GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	MOLECULAR GENETICS, PG_00065568		
Field of study	GENETYKA MOLEKULARNA		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	Subject group	Optional subject group Specialty 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	2	Language of instruction	Polish
Semester of study	3	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Faculty of Chemistry -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Beata Zalewska-Piątek	
	Teachers		

Lesson types

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	5.0	40.0	90

Subject objectives

The aim of the course is to familiarize yourself with the basic mechanisms of genome functioning, the regulation of their activity and inheritance, and the methods used to analyze the structure and function of genes, their deactivation and the effects of mutational changes.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U08] prepares documentation of experiments and technological processes using professional terminology in biotechnology and related fields	The student analyzes the functional annotation documentation of genes using available biotechnological methods, using appropriate specialized terminology.	[SU3] Ocena umiejętności wykorzystania wiedzy uzyskanej w ramach przedmiotu [SU5] Ocena umiejętności zaprezentowania wyników realizacji zadania [SU1] Ocena realizacji zadania
[K7_W01] defines the phenomena, processes and laws of living nature applied to the production of useful goods and the carrying out of services	The student defines the basic molecular phenomena and processes related to the functioning of the genome and analyzes methods of their use in biotechnology and services based on biological knowledge.	[SW3] Ocena wiedzy zawartej w opracowaniu tekstowym i projektowym
[K7_K02] is aware of the potential risks and opportunities associated with the development of science and technology for the natural environment and society	The student identifies and evaluates the possible consequences of the development of molecular genetics and related technologies for the natural environment and the functioning of society, taking into account ethical and social aspects.	[SK5] Ocena umiejętności rozwiązywania problemów występujących w praktyce

Subject contents

Course content – lecture

Genes as carriers of genetic information, the concept of the genome. Eukaryotic genomes. The physical structure of nuclear and organellar genomes, packaging mechanisms, and functions. **Prokaryotic genomes and mobile genetic elements.** Anatomy and global nucleoid organization, condensation mechanisms. Repetitive DNA. Transposons. **Functional annotation of genes.** Assigning genes their role in the organism: bioinformatics methods and experimental methods (homologous recombination, transposons, RNA_i, yeast two- and one-hybrid systems, site-directed mutagenesis). G**roup II RNA introns and bacterial gene knockout.** Generation of chromosomal libraries with knockout genes. Cre-loxP-dependent recombination and Cre recombinase. **Genome editing. Programmable nucleases.** Modifications of genomes via meganucleases, ZFN and TALE nucleases, CRISPR system. **The CRISPR-Cas9 II system and its alternative prime editing and potential applications.** Development of animal and cellular models of human diseases, therapy of genetic, cancer, viral, and parasitic diseases. Characterization of the prime editing system based on the SpCas9n-RT. **Regulation of genome activity through direct and indirect signaling.** Mechanisms determining short-term and permanent changes in genome activity (genome rearrangements, changes in chromatin structure, and feedback). **Regulation of genomic changes during developmental processes**. Developmental studies of unicellular and multicellular organisms (*B. subtilis, C. elegans, D. melanogaster*). Analysis of the mechanisms of neurodegenerative diseases. **Mutations, mutagens, and environmental mutagenesis.** Methods used to study genotoxic effects. Ames test. Analysis of chromosomal aberrations. Sister chromatid exchange. Micronucleus method. Comet assay and Tunnel. Fluorescent hybridization and its modifications. **Biological responses induced by mutagens.** Biomarkers (acetylcholinesterase, coagulation proteins, monooxygenases, vitellogenin, porphyrins) and biotransformation.

Course content – seminar

1. History written in genes. Which came first, DNA or RNA? The formation of new genes. 2. Constructing and using phylogenetic trees. 3. Forensic genetics. Identification of individuals and samples, determining paternity, examining material evidence. 4. Stem cells from umbilical cord blood. Applications and hopes. 5. Tissue transplants and organ transplants. Legal, ethical, and cultural conditions of brain death. 6. Tissue scaffolds as an alternative to organ and tissue transplants. Biomaterials mimicking native tissues. 7. Biotechnological nanomaterials and their application in medicine. 8. Recombinant proteins as useful therapeutic agents (insulin, growth hormone, blood clotting factors, cytokines). 9. Molecular mechanism of neurotransmission. Neurotransmitter molecules (excitatory and sensory). 10. Bacterial biofilm formation (detection methods) and alternative therapy to antibiotic therapy. 11. Ag43 adhesin in *E. coli* cells and its role in the pathogenesis of bacterial infections (structure and transport, biological properties, autoaggregation, and biofilm formation). 12. Gene therapy and cancer (suicide, immunomodulatory, antiangiogenic, and proapoptotic genes). 13. MDR systems as a mechanism of resistance of Gram-negative bacteria to chemotherapy. 14. Molecular diagnosis of genetic diseases (chromosomal aberrations, point mutations, deletions). 15. X-linked recessive diseases (hemophilia, Duchenne muscular dystrophy, mucopolysaccharidosis type II). 16. Neurodegenerative diseases (Alzheimer's, Parkinson's, and Huntington's). 17. Genetically determined recurrent fever syndromes in children and syndromes without a known genetic basis. 18. Genetic predisposition to breast and ovarian cancer in women (high-risk genes, mutation and cancer, genetic testing). 19. Pathomechanism of UTIs caused by uropathogenic *E. coli* strains and alternative forms of therapy (vaccines, innovative chemotherapeutics).

Prerequisites and co-requisites

Fundamentals of biochemistry and molecular biology.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture evalution includes evaluation of the oral exam.	60.0%	60.0%
Seminar evaluation includes evaluation for the presented paper and the classes activity.	60.0%	40.0%

Recommended reading

Basic literature

Brown T. A. Genomes. PWN. 2019.

Węgleński P. Molecular Genetics. PWN 2012.

Żeromski J. Immunology. PZWL. 2000.

Epstein R.J. Human Molecular Biology. CZELEJ. 2006.

Raszeja S., Nasiłowski W., Makarewicz J. Forensic Medicine. Student Textbook. PZWL. 1990.

Szczerkowska Z. Biological Tests in Forensic Paternity Establishment. Institute of Forensic Research Publishing House, IES. 1998.

Szczerkowska Z., Pawłowski R. Fundamentals of Forensic Genetics. Medical University of Gdańsk Publishing House, AMG, Gdańsk, 2002.

	Supplementary literature	Ridley M. Genome. New York Times. Księgrania Bookcity. 2016. Branden C., Tooze J. Introduction to protein structure. Garland. 1999.
	eResources addresses	
Example issues/ example questions/ tasks being completed	Mutagens and environmental mutagenesis. Functional gene annotation. Genome editing - CRISPR-Cas prime editing, programmable nucleases. Use of model organisms in gene expression analyses.	
Practical activites within the subject	Not applicable	

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