GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Molecular Genetics, PG_00058278		
Field of study	Biotechnology		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2024/2025
Education level	second-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Microbiology -> Faculty of Chemistry		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Beata Zalewska-Piątek	
	Teachers		

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	0.0	0.0	15.0	45

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	45	10.0	45.0	100

Subject objectives

The aim of the course is to familiarize the underlying mechanisms of the functioning genomes, regulating their activity and inheritance, and methods used to analyze the structure and function of genes,konockout of their activity and the effects of mutational changes.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U05] is able to apply instrumental methods of quantitative and qualitative analysis and studies on activity of biomolecules, select and apply diagnostic and analytical methods in the field of his/her specialty with particular emphasis on genetic, molecular and microbiological diagnostics and diagnostics based on antigen-antibody reaction	The student knows how to analyze mutational changes in the genome with regard to cytogenetic and molecular methods.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject
[K7_K02] is aware of the limitations and the necessity of continuous development of knowledge and technology; understands the need for education and constant training	Student analyzes the available state of knowledge regarding genome editing methods and their potential applications.	[SK2] Assessment of progress of work [SK5] Assessment of ability to solve problems that arise in practice [SK3] Assessment of ability to organize work
[K7_W01] has advanced knowledge of methods of genetic engineering and molecular genetics, functioning of the immune system and mechanisms of immune system response, diagnostic methods, and analytical methods in the area of specialty	Student is able to perform functional annotations of genes based on the available methods of molecular genetics.	[SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation

Subject contents	LECTURE **Genes as carriers of genetic information, the concept of genome. Eukaryotic genomes.** Physical structure of nuclear and non-nuclear (organellar) genomes - mitochondrial (mitochondria) and plastid DNA (chloroplasts), characteristics, genetic organization, packing mechanisms and functions performed in cells. **Prokaryotic genomes and mobile genetic elements.** Anatomy of prokaryotic genomes, global nucleoid organization and condensation mechanisms (NAP proteins, SMC group and homologous proteins, topoisomerases). The content of DNA repeating in genomes, tandem grouped (satellite DNA, mini-satellites and microsatellites) and scattered (LTR and non-LTR retrotransposons) and their use in various biological pathways of host cells. DNA transposons. **Functional annotations of genes.** Assigning to the found genes (their protein products) the function and role played in the cell / organism based on bioinformatic methods (e.g. searching for similar sequences, identification of motifs and structural domains in proteins, localization in the cell) and experimental (e.g. gene inactivation - homologous recombination) , transposons, RNA interference, analysis of protein interactions in yeast two- and one-hybrid systems, site-directed mutagenesis). **Group II RNA introns and switching off the action of bacterial genes.** The use of RNA group II introns (TargeTron Gene konockout system) in the process of site-specific inactivation of bacterial genes (localized recombination) of laboratory and clinical strains, introduction of point mutations and generation of chromosomal libraries with knocked out genes. Cre-loxP-dependent recombination based on Cre recombinase, showing a mechanism of action similar to type I DNA topoisomerases. **Genome editing. Programmed nucleases. CRISPR-Cas system.** Specific modifications of genomes (bacterial, plant, animal, human) mediated by programmed nuclease (meganuclease, zinc finger nuclease, ZFN, TALE nuclease, CRISPR system). **CRISPR-Cas9 system and its alternative - prime editing, potential applications.** The use of the CRISPR-Cas9 type II system in the creation of animal and cell models of human diseases (monogenic and multigeneous), in the therapy of genetic, cancer, viral and parasitic diseases. Characterization of the prime editing system, based on the fusion protein SpCas9n-RT (nicase Cas9-reverse transcriptase) and pegRNA (editing-homing RNA). **Regulation of genome activity by direct and indirect signal transduction.** Mechanisms determining short-term (direct and indirect signaling) and stable changes in genome activity (physical rearrangements of the genome, changes in the chromatin structure and feedback). **Regulation of changes in the genome during developmental processes on the basis of selected model organisms.** Research on the development of single and multicellular organisms and analysis of the mechanisms of neurodegenerative diseases (Bacillus subtilis, Caenorhabditis elegans, Drosophila melanogaster). **Mutations, mutagens and environmental mutagenesis.** Types and causes of mutations. Mutation effects (direct on the genome and indirect on the phenotype). Environmental mutagens. Methods used to study genotoxic effects. Ames test. Analysis of chromosomal aberrations. Sister chromatid exchange, SCE. The micronucleus method. Comet, SCGE and Tunnel Test. Fluorescence FISH hybridization and its modifications. **Biological responses at or below the organism level induced by chemical and physical factors (mutagens).** Biomarkers (acetylcholinesterases, coagulation proteins, monooxygenases, vitellogenin, porphyrins and heme synthesis) and biotransformation. **Transfection of eukaryotic cells as a basic tool for introducing biomolecules into cells.** Stable and transient transfection. Methods for introducing transgene and synthetic oligonucleotides into target cells. **Physical** (electroporation, microparticle bombardment, use of glass beads, direct microinjection into the cell nucleus), **chemical** (use of calcium phosphate, DEAE-dextran, cell penetrating peptides, lipid carriers) and **biological transfection** (viral vectors based on adenoviruses, retroviruses, lentiviruses, baculoviruses). SEMINAR 1.The history recorded in genes. What was the first DNA or RNA? Formation of new genes. 2. Construction and utilization of phylogentic trees. 3. Forensic genetics. Identification of persons and samples, paternity test, physical evidence examination. 4. Stem cells from cord blood. Applications and hope. 5. Tissue (genetic barriers in transplantation, the host response against the graft and graft versus host, the prevention of rejection, non-specific and specific immunosuppressive agents) and organ transplants. 6. Scaffolding tissue as an alternative to conventional transplantation of organs and tissues. Biomaterials mimicking the body's own tissues (polyesters and elastomers). 7. Biotechnological nanomaterials and their applications in medicine. 8. Recombinant proteins as useful therapeutic agents (insulin, growth hormone, blood coagulation factors, cytokines, humanizeg monoclonal antibodies).9. Molecular mechanism of neurotransmission. Neurotransmitter and sensor molecules. 10. Formation of bacterial biofilm (detection methods) and alternative therapy against antibioticotherapy. 11. Autoaggregative Ag43 adhesin in cells of *E. coli* and its role in the pathogenesis of bacterial infections (structure and transport of the domain of Ag43 antigen on the surface of bacterial cells, biological properties - adhesion, invasion, autoaggregation and biofilm formation). 12. Gene therapy and tumours (introduction of suicidal, immuno-modulating, anty-angiogenic and proapoptic genes into the cells). 13. MDR systems as the mechanism of Gram-negative bacteria drugresistance. 14. Molecular diagnostic of genetic diseases (diagnostic of chromosomal aberrations, point mutations, deletions). 15. Diseases X-linked transferred in recessive manner (haemophilia, Duchennes dystrophy, mucopolysaccharidosis type II). 16. Neurodegenerative diseases (Alzheimer, Parkinson, Huntington). 17. Autoimmunological diseases. 18. Syndromes s of recurrent fever in children genetically conditioned (TRAPS, MAPS - mild and very severe form, CINC and related syndromes type MWS and FCU) and without yet established genetic link (PFAPA). 19. Genetic predisposition to breast cancer and ovarian cancer in women ("high risk" genes, mutation and cancer, genetic tests). 20. The pathomechanism of urinary tract infections caused by uropathogenic *E. coli* strains and alternative forms of therapy (vaccines, innovative chemotherapeutics - pilicides).
Prerequisites and co-requisites	Fundamentals of biochemistry and molecular biology.

<table>
<tr><td>Assessment methods and criteria</td><td colspan="2"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>The composite mark including seminar and lecture. FINAL SCORE (%) = Seminar score - evaluation for the presented paper and the classes activity (%) x 0.4 + Lecture score - 2 written tests (%) x 0. 6.</td><td>60.0%</td><td>100.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>Brwon T. A. Genomes. PWN. 2019.

Żeromski J. Immunology. PZWL. 2000.

Epstein R.J. Molecular biology of human. CZELEJ. 2006.

Raszeja S., Nasiłowski W., Makarewicz J. Forensic medicine. Handbook for students. PZWL. 1990.

Szczerkowska Z. Biological studies in the judicial determination of paternity. Institute of Forensic Research, IES. 1998.

Szczerkowska Z., R. Pawlowski. Fundamentals of genetics court. Medical University of Gdansk, AMG. 2002.</td></tr>
<tr><td>Supplementary literature</td><td>Branden C., Tooze J. Introduction to protein structure. Garland. 1999.</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">Mutagens and environmental mutagenesis.

Functional annotations of genes.

Genome editing - CRISPR-Cas, prime-editing, programmed nucleases.

The use of model organisms in the analysis of gene expression.</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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