



# UNIWERSYTET PRZYRODNICZY WE WROCŁAWIU

## Cell biology Educational subject description sheet

### Basic information

|   |  |   |  |
|---|--|---|--|
| <b>Field of study</b><br>Bioinformatics                                 |  | <b>Education cycle</b><br>2024/25                               |  |
| <b>Speciality</b><br>-  |  | <b>Subject code</b><br>BD000000BBIS.I1BO.0336.24                |  |
| <b>Organizational unit</b><br>The Faculty of Biology and Animal Science |  | <b>Lecture languages</b><br>english                             |  |
| <b>Study level</b><br>First-cycle (engineer) programme                  |  | <b>Mandatory</b><br>optional                                    |  |
| <b>Study form</b><br>Full-time  |  | <b>Block</b><br>major subjects (conducted) in foreign languages |  |
| <b>Education profile</b><br>General academic                            |  | <b>Disciplines</b><br>Biological sciences                       |  |
|   |  | <b>Subject related to scientific research</b><br>Yes            |  |
|   |  | <b>Subject shaping practical skills</b><br>Tak                  |  |
| <b>Teacher responsible for the subject</b>                              | Magdalena Wołoszyńska  |   |  |
| <b>Other teachers conducting classes</b>                                | Magdalena Wołoszyńska, Adam Urantówka, Aleksandra Krocak-Zdańkowska  |   |  |
| <b>Period</b><br>Semester 1   | <b>Examination</b><br>exam   | <b>Number of ECTS points</b><br>5.0                             |  |
|   | <b>Activities and hours</b><br>lecture: 15<br>laboratory classes: 30 |   |  |

## 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 cellular respiration and photosynthesis.   |
| C6 | Explaining to students the structure of biological membranes and biosynthesis of its components, intracellular compartments and transport through membranes (endoplasmic reticulum smooth and rough, Golgi apparatus, endosomes, lysosomes). |
| C7 | Providing students with a knowledge about the structure of the cell nucleus, especially nuclear envelope, nuclear pore complex and protein transport into nucleus.   |
| C8 | Explaining to students the protein biosynthesis and mechanisms of protein transport and modification depending on their destination.   |

## Subject's learning outcomes

| Code  | Outcomes in terms of   | Effects   | Examination methods                 |
|---|--|---|-------------------------------------|
| <b>Knowledge - Student knows and understands:</b> |  |   |                                     |
| W1  | the molecular basis of the functioning of organisms, structure of subcellular organelles, their functions and communication.                     | BI_P6S_WG03,<br>BI_P6S_WG04,<br>BI_P6S_WG05,<br>BI_P6S_WG06,<br>BI_P6S_WK10                 | written exam, active participation  |
| W2  | the physiological processes occurring in cells of plants and animals.  | BI_P6S_WG02,<br>BI_P6S_WG03,<br>BI_P6S_WG04,<br>BI_P6S_WG05,<br>BI_P6S_WG06,<br>BI_P6S_WK10 | written exam, active participation  |
| W3  | the theories explaining the origin of organic molecules (biopolymers) and evolution of cells.  | BI_P6S_WG02,<br>BI_P6S_WG03,<br>BI_P6S_WG04,<br>BI_P6S_WG06,<br>BI_P6S_WK10                 | written exam, active participation  |
| <b>Skills - Student can:</b>                      |  |   |                                     |
| U1  | correctly preserve and store biological material.  | BI_P6S_UO12,<br>BI_P6S_UU14,<br>BI_P6S_UW02,<br>BI_P6S_UW05                                 | observation of student's work, test |
| U2  | properly perform simple DNA isolation, set-up PCR samples and interpret the results of this reaction visualized via agarose gel electrophoresis. | BI_P6S_UO12,<br>BI_P6S_UU14,<br>BI_P6S_UW02,<br>BI_P6S_UW05                                 | observation of student's work, test |
| <b>Social competences - Student is ready to:</b>  |  |   |                                     |

| Code | Outcomes in terms of  | Effects                     | Examination methods  |
|------|---|-----------------------------|--|
| K1   | systematically update of knowledge in the field of cell biology.                  | BI_P6S_KK01,<br>BI_P6S_KK02 | written exam,<br>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                 | written exam,<br>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                  |                    |
| <b>Student workload</b>           | <b>Hours</b><br>126 | <b>ECTS</b><br>5.0 |
| <b>Workload involving teacher</b> | <b>Hours</b><br>49  | <b>ECTS</b><br>1.9 |
| <b>Practical workload</b>         | <b>Hours</b><br>30  | <b>ECTS</b><br>1.0 |

\* hour means 45 minutes

### Study content

| No. | Course content  | Activities |
|-----|---|------------|
| 1.  | <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• Getting to know the most important scientific experiments proving that all cells in the organism contain the same genome.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• Understanding the differences in diffusion through biological membranes depending on size, polarity and charge of the molecules.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• Understanding the difference between cellular respiration or the gradual oxidation of organic compounds and their combustion.</li> <li>• 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.</li> <li>• 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.</li> </ul> | lecture    |

| No. | Course content   | Activities         |
|-----|--|--------------------|
| 2.  | <p>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.</p> <p>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 staff. The student will prepare the appropriate amount of biological material needed to obtain a good quality DNA isolate.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>6. Elektrophoresis, 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 electrophoretic 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 Imaging System, Ultra-Violet Products Ltd. and how to interpret individual results. The student will also learn how to properly document the experiments carried out.</p> | laboratory classes |

## Course advanced

### Teaching methods:

educational film, lecture, classes, problem-based learning (PBL)

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

## Entry requirements

Students should have knowledge of chemistry, biology and physics within the scope of the high school curriculum. Laboratory classes will be conducted in small groups of maximum 13 students.

## 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_UO12 | 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_UU14 | 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_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_WK10 | The graduate knows and understands at an advanced level the elementary techniques of molecular biology.   |