

**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»

**Pikovskii M.I.**  
Guarantor EO \_\_\_\_\_

**WORKING PROGRAM OF EDUCATIONAL DISCIPLINE**

**PLANT PHYSIOLOGY WITH BASICS OF BIOCHEMISTRY**

specialty 202 Plant protection and quarantine

educational program Plant protection and quarantine

Faculty of Plant Protection, Biotechnology and Ecology

Developers: docent, Ph.D. Babytskiy A.I., docent PhD Drozd P.Yu.

**1. Description of the course**  
**«PLANT PHYSIOLOGY WITH BASICS OF BIOCHEMISTRY»**

<b>Branch of knowledge, training direction, specialty, education level</b>		
Branch of knowledge	202 Plant protection and quarantine	
Specialty	Plant protection and quarantine	
Educational qualification	Bachelor	
<b>Characteristics of the course</b>		
Type	Normative	
Total number of hours	120	
Number of credits ECTS	4	
Number of content modules	2	
Form of control	Credit	
<b>Indicators of the course for full-time education and correspondence form of training</b>		
	full-time education	correspondence form of training
Year of preparation	2	
Semester	4	
Lectures	15 hours	
Practical, seminars	-	
Laboratory sessions	30 hours	
Independent work	75 hours	
Individual work	-	
Number of weekly hours for full-time:		
auditory	2,5 hours	
independent work of student	5 hours	

## 2. The purpose and objectives of the course

The purpose of studying the discipline "Plant Physiology with the basics of biochemistry" is to learn the laws of vital functions of plants, the disclosure of their mechanisms, forming an idea of structural and functional organization of plant systems at different levels and developing ways to control the plant organism.

### Course objectives

1. Study of plant cell physiology - chemical and molecular composition of the cell, its structural components.
2. The study of the vital processes of the plant organism - water regime, photosynthesis, respiration, mineral nutrition.
3. Finding out the peculiarities of growth and development of the plant organism.
4. Study of physiology of reproduction, adaptation and mechanisms of plant stability, physiology of stress.

### As a result of studying the discipline the student has to

**know:** physiological characteristics of the plant cell, the relationship of water regime with physiological processes; to have modern ideas about the mechanisms of photosynthesis, respiration, mineral nutrition To have physiological laws of growth processes. The student must have the basics of biotechnology - the theoretical foundations of creating nutrient media and models of microclonal reproduction.

**be able:** apply the acquired knowledge of plant physiology in solving practical problems, develop and conduct research on plant physiology; understand the physiological processes of the plant organism and have a scientific, professional approach to the technology of growing agricultural crops.

Acquisition of competencies:

#### **general competencies (GC):**

Ability to apply knowledge in practical situations.

#### **professional (special) competencies (PC):**

Ability to assess phytosanitary risks (biological, environmental, economic) due to the introduction or spread of regulated pests.

## 2. The program and structure of the course

### 3. 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	
<b>Content module 1. Plant cell physiology and patterns of water exchange</b>														
Topic 1 Introduction. Subject, purpose and tasks, directions and methods of modern plant physiology. History of the formation of plant physiology as a science	1	14	2		2		10	2	2		1			4
Topic 2. Plant cell physiology	3	17	3		4		10							10
Topic 3. Water exchange of plants	5	23	2		6		15	4			2			10
<b>Total hours:</b>		<b>54</b>	<b>7</b>		<b>12</b>		<b>35</b>		<b>2</b>		<b>3</b>			<b>24</b>
<b>Content module 2. Energy processes of the plant organism and physiology of nutrition, growth and development of plants</b>														
Topic 1. Photosynthesis	7	20	2		8		10	4			1			10
Topic 2. Plant respiration	9	16	2		4		10	2						10
Topic 3. Mineral nutrition of plants	11	14	2		2		10				2			10
Topic 4. Plant growth and development, adaptation of plants to environmental conditions	13	16	2		4		10							10
<b>Total hours:</b>		<b>66</b>	<b>8</b>		<b>18</b>		<b>40</b>				<b>3</b>			<b>40</b>

<b>The total number of hours:</b>	<b>15</b>	<b>120</b>	<b>15</b>		<b>30</b>		<b>75</b>	<b>72</b>	<b>2</b>		<b>6</b>		<b>64</b>
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#### 4. Topics of seminars

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

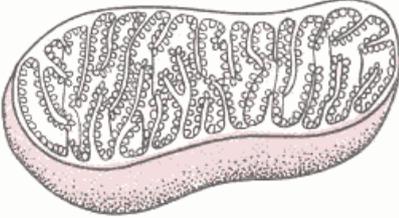
#### 5. Topics of practical training

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

#### 6. Topics of laboratory work

№	Topic title	Number of hours
1.	Plant cell structure	1
2.	Determination of membrane permeability	2
3.	The phenomenon of plasmolysis and deplasmolysis in plant cells	2
4.	Determination of sucrose activity	2
5.	Determination of water absorption rate by a plant	2
6.	Determination of the condition of the stomata by infiltration	2
7.	Determination of suction force of plant tissues by the method of strips	2
8.	Dependence of transpiration intensity on environmental conditions	2
9.	Physico-chemical properties of pigments	4
10.	Distribution of pigments by paper chromatography	2
11.	Determination of chlorophyll concentration by photolorimetric method	2
12.	Determination of the intensity of photosynthesis by gasometric method	2
13.	Detection of enzymes of oxidative electron transport chains	2
14.	Determination of plant respiration intensity	2
15.	Microchemical analysis of ash	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			
<b>EL Bachelor</b> <b>Training direction / Specialty</b> Plant protection and quarantine	<b>Department</b> <u>Physiology,</u> <u>biochemistry of</u> <u>plants and</u> <u>bioenergetics</u> 2021-2022 acad. year	<b>TEST PAPER № 1</b> <b>of discipline</b> <b>PLANT</b> <b>PHYSIOLOGY</b> <b>WITH BASICS OF</b> <b>BIOCHEMISTRY</b>	<b>Approved</b> Head of Department _____ (sign) Prylutska S.V. _____ 2020
<b>Exam questions</b>			
1. To reveal the concepts and principles of operation of the "lower" and "upper end engines" of the water flow.			
2. Classification of enzymes.			
<b>Test tasks of different types</b>			
<b>1. Which organelle is shown in the figure?</b>			
1.	Centriole		
2.	Chloroplast		
3.	Chromoplast		
4.	Mitochondria		
<b>2. The subject of plant physiology is/are ...</b>			
1	Functions of living plant organisms		
2	Functions of organs, tissues and cells of plants		
3	Processes of regulation and adaptation		
4	Formation of plants in the process of evolution		
<b>3. The main protein of the cell membrane is ...</b>			
1	Intensin		
2	Extensin		
3	Fibrillin		
4	Globulin		
<b>4. Crying plants - is...</b>			
1	Extraction of pasoka from a damaged stem		
2	Extraction of water drops with the tips of the leaves		
3	Extraction water through the hydátodes		
4	Extraction resin through the pores on the stem		
<b>5. Combine the names of the properties of the cytoplasm with their characteristics</b>			
1	Irritability	A	resistance to movement of some components relative to others
2	Viscosity	B	restoration of the form after deforming action
3	Elasticity	C	moving some areas relative to others
4	Moving	D	reaction to environmental factors
<b>5. Photolysis of water occurs in...</b>			
1	FS 1		
2	FS 2		
3	Calvin Cycle		
4	FS 1 and FS 2		
<b>6. What substance is formed in the case of substitution of the Mg<sup>2+</sup> atom in the chlorophyll</b>			

<b>molecule by hydrogen?</b>	
1	Chlorophyll
2	Carotene
3	Porphyrin
4	Theophytin
<b>7. Which substance is the primary CO<sub>2</sub> acceptor in the Hatch-Slack cycle?</b>	
1	Ribulose-1,5-bisphosphate
2	Phosphoenolpyruvic acid
3	Oxalic acetic acid
4	Succinic acid
<b>8. Studies of the distribution of pigments are carried out by the method of...</b>	
1	Molish
2	Boysen-Jensen
3	Kraus
4	Vant-Hoff
<b>9. Shoot growth hormones are called...</b>	
1	Auxins
2	Gibberellins
3	Cytokinins
4	Brassinosteroids
<b>10. What element gives a specific taste and smell to mustard and garlic oils?</b>	
1	Sulfur
2	Ammonia
3	Phosphorus
4	Chlorine

\_\_\_\_\_ (     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 **R<sub>DIS</sub>** (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 **R<sub>EW</sub>** (up to 70 points):

$$R_{DIS} = R_{ew} + R_{AT}$$

## 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. Мусієнко М.М. Фізіологія рослин: Підручник (для студ. вищ. навч. закл.) – К.: Либідь, 2005. – 808 с.
2. Мусієнко М.М. Фізіологія рослин: Підручник. – К.: Фітосоціоцентр, 2001. – 392 с.
3. Лебедев С.І. Фізіологія рослин: Підручник для студентів агрономічних спеціальностей сільськогосподарських вузів. – К.: Вища школа, 1972. – 415 с.
4. Макрушин М.М., Макрушина Є.М., Петерсон Н.В. та ін. Фізіологія сільськогосподарських рослин з основами біохімії – К.: Урожай, 1995. – 352 с.
5. Макрушин М.М., Макрушина Є.М., Петерсен Н.В., Меншиков М.М. Фізіологія рослин. – Вінниця: „Нова книга”, 2006. – 416 с.
6. Проценко Д.П. Фізіологія рослин: Підручник для студентів біологічних факультетів університетів. – К.: Вища школа, 1978. – 352 с.
7. Поліщук Л.К. Фізіологія рослин: Навч. посібник для студентів природничих факультетів педагогічних інститутів. – К.: Вища школа, 1971. – 400 с.
8. Самойленко Т.Г., Самойленко М.О., Рожок О.Ф. Практикум з фізіології рослин: Навч. посібник. – Миколаїв: МНАУ, 2013. – 431 с.
9. Романюк Н.Д., Цвілинюк О.М., Микієвич І.М., Терек О.І. Фізіологія рослин: Навч. посібник для студентів біологічних факультетів вищих навчальних закладів освіти. – Л.: Піраміда, 2005. – 160 с.
10. Ніколайчук В.І., Белчгазі В.Й. Фізіологія і біохімія рослин: Навч.-метод. посібник для студентів біологічних спеціальностей вищих навчальних закладів. – Ужгород: УжНУ, 192 с.

- 11.Брайон О.В., Чикаленко В.Г., Славний П.С., Мережинський Ю.Ю., Білановський М.Ф. Фізіологія рослин: Практикум. – К.: Вища школа, 1995. – 191 с.
- 12.Кожукало В.Є., Марченко О.М., Сурай О.О. Методичні вказівки для виконання лабораторно-практичних занять для студентів агробіологічних факультетів. – К.: Видавничий центр НАУ, 2006. – 46 с.
- 13.Негода О.В. Методичні рекомендації до лабораторних занять з дисципліни «Фізіологія рослин» для студентів аграрних університетів агрономічних спеціальностей. – К.: Фітосоціоцентр, 2000. – 64 с.
- 14.Казаков Є.О. Методологічні основи постановки експерименту з фізіології рослин. – К.: Фітосоціоцентр, 2000. – 272 с.
- 15.Мусієнко М.М. Фотосинтез. – К.: Вища школа, 1995. – 247 с.

### **Auxiliary**

1. Білокін І.П. Ріст і розвиток рослин: Навч. посібник для студентів біологічних факультетів університетів. – К.: Вища школа, 1975. – 432 с.
2. Кретович В.Л. Основи біохімії рослин / Кретович В.Л., за ред. акад. Опаріна. – К.: Держ. видавництво с/г літератури УРСР, 1959. – 479 с.
3. Тімірязєв К.А. Життя рослини. – Харків: Комуніст, 1952. – 215 с.
4. Проценко Д. Розвиток фізіології рослин в Київському Університеті за 40 рр. радянської влади // Наук. Записки Київського Університет. – 1957. – Вип. 20.
5. Грицаєнко З.М., Грицаєнко О.А., Карпенко В.П. Методи біологічних та агрохімічних досліджень рослин і ґрунтів. – К.: ЗАТ «Нічлава», 2003. – 320 с.
6. Костильов О.В., Романенко О.В. Біологія та екологія автотрофних організмів. – К.: Фітосоціоцентр, 1999. – 192 с.
7. Мусієнко М.М., Паршикова Т.В., Славний П.С. Спектрофотометричні методи в практиці фізіології, біохімії та екології рослин. – К.: Фітосоціоцентр, 2001. – 200 с.
8. Гродзінський Д.М. Основи хімічної взаємодії рослин. – К.: Наук. думка, 1973. – 206 с.
9. Рудишин С.Д. Основи біотехнології рослин. Підручник для вищих аграрних закладів. – Вінниця, 1998. – 234 с

### **Information Resources**

1. Фізіологія рослин <https://goo-gl.su/W4tYoy>
2. Фотосинтез <https://goo-gl.su/ozqA4t8>
3. Plant Physiology <http://www.plantphysiol.org/>
4. Photosynthesis [https://www.youtube.com/watch?v=sQK3Yr4Sc\\_k](https://www.youtube.com/watch?v=sQK3Yr4Sc_k)

5. Mineral nutrition of plants [https://www.youtube.com/playlist?list=PLKIDmF-iYAljqtM4XB1ojpOC\\_iw1s3fN](https://www.youtube.com/playlist?list=PLKIDmF-iYAljqtM4XB1ojpOC_iw1s3fN)

## **Content module 1. Plant cell physiology and patterns of water exchange**

### **The lecture theme 1. Introduction. Subject, purpose and tasks, directions and methods of modern plant physiology. History of the formation of plant physiology as a science.**

Subject of academic discipline, purpose and directions of plant physiology. History of plant physiology formation and contribution of domestic scientists to its development. Methods and directions of research in plant physiology. Connection of plant physiology with other sciences. The main directions of development of modern plant physiology: biochemical, biophysical, ontogenetic, evolutionary, mathematical, ecological and synthetic (cybernetic). The role of plant physiology in plant productivity programming, forecasting the state of ecological systems and nature protection. The main tasks of plant physiology at the present stage and ways of their implementation. The role of discipline in the formation of agrobiologists.

### **The lecture theme 2. Plant cell physiology.**

General ideas about the plant cell. Structural and functional organization of a plant cell. Modern ideas about the eukaryotic cell of plant organisms and the theory of endosymbiogenesis. The concept of compartmentalization. The main compartments of the plant cell. Cell membrane, its structure, properties and functions. Protoplast or cytoplasm as the living contents of a plant cell. Cytoplasmic conditions and its main components. Biological membranes, their structure and functions. Membrane models. Different approaches to the classification of organelles. Double-membrane organelles. Core. Plastids. Mitochondria. Single-membrane organelles. Endoplasmic reticulum. Golgi complex. Taurus (lysosomes, peroxisomes, glyoxisomes). Non-membrane organelles. Ribosomes. Vacuoles and vacuom.

### **The lecture theme 3. Water exchange of plants.**

The flow of water into the plant cell. Diffusion. The concept of chemical and water potential. Osmosis, osmotic potential. The cell as an osmotic system. Phenomena of plasmolysis and deplasmolysis. Turgor, turgor potential, cytoresis, absorption force. Changes in the relationship between turgor, osmotic pressure and suction force depending on the saturation of cells with water. Water absorption by the root system. Absorption mechanisms, symplastic and apoplastic pathways of water transport. Ways and driving forces of radial water transport at the root. The mechanism of root pressure. Gutation and "crying" of plants. Driving forces and mechanism of ascending water transport along the xylem. Detection and value of suction action of leaves (upper end engine). Adhesion and cohesion. Transpiration: its biological significance and types. Transpiration intensity, relative transpiration, transpiration productivity, transpiration coefficient. Mechanisms for regulating the

opening and closing of the stomata. Features of the water regime of plants of different ecological groups.

## **Content module 2. Energy processes of the plant organism and physiology of nutrition, growth and development of plants**

### **The lecture theme 4. Photosynthesis.**

Photosynthesis. History of discovery and study of photosynthesis. The value of photosynthesis in nature, its cosmic role. Characteristics of the main indicators of photosynthesis, methods and units of their measurement. Leaf structure due to photosynthesis. Chloroplasts, their structure, chemical composition and functions. Photosynthetic pigments (chlorophyll, carotenoids, phycobilins).

Modern idea of the mechanism of photosynthesis. Discovery of Francis Blackman. Light (light-dependent) stage of photosynthesis. General equation of photosynthesis. Primary processes of photosynthesis. Electron excitation states. Photosystem I and photosystem II. Robert Emerson's law. Cyclic and non-cyclic photosynthetic phosphorylation. The main products of the light-dependent phase of photosynthesis.

Dark stage of photosynthesis. C<sub>3</sub> - the path of photosynthesis (Calvin cycle). Chemistry, energy, meaning. C<sub>4</sub> - the path of photosynthesis (Hatch-Slek cycle). Chemistry, energy, meaning. SAM, its features and significance. Photorespiration, its features and physiological significance. Starch synthesis. Ecology of photosynthesis. Photosynthesis and yield. Works by A.O. Nechiporovich.

### **The lecture theme 5. Plant respiration.**

The concept of plant respiration. History of study and physiological role of respiration. Aerobic and anaerobic respiration. General equation of respiration. The relationship between respiration and fermentation. Primary stages of respiration. Glycolysis (Embden-Meyerhof-Parnassus path). The tricarboxylic acid cycle, or Krebs cycle. Chemistry and significance. Respiratory electron transport chain and oxidative phosphorylation. Respiratory energy.

The concept of alternative airways (shunts). Pentose phosphate pathway. Chemistry, energy, meaning. Oxidation of fats.  $\beta$ -oxidation of fatty acids. Glyoxylate cycle. Gluconeogenesis.

### **The lecture theme 6. Mineral nutrition of plants.**

Mineral nutrition is one of the main types of plant nutrition. History of the development of the doctrine of mineral nutrition. Physiological role of batteries. The concept of organogens. Macronutrients: physiological role of the main representatives. Trace elements: physiological role of the main representatives. Ultramicroelements: physiological role of the main representatives. Ways of absorption of mineral elements by a plant. Nitrogen metabolism.

### **The lecture theme 7. Plant growth and development, adaptation of plants to environmental conditions.**

The concept of plant development. The relationship between growth and development. Physiology of plant aging. Aging and rejuvenation of plants and organs in ontogenesis. Photoperiodism. Hormonal theory M.Кh. Чайлахяна. Thermoperiodism and vernalization. The theory of cyclic aging and rejuvenation PM Krenke. The concept of ontogenesis and its stages. Cytogenesis. Cell differentiation and histogenesis. Plant growth and dormancy.

The concept of stability (physiological endurance) of plants. Stability as a process of adaptation of plants to the environment. The concept of stress, their diversity. Adaptation. Resistance to drought and high temperatures. Cold resistance. Frost resistance. Salt resistance. Gas resistance. Radio resistance. Resistance to infectious diseases.