SYLLABUS – A COURSE DESCRIPTION

I. General informaion

1. Course name: **Advances in Molecular Medicine**
2. Course code: **01-BTA-ADVAMOL**
3. Course type (compulsory or optional): **optional**
4. Study programme name: **Biotechnology**
5. Cycle of studies (1st or 2nd cycle of studies or full master's programme): **2nd cycle of studies**
6. Educational profile (general academic profile or practical profile): **general academic profile**
7. Year of studies (if relevant): **I and II 2nd cycle of studies**
8. Type of classes and number of contact hours (e.g. lectures: 15 hours; practical classes: 30 hours):

   lectures: 15 hours
9. Number of ECTS credits: **2**
10. Name, surname, academic degree/title of the course lecturer/other teaching staff:

    Jacek Kolanowski, kolanowski.jacek@gmail.com, ICHB
11. Language of classes: **English**
12. Online learning – yes (partly – online / fully – online) / no:

II. Detailed information

1. Course aim (aims)

   1. Providing knowledge about modern tools (probes and technologies) to investigate molecular mechanisms of disease and matching them to selected biological question
   2. Presenting state-of-the-art tools to visualise and probe biophysical and biochemical parameters in various biological models
   3. Explaining physical, chemical and biological mechanisms of action of modern tools to investigate biological models on molecular level
   4. Presenting modern approaches (e.g. screening) in the discovery of bioactive molecules as potential drug candidates
   5. Demonstrating the use of various tools and technology in the search of new drug candidates (case study)
   6. Developing skills in designing, choosing and critically evaluating molecular tools and workflows to investigate mechanisms of disease in biological models
   7. Developing skills in understanding and critical evaluation of interdisciplinary scientific literature, in particular in the field of molecular tools

2. Pre-requisites in terms of knowledge, skills and social competences (if relevant)

   Cell and molecular biology, knowledge of biochemistry / spectroscopy / pharmacology / bioanalytics is suggested

3. Course learning outcomes (EU) in terms of knowledge, skills and social competences and their reference to study programme learning outcomes (EK)

Course learning outcome symbol (EU)	On successful completion of this course, a student will be able to:	Reference to study programme learning outcomes (EK)
EU_01	Choose molecular tools with appropriate properties to answer various scientific questions (taking into consideration a molecular target, type of information required and biological model)	BT_W01, BT_W03, BT_W06, BT_W09, BT_U01, BT_U03, BT_U04, BT_K01
EU_02	Understand differences in the requirements for tools to visualise / measure and modify / change molecular processes in biological models	BT_W01, BT_W02, BT_W03, BT_K01, BT_U7
EU_03	Discuss pros and cons of various designs of responsive probes in terms of their reliability and biocompatibility	BT_W03, BT_W06, BT_U02, BT_U04, BT_U05, BT_K01
EU_04	Describe mechanism of action of molecular tools – responsive fluorescent and bioluminescent probes (discuss	BT_W01, BT_W03, BT_U02, BT_U05, BT_K02

	differences and advantages of fluorescence vs bioluminescence)	
EU_05	Select suitable molecular designs of probes for studying various biological targets, including metal ions, reactive oxygen species, proteins (enzymes, receptors) and nucleic acids	BT_W01, BT_W03, BT_W04, BT_W06, BT_W09, BT_U01, BT_U02, BT_U03, BT_K01, BT_K02
EU_06	Critically evaluate molecular tools on the basis of scientific literature and reported experimental results	BT_W01, BT_W06, BT_U03, BT_U04, BT_U05, BT_K01, BT_K02
EU_07	Describe various stages of a modern workflow for the search and development of bioactive molecules	BT_W01, BT_W03, BT_W04, BT_W06, BT_U01, BT_U05
EU_08	Discuss differences and compare top-down (phenotypic) and bottom-up (target-based) approaches in the search for bioactive molecules	BT_W01, BT_W04, BT_W06, BT_U01, BT_U03, BT_U05, BT_K01
EU_09	Select appropriate tools and workflows for a search of molecular therapies for new diseases	BT_W01, BT_W02, BT_W03, BT_W04, BT_W06, BT_W09, BT_U01, BT_U02, BT_U03, BT_U04, BT_U05, BT_K01
EU_10	Describe strategies for turning bioactive molecules (drugs) into activatable ones (pro-drugs),in particular pro-drugs (pro-effectors) activated by enzymes and light	BT_W01, BT_W04, BT_W06, BT_W09, BT_U01, BT_K02

4. Learning content with reference to course learning outcomes (EU)

Course learning content	Course learning outcome symbol (EU)
Overview of types and molecular designs of tools to investigate molecular mechanisms of the disease	EU_01, EU_02, EU_03, EU_05, EU_06, EU_09
Molecular aspects of biocompatibility of probes	EU_01, EU_02, EU_03, EU_04, EU_05, EU_06
Mechanisms of action of fluorescent and bioluminescent probes	EU_01, EU_02, EU_04
Responsive probes for various molecular targets (metal ions, reactive oxygen species, hypoxia, enzymatic activity, receptors, nucleic acids)	EU_01, EU_03, EU_04, EU_05, EU_06
Modern workflows and state-of-the-art tools in the development and optimisation of bioactive molecules	EU_01, EU_07, EU_08, EU_09
Activiatable bioactive molecules (pro-drugs)	EU_02, EU_03, EU_05, EU_06, EU_10
Development of small-molecule-based drugs for new diseases (case study: molecular mechanisms and therapy development for COVID-19)	EU_01, EU_03, EU_05, EU_06, EU_07, EU_08, EU_09

5. Reading list : fragments indicated by the teacher

1. JR Lakowicz: Principles of Fluorescence Spectroscopy (https://doi.org/10.1007/978-0-387-46312-4), Springer-Verlag, Boston, 2006

Artykuły w czasopismach

1. G Hong, AL Antaris, H Dai (2017): Near-infrared fluorophores for biomedical imaging, Nat Biomed Eng, 1(1), 0010
2. LD Lavis, RT Raines (2008): Bright Ideas for Chemical Biology, ACS Chem Biol, 3, 3, 142

3. AS KlymcheBTo (2017): Solvatochromic and Fluorogenic Dyes as Environment-Sensitive Probes: Design and Biological Applications, Acc Chem Res, 50, 366
4. JL Kolanowski, A Kaur, EJ New (2016): Selective and Reversible Approaches Toward Imaging Redox Signaling Using Small-Molecule Probes, Antiox Redox Signall, April, 713
5. JL Kolanowski, C Shen, EJ New (2017): Fluorescent Probes for the Analysis of Labile Metals in Brain Cells, Neuromethods, 124, 51
6. AT Aron, KM Ramos-Torres, JA Cotruvo Jr, CJ Chang (2015): Recognition- and Reactivity-Based Fluorescent Probes for Studying Transition Metal Signaling in Living Systems, Acc Chem Res, 48, 2434
7. D Wu, AC Sedgwick, T Gunnlaugsson et alck, T Gunnlaugsson et al (2017): Fluorescent chemosensors: the past, present and future, Chem Soc Rev, 46, 7105
8. KP Carter, AM Young, AE Palmer (2014): Fluorescent Sensors for Measuring Metal Ions in Living Systems, Chem Rev, 114, 4564
9. J Liu, W Bu, J Shi (2017): Chemical Design and Synthesis of Functionalized Probes for Imaging and Treating Tumor Hypoxia, Chem Rev, 117, 6160
10. JL Kolanowski, A Kaur, EJ New (2018): Fluorescent probes for the simultaneous detection of multiple analytes in biology, Chem Soc Rev, 47, 195, 195
11. IJ Carney, JL Kolanowski, Z Lim et al (2018): A ratiometric iron probe enables investigation of iron distribution within tumour spheroidsn within tumour spheroids, Metallomics, 10, 553
12. C Shen, JL Kolanowski, CM-N Tran et al (2016): A ratiometric fluorescent sensor for the mitochondrial copper pool, Metallomics, 8, 915
13. W Zhang, P Li, F Yang et al (2013): Dynamic and Reversible Fluorescence Imaging of Superoxide Anion Fluctuations in Live Cells and in Vivo, JACS, 135, 14956
14. A Kaur, MA Haghighatbin, CF Hogan, EJ New (2015): A FRET-based ratiometric redox probe for detecting oxidative stress by confocal microscopy, FLIM and flow cytometry, Chem Commun, 51, 10510
15. YV Suseela, N Narayanaswamy, S Pratihara, T Govindaraju (2018): Far-red fluorescent probes for canonical and non-canonical nucleic acid structures: current progress and future implications, Chem Soc Rev, 47, 1098
16. M Li, M Zheng, S Wu et al (2018): In vivo production of RNA nanostructures via programmed folding of single-stranded RNAs, Nat Commun, 9, 2196
17. W Chyan, RT Raines (2018): Enzyme-Activated Fluorogenic Probes for Live-Cell and in Vivo Imaging, ACS Chem Biol, 13, 1810
18. AG Vorobyeva, M Stanton, A Godinat et al (2015): Development of a Bioluminescent Nitroreductase Probe for Preclinical Imaging, PLOS ONE, 10.1371/journal.pone.0131037
19. A Gauthier, A Juillerat, C Heinis et al (2008): An engineered protein tag for multiprotein labeling in living cells, Chem Biol, 15(2), 128(2), 128
20. K Amaike, T Tamura, I Hamachi (2017): Recognition-driven chemical labeling of endogenous proteins in multi-molecular crowding in live cells, Chem Commun, 53, 11972
21. BF Cravatt, AT Wright, JW Kozarich (2008): Activity-based protein profiling: from enzyme chemistry to proteomic chemistry, Annu Rev Biochem, 77, 383
22. ML Matthews, L He, BD Horning et al (2017): Chemoproteomic profiling and discovery of protein electrophiles in human cells, Nat Chem, 9(3), 234
23. S Florian et al (2007): Chemical genetics: reshaping biology through chemistry, HSFP Journal, 2, 104
24. JM Sanders (2020): Pharmacologic Treatments for Coronavirus Disease 2019 (COVID-19), JAMA, 10.10001/jama.2020.6019
25. W Rut et al (2020): Activity profiling of SARS-CoV-2-PLpro protease provides structural framework for anti-COVID-19 drug design, bioRxiv (preprint), 10.1101/2020.04.209..1101/2020.04.209.
26. D Bojkova et al (2020): SARS-CoV-2 infected host cell proteomics reveal potential therapy targets, Research Square (preprint), 10.21203/rs.3.rs-17218/v1
27. DE Gordon et al (2020): A SARS-CoV-2 protein interaction map reveals targets for drug repurposing, Nature, doi.org/10.1038/s41586-020-2286-9
28. L Zhang, D Lin, X Sun (2020): Crystal structure of SARS-CoV-2 main protease provides a basis for design of improved α-ketoamide inhibitors, Science, 368, 409

29. H Zhang, JM Penninger, Y Li (2020): Angiotensin-converting enzyme 2 (ACE2) as a SARS-CoV-2 receptor: molecular mechanisms and potential therapeutic target, Intens Care Med, 46, 586
30. S Seo et al (2020): Supercomputer-aided Drug Repositioning at Scale: Virtual Screening for SARS-CoV-2 Protease Inhibitor, chemRxiv (preprint), 12101457/1

III. Additional information

1. Teaching and learning methods and activities to enable students to achieve the intended course learning outcomes (please indicate the appropriate methods and activities with a tick or/and suggest different methods)

Teaching and learning methods and activities	
Lecture with a multimedia presentation	X
Interactive lecture	X
Problem – based lecture	X
Discussions	X
Text-based work	X
Case study work	X
Problem-based learning	X
Educational simulation/game	
Task – solving learning (eg. calculation, artistic, practical tasks)	
Experiential work	
Laboratory work	
Scientific inquiry method	
Workshop method	
Project work	
Demonstration and observation	
Sound and/or video demonstration	
Creative methods (eg. brainstorming, SWOT analysis, decision tree method, snowball technique, concept maps)	
Group work	

2. Assessment methods to test if learning outcomes have been achieved (please indicate with a tick the appropriate methods for each LO or/and suggest different methods)

Assessment methods	Course learning outcome symbol									
	EU_1	EU_2	EU_3	EU_4	EU_5	EU_6	EU_7	EU_8	EU_9	EU_10
Written exam										
Oral exam										
Open book exam										
Written test	X	X	X	X	X	X	X	X	X	X
Oral test										
Multiple choice test										
Project										
Essay										
Report										
Individual presentation										
Practical exam (performance observation)										
Portfolio										

3. Student workload and ECTS credits

Activity types	Mean number of hours spent on each activity type
Contact hours with the teacher as specified in the study programme	15
Preparation for classes	5
Reading for classes	10
Essay / report / presentation / demonstration preparation, etc.	5
Project preparation	
Term paper preparation	
test preparation	15
Total hours	50
Total ECTS credits for the course	2

4. Assessment criteria according to AMU in Poznan grade system

Very good (bdb; 5,0): the student demonstrates excellent or outstanding performance.
Good plus (+db; 4,5): the student demonstrates very good performance
Good (db; 4,0): the student demonstrates good performance
Satisfactory plus (+dst; 3,5): the student demonstrates satisfactory performance
Satisfactory (dst; 3,0): the student demonstrates minimally acceptable performance
Unsatisfactory (ndst; 2,0): below 50% - the student has not met minimal requirements/has not met expectations