SYLLABUS – A COURSE DESCRIPTION

I. General information

1. Course name: **Stem cells**
2. Course code: **01-BTA-STEMCELLS**
3. Course type (compulsory or optional): **Compulsory**
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**
8. Type of classes and number of contact hours (e.g. lectures: 15 hours; practical classes: 30 hours):

   Lectures: 25 hours
   Practical classes: 40 hours

9. Number of ECTS credits: **6**
10. Name, surname, academic degree/title of the course lecturer/other teaching staff:

dr hab. Małgorzata Borowiak, malgorzata.borowiak@amu.edu.pl

11. Language of classes: **English**
12. Online learning – yes (partly – online / fully – online) / no:

II. Detailed information

1. Course aim (aims):

The principle goals of learning are:

1.1 To familiarize students with **Stem Cells definition** and different types of Stem Cells: Embryonic Stem Cells (ESC), Induced Pluripotent Stem Cells (iPS), Tissue Specific Somatic or Adult Stem Cells (ASC), Nuclear Transfer Embryonic Stem Cells (ntESCs). To explain the concept of ESC differentiation into three embryonic germ layers: ectoderm, mesoderm and endoderm and subsequently explain the mechanism of these three germ layers to give rise to all cell types and tissues in an organism's body. To describe the differences between mouse and human stem cells: differences in cell cycle regulation, control of apoptosis, and cytokine expression. To familiarize students with Stem Cells morphology and culture techniques. To familiarize students with Mouse Embryonic Fibroblasts (MEF) collection from mouse embryos.
1.2 To familiarize students with **pluripotency** of stem cells: To understand definitions: totipotent (eg. zygote) vs pluripotent (ESC) vs multipotent. (haematopoietic). To define prime, and naïve pluripotency and formative pluripotency.To familiarize students with molecular and functional methods to assess pluripotency. Molecular methods such as: morphology, alkaline phosphatase staining, epigenetic state and pluripotency markers detected with PCR, immunofluorescence, flow cytometry or NGS -PluriTest. Functional methods such as: *in vitro* differentiation, teratoma formation assay, chimera development, tetraploid complementation, germline transmission. To define pluripotency markers, e.g.: Oct4, Nanog, Sox2, Tra-1-60, Tra-1-81, SSEA3, SSEA4. To explain to the students what triggers stem cells to differentiate. To familiarize students with pluripotency exit and proteins that keep cells in undifferentiated state such as LIF, TGFb and bFGF one the examples of mouse embryoid bodies (mESC Bra-GFP and mESC Sox17-GFP).
1.3 To familiarize students with cells **reprogramming**. To introduce concept of iPSC and cellular reprogramming factors such as Oct3/4, Sox2, Klf4, c-Myc - Yamanaka's factors as critical regulators in the developmental signaling network. To focus on the role of the epigenetic remodeling during reprogramming. To explain transdifferentiation and dedifferentiation. To familiarize students with nuclear reprogramming methods: somatic nuclear transfer (SCNT), cell fusion, transcription factor transduction. To explain techniques for generating integration-free hiPSCs such as SeV reprogramming, mRNA reprogramming, miRNA + mRNA reprogramming and Epi reprogramming and Retro/Lenti reprogramming with their pros and cons. To explain Mesenchymal-to-epithelial transition. To familiarize students with the dark sides" of reprogramming. To familiarize students with MEFs reprogramming by piggyBac transposon (as a carrier of reprogramming factors) integration into the genome.

1.4To familiarize students with **small molecule** enhancers of reprogramming. To explain **signaling pathways**: EGF, TGF-beta, BMB, Wnt, Notch and the effects of small molecules on these pathways. To familiarize students with embryoid bodies differentiation towards cardiac (ActivinA, CHIR99021), endoderm (IDE1, ActivinA, CHIR99021, LDN193189) and towards ectoderm (LDN193189, RepSox, Retinoic Acid).

1.5To explain to students the characteristics of derived cells in vitro and in vivo. To familiarize students with 3D culture and their pros and cons. To introduce definitions: organoids, human mini-organs, organ-on-chip, multi-organ systems. To familiarize students with the directed cell fate with the example of β-cells.
1.6To familiarize students with **applications in stem cell science**: drug toxicity screening, new drug discovery, genetically reprogrammed cells (iPS) = patient-specific disease models, autologous therapies, gene editing in stem cells with the example of CRISPR-Cas9 tool. To familiarize students with Stem cells application examples: bone marrow stem cells in leukemia, umbilical cord blood stem cells to treat more than 80 diseases, pancreatic progenitors organoids containing β-cells for insulin therapy. To explain stem cell- based therapy pros and cons as well as imunorejection aspect.

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

Before students start classes of Stem Cells they should know basics of: 1. human cell biology 2. developmental biology 3. biochemistry: structure of DNA and RNA, proteins 4. biochemical cycles and major metabolic cellular pathways 5. human gene structure and expression 6. cell signaling principles 7. principles of endocrinology and physiology 8. tissue culture techniques particularly aseptic techniques.

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)
Effect_01	use with understanding scientific terminology in the field of stem cells, is able to explain concept of ESC definition, differentiation with differences between mouse and human stem cells.	BT_W02, BT_W03, BT_W04, BT_W06, BT_U01, BT_U02, BT_W08
Effect_02	explain the concept of pluripotency, mechanisms regulating pluripotency. Molecular and functional methods to assess pluripotency in vitro and in vivo for mouse and human cells	BT_W02, BT_W01, BT_W03, BT_W06, BT_U01, BT_U02
Effect_03	explain concept of reprogramming and knows cellular reprograming markers. Knows reprogramming methods. is able to define and discuuss linaeage programming	BT_W01, BT_W02, BT_W03, BT_W04, BT_W08, BT_U01, BT_U02, BT_U03, BT_U04, BT_K01, BT_K02
Effect_04	explain different signaling pathways that play a role in stem cells life and differentiation. Knows various small molecule enhancers of reprogramming. is able to critically assess in vitro differentation and in vitro derived cells	BT_W01, BT_W02, BT_W03, BT_W09, BT_U01, BT_U05
Effect_05	use with understanding scientific terminology: 3D culture, organoids, human mini-organs, organ-on-chip, multi-organ systems. Is able to explain characteristics of derived cells in vitro and in vivo.	BT_W01, BT_W02, BT_W03, BT_W04, BT_W05, BT_W06, BT_U01, BT_U02, BT_U04, BT_U07, BT_U02
Effect_06	explain applications in stem cell science, Is able to explain stem cells therapy pros and con on examples. Is competent in terms of finding adequate scientific literature covering topics of stem cells.	BT_W01, BT_W02, BT_W09, BT_U02, BT_K01

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

Course learning content:	**Course learning outcome symbol (EU)**
Different types of stem cells:(ESC), (iPS)C, (ASC), (ntESCs), ESC differentiation into three embryonic germ layers: ectoderm, mesoderm and endoderm, mouse vs. human stem cells, stem cells morphology and culture techniques.	Effect_01, Effect_02, Effect_03, Effect_06
Pluripotency of stem cells, types of cell potency: totipotent vs pluripotent vs multipotent, prime, and naïve pluripotency and formative pluripotency. molecular methods to assess pluripotency: alkaline phosphatase staining, epigenetic state and pluripotency markers detected with PCR, immunofluorescence, flow cytometry or NGS -PluriTest. Functional methods : in vitro differentiation, teratoma formation assay, chimera development, tetraploid complementation, germline transmission, pluripotency markers, pluripotency exit, LIF, TGFb and bFGF.	Effect_01, Effect_02, Effect_03, Effect_06
Cells reprogramming, transdifferentiation and dedifferentiation, cellular reprogramming factors - Yamanaka’s factors, epigenetic remodeling during reprogramming, nuclear reprogramming methods: somatic nuclear transfer (SCNT), cell fusion, transcription factor transduction. techniques for generating integration-free hiPSCs: SeV, mRNA, miRNA + mRNA, Epi and Retro/Lenti reprogramming, Mesenchymal-to-epithelial transition.	Effect_03, Effect_04, Effect_06
Small molecule screen with stem cells . Small molecule enhancers of reprogramming, Signaling pathways: EGF, TGF-beta, BMB, Wnt, Notch, embryoid bodies differentation towards cardiac (ActivinA, CHIR99021), endoderm (ActivinA, CHIR99021, LDN193189) and towards ectoderm (LDN193189, RepSox, Retinoic Acid).	Effect_01, Effect_04, Effect_06
Characteristics of derived cells in vitro and in vivo, 3D culture, organoids, human mini-organs, organ-on-chip, multi-organ systems, directed cell fate with the example of pancreatic β-cells	Effect_04, Effect_05, Effect_06
Applications in stem cell science: drug toxicity screening, new drug discovery, genetically reprogrammed cells (iPSC) = patient-specific disease models, autologous therapies, gene editing in stem cells with the example of CRISPR-Cas9 tool, stem cells application examples: bone marrow stem cells in leukemia, umbilical cord blood stem cells, pancreatic progenitors organoids containing β-cells for insulin therapy, imunorejection.	Effect_01, Effect_02, Effect_03, Effect_04, Effect_05, Effect_06

5. Reading list: fragments indicated by the teacher

1. Robert Lanza John Gearhart Brigid Hogan Douglas Melton Roger PedersenE. Donnall Thomas James Thomson Ian Wilmut: Essentials of Stem Cell Biology , Academic Press, London, 2013
2. Anthony Atala Robert Lanza Tony Mikos Robert Nerem: Principles of Regenerative Medicine, Academic Press, London, 2018
3. Robert Lanza Robert Langer Joseph Vacanti Anthony Atala: Principles of Tissue Engineering, Academic Press, London, 2020

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 and/or suggest different methods)

Teaching and learning methods and activities	**X**
Lecture with a multimedia presentation	X
Interactive lecture	

Problem – based lecture	X
Discussions	X
Text-based work	
Case study work	X
Problem-based learning	
Educational simulation/game	
Task – solving learning (eg. calculation, artistic, practical tasks)	
Experiential work	
Laboratory work	X
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	X

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

Assessment methods	**Course learning outcome symbol**					
	1	2	3	4	5	6
Written exam	X	X	X	X	X	
Oral exam	X	X	X	X	X	
Open book exam						
Written test						
Oral test						
Multiple choice test						X
Project						
Essay						
Report						
Individual presentation						X
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		40
Independent study*	Preparation for classes	15
	Reading for classes	25
	Essay / report / presentation / demonstration preparation, etc.	15
	Project preparation	15

	Term paper preparation	
	Exam preparation	25
	Other (please specify) -	
Total hours		135
Total ECTS credits for the course		6

* please indicate the appropriate activity types and/or suggest different activities

4. Assessment criteria in accordance with AMU in Poznan's grading system:

   Very good (bdb; 5,0): Student has very good knowledge of the entire content taught during classes.
   Good plus (+db; 4,5): Student has very good knowledge of the entire content taught during classes with some minor errors.
   Good (db; 4,0): Student has good knowledge of the entire content taught during classes.
   Satisfactory plus (+dst; 3,5): Student has good knowledge of the entire content taught during classes with some minor errors.
   Satisfactory (dst; 3,0): Student has sufficient knowledge of the entire content taught during classes
   Unsatisfactory (ndst; 2,0): Student has insufficient knowledge of the entire content taught during classes