University of Gdańsk

Subject card

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| Subject name and code | Embryology, PG_00198264 | | | | | | |
| Field of study | Biotechnology | | | | | | |
| Date of commencement of studies | October 2026 | | Academic year of realisation of subject | 2027/2028 | | | |
| Education level | Bachelor's studies | | Subject group | Obligatory subject group in the field of study<br>Optional subject group | | | |
| Mode of study | full-time studies | | Mode of delivery | at the university | | | |
| Year of study | 2 | | Language of instruction | Polish | | | |
| Semester of study | 4 | | ECTS credits | 1.0 | | | |
| Learning profile | academic | | Assessment form | credit | | | |
| Conducting unit | | | | | | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | | prof. dr hab. Mirosława Cichorek | | | | |
| | Teachers | | | | | | |
| Lesson types | Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
| | Number of study hours | 16.0 | 0.0 | 0.0 | 0.0 | 0.0 | 16 |
| | E-learning hours included: 0.0 | | | | | | |
| Learning activity and number of study hours | Learning activity | Participation in didactic classes included in study plan | | Participation in consultation hours | | Self-study | SUM |
| | Number of study hours | 16 | | 2.0 | | 7.0 | 25 |
| Subject objectives | By learning about the stages of human embryonic development and the fundamental stages of development of individual organs and the systems they create, students will understand the processes occurring during embryogenesis at the cellular, tissue, and organismal levels. Students will appreciate the complexity of these processes and the importance of understanding them for the development of biotechnology. Students will learn and acquire the ability to correctly use embryological concepts and terminology, as well as concepts from related scientific fields and disciplines, such as histology and anatomy, used in biotechnology. | | | | | | |

| Learning outcomes | Course outcome | Subject outcome | Method of verification |
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| | [BIOTECHL3_W04] The graduate has an advanced level of knowledge on the structure and functions of the human body in terms of anatomy, histology and physiology and understands their importance for medicine and medical biotechnology. | Understands the stages of human embryonic and fetal development, from fertilization to birth. Demonstrates understanding of embryological processes such as gastrulation, neurulation, and organogenesis, and their importance for the proper development of anatomical structures. Understands the connections between embryonic development and the anatomy of the adult organism. Knows the origin of tissues and organs from germ layers and can identify which structures develop from ectoderm, endoderm, and mesoderm. Understands the connections between prenatal development and the functioning of physiological systems after birth (e.g., circulation, respiration). | [SW4] test/exam - oral or written<br>[SW3] text preparation/written work |
| | [BIOTECHL3_W05] The graduate understands at an advanced level the mechanisms of vital function disorders and knows the causes, symptoms and methods of assessing selected disorders and pathological changes in the field of pathophysiology, biochemical disorders, and neoplasia; proposes advanced methods of assessing these disorders in the field of medical biotechnology and molecular diagnostics. | Understands the causes and effects of developmental disorders (teratogenesis) and their clinical significance. Familiar with methods for assessing biological and molecular function abnormalities used in medical biotechnology and molecular diagnostics (e.g., PCR, ELISA, sequencing, microarrays). Understands the importance of molecular biomarkers in assessing the course of disease and monitoring therapy. Understands the principles of embryological assessment of pathological changes, with particular emphasis on developmental defects and their prenatal diagnosis. | [SW4] test/exam - oral or written<br>[SW3] text preparation/written work |

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| Subject contents | GENERAL EMBRYOLOGY 1. Human Gametogenesis. Site of gametogenesis and period of individual life; Spermatogenesis: spermocytogenesis, spermiogenesis; Oogenesis in the fetal period and sexual maturity. The female ovarian and menstrual cycle. Fertilization. Capacitation; Multistage process (including the acrosomal reaction); Defense mechanisms against polyspermy; Male and female pronuclei; Zygote and its characteristics. 2. First week of development. Cleavage. Blastomeres. Adhesion molecules and their role in blastocyst formation. Implantation. The role of the zona pellucida. The role of the secretory properties of the trophoblast and adhesion molecules in the implantation process. hCG. Second week of development. Formation of the bilayered germinal disc: epiblast, hypoblast. Formation of the fetal membranes: yolk sac, amnion, chorion, allantois. 3. Gastrulation - formation of three germ layers. Germ shield: ectoderm, endoderm, mesoderm. Differentiation of germ layers. Ectoderm differentiation: neurulation, neuroectoderm, neural tube, neural crest cells (NCC), covering ectoderm. Endoderm differentiation - formation of the primitive gut. Mesoderm differentiation: paraxial, intermediate, lateral; intraembryonic body cavity. Somite formation: sclerotome, myotome, dermatome. 4. Fetal membranes as embryonic organs. Amnion - formation, structure, role of fluid in embryonic and fetal development. Formation of the umbilical cord. Primary and secondary yolk sac; role and fate. Allantois - function and fate. Chorion - origin, timing of development, developmental modifications. Placenta formation, structure of the maternal (basal decidua) and fetal (hairy chorion) parts. Placental circulation, placental barrier. Functions of the placenta. Monozygotic and dizygotic pregnancy. MAIN STAGES IN THE DEVELOPMENT OF HUMAN ORGANS AND SYSTEMS 5. The pharyngeal organ and its derivatives. Head mesenchyme (KGN), mesoderm. Timing of formation and structure of the pharyngeal arches, pouches, membranes, and grooves. Structures arising from individual arches. Structures arising from individual pharyngeal pockets, grooves, and membranes. The pharyngeal organ and the development of the face and oral cavity. Facial development - primordia and structures arising from them. Development of the oral cavity and selected its elements: tongue, palate, salivary glands. Development of the nasal cavities and the olfactory organ. 6. Outline of the development of the vascular system. Vasculogenesis. Angiogenesis. Heart formation, transformations of the sinus venosus, and the involvement of the GN. Selected elements in the development of the arterial and venous systems. Sites of hematopoiesis in the embryonic/fetal period. Fetal circulation and postnatal changes. Outline of respiratory system development. Formation of the lung bud from the primordial foregut. Stages of lung development: embryonic, pseudoglandular, canalicular, and terminal sacs. The relationship between the degree of respiratory epithelial differentiation and the survival of preterm fetuses. 7. Outline of gastrointestinal tract development. Development of the primordial foregut: foregut, midgut, and hindgut. Physiological umbilical hernia. Mesentery. Development of the liver and pancreas. Formation of pancreatic islets. Molecular aspects of primordial gut differentiation. 8. Outline of nervous system development. Neural tube differentiation - the involvement of HOX genes, Shh proteins, and BMPs. Differentiation of neural tube cells. The contribution of neural crests to the formation of various elements of the nervous system. Morphological and functional maturation of the nervous system. 9. Outline of the development of the urinary system. The role of the intermediate mesoderm in the formation of the nephrogenic and sex crests; Formation of the pronephros, mesonephros, and definitive kidney. Nephrons. The urogenital sinus. Development of the urinary bladder and urethra. 10. Outline of the development of the genital system and basis of sex differentiation. The chromosomal basis of sex determination. The Y chromosome, SRY gene; TDF and its role in testis formation; X chromosome; X inactivation, XIST gene. Gonadal formation: testis, ovary. The stage of undifferentiated gonads in the 6th week. Differentiation of the mesonephric and paramesonephric ducts according to sex. Hormones and sexual differentiation: antimüllerian hormone MIS/AMH, androgens, estrogens. Development of the external genitalia. 11. Outline of the development of the skeletal system, muscles, and skin. Formation of the spine; the involvement of HOX genes. Formation of the craniofacial bones. Limb development; HOX genes, morphogenetic proteins (BMPs) and their involvement in limb development; AER - apical crest. Origin of smooth muscle, skeletal muscle, and the heart. Myogenesis and its regulators. Origin of the epidermis and dermis. Derivatives of the epidermis: hair, nails, glands. Selected elements of the development of sensory organs: ear, eye. 12. Characteristics of the embryonic and fetal periods. Morphological characteristics of the embryo and fetus in each trimester of pregnancy. Carnegie stages. Parameters describing fetal size. Determining the duration of pregnancy and the due date. Labor inducers. Demonstrations of embryos and fetuses at different periods of development. Methods of prenatal diagnosis. 13. Causes of congenital defects - genetic, influence of the external environment.Genetic factors; trisomies of chromosomes 13, 18, and 21; chromosome structural disorders - deletion in chromosomes 5 and 15. Infectious factors; rubella virus as the earliest identified infectious agent causing fetal damage. Chemical factors; thalidomide and dimethylmercury as the earliest identified chemical agents causing fetal damage; Fetal Alcohol Syndrome (FAS). Physical factors. Time and degree of sensitivity of individual organs to teratogens. Polish Registry of Congenital Defects. SELECTED ISSUES OF MOLECULAR MECHANISMS OF DEVELOPMENTAL BIOLOGY 14. The process of cell growth and its molecular aspects. Definition of growth. Cell populations and the nature of their growth. Phased and asynchronous growth. The cell cycle and its regulation (cyclins, cdk kinases and their inhibitors; tumor suppressor genes - p53 and Rb. Growth factors. Proto-oncogenes. The role of cyclins and kinases in the regulation of oogenesis - MPF. The differentiation process as one of the fundamental problems of developmental biology. Various organizational levels of this process (morphological, biochemical, functional differentiation). The phenomenon of genome imprinting (imprinting of genomes). Homeotic genes in animals. HOX genes in humans; Transcription factors (homeodomains) and signaling proteins (TGF, BMP, Shh) in differentiation). 15. Adhesion molecules. Plasma membrane molecules (CAMs; integrins, cadherins, selectins, lectins). Intercellular space molecules (SAMs; e.g., fibronectin, collagens). Adhesion molecules: the molecular basis of cell morphogenesis and shape, signaling to cells that induce growth and differentiation. Cell death: necrosis, apoptosis. Morphological features of necrosis and apoptosis; Main components of the apoptotic mechanism (Fas/FasL system; TNF-α; Bcl-2 proteins: Bax, Bad, Bcl-2; p53 gene, caspases); Sequence of events in a cell undergoing apoptosis. Telomeres as biological clocks. Telomerase in gametes. |
| Prerequisites and co-requisites | |
| Assessment methods and criteria | |

| Subject passing criteria | Passing threshold | Percentage of the final grade |
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| colloqium | 51.0% | 100.0% |

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| Recommended reading | Basic literature | H. Bartel. EMBRYOLOGY, Publisher: PZWL, Year of publication: 2020, Edition: VI |
| | Supplementary literature | J.Malejczyk, M. Kujawa, T.W. Sadler. LANGMAN EMBRYOLOGY, Publisher: Edra Urban & Partner, Year of publication: 2025, Edition: XV |
| | eResources addresses | |
| Example issues/ example questions/ tasks being completed | | |
| Work placement | Not applicable | |

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