Module syllabus: ***Eukaryotic cell ultrastructure and electron microscopy techniques***

1. Overall information

Module coordinator	prof. dr hab. Piotr Świątek
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ECTS	**4**
Method for the verification of learning outcomes	The final grade for the module is weighted on the average of the following student activities: - Active participation in laboratory classes (continuous evaluation of practical skills, tests and reports) (0.7) - Written final exam (0.3) To be awarded a final grade, the student must have passed each activity of the module. Grades: below 51% – fail (F); 52-60% – with minimum academic criteria (E); 61-65% – satisfactory (D); 66-75% – good (C); 76-85% – very good (B), ≥ 85% – excellent (A)

2. Description of student activity and work

Lecture/discussion sessions	
Responsible instructors	prof. dr hab. Piotr Świątek, prof. dr hab. Ewa Kurczyńska
Content	**The main objective of this module** is to give students practical knowledge and skills in recognising the nanostructure (ultrastructure) of eukaryotic cells (laboratory; both plants and animals) and to present contemporary techniques that permit the analysis of cell organisation at high magnifications (lectures). Students will learn the types of plant and animal tissues with special emphasis on their functions in plant and animal bodies. **Lectures/discussion sessions** will cover the current methods that are commonly used to visualise the cell ultrastructure (sample preparation; including immunocytochemistry) and principles of different types of electron microscopes. **Lecture/discussion session content:** Historical background; physical basis of electron microscopy; components of transmission electron microscope (TEM) and scanning electron microscope (SEM); imaging methods; sample preparation – fixation, embedding into resins, cutting, critical point drying, gold coating, staining; scanning transmission electron microscope (STEM), environmental SEM, cryo methods in electron microscopy; 3D reconstructions in TEM and SEM; immunodetection techniques at the level of an electron microscope
Number of didactic hours (contact hours)	**10**

Literature	1) An introduction to electron microscopy. Prepared by FEI – https://www.fei.com/documents/introduction-to-microscopy-document/ 2) Fundamentals of Scanning Electron Microscopy. Written by Weilie Zhou, Robert P. Apkarian, Zhong Lin Wang and David Joy http://homes.ufam.edu.br/berti/nanomateriais/aulas%20pptx%20e%20livros/livro/Scanning%20Microscopy%20for%20Nanotechnology/Fundamentals%20of%20Scanning%20Electron%20Microscopy%20%28SEM%29.pdf 3) Physical Principles of Electron Microscopy An Introduction to TEM, SEM and AEM. Written by Ray F. Egerton 4) Electron Microscopy: The Basics. Written by Voutou B. and Stefanak E-C. https://optiki.files.wordpress.com/2013/03/electron-microscopythe-basics.pdf 5) Transmission and Scanning Electron Microscopy for Plant Protoplasts, Cultured Cells and Tissues. Larry C. Fowke http://link.springer.com/chapter/10.1007%2F978-3-642-79048-5_18 6) A.K. Pathan, J. Bond, R.E. Gaskin http://dx.doi.org/10.1016/j.micron.2008.05.006

Laboratory	
Responsible instructor instructors	Staff of the Department of Animal Histology and Embryology and the Department of Cell Biology
Laboratory projects	Project 1: General ultrastructure of the animal cell Project 2: Ultrastructure of the cell cytoskeleton, cell junctions, extracellular matrix Project 3: Ultrastructure of the epithelia, muscles and connective tissue Project 4. Sperm and ova ultrastructure Project 5: General ultrastructure of plant cell Project 6: Cell wall ultrastructure Project 7: Diversity of plastid ultrastructure Project 8: Plasmodesmata ultrastructure
Methodology of laboratory classes	Theoretical introduction presented by the instructors; individual work with micrographs; individual observations of the cell ultrastructure under a transmission electron microscope. Train students to make deductions from measurements and to interpret data; observation and bridge theory and practice. Work under the direction and supervision of a lecturer – the acquisition of practical skills in the preparation of biological material based on instructions. Analysis of specimens in electron microscopy; analysis and documentation of obtained results (note, drawing), discussion.

Number of didactic hours (contact hours)	40
Literature	Students will receive instructions for the reactions to be carried out and/or worksheets and relevant literature from the person handling the protocols for each laboratory.

3. Forms of verification

Continuous evaluation of knowledge, activity and practical skills	
Grades	Grades are awarded on a scale: A-F, where A is the best and F is a fail. An excellent performance (A) – the student actively participates in laboratory work, demonstrates an excellent understanding of the experimental procedures (its aims, sequence and outcomes) is engaged and creative in solving current problems and in an assessment and presentation of results. A good performance (C) – the student demonstrates a good judgment and knowledge, correctly provides an experiment, correctly exhibits a sense of an experimental procedure, properly provides an assessment and presentation of results. A satisfactory performance (E) – the student demonstrates a satisfactory judgment and knowledge, is poorly engaged and needs additional help to finish the experiment and final assessment of the experimental results correctly, present satisfactory presentation of results. A performance that does not meet the minimum academic criteria (F) – the students is not engaged in experiment, did not exhibit sense of experimental procedures, poorly interprets and presents results.

Reports from realised laboratory projects	
Evaluation	Evaluation comprises judgment and knowledge related to the sense and methods of the laboratory project, engagement in realisation, quality of assessing and presenting the experimental results, use of reference materials. Grades for reports are awarded on a scale: A-F, where A is the best and F is a fail. An excellent report (A) – without any essential errors Fail (F) – no report

Final test	
Grades	Grades are awarded on a scale: A-F, where A is the highest and F is a fail. Excellent (A) – the student presents a fluent knowledge of the principles of electron microscopy and the described sample preparation techniques. Good (C) – the student presents a good knowledge of the principles of electron microscopy and the described sample preparation techniques, makes rare but subtle errors.

	Satisfactory (E) – the student exhibits a satisfactory knowledge of the principles of electron microscopy and the described sample preparation techniques, but with a poor understanding of some aspects of electron microscopy and makes subtle errors. Fail (F) – the student does not present a satisfactory knowledge of the principles of electron microscopy and the described sample preparation techniques and makes many substantial errors, which disqualify their presentation.