GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Separation Techniques, PG_00054721		
Field of study	Biotechnology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
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/bioproduct 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_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
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

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

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

Prerequisites and co-requisites

- 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.

Assessment methods and criteria

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. Ryszczuk, M. Molenda, *Separation Processes in Chemical and Bioprocess Engineering* (*Procesy rozdzielania mieszanin w inżynierii chemicznej i bioprocesowej*), 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, *Fundamentals of Chromatography* (*Podstawy chromatografii*), WNT, Warsaw.

  (Recommended English equivalent: A. Braithwaite, F. J. Smith, "Chromatographic Methods", 5th ed., Springer, 1996).
- M. Cheryan, *Ultrafiltration and Microfiltration Handbook*, 2nd ed., CRC Press, 1998. / K. Scott, *Handbook of Industrial Membranes*, Elsevier Advanced Technology, Oxford.
- J. W. Mullin, *Crystallization*, 4th ed., Butterworth-Heinemann, Oxford, 2001.
- P. A. Belter, E. L. Cussler, W.-S. Hu, *Bioseparations: Downstream Processing for Biotechnology*, John Wiley & Sons, New York, 1988.

Supplementary literature

- M. Ladisch, *Bioseparation Engineering: Principles, Practice, and Economics*, John Wiley & Sons, New York, 2001.
- J. M. Walker (Ed.), *The Protein Protocols Handbook*, 3rd ed., Humana Press, Totowa, 2009.
- L. R. Snyder, J. J. Kirkland, J. W. Dolan, *Introduction to Modern Liquid Chromatography*, 3rd ed., John Wiley & Sons, Hoboken, 2010.

eResources addresses

Example issues/ example questions/ tasks being completed

- 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.

Practical activites within the subject

Not applicable

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