Course name: Environmental biotechnology and bioremediation

ECTS	5
Course status	facultative
Course final assessment /evaluation of outcomes	*Exam*
Prerequisite	*Basic knowledge and skills in biology, cell physiology, and biochemistry*

Main field of study:
Agriculture and Horticulture, Biology and Biotechnology (Erasmus+)

Educational profile	General academic
Code of studies and education level	bachelor/engineer (SI) or master of science (SM)
Semester of studies	Winter or summer
Language of instruction	English

Course offered by:

Name of faculty offering the course	Faculty of Biotechnology and Horticulture
Name of department offering the course	Dept. Plant Biology and Biotechnology
Course coordinator	dr hab. Paweł Kaszycki, prof. URK

Learning outcomes:

Symbol of outcome	Description of the learning outcome	Reference to main field of study outcomes	Area symbol*
KNOWLEDGE – student knows and understands			
EnBtB_W1	The scope and particular aims of environmental biotechnology together with the applied methodology	BIOT1_W10 BIOT1_W12 BIOT1_W16 BIOT1_W19 BIOT1_W20 BIOT1_W25	R, P
EnBtB_W2	The mechanisms and processes leading to degradation of particular elements of the natural environment	BIOT1_W20	R, P
EnBtB_W3	Biological methods that use microorganisms and plants, employed in actions taken to protect the environment and bioremediate pollutants	BIOT1_W04 BIOT1_W12 BIOT1_W16 BIOT1_W19 BIOT1_W20 BIOT1_W25	R, P
EnBtB_W4	Metabolic and genetic strategies of adaptation of microorganisms to anthropogenic environmental contaminants and metabolic pathways of selected xenobiotics	BIOT1_W02 BIOT1_W03 BIOT1_W05 BIOT1_W10	R, P
EnBtB_W5	Selected techniques for utilization of biological processes in environmental protection together with their optimization and scaling from laboratory studies to industrial practice, while illustrating them with specific implementation examples	BIOT1_W10 BIOT1_W12 BIOT1_W16 BIOT1_W25	R, P
EnBtB_W6	The concept and scope of utilization of biomass, biofuels and vegetation cover as a means to decrease an impact of global climatic changes	BIOT1_W02 BIOT1_W10 BIOT1_W25	R, P

SKILLS – student is able to			
EnBtB_U1	Characterize various research levels upon elaborating biological technologies and properly evaluate the role of basic and application studies	BIOT1_U01 BIOT1_U03 BIOT1_U07	R, P
EnBtB_U2	Properly evaluate the need and advantages of the use of novel scientific research achievements for applications in environmental practice	BIOT1_U01 BIOT1_U03 BIOT1_U13	R, P
EnBtB_U3	Select optimal research strategies for environmental studies as well as carry out and describe scientific experiment together with the analysis and interpretation of results	BIOT1_U01 BIOT1_U03 BIOT1_U06 BIOT1_U07 BIOT1_U13 BIOT1_U16 BIOT1_U19	R, P
SOCIAL COMPETENCIES – student is ready to:			
EnBtB_K1	Apply the occupational laboratory safety regulations, professionally carry out the assigned tasks and take care of the workplace in the laboratory of environmental biotechnology	BIOT 1_K02 BIOT 1_K10	R, P
EnBtB_K2	Undertake conscious actions to eliminate civilization risks, to protect the environment and assure biological balance and biodiversity in ecosystems, according to the rules of sustainable development	BIOT1_K05 BIOT1_K06	R, P
EnBtB_K3	enhancing professional qualifications and updating of the relevant knowledge	BIOT 1_K01 BIOT 1_K07	R, P

Teaching contents

Lectures	30 hours
Topics	1. The concept of Anthropocene; anthropogenic activities involving industrial and agricultural expansion negatively affect all the elements of the environment. 2. Examples of ecological risks as caused by industrial injuries, ecological damages and disasters. 3. Environmental pollutants as xenobiotics. Classes of contaminants, emission sources, toxicity and ecological risk. 4. Current scientific research topics and application efforts aimed at environmental protection, conservation and reclamation of degraded sites – challenges for modern biotechnology. Advantages of biological methods compared to alternative approaches. 5. Basic definitions and terms used in environmental biotechnology. Elements of legal regulations regarding the environment. 6. Preventive actions taken to protect the environment: ecotones, biogeochemical barriers, protective zones. The issue of climate change and biotechnologies aimed at preventing global warming (idea of biomass, biofuels, green roofs, CO2 biosequestration). 7. Bioremediation – definition and strategies; key processes: bio-sorption, -extraction, -accumulation, -transformation and -degradation. 8. Elements of aerobic and anaerobic metabolism of xenobiotics: examples of microbial enzymatic biodegradation pathways. 9. Bioremediation of heavy-metal contamination: adsorption, metal uptake and metabolism, transformations, biosequestration. Phytotechnologies – phytostabilization and phytoremediation, elements of biohydrometallurgy, constructed wetland plants. 10. Microbial-based biotechnologies: Mechanisms of microorganisms adaptation to the presence of xenobiotics. Applications: monocultures, co-cultures and microbial consortia for bioremediation. Synergy effect, biostimulation and bioaugmentation techniques. 11. Biological treatment of wastewaters with the activated sludge. Modern trends in biological

	wastewater treatment systems. 12. Anaerobic organic waste management: biomethanation. Biotreatment of waste gases. Composting of soil, sludges and organic waste. 13. Methods for microbial reclamation of soil polluted with organic substances – the in situ and ex situ technologies. Biotransformation of contaminants including plastics into environmentally-safe added-value products and bio-based materials. The concept of biorefineries. 14. From basic research to biotechnological applications: current trends in biochemical, molecular biology, genomic and proteomic studies of bioremediation mechanisms. 15. Examples of environmental practice – description of selected large-scale cleanup projects carried out by the team of Plant Biol. & Biotech. Dept.
Accomplished learning outcomes	*EnBtB_W1-W6, EnBtB_K2, EnBtB_K3*
Means of verification, rules and criteria of assessment	*Time-restricted written exam (70% participation to the final score)*
Classes:	15 hours
Topics	1. Biological treatment of industrial effluents: the application of methylotrophic yeasts for formaldehyde and methanol biodegradation in model wastewater systems (5h). 2. Isolation of autochthonous microorganisms from soil contaminated with petroleum products (5 h). 3. Selection and adaptation of bacterial isolates to the presence of organic compounds; testing the microorganisms potential to degrade contaminants (5 h).
Accomplished learning outcomes	*EnBtB_U1-U3, EnBtB_K1-K3*
Means of verification, rules and criteria of assessment	*Evaluation of the preparedness for classes; written report on laboratory work (30%)*

References:

Basic	*1. Liu W.-T., Jansson J.K. (eds.) Environmental Molecular Microbiology, Caister Academic Press, 2009.* *2. Wood T. K. (2008) Molecular approaches in bioremediation. Current Opinion in Biotechnology 19: 572–578.* *3. Macek T., Kotrba P., Svatos A., Novakova M., Demnerova K., Mackova M. (2007) Novel roles for genetically modified plants in environmental protection. Trends in Biotechnology 26 (3): 146-152*
Supplementary	*4. van Hamme J.D., Singh A., Ward O.P. (2003) Recent advances in petroleum microbiology. Microbiology and Molecular Biology Reviews 67 (4): 503–549.* *5. Brzeszcz J., Kaszycki P. (2018) Aerobic bacteria degrading both n-alkanes and aromatic hydrocarbons - an undervalued strategy for metabolic diversity and flexibility. Review. Biodegradation 29(4): 359-407.* *6. Kaszycki P., Petryszak P., Pawlik M., Kołoczek H. (2011) Ex situ bioremediation of soil polluted with oily waste: use of specialized microbial consortia for process bioaugmentation. Ecological Chemistry and Engineering S 18 (1): 83-92.* *7. Brzeszcz J., Steliga T., Kapusta P., Turkiewicz A., Kaszycki P. (2016) r-strategist versus K-strategist for the application in bioremediation of hydrocarbon-contaminated soils. International Biodeterioration and Biodegradation 106: 41–52*

Structure of learning outcomes

Area of academic study: R – Agricultural, forestry and veterinary sciences	2.5
Area of academic study: P – Biological sciences	2.5

Structure of student activity

Contact hours		53	hrs.	2.1	ECTS**
Including:	lectures	30	hrs.		
	classes and seminars	15	hrs.		
	consultations	4	hrs.		
	participation in research	…	hrs.		
	obligatory traineeships	…	hrs.		
	participation in examination	4	hrs.		
e-learning		…	hrs.	….	ECTS**
student own work		72	hrs.	2.9	ECTS**

*Areas of academic study in the fields of: P – biological sciences; R – agriculture and horticulture

** stated with an accuracy to 0.1 ECTS, where 1 ECTS = 25 - 30 hours of classes