UNIWERSYTET PRZYRODNICZY WE WROCŁAWIU

Cell biology

Educational subject description sheet

Basic information

Field of study Bioinformatics	**Education cycle** 2021/22
Speciality -	**Subject code** WBiHZBBIS.I1BO.0336.21
Organizational unit The Faculty of Biology and Animal Science	**Lecture languages** english
Study level First-cycle (engineer) programme	**Mandatory** optional
Study form Full-time	**Block** major subjects (conducted) in foreign languages
Education profile General academic	**Disciplines** Biological sciences
	Subject related to scientific research Yes
	Subject shaping practical skills Tak

Teacher responsible for the subject	Magdalena Wołoszyńska
Other teachers conducting classes	Magdalena Wołoszyńska, Adam Urantówka

Period	**Examination**	**Number of ECTS points**
Semester 1	exam **Activities and hours** lecture: 15 laboratory classes: 30	5.0

Goals

C1	Presenting to the students the detailed description of the most popular theories of the origin of life and cells.
C2	Providing students with the knowledge about the model organisms representative for particular groups of living organisms
C3	Explaining to students the most important differences between pro- and eukariotic cells as well as between plant and animal cells.
C4	Presenting to students the mechanisms of the gene expression regulation underlying the diversity of cells of the same organism.
C5	Providing students with the knowledge about phenomena related to energy production by cells - the mechanism of enzymatic reaction, the second low of thermodynamics in the context of the cellular processes, activated energy carriers, cellular respiration and photosynthesis as well as the structure of mitochondria and chloroplasts in the context of these two processes
C6	Explaining to students the structure of biological membranes, intracellular compartments and transport through membranes.

Subject's learning outcomes

Code	Outcomes in terms of	Effects	Examination methods
Knowledge – Student knows and understands:			
W1	the molecular basis of the functioning of organisms.	BI_P6S_WG03, BI_P6S_WG04, BI_P6S_WG05, BI_P6S_WG06, BI_P6S_WG10	written exam, oral exam, active participation
W2	the physiological processes occurring in cells and the functioning of plant and animal tissues and organs.	BI_P6S_WG02, BI_P6S_WG03, BI_P6S_WG04, BI_P6S_WG05, BI_P6S_WG06, BI_P6S_WG10	written exam, oral exam, active participation
W3	the theories explaining the origin and evolution of life on Earth.	BI_P6S_WG02, BI_P6S_WG03, BI_P6S_WG04, BI_P6S_WG06, BI_P6S_WG10	written exam, oral exam, active participation
Skills – Student can:			
U1	correctly perform observations in biological laboratory and under the field conditions. Interprets the results and formulates conclusions, using scientific terminology in the field of biology using information technology.	BI_P6S_UK12, BI_P6S_UK14, BI_P6S_UO16, BI_P6S_UW02, BI_P6S_UW05	written credit, oral credit, observation of student’s work, test, performing tasks
U2	perform simple research tasks and experiments in the field of biology. The student can plan and organize work by acting in an entrepreneurial way. He/she makes the right decisions about the selection of research techniques and is able to apply them.	BI_P6S_UK12, BI_P6S_UK14, BI_P6S_UO16, BI_P6S_UW02, BI_P6S_UW05	written credit, oral credit, observation of student’s work, test, performing tasks
Social competences – Student is ready to:			

Code	Outcomes in terms of	Effects	Examination methods
K1	systematic updating of knowledge in the field of biology and related disciplines, recognizes its cognitive significance. He/she critically evaluates his/her knowledge.	BI_P6S_KK01, BI_P6S_KK02	written exam, oral exam, active participation
K2	critically evaluates information on biology presented in mass media.	BI_P6S_KK01, BI_P6S_KR10	written exam, oral exam, active participation

Balance of ECTS points

Activity form	Activity hours*
lecture	15
laboratory classes	30
exam / credit preparation	50
exam participation	2
consultations	2
lesson preparation	15
class preparation	20

Student workload	**Hours** 134	**ECTS** 5.0
Workload involving teacher	**Hours** 49	**ECTS** 1.9
Practical workload	**Hours** 30	**ECTS** 1.0

* hour means 45 minutes

Study content

No.	Course content	Activities
1.	• learning the panspermia hypothesis, the thermal source theory, the Oparin theory, the primordial soup theory, the Miller experiment, the RNA world theory, the progene concept, theories on the evolution of prokaryotes and eukaryotes and the endosymbiotic theory • understanding the concept of the model organism and the role of such organisms in scientific research, in particular such organisms as: Escherichia coli, Saccharomyces cerevisiae, Dictiostelium discoideum, Ceanorhabditis elegans, Drosophila melanogaster, Mus musculus, Arabidopsis thaliana. • learning the diversity of the cell size and shape in bacteria, but also the diversity of eukaryotic cells, including protozoa, understanding the basic similarities between living organisms that confirm their common origin - similarities of metabolic processes and unity at the level of macromolecules. Getting to know the most important facts about the structure of prokaryotic and eukaryotic cells and the most important cellular organelles, including basic information about mitochondrial and plastid genomes. • understanding that the diversity of cells results from the regulation of gene expression, understanding the mechanism of combinatorial gene expression and the concept of key transcription regulators that allow the coordination of gene expression. • understanding why the growth and development of living organisms does not contradict the second law of thermodynamics, how do living organisms obtain and use energy. Learning the principles of oxidation and reduction of organic compounds, understanding the complementarity of photosynthesis and respiration and the role of enzymes in metabolic reactions. Getting to know the concepts of energy activation, standard free energy, enzymatic reaction rate and Michaelis-Menten constant. • understanding the role of activated energy carriers in energy transport and the functions of the ATP, NAD, NADP and FAD carriers in the context of their structure and the resulting chemical properties. Understanding the difference between cellular respiration or the gradual oxidation of organic compounds and their combustion. Understanding the role and energetic aspects of glycolysis with emphasis on substrate phosphorylation • in-depth understanding of the mitochondrial stage of cellular respiration: pyruvate decarboxylase (mechanism of the bridging reaction), acetyl-CoA sources, the course of the Krebs cycle, the formation of activated energy carriers and the fate of transferred energy, the location of respiratory chain proteins and ATP synthase in the mitochondria, the mechanism of ATP synthase action, chemiosmotic theory. • Understanding changes in the morphology of mitochondria and their dynamics depending on the energy state of these organelles. • understanding the biogenesis of plastids and plasticity of these organelles, their location in the photosynthetic tissues and morphology dictated by the requirements of photosynthesis. Understanding the mechanism of photosystems' functioning and the role of water photolysis, which processes are fueled by the energy released by electrons leaving photo-system II and I, the double role of the Rubisco enzyme - as carboxylase in the Calvin-Benson cycle and as oxygenase in photorespiration. Understanding the mechanisms that help plants solve the problem of photorespiration. • expanding the knowledge of biological membranes - their structure, role in the separation of intracellular compartments, and at the same time ensuring communication between them. Understanding the properties of lipid bilayers, structures and domains of various membrane proteins, the role of cell cortex and glycocalyx, the role of the endoplasmic reticulum and Golgi in the synthesis of biological membranes. Understanding the differences in diffusion through biological membranes depending on size, polarity and charge of the molecules. Understanding the principles of transport across membranes. Understanding how different types of proteins are incorporated into biological membranes and how vesicular transport functions.	lecture

No.	Course content	Activities
2.	1. Biological material and its storage (2h) The student will acquire knowledge about the type of biological material from which genetic material can be obtained. He/she will also learn how to properly download, protect and store biological samples. The student will learn various methods of biological material conservation and their influence on various molecular techniques. He/she will also learn how the quality of material affects the ability to carry out various laboratory tests. 2. Biological material and its preparation (4h) So-called dry spots of blood and feathers will be used. The samples were collected from various species of birds by qualified stuff. The student will prepare the appropriate amount of biological material needed to obtain a good quality DNA isolate. 3. DNA isolation (6h) The aim of the isolation is to obtain the highest efficiency of high-molecular and high purity DNA free of enzyme inhibitors, which may hinder the subsequent stages of work with DNA. The student will learn about different methods of isolation of deoxyribonucleic acids, learn the differences between the methods and their application. On the exercises, the student will learn how to isolate genomic DNA (containing the mitochondrial genome and the nuclear genome) by the column method and learn the principles of proper storage of the obtained isolates. 4. PCR reaction - nuclear DNA (6h) Once the isolates have been obtained for each of the test subjects, a test will be carried out using the polymerase chain reaction to determine the genetic gender of birds. This test is a fast and non-invasive method commonly used to determine the genetic gender of very young birds or species that do not exhibit sexual dimorphism and is of particular importance for Institutions such as Zoological Gardens. The diagnosis of the test is based on the polymorphism of the intron lengths of the conservative CHD1 gene, which is located on the Z and W chromosomes in birds. The student will independently design a PCR reaction in accordance with the principles of nuclear DNA amplification. 5. PCR reaction - mitochondrial DNA (6h) Once the isolates have been obtained, the mitochondrial ND2 gene will also be amplified for each subject. The student will independently design a PCR reaction in accordance with the principles of the mitochondrial DNA amplification. The student will learn the differences in the method of amplification of nuclear DNA and mitochondrial DNA. He/she will also learn to design genome-specific primers that allow the amplification of selected DNA fragments. 6. Elektorphoresis, visualization and analysis of obtained results (6h) The student will learn about the different methods of separation of macromolecules under the influence of the electric field. He/she will learn about various buffers and electorophretic media and their application. The diagnostic fragments obtained by the Student using the PCR reaction will be separated on the exercises with the use of horizontal agarose gel electrophoresis. The student will learn how to prepare an agarose gel with the right percentage. He/she will become familiar with the operation of the electrophoresis apparatus and the power supply device. He/she will also learn how to visualize the effects of electrophoretic separation using the GelDoc-It Imagining System, Ultra-Violet Products Ltd. and how to interpret individual results. The student will also learn how to properly document the experiments carried out.	laboratory classes

Course advanced

Teaching methods:

case analysis, educational film, problem-solving method, lecture, classes

Activities	Examination methods	Percentage in subject assessment
lecture	written exam, oral exam, active participation	75%
laboratory classes	written credit, oral credit, observation of student’s work, active participation, test, performing tasks	25%

Entry requirements

Students should have the knowledge of organic and inorganic chemistry, zoology, botany, morphology and physiology of plants, biochemistry and physics.

Literature

Obligatory

1. Podstawy biologii komórki B. Alberts, D. Bray, K. Hopkin, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, PWN, Wydanie II lub III
2. Genetyka molekularna. Pod redakcją P. Węgleńskiego, PWN
3. Krótkie wykłady. Biologia molekularna P. Turner, A. McLennan, A. Bates, M. White, Trzecie wydanie
4. Genomy, T.A. Brown, PWN

Optional

1. Altstein AD, The progene hypothesis: the nucleoprotein world and how life began. 2015, Biology Direct 10:67
2. Reiter F, Wienerroither S, Stark S Combinatorial function of transcription factors and cofactors. 2017, Current Opinion in Genetics and Development 43: 73-81
3. Zimorski V, Ku C, Martin WF, Gould SB Endosymbiotic theory for organelle origins. 2014, Current Opinion in Microbiology 22: 38-48
4. Yang DC, Blair KM, Salama NR Staying in shape: the impact of cel shape on bacterial survival in diverse environments. 2016, Microbiology and Molecular Biology Reviews 80 (1): 187-203
5. Forterre P The universal tree of life: an update. 2015, Frontiers in Microbiology 6, 717
6. Penny D, Poole A The nature of the last universal common ancestor. 1999, Current Opinion in Genetics and Development 9:672-677
7. McCarron JG et al., From structure to function: mitochondrial morphology, motion and shaping in vascular smooth muscle. 2013, Journal of Vascular Research 50:357-371.
8. Solymosi K, Keresztes A, Plastid structure, diversification and interconversions II. Land Plants. 2012, Current Chemical Biology 6:187-204.

Kierunkowe efekty uczenia się

Kod	Treść
BI_P6S_KK01	krytycznej oceny posiadanej wiedzy i jej aktualizacji
BI_P6S_KK02	odpowiedniego określania priorytetów służących realizacji określonego zadania
BI_P6S_KR10	przestrzegania i rozwijania zasad etyki zawodowej oraz podejmowania działań na rzecz przestrzegania tych zasad
BI_P6S_UK12	poprawnie wnioskować na podstawie danych pochodzących z różnych źródeł nauk przyrodniczych, rolniczych, technicznych i matematycznych wykorzystując do dyskusji język naukowy
BI_P6S_UK14	posługiwać się językiem obcym w zakresie dziedzin nauki i dyscyplin naukowych, właściwych dla bioinformatyki, zgodnie z wymaganiami określonymi dla poziomu B2 Europejskiego Systemu Opisu Kształcenia Językowego
BI_P6S_UO16	współdziałać i pracować w grupie, przyjmując w niej różne role
BI_P6S_UW02	stosować techniki i narzędzia badawcze w zakresie biologii eksperymentalnej, ze szczególnym uwzględnieniem biochemii, biofizyki i biologii molekularnej
BI_P6S_UW05	samodzielnie projektować lub wykonywać ekspertyzy z zakresu biologii, zootechniki i informatyki pod kierunkiem opiekuna naukowego oraz w ramach pracy grupowej i wykorzystywać przy tym dostępne źródła informacji, w tym elektroniczne
BI_P6S_WG02	specyfikę interpretacji wyników analiz biologicznych
BI_P6S_WG03	zjawiska i procesy fizyczne, chemiczne oraz biochemiczne zachodzące w przyrodzie i w organizmach żywych
BI_P6S_WG04	mechanizmy ewolucji
BI_P6S_WG05	w stopniu zaawansowanym zagadnienia z zakresu praw genetyki klasycznej, molekularnej, populacyjnej oraz cytogenetyki
BI_P6S_WG06	znaczenie interdyscyplinarnego wykorzystania wiedzy z zakresu, matematyki, fizyki, biofizyki, chemii, biochemii niezbędną dla zrozumienia zjawisk i procesów przyrodniczych
BI_P6S_WG10	w stopniu zaawansowanym elementarne techniki biologii molekularnej