GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	DESIGN BIOTECHNOLOGICAL PROCESSES, PG_00065560		
Field of study	Biotechnology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2024/2025
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	1	Language of instruction	Polish
Semester of study	2	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Chemistry, Technology and Biotechnology of Food -> Faculty of Chemistry		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Robert Tylingo	
	Teachers	dr hab. inż. Robert Tylingo dr inż. Szymon Mania mgr inż. Adrianna Banach-Kopeć	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	30.0	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	10.0	35.0	90

Subject objectives	The aim of the course is to provide knowledge and skills in the design of biotechnological processes, from the conceptual stage to project implementation. Students will learn the principles of developing the assumptions necessary for designing the course of a biotechnological process and gain experience in executing projects according to defined guidelines. Particular emphasis is placed on integrating biological and engineering knowledge in process planning (including fermentation) and preparing students for work in the biotechnological industry.

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	Is prepared to work in a team in the implementation of an engineering project and shows initiative in solving problems arising during the design of the bioprocess and its reporting	[SU5] Assessment of ability to present the results of task
[K7_W06] recognizes the technological and scientific, as well as organizational and economic opportunities and limitations in biotechnology and related fields	Has structured knowledge of methods for conducting and designing biotechnological processes, understands their capabilities and limitations and the specifics of the biotechnological industry (including organizational aspects, management and economic analysis). Also has knowledge in the selection of appropriate processes, unit operations and equipment that meet the requirements specific to biotechnological production	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
[K7_U06] plans research and designs biotechnological products and processes taking into account legal regulations and bioethical principles	Is able to plan the course of a bioprocess and experimentally implement the designed process taking into account legal and technical requirements (e.g. bioethical regulations and principles of intellectual property protection). In addition, is able to analyze and interpret process data and update their knowledge in order to optimally design the process.	[SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information
[K7_K03] understands the social role and importance of providing reliable information and opinions to the public	Is aware of the importance of developing bioprocess science and technology for the economy and understands the responsibility associated with designing biotechnological processes. Is able to justify the need to comply with the principles of bioethics and Good Manufacturing Practice (GMP) when planning and conducting processes.	[SK4] Assessment of communication skills, including language correctness

Subject contents

Lectures (15h)The course is divided into a series of lectures presenting theoretical and practical aspects of bioprocess design, conducted in hybrid, synchronous and asynchronous mode. Introduction to bioprocess design: Basic concepts and stages of biotechnological process design. Discussion of the components of the process design and technological principles of its creation. Fermentation in biotechnological production: Characterization of fermentation processes as examples of bioprocesses. Selection and improvement of production microorganisms, their nutritional requirements and growth kinetics. Mass and energy balances in microorganism cultivation (elemental balance of substrate and biomass, oxygen balance, process heat balance). The energetic processes of microorganisms and the effect of cultivation conditions on bioprocess efficiency will also be presented. Bioprocess engineering technologies: Review of unit operations in biotechnology (including mixing, aeration, sterilization, separation) and types of bioreactors used on a laboratory and industrial scale. Scale-up principles of biotechnological processes: criteria for similarity and methods for transferring results from the laboratory to an industrial scale. Discussion of the selection of process parameters and equipment to ensure that efficiency is maintained when changing scale. Design of the technological process: Creation of process documentation, conceptual and technological diagrams of biotechnological processes and scheduling of equipment operation. Economic and environmental analysis of processes: Discussion of methods for assessing the profitability of a biotechnological process, estimating the costs of raw materials, media, equipment and calculating economic indicators (e.g. ROI, NPV). Introduction to the analysis of the environmental impact of processes (LCA, energy consumption, waste management) and to the issues of sustainable development in biotechnology (Earlystage sustainability assessment of biotechnological processes: A case study of citric acid production - PMC). Legal requirements and regulations (e.g. IPPC guidelines for integrated pollution prevention) related to the design of biotechnological installations will also be discussed. Industrial case studies: Analysis of selected examples of biotechnological processes in the food and pharmaceutical industries, along with a discussion of the technological solutions used. The presented case studies may include, among others: fermentation production (e.g. antibiotics, bioethanol, citric acid) and enzymatic processes. These examples cover practical aspects such as ensuring product quality and safety (including compliance with GMP principles), production scaling and risk assessment and remedial strategies in the event of failures or process deviations. Laboratory (30h): Laboratory classes take the form of projects and practical exercises, during which students (working in small teams) use the acquired knowledge to solve specific bioprocess engineering problems in creating their own biotechnological product. Modern teaching methods are used in the course to increase student engagement and teaching effectiveness. Lectures are conducted using multimedia presentations and discussion elements, and some of the content is delivered in a blended learning model (hybrid education) - students receive teaching materials on the eNauczanie PG e-learning platform (e.g. short recordings of lectures, online quizzes) to familiarize themselves with before classes. Lecturers and laboratory instructors act as mentors, providing ongoing feedback. In the evaluation process, the presentation of project results by teams is of great importance - each group prepares a report and a short presentation summarizing its process project. This approach emphasizes the development of engineering communication skills (reporting results, justifying design decisions)

Prerequisites and co-requisites	Students starting the course are required to have basic knowledge of engineering and biological sciences, including in particular: elements of mechanical engineering and industrial equipment, basics of chemical/ process engineering, and general basics of biotechnology. It is essential to understand physicochemical and biochemical processes (e.g. basics of biochemistry and microbiology) as a basis for designing biotechnological processes. The student should also be able to use basic engineering calculations (mass and energy balances, process units) and know the basics of bioreactor technology from previous courses.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Exam	60.0%	30.0%
Project	100.0%	70.0%

Recommended reading

Basic literature

1. Shuler M.L., Kargi F. Bioprocess Engineering: Basic Concepts. Prentice Hall, 2nd ed., 2002 (lub nowsze wydanie). Podręcznik wprowadzający w inżynierię bioprocesową, zawierający omówienie kluczowych procesów (w tym fermentacji) i łączący aspekty biologiczne z inżynierskimi (Bioprocess Engineering: Basic Concepts: 9780131228573: Amazon.com: Books).

1. Ratledge C., Kristiansen B. Podstawy biotechnologii przemysłowej. PWN, Warszawa 2011. Nowoczesne kompendium biotechnologii przemysłowej omawiające zarówno podstawy teoretyczne, jak i przykłady zastosowań; przydatne jako uzupełnienie treści kursu ().

1. Bednarski W., Fiedurek J. Podstawy biotechnologii przemysłowej. WNT, Warszawa 2015. Podręcznik (wyd. poprawione) w języku polskim opisujący procesy biotechnologiczne z perspektywy inżynierskiej i technologicznej zawiera liczne przykłady procesów fermentacyjnych i metod ich intensyfikacji.

1. Stanbury P.F., Whitaker A., Hall S.J. Principles of Fermentation Technology. Elsevier, 3rd ed., 2017. Klaszczyny podręcznik szczegółowo opisujący technologię fermentacji, od hodowli mikroorganizmów po zagadnienia skalowania i aparatury fermentacyjnej; stanowi cenne źródło wiedzy pogłębiającej zagadnienia poruszane na wykładach.

Supplementary literature

1. Towler G., Sinnott R. Chemical Engineering Design. Butterworth-Heinemann/Elsevier, 2008. Podręcznik z zakresu projektowania inżynierskiego (chemicznego i procesowego) przydatny w kontekście metod projektowania aparatów i oceny ekonomicznej procesu (rozdziały dotyczące analizy kosztów i ekonomii procesowej) ().

1. Synoradzki L., Wiśialski J. Projektowanie procesów technologicznych. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2006. Polska publikacja szczegółowo opisująca metodykę projektowania procesów przemysłowych (w tym biotechnologicznych) od bilansowania masy i energii, przez dobór operacji, po zagadnienia optymalizacji i bezpieczeństwa.

1. Kucharski S., Głowiński J. Podstawy obliczeń projektowych w technologii chemicznej. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2000. Źródło pomocne przy wykonywaniu obliczeń inżynierskich na etapie projektowania procesów; zawiera liczne przykłady obliczeniowe przydatne w zadaniach laboratoryjnych ().

1. Heinzle E., Biwer A., Cooney C. Development of Sustainable Bioprocesses: Modeling and Assessment. John Wiley & Sons, 2006. Publikacja naukowa w języku angielskim skupiająca się na modelowaniu bioprocesów oraz ich ocenie pod kątem zrównoważonego rozwoju (ekonomia i ekologia); stanowi wartościowe uzupełnienie kursu w obszarze analizy środowiskowej procesów biotechnologicznych.

eResources addresses

Adresy na platformie eNauczanie:

PROJEKTOWANIE PROCESÓW BIOTECHNOLOGICZNYCH - Moodle ID: 44667
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=44667

Example issues/ example questions/ tasks being completed	Mass and heat balance of biochemical transformationsDesigning a fermentation tank using the principles of scaling upUnsteady heat transfer in a batch reactorMaking assumptions for the process design of the selected bioprocess.
Work placement	Not applicable

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