</i>
		<i>Independent work (60 hours)</i> <i>including individual tasks (0 hours)</i>
		<i>Form of final control - credit</i>

## 2. The purpose and tasks of the educational discipline, competences, program learning outcomes.

**Goal:** the formation of students of a complete system of knowledge about high- and low-molecular essential nutrients, their structures, metabolism and functional impact on the human body.

**Task:** familiarize with the peculiarities of the metabolism of vitamins, essential fatty acids and amino acids; to acquire the fundamental knowledge necessary for the interpretation of the results of detection of abnormalities in the functioning of one or more organs; teach to characterize the involvement of vitamins and other nutrients in the development, progression and correction of pathological processes; evaluate the reserve of functional capabilities of the body.

The process of studying the discipline is aimed at forming elements of the following competencies:

- **General (GC):**

GC01. Ability to think abstractly, analyze and synthesize, learn and be modernly educated.

GC07. The ability to realize one's rights and responsibilities as a member of society; to realize the values of a civil (free democratic) society and the need for its sustainable development, the rule of law, the rights and freedoms of a person and a citizen in Ukraine.

GC10. The ability to act socially responsibly and consciously.

GC12. The desire to preserve the environment.

GC13. Ability to show initiative and entrepreneurship.

GC16. The ability to conduct experimental research at the appropriate level.

- **Special (professional, subject) (SC):**

FK08. The ability to consult on prescription and non-prescription drugs and other products of the pharmacy assortment; pharmaceutical care during the selection and sale of medicinal products of natural and synthetic origin by assessing the risk/benefit ratio, compatibility, taking into account biopharmaceutical, pharmacokinetic, pharmacodynamic and physicochemical and chemical features, indications/contraindications for use guided by data on the health status of a particular patient.

FK09. Ability to provide pre-medical assistance to the sick and injured in extreme situations and

emergencies.

SC11. The ability to identify medicinal products, xenobiotics, toxins and their metabolites in biological fluids and tissues of the body, to conduct chemical and toxicological studies for the purpose of diagnosing acute poisoning, drug and alcohol intoxication.

SC20. Ability to develop and evaluate methods of quality control of medicinal products of natural and synthetic origin, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical, physico-chemical, biological, microbiological, pharmaco-technological methods; carry out standardization of medicinal products in accordance with current requirements.

SC21. The ability to ensure the rational use of prescription and non-prescription drugs in accordance with the physicochemical, pharmacological characteristics, biochemical, pathophysiological features of a particular disease and pharmacotherapeutic schemes of its treatment.

#### **Program learning outcomes (PLO):**

PLO01. Have and apply specialized conceptual knowledge in the field of pharmacy and related fields, taking into account modern scientific achievements.

PLO03. Have specialized knowledge and skills/skills for solving professional problems and tasks, including for the purpose of further development of knowledge and procedures in the field of pharmacy.

PLO09. Formulate, argue, clearly and concretely convey to specialists and non-specialists, including those seeking higher education, information based on one's own knowledge and professional experience, the main trends in the development of world pharmacy and related industries.

PLO12. Provide pre-medical assistance to patients in emergency situations and victims in extreme situations.

PLO21. Ensure competitive positions and effective development of pharmaceutical organizations, including taking into account the results of marketing research and market processes at the national and international levels.

PLO22. Ensure and carry out quality control of medicinal products of natural and synthetic origin and document its results; draw up quality certificates and analysis certificates taking into account the requirements of the current edition of the State Pharmacopoeia of Ukraine, quality control methods (QC), technological instructions, etc.; take measures to prevent the distribution of low-quality, falsified and unregistered medicinal products.

PLO25. Adhere to the norms of the sanitary and hygienic regime and the requirements of safety equipment when carrying out professional activities.

#### **As a result of studying the academic discipline, the student of higher education must:**

##### **Know:**

- chemical structure and chemical properties of essential macro- and micronutrients;
- processes of metabolic transformations of vitamins, quasi-vitamins, essential amino and fatty acids;
- the main metabolic pathways of essential macro- and micronutrients and the key mechanisms regulating these pathways;
- biochemical mechanisms and regularities of their metabolic and regulatory role in human cells and tissues;
- characteristics of pathologies, the development of which is associated with a deficiency of macro- and micronutrients, the toxicity of these compounds and general metabolic disorders.

##### **Be able:**

- to classify essential nutrients and their metabolically active forms according to the structure and nature of functional activity;
- analyze and interpret molecular mechanisms of metabolic activity of vitamins, essential amino

acids,  $\omega$ -3 fatty acids;

- use acquired theoretical knowledge to set and solve practical tasks;
- to diagnose the state of biological systems based on the results of the study of organisms at different levels of the organization;
- analyze biological phenomena and processes at the molecular, cellular, organismal, population-species and biosphere levels from the point of view of fundamental general scientific knowledge, as well as using special modern research methods.

### **3. Content of the academic discipline**

#### **Content module 1.**

#### **Biochemistry of rational nutrition and essential nutrients**

##### **Topic 1. Nutritional biochemistry. Food components.**

Anatomical and physiological basis of nutrition. Nutritional biochemistry as a science. Components of human nutrition. The needs of the human body in nutritional compounds. Essential nutrients, phytonutrients, antinutrients. Micronutrients. Nutritional value of trace elements. Nutrition of the population as a component of public health.

##### **Topic 2. Biochemical aspects of the regulation of eating behavior and digestive processes.**

Biochemical basis of digestion and absorption of nutrients. Biochemical bases of regulation of human eating behavior. The concept of nutritional genomics.

##### **Topic 3. Carbohydrates as components of food and their role in the formation of health.**

Biological role of carbohydrates in human nutrition. The main carbohydrate components of food. The main metabolic ways of using carbohydrates as the main source of energy. Peculiarities of carbohydrate metabolism in normal and pathological conditions.

##### **Topic 4. Lipids as components of food and their role in the formation of health.**

Biological role of lipids in human nutrition. The main lipid components of food. Peculiarities of lipid metabolism in normal and pathological conditions. Integrative mechanisms of functioning of  $\omega$ -3 fatty acids and mitochondria. Fatty acid profile of nutrition. Unsaturated fatty acids: vital or toxic.

##### **Topic 5. Proteins as components of food and their role in the formation of health.**

Biological role of proteins in human nutrition. The concept of "complete protein". Nitrogen balance in normal and pathological conditions. Metabolism of essential amino acids. Integrated index of essential amino acids. Prediction of the biological value of proteins.

##### **Topic 6. Water-soluble vitamins as components of human nutrition. Bioflavonoids. Nutritional supplements.**

Water-soluble vitamins. Distribution and daily requirement of water-soluble vitamins. Features of absorption, transportation and chemical modifications of water-soluble vitamins in the human body. Biochemical bases of vitamin interventions in correcting the functioning of the methionine cycle. Experimental contradictions in the use of vitamin preparations.

##### **Topic 7. Fat-soluble vitamins as components of human nutrition.**

Fat-soluble vitamins. Distribution and daily need of fat-soluble vitamins. Features of absorption, transportation and chemical modifications of fat-soluble vitamins in the human body. Violation of the balance of vitamins in the body.

**Topic 8. Micro- and macroelements as components of human nutrition.**

The concept of micro- and macroelements, their biological activity. The role of the main macronutrients in human nutrition. Daily need. The role of basic trace elements in human nutrition. Daily need. Pathological conditions associated with a lack of macro- and microelements in the body. Water and drinking mode.

**Topic 9. Biochemical aspects of dietetics depending on age.**

The role of balanced nutrition in the formation and strengthening of health (rational nutrition, diet, composition and calculation of the daily ration). Peculiarities of rational nutrition depending on age (children, teenagers, the elderly). Deficiencies in the nutrition of modern man.

**Topic 10. Biochemical aspects of nutrition of athletes.**

Peculiarities of rational nutrition depending on the type of activity (people with mental work, physical work, athletes). Principles of rational nutrition. Dependence of the body's energy needs on the work performed. The role of individual chemical components of food in ensuring muscle activity. Types of diets.

**Topic 11. General characteristics of dietetics and dietetics.**

Peculiarities of food preparation when dieting. Basic food products that are not used in diet therapy. Calculation of body weight, value in the conditions of diet therapy. Excess weight, causes of development, features of choosing a diet for weight loss. Types of diet therapy for overweight, meaning.

**Topic 12. Peculiarities of medical and dietary nutrition in restoring health.**

Food supplements and their impact on health. Diseases transmitted through food (food poisoning, dysentery, botulism, brucellosis, viral hepatitis A, trichinellosis and other helminths). Non-traditional types of nutrition (raw food, vegetarianism, nutrition depending on blood group) and their impact on health formation. Unloading diets. Peculiarities of separate nutrition, its role in shaping human health.

**Topic 13. Diet for various diseases.**

Nutrition for chronic diseases of the stomach with normal and increased acidity, for peptic ulcer disease of the stomach and duodenum, with secretory insufficiency, for chronic inflammation of the intestines (colitis, enterocolitis). Constipation of food origin in order to strengthen the motor function of the intestines. Diet for chronic diseases of the liver and gall bladder, gout and uric acid diathesis. Principles of diet for cardiovascular pathology, kidney diseases (nephritis, pyelonephritis, pyelocystitis, etc.), diabetes.

**Topic 14. Nutrition as an element of public health.**

Public health and the importance of nutrition. The influence of nutrition on the state of population health. Individual nutrition as a component of social. National food pyramid. Food safety. Genetically modified products and organisms.

**Final control of knowledge: credit.****4. The structure of the academic discipline**

Names of topics	Number of hours				
	That's all	including			
		lectures	seminars	practical	laboratory
<b>Content module 1.</b>					

<b>Metabolic transformations in the body during pathology</b>						
Topic 1. Nutritional biochemistry. Food components	6	0	0	2	0	4
Topic 2. Biochemical aspects of the regulation of eating behavior and digestive processes	6	0	0	2	0	4
Topic 3. Carbohydrates as components of food and their role in the formation of health.	6	0	0	2	0	4
Topic 4. Lipids as components of food and their role in the formation of health	6	0	0	2	0	4
Topic 5. Proteins as components of food and their role in the formation of health	6	0	0	2	0	4
Topic 6. Water-soluble vitamins as components of human nutrition. Bioflavonoids. Nutritional supplements	6	0	0	2	0	4
Topic 7. Fat-soluble vitamins as components of human nutrition	6	0	0	2	0	4
Topic 8. Micro- and macroelements as components of human nutrition	6	0	0	2	0	4
Topic 9. Biochemical aspects of dietetics depending on age.	6	0	0	2	0	4
Topic 10. Biochemical aspects of nutrition of athletes	6	0	0	2	0	4
Topic 11. General characteristics of dietetics and dietetics	6	0	0	2	0	4
Topic 12. Peculiarities of medical and dietary nutrition in restoring health	6	0	0	2	0	4
Topic 13. Diet for various diseases	6	0	0	2	0	4

Topic 14.Nutrition as an element of public health	6	0	0	2	0	4
<i>Together according to content module 1</i>	48	0	0	16	0	32
Final control of knowledge: credit.	6	0	0	2	0	4
<i>Individual tasks</i>	0	0	0	0	0	0
<b>Only hours</b>	90	0	0	30	0	60

## 5. Topics of lectures / seminars / practical / laboratory classes

### 5.1. Topics of lectures

Lectures are not provided.

### 5.2. Topics of seminar classes

Seminar classes are not provided.

### 5.3. Topics of practical classes

No	Topic name	How many hours?
1.	Topic 1. Practical lesson 1. Anatomical and physiological basis of nutrition. Nutritional biochemistry as a science. Components of human nutrition. The needs of the human body in nutritional compounds. Essential nutrients, phytonutrients, antinutrients. Micronutrients. Nutritional value of trace elements. Nutrition of the population as a component of public health.	2
2.	Topic 2. Practical lesson 2. Biochemical basis of digestion and absorption of nutrients. Biochemical bases of regulation of human eating behavior. The concept of nutritional genomics	2
3.	Topic 3. Practical lesson 3. Biological role of carbohydrates in human nutrition. The main carbohydrate components of food. The main metabolic ways of using carbohydrates as the main source of energy. Peculiarities of carbohydrate metabolism in normal and pathological conditions	2
4.	Topic 4. Practical lesson 4. Biological role of lipids in human nutrition. The main lipid components of food. Peculiarities of lipid metabolism in normal and pathological conditions. Integrative mechanisms of functioning of $\omega$ -3 fatty acids and mitochondria. Fatty acid profile of nutrition. Unsaturated fatty acids: vital or toxic.	2
5.	Topic 5. Practical lesson 5. Biological role of proteins in human nutrition. The concept of "complete protein". Nitrogen balance in normal and pathological conditions. Metabolism of essential amino acids. Integrated index of essential amino acids. Prediction of the biological value of proteins.	2
6.	Topic 6. Practical lesson 6. Water-soluble vitamins. Distribution and daily requirement of water-soluble vitamins. Features of absorption, transportation and chemical modifications of water-soluble vitamins in the human body. Biochemical bases of vitamin interventions in correcting the functioning of the methionine cycle.	2



	Experimental contradictions in the use of vitamin preparations.	
7.	Topic 7. Practical lesson 7. Fat-soluble vitamins. Distribution and daily need of fat-soluble vitamins. Features of absorption, transportation and chemical modifications of fat-soluble vitamins in the human body. Violation of the balance of vitamins in the body.	2
8.	Topic 8. Practical lesson 8. The concept of micro- and macroelements, their biological activity. The role of the main macronutrients in human nutrition. Daily need. The role of basic trace elements in human nutrition. Daily need. Pathological conditions associated with a lack of macro- and microelements in the body. Water and drinking mode.	2
9.	Topic 9. Practical lesson 9. The role of balanced nutrition in the formation and strengthening of health'I (rational nutrition, diet, composition and calculation of the daily ration). Peculiarities of rational nutrition depending on age (children, teenagers, the elderly). Deficiencies in the nutrition of modern man.	2
10.	Topic 10. Practical lesson 10. Peculiarities of rational nutrition depending on the type of activity (people with mental work, physical work, athletes). Principles of rational nutrition. Dependence of the body's energy needs on the work performed. The role of individual chemical components of food in ensuring muscle activity. Types of diets.	2
11.	Topic 11. Practical lesson 11. Peculiarities of food preparation when dieting. Basic food products that are not used in diet therapy. Calculation of body weight, value in the conditions of diet therapy. Excess weight, causes of development, features of choosing a diet for weight loss. Types of diet therapy for overweight, meaning.	2
12.	Topic 12. Practical lesson 12. Food supplements and their impact on health'I. Diseases transmitted through food (food poisoning, dysentery, botulism, brucellosis, viral hepatitis A, trichinellosis and other helminths). Non-traditional types of nutrition (raw food, vegetarianism, nutrition depending on blood group) and their impact on health formation. Unloading diets. Peculiarities of separate nutrition, its role in shaping human health.	2
13.	Topic 13. Practical lesson 13. Nutrition for chronic diseases of the stomach with normal and increased acidity, for peptic ulcer disease of the stomach and duodenum, with secretory insufficiency, for chronic inflammation of the intestines (colitis, enterocolitis). Constipation of food origin in order to strengthen the motor function of the intestines. Diet for chronic diseases of the liver and gall bladder, gout and uric acid diathesis. Principles of diet for cardiovascular pathology, kidney diseases (nephritis, pyelonephritis, pyelocystitis, etc.), diabetes.	2
14.	Topic 14. Practical lesson 14. Public health and the importance of nutrition. The influence of nutrition on the state of population health. Individual nutrition as a component of social. National food pyramid. Food safety. Genetically modified products and organisms.	2
15.	Practical lesson 15. Final control of knowledge: credit.	2

	<b>Together</b>	<b>30</b>
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#### 5.4. Topics of laboratory classes

Laboratory classes are not provided.

### 6. Independent work of a student of higher education

No	Title of the topic / types of tasks	How many hours?
1.	Topic 1. Preparation for practical lesson 1	4
2.	Topic 2. Preparation for practical class 2	4
3.	Topic 3. Preparation for practical class 3	4
4.	Topic 4. Preparation for practical class 4	4
5.	Topic 5. Preparation for practical class 5	4
6.	Topic 6. Preparation for practical lesson 6	4
7.	Topic 7. Preparation for practical lesson 7	4
8.	Topic 8. Preparation for practical class 8	4
9.	Topic 9. Preparation for practical lesson 9	4
10.	Topic 10. Preparation for practical lesson 10	4
11.	Topic 11. Preparation for practical class 11	4
12.	Topic 12. Preparation for practical lesson 12	4
13.	Topic 13. Preparation for practical lesson 13	4
14.	Topic 14. Preparation for practical lesson 14	4
15.	Preparation for practical class 15	4
	<b>Together</b>	<b>60</b>

### 7. Teaching methods

**Practical training:** conversation, discussion of problem situations, role-playing games, practical works; solving situational problems clinical tasks, drawing up graphic schemes, writing tasks, individual control interview.

**Independent work:** independent work with recommended basic and additional literature, with electronic information resources.

### 8. Forms of control and assessment methods (including criteria for evaluating learning outcomes)

**Current control:** oral survey, testing, control of learning practical skills, solving situational clinical tasks, assessment of activity in class.

**Final control:** credit

Credit is carried out in the last class after the end of the practical classes before the beginning of the examination session

***The structure of the current assessment in the practical session:***

- Evaluation of theoretical knowledge on the subject of the lesson:
  - methods: survey, written work, solving a situational problem, solving test problems;
  - the maximum score is 5, the minimum score is 3, the unsatisfactory score is 2.
- Assessment of the acquisition of practical skills:
  - methods: methods: survey, solving a situational problem, solving test problems.

**Current assessment criteria for practical training:**

"5"	The acquirer is fluent in the material, takes an active part in discussing and solving the situational problem, knows how to determine the main biochemical indicators in biological objects and give them a medical (medical-biological) assessment.
"4"	The acquirer has a good command of the material, takes part in the discussion and solution of the situational problem, knows how to determine the main biochemical indicators in biological objects and give them a medical and biological assessment, but allows some insignificant mistakes (inaccuracies) in answering questions.
"3"	The acquirer does not have sufficient knowledge of the material, takes part in the discussion and solution of the situational problem without confidence, makes mistakes when explaining the laws of human metabolism.
"2"	The acquirer does not know the material, does not take part in the discussion and solution of the situational clinical problem, has significant gaps in the knowledge of the program material, makes fundamental mistakes when explaining the laws of human metabolism, does not have the necessary practical skills.

Credit is given to the applicant who completed all tasks of the work program of the academic discipline, took an active part in practical classes, completed and defended an individual assignment and has an average current grade of at least 3.0 and has no academic debt.

Test is carried out: at the last lesson before the beginning of the examination session - with the tape system of learning, at the last lesson - with the cyclical system of learning. The credit score is the arithmetic mean of all components on a traditional four-point scale and has a value that is rounded using the statistical method with two decimal places after the decimal point.

**9. Distribution of points received by applicants of higher education**

The obtained average score for the academic discipline for applicants who have successfully mastered the work program of the academic discipline is converted from a traditional four-point scale to points on a 200-point scale, as shown in the table:

**Conversion table of a traditional assessment into a multi-point scale**

<b>Traditional four-point scale</b>	<b>Multipoint 200-point scale</b>
Excellent ("5")	185 - 200
Good ("4")	151 - 184
Satisfactory ("3")	120-150
Unsatisfactory ("2")	Below 120

A multi-point scale (200-point scale) characterizes the actual success of each applicant in learning the educational component. The conversion of the traditional grade (average score for the academic discipline) into a 200-point grade is performed by the information and technical department of the University.

According to the obtained points on a 200-point scale, the achievements of the applicants are evaluated according to the ECTS rating scale. Further ranking according to the ECTS rating scale allows you to evaluate the achievements of applicants from the educational component who are studying in the same course of the same specialty, according to the points they received.

The ECTS scale is a relative-comparative rating, which establishes the applicant's belonging to the group of better or worse among the reference group of fellow applicants (faculty, specialty). An "A" grade on the ECTS scale cannot be equal to an "excellent" grade, a "B" grade

to a "good" grade, etc. When converting from a multi-point scale, the limits of grades "A", "B", "C", "D", "E" according to the ECTS scale do not coincide with the limits of grades "5", "4", "3" according to the traditional scale. Acquirers who have received grades of "FX" and "F" ("2") are not included in the list of ranked acquirers. The grade "FX" is awarded to applicants who have obtained the minimum number of points for the current learning activity, but who have not passed the final examination. A grade of "F" is assigned to applicants who have attended all classes in the discipline, but have not achieved a grade point average (3.00) for the current academic activity and are not admitted to the final examination.

Applicants who study in one course (one specialty), based on the number of points scored in the discipline, are ranked on the ECTS scale as follows:

#### **Conversion of the traditional grade from the discipline and the sum of points on the ECTS scale**

<b>Evaluation on the ECTS scale</b>	<b>Statistical indicator</b>
A	Top 10% achievers
B	The next 25% of earners
C	The next 30% of earners
D	The next 25% of earners
E	The next 10% of earners

### **10. Methodological support**

- Working program in the discipline
- Syllabus
- Methodological recommendations for the practical classes in the discipline
- Methodological recommendations for the individual work of higher education applicants
- Multimedia presentations
- Situational tasks
- Tests on the theme

### **11. Questions for preparing for the final control**

- Creation of schemes: mechanism of digestion in different parts of the gastrointestinal tract.
- Creation of schemes: the content of necessary substances in the daily diet;
- Create a scheme: nutritional features, depending on blood groups.
- Create a scheme: causes contributing to the development of diseases of the digestive organs.
- Create a scheme: types of detoxification and body cleansing systems.
- Create a scheme: principles of rational nutrition.

### **12. Recommended literature**

1. Gubsky Yu.I., I.V. Nizhenkovska, Korda M.M. Biological and Bioorganic Chemistry: in 2 books. Book 2. Biological Chemistry: textbook. 2021. 544 p.
2. Satyanarayana U. Biochemistry. 5th edition. India 2020. 777 p.
3. Lehninger. Principles of Biochemistry. 7th edition. NY, United States. 2017.
4. Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto. Biochemistry. 8th Revised edition. 2015.
5. Lippincott Illustrated Reviews: Biochemistry. Philadelphia :Wolters Kluwer, 2017. 560 p.
6. Baynes J., Dominiczak M. Medical Biochemistry. 5th Edition. Elsevier, 2018. 712 p.

7. Olivia Vanbergen, Gareth Wintle, Marek H. Dominiczak. Crash Course Metabolism and Nutrition. 5th Edition. Elsevier. 2019.
8. Carol Byrd-Bredbenner. Wardlaw's Perspectives in Nutrition 11 Edition. McGraw-Hill Education. 2019.

### **13. Electronic information resources**

1. <https://info.odmu.edu.ua/chair/biology/>- materials of the Department of Medical Biology and Chemistry
2. <http://libblog.odmu.edu.ua/> - ONMedU library
3. <https://moodle.odmu.edu.ua/login/index.php> - system of electronic testing and electronic journal of ONMedU
4. <http://moz.gov.ua> – Ministry of Health of Ukraine
5. [www.who.int](http://www.who.int) – World Health Organization
6. [www.dec.gov.ua/mtd/home/](http://www.dec.gov.ua/mtd/home/) - State Expert Center of the Ministry of Health of Ukraine
7. <http://bma.org.uk> – British Medical Association
8. [www.gmc-uk.org](http://www.gmc-uk.org) - General Medical Council (GMC)
9. [www.bundesaerztekammer.de](http://www.bundesaerztekammer.de) – German Medical Association