

STUDY GUIDE

MICROBIAL INTERACTIONS IN THE BIODEGRADATION OF ENVIRONMENTAL POLLUTANTS

Organised by

Poznan University of Technology

1. IDENTIFYING DATA.											
• Course Name.	Microbial Interactions in the Biodegradation of Environmental Pollutants										
• Coordinating University.	Poznan University of Technology (PUT)										
• Partner Universities Involved.	-										
• Course Field(s).	Environmental Biotechnology; Environmental Microbiology; Bioremediation										
• Related Study Programme.	Environmental Protection, Biotechnology, Chemical & Bioprocess Engineering										
• ISCED Code.	ISCED 0511 – Biology										
• SDG.	SDG 6 – Clean Water and Sanitation SDG 12 – Responsible Consumption and Production SDG 13 – Climate Action SDG 15 – Life on Land										
• Study Level.	Master (M) / Doctorate (D)										
• EUNICE Key Competencies	[Indicate the Key Competencies offered by the course.] • Green – strongly • Orange - moderately • Red – partially • Blank cell - not at all <table border="1"> <tbody> <tr> <td>Problem solving</td> <td></td> </tr> <tr> <td>Teamworking</td> <td></td> </tr> <tr> <td>Communication</td> <td></td> </tr> <tr> <td>Self-management</td> <td></td> </tr> <tr> <td>Cognitive flexibility</td> <td></td> </tr> </tbody> </table>	Problem solving		Teamworking		Communication		Self-management		Cognitive flexibility	
Problem solving											
Teamworking											
Communication											
Self-management											
Cognitive flexibility											

	Digital competence	
	Technical competence	
	Global intercultural competence	

• Number of ECTS credits allocated.	3 ECTS
• Mode of Delivery.	Online live / Online self-study
• Language of Instruction.	English 100%
• Course Dates.	1 March – 30 April 2027, Thursday 10:00 – 11:30
• Precise Schedule of the Lectures.	The course consists of 10 weekly sessions of 1.5 hours each. The first 6 sessions are lecture-based, followed by 2 sessions dedicated to group work and consultation, and 2 sessions for student presentations.
• Key Words.	biodegradation, microbial interactions, pollutants, soil microbiome, bioavailability, bioremediation
• Catchy Phrase.	Biodegradation - why it works, why it fails, and what microbes really do.

• Prerequisites and co-requisites.	The course is open to Master and Doctoral students with English proficiency at B2 level or higher. Basic knowledge of microbiology and environmental science is recommended, but not required.
• Number of EUNICE students that can attend the Course.	40
• Number of EUNICE students that can attend the course per institution	4
• Course inscription procedure(s).	Standard EUNICE procedure

2. CONTACT DETAILS.

· Department.	Faculty of Chemical Technology, Department of Organic and Bioorganic Chemistry
· Name of Lecturer.	Marta Woźniak-Karczewska, PhD Eng., Assistant Professor
· E-mail.	marta.wozniak-karczewska@put.poznan.pl
· Other Lecturers.	-

3. COURSE CONTENT.

This course explores the complexity of microbial interactions involved in the biodegradation of environmental pollutants, positioning biodegradation as a dynamic outcome of interactions between microorganisms, pollutants, and environmental conditions.

The course focuses on selected groups of contaminants, including hydrocarbons (e.g., petroleum-derived compounds), herbicides and pesticides, pharmaceuticals and personal care products, as well as surfactants, microplastics and other emerging pollutants. These examples are used to illustrate how physicochemical properties of pollutants influence their bioavailability and susceptibility to microbial degradation.

The course is delivered through a series of lectures introducing key concepts and mechanisms, followed by problem-oriented group work. During the lectures, students will be provided with a theoretical and conceptual framework covering microbial ecology, biodegradation pathways, and environmental constraints. This knowledge will then be applied in small-group projects, where students analyze real-world environmental scenarios.

Students will explore not only why biodegradation processes succeed or fail, but also how they can be improved, predicted, or misinterpreted. Problem-based tasks will address issues such as discrepancies between laboratory and field results, limitations of bioaugmentation strategies, the role of microbial diversity, and the influence of environmental and operational factors on bioremediation outcomes.

Particular emphasis is placed on microbial community interactions (e.g., competition, cooperation), pollutant bioavailability, and environmental constraints such as soil moisture, nutrient availability, and matrix heterogeneity. Through selected case studies, students will examine the complex interplay between these factors and their impact on biodegradation efficiency.

As part of the course, students will work in small groups (2–3 persons) to investigate a selected biodegradation-related problem and present their findings in the form of a short presentation. This task is designed to integrate theoretical knowledge gained during lectures with critical analysis, data interpretation, and collaborative problem-solving.

4. LEARNING OUTCOMES.

After completing the course, students will be able to:

1. Describe and explain the mechanisms of microbial biodegradation of environmental pollutants
2. Analyze microbial interactions in complex environmental systems
3. Evaluate the role of environmental factors in shaping biodegradation processes
4. Interpret scientific data related to microbial communities and pollutant degradation
5. Critically assess the effectiveness and limitations of bioremediation strategies in real environments
6. Develop and present a structured solution to a biodegradation-related problem based on scientific evidence

5. OBJECTIVES.

The main objectives of this course are to:

1. Provide a systems-level understanding of biodegradation processes in environmental contexts, with particular emphasis on the role of microbial interactions
2. Present key groups of environmental pollutants and their physicochemical properties in relation to microbial degradation and bioavailability
3. Highlight the complexity of real-world biodegradation processes and the limitations of transferring laboratory findings to environmental applications
4. Introduce the influence of environmental factors, such as moisture, nutrient availability, and soil structure, on microbial activity and pollutant transformation
5. Develop critical thinking in analyzing biodegradation and bioremediation processes, including identifying factors that determine their success or failure
6. Encourage the integration of theoretical knowledge with practical problem-solving through analysis of real-world case studies
7. Foster collaborative work and structured scientific reasoning through small-group problem-based tasks and discussion

6. COURSE ORGANISATION.

UNITS

1.	Introduction to biodegradation and environmental pollutants Overview of major pollutant groups (hydrocarbons, pesticides, pharmaceuticals, surfactants) and fundamental concepts of microbial biodegradation.
2.	Microbial communities and interactions in biodegradation processes Cooperation, competition, functional redundancy, and the role of microbial diversity in pollutant degradation.

3.	Bioavailability and pollutant–matrix interactions Distinction between total concentration and bioavailable fraction; sorption, desorption, and accessibility of pollutants.
4.	Environmental constraints as a key factor in bioremediation Influence of soil moisture, nutrient availability, and physical structure on microbial activity and degradation processes.
5.	From laboratory to environment: limitations and challenges Differences between controlled experiments and field conditions; why biodegradation and bioremediation strategies fail or succeed.
6.	Bioremediation approaches and their effectiveness Natural attenuation, biostimulation, bioaugmentation - opportunities, limitations, and common misconceptions.
7.	Problem formulation and group work (part I) Introduction of problem-based tasks, selection of topics, and initial group work (2–3 students per group). Students will be required to formulate a research question and define the scope of their analysis.
8.	Group work (part II) and consultation Independent group work supported by instructor consultation and discussion.
9.	Student presentations (part I) Group presentations and discussion.
10.	Student presentations (part II) and course wrap-up Continuation of presentations, feedback, and synthesis of key concepts.
LEARNING RESOURCES AND TOOLS.	
• Lecture materials (slides and supplementary notes) • Scientific literature (selected research papers and review articles) • Case study descriptions and problem-based assignments • Online learning platform (e.g., Moodle or equivalent) for materials and communication • Presentation tools (e.g., PowerPoint or equivalent) • Optional interactive tools (e.g., Mentimeter) to support discussion and engagement	
PLANNED LEARNING ACTIVITIES AND TEACHING METHODS.	
• Lectures introducing key concepts related to biodegradation and microbial interactions • Discussion of selected real-world examples of biodegradation and bioremediation processes • Problem-based group work (2–3 students per group) focused on analyzing a selected environmental issue • Independent preparation of group presentations based on scientific literature and course materials • Presentation of results followed by discussion and feedback	

7. ASSESSMENT METHODS, CRITERIA AND PERIOD.

The course is graded. The final grade is based on continuous assessment and group work.

Assessment consists of the following components:

1. Group project (presentation): 70%

Students work in small groups (2–3 persons) to analyze a selected problem related to biodegradation processes. The project is presented during the final sessions of the course.

Each group member is expected to actively participate in the presentation and discussion.

The evaluation is based on:

- understanding of the problem and its scientific background
- ability to apply theoretical concepts introduced during lectures
- quality of analysis and critical discussion
- use of scientific literature
- clarity and structure of the presentation

2. Participation and engagement: 30%

This component reflects the student's individual involvement during the course and is evaluated based on:

- attendance
- contribution to in-class discussions
- engagement during group work sessions

Final grades are assigned according to the grading system of the coordinating university (PUT).

OBSERVATIONS.

Attendance is expected throughout the course, as active participation is an essential part of the learning process. Students are required to contribute to group work and be present during the presentation sessions.

The lecturer may adjust the assessment in justified cases (e.g., uneven contribution within a group), based on observed engagement and participation.

8. BIBLIOGRAPHY AND TEACHING MATERIALS.

Vidali, M. (2001). Bioremediation. Pure and Applied Chemistry, 73(7), 1163–1172.

Thompson, I. P., van der Gast, C. J., Ciric, L., & Singer, A. C. (2005). Bioaugmentation for bioremediation: the challenge of strain selection. Environmental Microbiology, 7(7), 909–915.

Bala, S. et al. (2022). Recent strategies for bioremediation of emerging pollutants. *Toxics*, 10(8), 484.

Atlas, R. M., & Hazen, T. C. (2011). Oil biodegradation and bioremediation: a tale of the two worst spills in U.S. history. *Environmental Science & Technology*, 45(16), 6709–6715.

Ciesielski, T. et al. (2025). Moisture governs diesel biodegradation in sand soil – polystyrene microplastic have a negligible impact. *Journal of Hazardous Materials*, 498, 139907.

Woźniak-Karczewska, M. et al. (2022). Effect of Cation Sorption on 2,4-D Mobility of Herbicidal Ionic Liquids in Agricultural Soil Combined with Diversity of the Bacterial Community. *ACS Sustainable Chemistry & Engineering*, 10, 12559–12568.

Woźniak-Karczewska, M. et al. (2019). Effect of bioaugmentation on long-term biodegradation of diesel/biodiesel blends in soil microcosms. *Science of the Total Environment*, 671, 948–958.

Additional scientific papers and case studies will be provided during the course.