UNIWERSYTET PRZYRODNICZY WE WROCŁAWIU

Cell biology

Educational subject description sheet

Basic information

Field of study Bioinformatics	**Education cycle** 2023/24
Speciality -	**Subject code** BD000000BBIS.I1BO.0336.23
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 Semester 1	**Examination** exam **Activities and hours** lecture: 15 laboratory classes: 30	**Number of ECTS points** 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 mitochondria and chloroplasts in the context of cellurar respiration and photosynthesis.
C6	Explaining to students the structure of biological membranes, intracellular compartments and transport through membranes.
C7	Providing students with a knowledge about the structure of the cell nucleus, especially nuclear envelope, nuclear pore complex and protein transport into nucleus.

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, structure of subcellular organella, their functions and communication.	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 of plants and animals.	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 of organic molecules (biopolymers) and evolution of cells.	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 preserve and store biological material.	BI_P6S_UK12, BI_P6S_UK14, BI_P6S_UO16, BI_P6S_UW02, BI_P6S_UW05	observation of student’s work, test
U2	properly perform simple DNA isolation, set-up PCR samples and interprete the results of this reaction visualized via agarose gel electrophoresis.	BI_P6S_UK12, BI_P6S_UK14, BI_P6S_UO16, BI_P6S_UW02, BI_P6S_UW05	observation of student’s work, test
Social competences – Student is ready to:			

Code	Outcomes in terms of	Effects	Examination methods
K1	systematically update of knowledge in the field of cell biology.	BI_P6S_KK01, BI_P6S_KK02	written exam, oral exam, observation of student's work, active participation
K2	critically evaluate news related to the field of biology and given in mass-media.	BI_P6S_KK01, BI_P6S_KR10	written exam, oral exam, observation of student's work, active participation

Balance of ECTS points

Activity form	Activity hours*
lecture	15
laboratory classes	30
exam / credit preparation	45
exam participation	2
consultations	2
lesson preparation	20
class preparation	12

Student workload	**Hours** 126	**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 scientific experiments proving that all cells in the organism contain the same genome. • 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. • Expanding the knowledge of biological membranes - a bit of history (from the sandwich model to the liquid mosaic) their structure, role in the separation of intracellular compartments, and at the same time ensuring communication between them. • Understanding the properties of lipid bilayers, amphipatic nature of lipids, the mechanism of selfrepair and regeneration of biological membranes, membrane fluidity, lipids distribution, 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 - strycture and function of chanelles, transporters and pumps, (uniport, symport, antiport). Learning the role of the sodium ions in maintaining the membrane transport along with or against the concentration gradient. • Understanding how different types of proteins are incorporated into biological membranes and how vesicular transport functions. Learning about the structure of the cell nucleus especially the structure of the nuclus envelope and its continuity with the endoplasmic reticulum. Getting to know the structure and function of the nuclear pore complex and protein transport into nucleus. • 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. • Understanding the difference between cellular respiration or the gradual oxidation of organic compounds and their combustion. Getting to know the cellular respiration in the context of mitochondrial structure: 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.	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:

educational film, lecture, classes

Activities	Examination methods	Percentage in subject assessment
lecture	written exam, oral exam, active participation	60%
laboratory classes	observation of student’s work, active participation, test	40%

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. Essential Cell Biology, B. Alberts, D. Bray, K. Hopkin, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, Fifth Edition, WW Norton & Co
2. Genetyka molekularna. Pod redakcją P. Węgleńskiego, PWN
3. BIOS Instant Notes in Molecular Biology , P. Turner, A. McLennan, A. Bates, M. White, 3rd Edition, Taylor & Francis
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.
9. Caccamo PD, Brun YV, The molecular basis of noncanonical bacterial morphology. 2018, Trends Microbiol. 26(3): 191-208.
10. Krysan PJ, Young JC, Sussman MR, T-DNA as an insertional mutagen in Arabidopsis. 1999, The Plant Cell, 11: 2283–2290.

Kierunkowe efekty uczenia się

Kod	Treść
BI_P6S_KK01	The graduate is ready to critically evaluate his/her knowledge and update it.
BI_P6S_KK02	The graduate is ready to appropriately set priorities to accomplish a specific task.
BI_P6S_KR10	The graduate is ready to observe and develop the principles of professional ethics and take action to uphold these principles.
BI_P6S_UK12	The graduate is able to correctly make inferences on the basis of data from various sources of natural, agricultural, technical and mathematical sciences, using scientific language for discussion.
BI_P6S_UK14	The graduate is able to speak a foreign language in the fields of science and scientific disciplines relevant to bioinformatics, in accordance with the requirements specified for level B2 of the Common European Framework of Reference for Languages.
BI_P6S_UO16	The graduate is able to interact and work in a group, taking on various roles in it.
BI_P6S_UW02	The graduate is able to apply research techniques and tools in the field of experimental biology, with particular emphasis on biochemistry, biophysics and molecular biology.
BI_P6S_UW05	The graduate is able to independently design or perform expertise in the fields of biology, animal science and computer science under the leadership of a research supervisor and as part of group work and use available sources of information, including electronic.
BI_P6S_WG02	The graduate knows and understands at an advanced level the specifics of interpreting the results of biological analysis.
BI_P6S_WG03	The graduate knows and understands at an advanced level the physical, chemical and biochemical phenomena and processes occurring in nature and in living organisms.
BI_P6S_WG04	The graduate knows and understands at an advanced level the mechanisms of evolution.
BI_P6S_WG05	The graduate knows and understands at an advanced level issues of the laws of classical genetics, molecular genetics, population genetics and cytogenetics.
BI_P6S_WG06	The graduate knows and understands at an advanced level the importance of interdisciplinary use of knowledge in mathematics, physics, biophysics, chemistry, biochemistry necessary for understanding natural phenomena and processes.
BI_P6S_WG10	The graduate knows and understands at an advanced level the elementary techniques of molecular biology.