



Subject card

Subject name and code	Separation Techniques, PG_00054721						
Field of study	Biotechnology						
Date of commencement of studies	October 2025		Academic year of realisation of subject		2027/2028		
Education level	first-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	3		Language of instruction		Polish		
Semester of study	5		ECTS credits		3.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Department of Process Engineering and Chemical Technology -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Patrycja Makoś-Chełstowska				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	30.0	0.0	0.0	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		25.0	75
Subject objectives	To provide students with a comprehensive understanding of the physicochemical and technological principles underlying classical and advanced mixture separation, purification, and concentration techniques in biotechnology. The course aims to foster proficiency in selecting optimal separation methodologies based on physical states, analyte/bioprocess physicochemical properties, and matrix complexity, while developing practical skills in designing, planning, and critically assessing process performance and efficiency.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	K6_U09		is able to select and apply appropriate chromatographic, spectroscopic, and key separation techniques (including membrane, extraction, sorption, and crystallization processes) for the isolation, purification, identification, and quantitative analysis of analytes and bioproducts from complex bioprocess matrices.		[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task		
	K6_W09		knows and describes the theoretical foundations, physicochemical mechanisms, and operating principles of key analytical methods as well as preparative mixture separation methods, and understands their applications in bioprocesses and biotechnological analytics.		[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects		

Subject contents	Course content – lecture		
	- Primary phase separation and mechanical methods - Pressure-driven membrane techniques (Microfiltration (MF), Ultrafiltration (UF), Nanofiltration (NF), and Reverse Osmosis (RO)) - Specialised membrane processes: Dialysis, electrodialysis, and pervaporation - Extraction processes - Surface phenomena and adsorption processes - Theoretical fundamentals of chromatographic separation - Liquid chromatography in biotechnology - Gas chromatography - Thermal separation methods - Crystallisation and precipitation - Electromigration techniques		
Prerequisites and co-requisites	Course content – laboratory		
	- Membrane processes - Low-pressure chromatography and thin-layer chromatography (TLC) in dye separation - Clarification of biotechnological mixtures (centrifugation/filtration) - Adsorptive protein separation		
Assessment methods and criteria	- Fundamental knowledge of analytical, organic, and physical chemistry, as well as bioprocess engineering. - Proficiency in concentration and mass balance calculations. - Ability to work safely in a chemical laboratory environment in accordance with HSE standards.		
	Subject passing criteria	Passing threshold	Percentage of the final grade
	Lectures - Written test	60.0%	60.0%
	Laboratories - Short written quizzes (entry tests) and lab reports	60.0%	40.0%
Recommended reading	Basic literature		
	S. Wroński, M. Ryszczyk, M. Molenda, <i>Separation Processes in Chemical and Bioprocess Engineering (Procesy rozdzielania mieszanin w inżynierii chemicznej i bioprocessowej)</i>, PWN, Warsaw. (Recommended English equivalent: R. G. Harrison, P. W. Todd, S. R. Rudge, D. P. Petrides, "Bioseparations Science and Engineering", 2nd ed., Oxford University Press, 2015). Z. Witkiewicz, <i>Fundamentals of Chromatography (Podstawy chromatografii)</i>, WNT, Warsaw. (Recommended English equivalent: A. Braithwaite, F. J. Smith, "Chromatographic Methods", 5th ed., Springer, 1996). M. Cheryan, <i>Ultrafiltration and Microfiltration Handbook</i>, 2nd ed., CRC Press, 1998. / K. Scott, <i>Handbook of Industrial Membranes</i>, Elsevier Advanced Technology, Oxford. J. W. Mullin, <i>Crystallization</i>, 4th ed., Butterworth-Heinemann, Oxford, 2001. P. A. Belter, E. L. Cussler, W.-S. Hu, <i>Bioseparations: Downstream Processing for Biotechnology</i>, John Wiley & Sons, New York, 1988.		
	Supplementary literature		
Example issues/ example questions/ tasks being completed	M. Ladisch, <i>Bioseparation Engineering: Principles, Practice, and Economics</i>, John Wiley & Sons, New York, 2001. J. M. Walker (Ed.), <i>The Protein Protocols Handbook</i>, 3rd ed., Humana Press, Totowa, 2009. L. R. Snyder, J. J. Kirkland, J. W. Dolan, <i>Introduction to Modern Liquid Chromatography</i>, 3rd ed., John Wiley & Sons, Hoboken, 2010.		
	eResources addresses		
Practical activities within the subject	- Discuss the mechanisms of concentration polarization and membrane fouling in pressure-driven membrane processes (MF, UF, NF, RO). Explain industrial strategies for their mitigation. - Perform the separation of a plant or food dye mixture using thin-layer chromatography (TLC) and low-pressure column chromatography. Calculate retention factors and retention volumes. - Construct a mass balance for an adsorptive/extractive protein separation process. - Determine the adsorption isotherm (Langmuir or Freundlich model) and calculate the yield and purity factor of the obtained fraction.		
	Not applicable		

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