(Table 5.2) Course unit description

Study program: Master of Academic Studies in Molecular Biology and Physiology
Type and level of studies: Master of Academic Studies
Course unit: Mechanisms of cell signaling
Teacher in charge: Branka I. Ognjanović
Language of instruction: English
ECTS: 5
Prerequisites:
Semester: winter semester
Course unit objective Familiarizing students with the fundamental concepts of intercellular communication and signaling, the signaling pathways responsible for information transfer within the cell, and the integration and regulation of cellular functions.
Learning outcomes of Course unit Upon completion of the theoretical and practical activities, students will be able to: understand the fundamental molecular principles underlying physiological processes in intercellular communication and signaling mediated by chemical signals; explain signal transduction via G protein-coupled receptors; explain signaling pathways involving enzyme-linked receptors; explain the transmission, propagation, and amplification of information required to elicit an appropriate cellular biological response; use literature available online; and present their knowledge and ideas in the form of seminar papers.
Course unit contents *Theoretical classes:* Overview of the types of cell communication and the major pathways of signal transduction. Models of intercellular communication. Signaling molecules (neurotransmitters, hormones, cytokines, etc.), their chemical structures and functions. Functional organization of membrane proteins and their translocation. Molecular basis of interactions between cells and/or the extracellular matrix. Receptors: structure and types. Membrane receptors. Ion channels and transporters. Signal transduction associated with changes in ion concentrations. Signal transduction via G protein-coupled receptors (GPCRs). GPCR-mediated activation of adenylyl cyclase and protein kinase A. GPCR-mediated activation of phospholipase C and calcium signaling. Enzyme-linked receptors and signaling pathways associated with enzyme-linked receptors: protein kinases; signal-regulated proteolysis. The MAPK signaling pathway. Guanylyl cyclases and the NO/cGMP signaling pathway. Intracellular receptors. Synaptic transmission. Neurotransmitters and their receptors. The role of signaling systems in maintaining cell-cycle regulation and their involvement in cell-cycle disorders and programmed cell death (apoptosis). *Practical classes:* Practical classes are organized as laboratory-based experimental exercises, computer simulations, and demonstration sessions aligned with the theoretical course syllabus. Nitric oxide (NO) as a signaling molecule in intracellular processes and intercellular communication. Cell signaling mediated by the p38 MAPK, JNK, and ERK1/2 MAPK pathways - analysis of phosphorylation of signaling pathway components. Reactive oxygen species (ROS) as signaling molecules. Mechanisms of NF-κB signaling pathway activation. Post-transcriptional regulation of gene expression—gene silencing (siRNA, dsRNA, antisense oligonucleotides). The following analytical techniques will be covered: spectrophotometry, ELISA, RT-PCR, Western blotting, and chromatin immunoprecipitation (ChIP). Preparation of seminar papers.
Literature Alberts et al., Molecular Biology of the Cell, 7th edition, 2022.

Krauss G. Biochemistry of Signal Transduction and Regulation. 5th edition, Wiley-VCH, Weinheim, Germany. 2014.
Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. Molecular Biology of the Cell. 5th ed. GarlandScience, New York, 2008.

Number of active teaching hours				
Lectures: 2	Practice: 2	Other forms of classes:	Independent work:	Other classes:

Teaching methods
Theoretical instruction – lectures using PowerPoint presentations; seminar papers.
Practical instruction is delivered through experimental laboratory work

Examination methods (maximum 100 points)

Exam prerequisites	**No. of points**	**Final exam**	**No. of points**
Practical classes	**5**	Written examination	**20**
Tests	**10**	Oral examination	**50**
Homework	**5**	Other	
Seminars	**10**		
Project			

Grading system

Grade	**No. of points**	**Description**
10	>= 91	Excellent
9	81-90	Exceptionally good
8	71-80	Very good
7	61-70	Good
6	51-60	Passing
5	<=50	Failing