NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of physiology, biochemistry of plants and bioenergetics

"**APPROVED**"
Dean of Faculty of Plant Protection,
Biotechnology and Ecology
_____ Kolomiets Yu.V.
"_____"_____2021

"**REVIEWED**"
on the meeting of physiology, biochemistry of plants
and bioenergetics department
Protocol № __ from «__» ___ 2021
Head of Department
_____ Prylutska S.V.

"**REVIEWED**"
Guarantor EO 202 «Plant protection and quarantine»
Kliachenko O.L.
Guarantor EO _____

WORKING PROGRAM OF EDUCATIONAL DISCIPLINE

OBJECTS OF BIOTECHNOLOGICAL RESEARCH

specialty 162 Biotechnology and bioenergetic
educational program Biotechnology and bioenergetic
Faculty of Plant Protection, Biotechnology and Ecology
Developers: docent, Ph.D. Babytskiy A.I., docent PhD Drozd P.Yu.

Kyiv – 2021

1. **Description of the course**

«OBJECTS OF BIOTECHNOLOGICAL RESEARCH»

Branch of knowledge, training direction, specialty, education level		
Branch of knowledge	162 «Biotechnology and bioenergetic»	
Specialty	«Biotechnology and bioenergetic»	
Educational qualification	Bachelor	
Characteristics of the course		
Type	Normative	
Total number of hours	150	
Number of credits ECTS	5	
Number of content modules	5	
Form of control	Exam	
Indicators of the course for full-time education and correspondence form of training		
	full-time education	correspondence form of training
Year of preparation	2	
Semester	3–4	
Lectures	75 hours	
Practical, seminars	-	
Laboratory sessions	30 hours	
Independent work	45 hours	
Individual work	-	
Number of weekly hours for full-time: auditory independent work of student	 2,5 hours 1,5 hours	

2. The purpose and objectives of the course

The purpose of studying the principles of biotechnological processes technologies, technical tools that provide them, and how to determine the main parameters of the raw materials and products of biotechnological processes.

Objectives to give deep knowledge of the principles and processes of the theory of business processes and technological adjustment of basic parameters for controlling bioprocesses that are necessary for their highly efficient use in agricultural production, research aimed at improving existing and developing new technical solutions.

Following the completion of the course the student should

know:

- Chemical, physical, physical-chemical, biochemical, physiological bases of biotechnological processes;
- Basic processes, technological regimes, technical equipment production biotech industries;
- Basic types and characteristics of source objects biotechnology;
- The rules and standards of control and accounting of biotechnology;
- Environmental issues, the basic safety requirements during manufacturing processes and production testing;
- The basis of scientific and technological foundations of professional production management;
- Basic design principles biotechnology industries;
- Methods and means of research aimed at the development of agriculture and related industries.

be able to:

- Plan and organize processes, to choose optimal conditions implementation biotechnologies and manage them according to modern methods of control of manufacturing operations and finished products;
- Design production according to the requirements of safety, labor protection and civil defense;
- Identify problems biotechnological industries and to ensure their removal together with specialists of compatible industries (electricity, experts on the TRC and A, mechanics, plumbers, etc.);
- Formulate objectives to develop new and improve existing biotechnology and process equipment for its implementation as necessary with due regard for the commercial effect;
- Conduct scientific, theoretical and experimental research by fundamentals and regulations using computer technology software and simulation;
- To create appropriate creative and psychologically favorable atmosphere in the team for the successful solution of the task.

Acquisition of competencies:

general competencies (GC):

Ability to apply knowledge in practical situations.

professional (special) competencies (PC):

загальні компетентності (ЗК):

Ability to learn and master modern knowledge.

Ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, techniques and technologies. active recreation and a healthy lifestyle.

фахові (спеціальні) компетентності (ФК):

Ability to analyze regulatory documentation required to ensure engineering activities in the field of biotechnology.

Ability to work with biological agents used in biotechnological processes (microorganisms, fungi, plants, animals, viruses, their individual components).

3. The program and structure of the course

Structure of the course

Names of content modules and topics	Number of hours												
	full-time education							correspondence form of training					
	weeks	total	included					total	included				
			lec	prac	lab.	ind.	in.w.		lec	prac	lab.	ind.	in.w.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Module 1 «Diversity Of Biotechnological Production Facilities»													
1. Subject, purpose and objectives of the course objects of biotechnological productions.	1	6	2				4						
2. Technological classification and principles of selection of producers of target substances.	2	9	2		3		4						
3. Bacteria as producers of target substances.	3	9	2		3		4						
4. Viruses and plasmids as objects of biotechnological research.	4	6	2				4						
5. Fungi and fungal organisms as objects of biotechnological production.	5	8	2		2		4						
6. Plant and animal tissues as objects of biotechnological research.	6	5	2				3						
Total hours:		**43**	**12**		**8**		**23**						
Module 2. Physiological Processes as the Objects of Biotechnological Production													
7. General concept of biological processes in biotechnology. Specialized enzymatic processes.	7	5	2		3								
8. Enzymatic catalysis, protein	8	6	2				4						

synthesis and regulation.													
9. Alcohol fermentation.	9	6	2				4						
10. Lactic fermentation.	10-11	8	4				4						
11. Butyric fermentation.	12	8	2		2		4						
12. Propionic fermentation.	13	6	2				4						
13. Acetic acid, citric acid and methane fermentation.	14-15	10	4		2		4						
Total hours:		**49**	**18**		**7**		**24**						
Module 3. Morphological organization of plant organisms													
14. Morphological structure of the shoot.	1	6	2				3						
15. Morphological structure and variety of buds and stems.	1	5	2		3								
16. Morphological structure of leaves. Metamorphosis of leaves.	2	7	2		2		3						
17. Morphological structure and metamorphosis of the root.	3	5	2				3						
18. Features of morphological organization of a flower.	3	5	2				3						
19. Morphological diversity of inflorescences.	4	5	2				3						
20. Morphological diversity of seeds and fruits.	5	4	2		2								
Total hours:		**37**	**14**		**7**		**15**						
Module 4. Anatomical structure of plant objects of biotechnological productions													
21. Meristematic and integumentary tissues.	5	5	2				3						
22. Basic, mechanical and conductive tissues.	6	5	2				3						
23. Excretory structures.	7	4	2		2								
24. Anatomical	7	7	4				3						

structure of the stem													
25. Anatomical structure of the leaf and root.	8	8	2				6						
26. Anatomy of generative organs.	9	7	5		2								
Total hours:		**36**	**17**		**4**		**15**						
Module 5. Systematic diversity of plant objects of biotechnological productions													
27. Bryophytes.	9	5	2				3						
28. Lycopsids.	10	5	2				3						
29. Equisetophyts.	11	5	2				3						
30. Polypodiophyts.	12	5	2				3						
31. Gymnosperms.	13	4	2		2								
32. Angiosperms. Class Dicotyledons.	14	5	2				3						
33. Angiosperms. Class Monocotyledons.	15	4	2		2								
Total hours:		**33**	**14**		**4**		**15**						
The total number of hours::	**30**	**150**	**75**		**30**		**92**						

4. Topics of seminars

№	Topic title	Number of hours
1	Not provided in working curriculum	

5. Topics of practical training

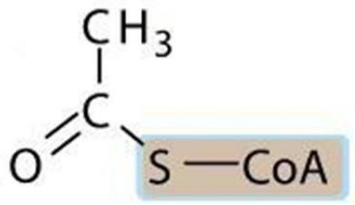
№	Topic title	Number of hours
1	Not provided in working curriculum	

6. Topics of laboratory work

№	Topic title	Number of hours
1	Laboratory rules and biotechnological facilities that determine alcohol fermentation/	3
2	Biotechnological objects that cause lactic acid fermentation.	2
3	Morphological features and variety of shoots and their constituent organs.	2
4	Morphological features and diversity of roots, their metamorphoses and modified shoots.	2
5	Morphological features of generative organs of plants.	2
6	Peculiarities of butyric acid fermentation and biotechnological objects that determine it.	2
7	Peculiarities of acetic fermentation and biotechnological objects that cause it.	2
8	Morphological features and variety of shoots and their constituent organs.	3
9	Morphological features and diversity of roots, their metamorphoses and modified shoots.	2
10	Morphological features and generative organs of plants.	2
11	Features of anatomical organization of plant tissues and excretory structures.	2
12	Anatomical structure of vegetative organs of plants	2
13	The spore plants diversity.	2
14	The seed plants diversity.	2

7. Control questions, sets of tests to determine the level of knowledge acquisition by students

NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE			
EL _Bachelor___ **Training direction / Specialty** ____Biotechnology__	**Department** Physiology, biochemistry of plants and bioenergetics 2021-2022 acad. year	**TEST PAPER № 1 of discipline** Objects of Biotechnological Investigations	**Approved** Head of Department _____ (sign) Prylutska S.V. _____2020

Exam questions	
1. General concept of biotechnological research objects. Subject, purpose and objectives of the course.	
2. Metabolic pathway of propionic fermentation, leading to the formation of acetic acid. Conditions, chemistry and energy, application.	
Test tasks of different types	
1. The formula of which compound is shown in the figure?	
1.	Butyryl-CoA
2.	Succinyl-CoA
3.	Acetyl-CoA
4.	Acyl-CoA
2. What microorganisms are called industrial?	
1	Those that have found application in industry.
2	A group of well-studied microorganisms that serve as model objects for the study of fundamental biological processes.
3	Those that are defined as safe.
4	Widely involved in biotechnology production.
3. How many molecules of ATP are formed from one molecule of glucose as a result of homofermentative lactic acid fermentation?	
1	1
2	2
3	3
4	4
4. How many molecules of ATP are formed from one molecule of glucose as a result of acetic fermentation?	
1	1
2	2
3	3
4	4
5. How many substrate phosphorylation reactions in alcoholic fermentation?	
1	1

2	2
3	3
4	4
6. Which of the following cycles can begin pentose phosphate?	
1	Lactic acid homofermentative fermentation
2	Lactic acid heterofermentative fermentation
3	Butyric fermentation
4	Propionic fermentation
7. What is the name of the reaction that results in the stereoscopic movement of groups inside a compound that touches two carbon atoms in the structure of its carbon skeleton??	
1	Epimerization
2	Ligations
3	Restrictions
4	Isomerization
8. What enzymes provide the process of retroinhibition?	
1	Active
2	Allosteric
3	Constitutive
4	Inducible
9. What is the slow way of regulating biochemical reactions in the cell?	
1	In changing the catalytic activity of enzyme molecules.
2	In changing the rate of enzyme synthesis.
3	In the extensification of metabolism
4	In lowering the ambient temperature.
10. Choose the correct statement for methane fermentation.	
1	This is a metabolic pathway of dissimilation
2	This is a metabolic pathway of assimilation
3	This is an anabolic cycle of bacterial metabolism
4	This is a biotechnological method

_____ (_____Babytskiy A.I._____)

(sign) (last name and initials of SPE)

8. Teaching methods

Success depends on training in general internal activity of students on the nature of their activities, it is the nature of the activity, the degree of autonomy and creativity should be important criteria in choosing a method.

Explanatory, illustrative technique. Students acquire knowledge by listening to the story, lecture on educational or instructional materials through screen guide in "ready" form. Perceiving and interpreting the facts, evaluations, conclusions, they remain within the reproductive (reproduction) thinking. This method is used to transfer the widest possible array of significant information. It can be used to express facts and learning approaches, assessment, conclusions.

The reproductive method. This refers to the application on the basis of the sample studied or regulations. Activities of trainees is algorithmic, ie with the instructions, orders, rules - in the present sample of similar situations.

The method of problem statement. Using any sources and means teacher before teaching material, poses the problem, formulating cognitive task, and then opening the system proofs, comparing views, different approaches, shows the way to solve the problem. Students are like witnesses and accomplices scientific research.

Partly retrieval or heuristic method. Its essence - in finding solutions for the organization of nominated teacher (or self-contained) or cognitive tasks under the supervision of a teacher or heuristic-based programs and guidance. The process of thinking becomes productive character, but it gradually directs and supervises the teacher or students themselves based on the work programs (including the computer) and manuals. This method is one form of which is heuristic conversation - a proven way to enhance thinking, motivation to cognition.

The research method. After reviewing the material, production problems and objectives and short oral or written instruction of those who teach self-study literature sources are monitoring and measurements and performing other search action. The initiative, independence, creativity found in research activities fully. Methods of academic work directly pass into the methods that mimic and sometimes implement scientific research.

9. Forms of control

Control of knowledge and skills of students (current and final) with exercise discipline according to credit-modular system of educational process. Rating assimilation of student discipline is determined by the 100 point scale. It consists of rating of educational work, for which the assessment is assigned 70 points and ranking of certification (exam) - 30 points.

Criteria for evaluation of the level of knowledge in laboratory and workshops. At the laboratory classes each student for each topic takes individual task. Level of knowledge estimates "excellent" - the student gives vycherpni, grounded theoretically i almost right answers to no less than 90% of the questions, problems and decisions correct Laboratory exercises demonstrating knowledge

textbooks, manuals, instructions, generalization holds i findings, gently draws problem was Those present at the lecture, a compendium of essays or lectures on the main themes of the course; "Good" - when a student possesses knowledge of the material, but allows insignificant errors in formation terminiv, categories i calculations, but with the help of a teacher i locates quickly orients and give correct answers was to lecture are present, a compendium of essays or lectures on the main themes of the course; "Satisfactory" - the student gives the correct answer is not less than 60% of the questions or the question is not all grounded, inexhaustible answer, allows rough mistakes, which corrects the help of a teacher. This takes into account the presence of compendium on the topic objectives and individual; “Non- Satisfactory” with the possibility of re-drafting" - the student gives the correct answer is not less than 35% of issues or questions on all makes nongrounded, inexhaustible answer, allows rough errors. Has a partial outline of lectures.

Result (overall evaluation) course discipline. Is the amount of rating estimations (points) obtained by separate estimation forms of educational activity: current and result test level holding of theoretical material during classroom and work independently (control module); evaluation (points) for laboratory research. Final result exposed after a full evaluation of learning discipline, which is derived as the sum of intermediate evaluations for content modules. The final evaluation of the level of knowledge consists of rating of educational work, for which the assessment is assigned 70 points and ranking of certification (exam) - 30 points.

10. Distribution of the points that get students

Assessment of student knowledge is on a 100-point scale and is translated into national assessments according to table. 1 "Regulations on examinations and tests in NULES of Ukraine" (order of entry into force of 27.12.2019 № 1371).

Student rating, points	**The assessment is national for the results of passing**	
	exams	**credits**
90-100	**Excellent**	**Credited**
74-89	**Good**	
60-73	**Satisfactorily**	
0-59	**Non-Satisfactorily**	**Non-Credited**

To determine the rating of the student (listener) for mastering the discipline $\mathbf{R_{DIS}}$ (up to 100 points), the obtained rating for certification (up to 30 points) is added to the rating of the student (listener) for the educational work of the **Rew** (up to 70 points):

$$\mathbf{R_{DIS} = Rew + R_{AT}}$$

11. Methodical maintenance

Scientific methods of teaching includes: state educational standards, curricula and training programs for all standard and optional subjects; program of educational, industrial and other practices; textbooks and teaching aids; instructional and teaching materials for seminars, practical and laboratory lessons; individual educational and research objectives; tests; text and electronic versions of tests for current and final control, teaching materials for the students individual work.

12. Recommended Literature

Basical

1. Ніколайчук В.І. Генетична інженерія / В.І. Ніколайчук, І.Ю. Горбатенко. - Ужгород, 1999.- 101 с.
2. Рудишин С.Д. Основи біотехнології рослин. Підручник для вищих аграрних закладів. – Вінниця, 1998. – 234 с.
3. Векірчик К. М. Мікробіологія з основами вірусології / Векірчик К. М. –К. : Либідь, 2001. – 312с.
4. Дикий И. Л. Мікробіологія / Дикий И. Л. – К. : Видавничий дім “Професіонал”, 2007. – 624с.
5. Ситник І. О. Мікробіологія, вірусологія, імунологія / І. О. Ситник, С. І.Климнюк., М. С. Творко. – Тернопіль : ТДМУ, 2009. – 392 с.
6. Каплін, М. М. Практикум до практичних занять з мікробіології,вірусології та імунології / Ч.1 : Загальна бактеріологія та імунологія / М.М. Каплін, В. М. Голубнича, Т. В. Івахнюк. – Суми : СумДУ, 2013. – 157с. – 79-85.
7. Ткачук О. О. Основи мікробіології та інфекційних хвороб / О. О Ткачук,О. Л. Завальнюк. – Вінниця. – 2013. – 152 с.
8. Molecular biology of plant viruses/ Ed. by C.L.Mandahar. – Kluver Academic Rublisher, USA. – 28 1p.
9. Гудзь С.П., Перетятко Т.Б., Павлова Ю.О. Загальна вірусологія. Л.: Видавництво: Видавничий центр ЛНУ ім. Івана Франка, 2010. – 264 с.
10. Ткаченко Н.М., Сербін А.Г. Ботаніка. - Харків: Основа, 1997. – С. 40-70.
11. Сербін А.Г., Сіра Л.М., Слободянюк Т.О. Фармацевтична ботаніка. Підручник. – Вінниця: Нова книга, 2007. – С. 41-57.
12. Нечитайло В.А., Кучерява Л.Ф. Ботаніка. Вищі рослини. - К.: Фітосоціо-центр. - 2000. – С. 10-21, 27-36.
13. Хржановский В.Г., Пономаренко С.Ф. Ботаніка. - К.: Вища школа, 1985. – С. 10-35, 47-61.

Auxiliary

1. Векірчик К. М. Практикум з мікробіології / К. М. Векірчик – К. : Либідь,2001. – 144с.

2. Громов Б. В. Экология бактерий / Б. В. Громов, Г. В. Павленко. – Л. : Изд-во ЛТУ, 1989.– 248с.
3. Люта В. А. Практикум з мікробіології: навчальний посібник / В. А. Люта,О. В. Кононов. – К. : Медицина, 2008. – 184 с.
4. Словник по мікробіології, вірусології, імунології та інфекційних хвороб /[Під ред. Палія Т. К.]. – Вінниця: Б.в. 1995. – 109 с.
5. Стеблянко М.І., Гончарова К.Д., Закорко Н.Г. Ботаніка: анатомія і морфологія рослин. - К.: Вища школа, 1995. – 384 с.
6. Липа О.Л., Добровольський І.А. Ботаніка. – К.: Вища школа, 1985. – 375 с.
7. Брайон О.В., Чикаленко В.Г. Анатомія рослин: Підручник. - К.: Вища школа, 1992. – 272 с.

15. Information Resources

1. Спиртове бродіння https://cutt.ly/ytW8Gx9
2. Молочнокисле бродіння https://cutt.ly/NtW8H4o
3. Метанове бродіння https://cutt.ly/BtW8KEL
4. Пропіоновокисле бродіння https://cutt.ly/XtW8KHH
5. Маслянокисле бродіння https://cutt.ly/TtW8Zgo
6. Лимоннокисле бродіння https://cutt.ly/AtW8XLq

Content module 1. «Diversity Of Biotechnological Production Facilities».

The lectere theme 1. Subject, purpose and objectives of the course objects of biotechnological productions.

Object and subject, purpose and tasks of the course are objects of biotechnological productions. The value of the course in the training of biotechnologists. Connection of the course with other biological sciences and academic disciplines.

Research methods of biotechnological production facilities.

History of the course development of objects of biotechnological productions as an independent branch of knowledge. Historical stages of formation of the course. The contribution of foreign and domestic scientists to the development of the theory of biotechnological industries. Studies by L. Pasteur, F. Crick and D. Watson, etc.

Course structure and general concept of biotechnological production objects: biological systems of different levels of organization and metabolic processes used to obtain target substances in biotechnology.

The lectere theme 2. Technological classification and principles of selection of producers of target substances.

The concept of biotech production facilities. Obtaining a pure culture of microorganisms and microbiological synthesis. Industrial, non-industrial and GRAS microorganisms. Criteria for selection of microorganisms for

biotechnological production. Groups into which biotech production facilities are divided.

Selection of microorganisms. Methods of selection and subsequent cultivation of the most productive strains of microorganisms. Creation of highly efficient strains by induced mutagenesis.

The lectere theme 3. Bacteria as producers of target substances.

Principles of bacterial classification and their biotechnologically promising groups. The most common representatives of bacteria in biotechnology are Gracilicutes, Firmicutes, Tenericutes and Mendosicutes. Escherichia coli (Escherichia coli T. Escherich, 1885), Escherichia coli Lactobacillus delbrueckii subsp. bulgaricus (Orla-Jensen 1919) Weiss et al. 1984, Lactobacillus casei (Orla-Jensen 1916) Hansen & Lessel 1971, Lactobacillus fermentum Beijerinck 1901, Acidophilus bacillus Lactobacillus acidophilus (Moro 1900) Hansen & Mocquot 1970, Lactic acid streptococcus Streptococcus salivarius Andrewescophy 190 Roselocolocy Staphylococcus 190 and other.

The lectere theme 4. Viruses and plasmids as objects of biotechnological research.

General concept of transduction and its significance for biotechnological use of viruses and plasmids. Biotechnological objects used as vectors are viruses, plasmids and phasmids. Types of plasmids. The most common viruses in biotechnology - Adenoviruses, Herpesviruses, Retroviruses, Adeno-associated virus, SV40 virus, Bacteriophages.

The lectere theme 5. Fungi and fungal organisms as objects of biotechnological production.

Representatives of fungi and fungal organisms in biotechnology. Penicillum golden. Penicillum Roquefort. Penicillum camemberti. Aspergillus is black. Aspergillus oryzae. Brewer's or baker's yeast. Torulaspora delbrueckii. Brettanomyces bruxellensise. Candida stellata. Schizosaccharomyces pombe. Zygosaccharomyces bailii. Surface cultivation of molds. Obtaining mycelium for the cultivation of macromycetes.

The lectere theme 6. Plant and animal tissues as objects of biotechnological research.

Plant biosystems in biotechnological productions. Molecular level of organization of plant biosystems. Cellular level of organization of plant biosystems. Tissue level of plant biosystems organization. Organ level of organization of plant biosystems. Organismal level of organization of plant biosystems. Animal organisms in biotechnology. Germ cell fusion and embryo production in vitro. Cloning of organisms by transplantation of somatic cell nuclei. Obtaining monoclonal antibodies. Cultivation of animal cells to obtain other target products. Features of culturing animal cells.

Content module 3. «Physiological Processes As Objects Of Biotechnological Production».

The lectere theme 1. General concept of biological processes in biotechnology. Specialized enzymatic processes.

General concept of biological process. Types of processes. Specialized enzymatic processes. Anaerobic processes. Alcohol, lactic acid, propionic acid and butyric acid fermentation. Solid phase processes. Surface and deep processes, processes with mixing. Gas-phase processes.

The lectere theme 2. Enzymatic catalysis, protein synthesis and regulation.

Proteins. Their structure, structure and synthesis. Levels of structural organization of proteins: primary, secondary, tertiary and quaternary structures. Denaturation and renaturation of protein molecules. Separation of proteins by structure and physical and chemical properties. Structure of ribosomes, their role in the synthesis of polypeptide chains. The concept of translation and its stages: initiation, elongation, termination. The concept of enzymes. Division of enzymes into classes. Stages of enzymatic catalysis. Hand-glove model. Regulation of matrix syntheses. Repression and induction, operon model. Retroinhibition and allosteric enzymes. Mechanisms of regulation of microorganism metabolism activity. Retroinhibition.

The lectere theme 3. Alcohol fermentation.

The general concept of alcoholic fermentation. History of the discovery. Pathogens. Features of metabolism. Chemistry of alcohol fermentation. Glycolytic cleavage of the glucose molecule to pyruvic acid and the way of its conversion into ethyl alcohol. Energy yield of alcohol fermentation. The use of alcoholic fermentation. Production of alcoholic beverages. Bakery. Biofuel production. Glycerol production.

The lectere theme 4. Lactic fermentation.

The general concept of lactic acid fermentation. History of the discovery. Pathogens. Features of metabolism. Types of lactic acid fermentation. Homofermentative lactic fermentation. Pathogens. Features of metabolism. Chemistry of homoenzymatic lactic acid fermentation. Glycolytic cleavage of the glucose molecule to pyruvic acid. Conversion of pyruvate to lactic acid. Energy yield of homoenzymatic lactic acid fermentation. Heteroenzymatic lactic fermentation. Pathogens. Features of metabolism. Chemistry of heteroenzymatic lactic acid fermentation. Acetyl-CoA conversion pathways, energy and products of this type of lactic acid fermentation. Application of lactic acid fermentation in biotechnological productions.

The lectere theme 5. Butyric fermentation.

The general concept of butyric fermentation. History of the discovery. Pathogens. Features of metabolism. Chemistry of butyric fermentation. Glycolytic cleavage of the glucose molecule to pyruvic acid. The first metabolic pathway of butyric acid fermentation, which leads to the formation of acetic acid. Its chemistry and energy. The second metabolic pathway of butyric acid fermentation, which leads to the formation of butyric acid. Its chemistry and energy. Alternative ways to convert pyruvic acid in butyric acid fermentation that do not form acids: acetone-butyl, ethyl and isopropanoic. Their chemistry and energy. Application of

butyric fermentation in biotechnological productions. Discovery of Chaim Weizmann. Negative value of butyric fermentation.

The lectere theme 6. Propionic fermentation.

The general concept of propionic acid fermentation. History of the discovery. Pathogens. Features of metabolism. Chemistry of propionic acid fermentation. Conversion of lactic acid into pyruvic acid and synthesis of propionate. Decarboxylation of pyruvate and acetate synthesis. Energy and products of propionic acid fermentation. Application of propionic acid fermentation in biotechnological productions, in particular for production of Swiss cheeses and industrial production of vitamin B_{12}.

The lectere theme 7. Acetic acid, citric acid and methane fermentation.

Peculiarities of acetic acid fermentation and its significance for biotechnological productions. History of the discovery. Pathogens. Features of metabolism. Industrial production of vinegar. Peculiarities of citric acid fermentation and its significance for biotechnological productions. History of the discovery. Pathogens. Features of metabolism. Industrial production of citric acid. Features of methane fermentation and its significance for biotechnological industries. History of the discovery. Pathogens. Features of metabolism. Hydrolysis (acetogenic), homoacetate and methanogenic bacteria. Stages of methane fermentation. Hydrolysis. Acidogenesis. Acetogenesis. Methanogenesis. Biotechnological production of biogas and utilization of organic waste.

Content module 3. Morphological Features Of Plant Objects Of Biotechnological Productions

The lectere theme 1. Morphological structure of the shoot.

The general concept of the shoot. Metamerism of the shoot. Classification of shoots. Main and side shoots. Vegetative, generative, reproductive and mixed shoots. Orthotropic, plagiotropic and heterotropic shoots. Types of branching shoots. Dichotomous, monopodial and sympodial branching. Growth and development of the shoot.

The lectere theme 2. Morphological structure and variety of buds and stems.

The general concept of the kidney. Classification of kidneys. General characteristics of the stem and its function. Stem metamorphosis. Thorns. Areolas. Whiskers. Philocladia (cladophiles). Cladodes. Philodia. Shoots of succulents. Head. Overhead stolons (whips). Mustache. Wooden stems. Caudex (stem root). Rhizome. Bulb. Bulbocibulina. Tuber. Underground stolons.

The lectere theme 3. Morphological structure of leaves. Metamorphosis of leaves.

The general concept of a leaf and its structure. Abaxial and adaxial leaf surfaces. Leaf blade, petiole and stipules. Veining of leaves: simple, dichotomous,

reticulate, parallel and arcuate. Types of leaves. Simple and complex leaves. Leaf series and formations. Leaf placement. Functions of leaves.

The lectere theme 4. Morphological structure and metamorphosis of the root.

The general concept of the root and its functions. Morphological and genetic zones of the young root. Types of roots and root systems. Metamorphoses of roots. Storage roots. Stilt roots. Aerial roots. Board-shaped roots. Respiratory roots, or pneumatophores. Retracting or contractile (contractile) roots. Roots-hooks. Assimilation roots. Sucker roots or haustoria. Root sprouts. Mycorrhiza. Bacteriosis.

The lectere theme 5. Features of morphological organization of a flower.

General concept of a flower and its structure. Perianth. Cup and podchasha. Corolla. The generative part of the flower. Androcey. Gynoecium. Syncarpous, apocarpous, cenocarpous, paracarpous and lysicarpous gynoecium. Types of flowers. Actinomorphic, zygomorphic and asymmetric flowers. Formulas and diagrams of flowers.

The lectere theme 6. Morphological diversity of inflorescences.

The general concept of flower arrangement. Types of flowers by position on the shoots. Types of inflorescences. Monopodial and sympodial. Simple and complex inflorescences. Tassel. Ear. Beginning. Circle (umbrella). Shield. Head. Basket. Monochasium. Dichasium. Pleiochasium. Mixed thyroid inflorescences.

The lectere theme 7. Morphological diversity of seeds and fruits.

General concept and structure of seeds. General concept and structure of the fetus. Parthenocarpy. Fruit classification. Dry and juicy fruits. Leaf. Bean. Pod. Pods. Small box. Nut. Nut. Achene. Zernivka. Samara. Berry. Bone Apple. Pumpkin. Orange (hesperidia). Garnet. Banana. Ways of fruit distribution. Anemochoria Zoochoria. Hydrochoria. Autochoria.

Content module 4. Anatomical structure of plant objects of biotechnological productions

The lectere theme 1. Meristematic and integumentary tissues.

General concept and classification of plant tissues. Meristematic tissues. Primary and secondary meristems. Apical, lateral, intercalary and wound meristems. Integumentary tissues. External and internal. Epidermis. Epiblem. Endoderm and exoderm. Periderm. Crust.

The lectere theme 2. Basic, mechanical and conductive tissues.

Basic tissues. Core parenchyma. Mesophile. Storage parenchyma. Hydroparenchyma. Aerenchyma. Absorbent parenchyma. Mechanical (reinforcing)

fabrics. Sclerenchyma. Collenchyma. Bast fibers and libriforms. Scleroids. Conductive fabrics. Xylem. Phloem.

The lectere theme 3. Excretory structures..

External secretory structures. Trichomes (secretory hairs). Salt hairs. Salt glands. Nectaries (floral, extrafloral, septal). Osmophores. Hydatodes (water stomata). Internal secretory structures. Idioblasts. Secretory containers. Milk vessels (milkmen).

The lectere theme 4. Anatomical structure of the stem.

The structure of the apex and stem growth. Primary stem structure. Types of leading beams. Stellar theory. Secondary structure of the stem.

The lectere theme 5. Anatomical structure of the leaf and root.

Histological elements of the leaves. Types of anatomical organization of leaves. Root apex structure and primary root structure of monocotyledonous and dicotyledonous plants. Secondary structure of the root of dicotyledonous plants.

The lectere theme 6. Anatomy of generative organs.

Modern views on the evolution of the flower. The concept of gametophyte and sporophyte. Sexual reproduction of gymnosperms. Double fertilization and sexual process in angiosperms. Embryo development of angiosperms. Forms of plant pollination.

Content module 5. Systematic diversity of plant objects of biotechnological productions.

The lectere theme 1. Bryophytes.

General characteristics of mosses. Department of Anthocerotophyta (Anthocerotophyta). Department of Marchantiophyta. Department of Leaf Stem Moss, or Moss (Bryophyta).

The lectere theme 2. Lycopsids.

eneral characteristics of the Rhyniophyta department. Order Rhyniales. Order Psilophytales. General characteristics of the department Rhyniophyta, taxonomy and representatives. General characteristics of the department Zosterophyllophyta (Zosterophyllophyta), systematics and representatives. General characteristics of plaunoids (Lycopodiophyta). Class Plaunovidnye, or Lycopodiopsida (Lycopodiopsida). Class Molodylnikovidny, or Isoetopsida (Isoetopsida).

The lectere theme 3. Equisetophyts.

General characteristics of the department Psilotophyta. General characteristics of the division Equisetophyta. Hyenopsida. Wedge-shaped (Sphenophyllopsida). Horsetail (Equisetopsida). Order Calamitales. Horsetail (Equisetopsida). Order Horsetail (Equisetales).

The lectere theme 4. Polypodiophyts.

General characteristics of the division Ferns (Polypodiophyta). Class Aneurophytopsida. Class Archaeopteridopsida. Class Cladoxylopsida. Class Zygopteridopsida. Class Ophioglossopsida. Class Marathioids (Marathiopsida). Class Ferns (Polypodiopsida). Subclass Polypodiidae. Subclass Marsileidae. Subclass Salviniidae.

The lectere theme 5. Gymnosperms.

General characteristics of the division Pinophyta. Class Seed Ferns, or Lipnopteridopsida (Lyginopteridopsida). Class Cycadopsida. Class Bennettitopsida. Class Gnetopsida. Class Ginkgopsida. Class Pine (Pinopsida).

The lectere theme 6. Angiosperms. Class Dicotyledons.

Division of Angiosperms (Magnoliophyta). Class Dicotyledons (Magnoliopsida). Subclass Magnoliidae. Subclass Ranunculiidae. Subclass Hamamelididae. Subclass Caryophyllidae. Subclass Dilleniidae. Subclass Rosidae. Subclass Lamiidae. Subclass Asteridae.

The lectere theme 7. Angiosperms. Class Monocotyledons.

Division of Angiosperms (Magnoliophyta). Class Monocotyledons (Liliopsida). Subclass Liliadae. Order Liliales. Family Liliaceae.