Subject name	Bioremediation and soil reclamation	
Subject code		
Department	Department of Botany and Plant Physiology	
Faculty	Faculty of Biotechnology and Horticulture	
Subject supervisor/Lecturer	dr hab. Joanna Augustynowicz/dr hab. Joanna Augustynowicz, dr hab. Ewa Hanus-Fajerska, dr hab. Paweł Kaszycki, dr hab. Agnieszka Lis-Krzyścin	
General information	Teaching period	1 semester / summer semester
	ECTS credit	6
	Lectures total	30 h
	Lab practical's	30 h
Objective and general description	The course is aimed to bring theoretical knowledge on bioremediation and phytoremediation processes. During the course students learn about biological-based methods to eliminate environmental pollution and to recover air, and soil-water environments affected by various contaminants (organic substances, heavy metals, etc.) Genetic, physiological, and metabolic adaptation strategies of organisms to the presence of toxic contaminants are discussed. Several biochemical degradation pathways of organic compounds are shown and bioremediation mechanisms of heavy metal contamination are given. A wide resource of unique environmental microorganism strains with biotechnological applications are presented. Examples of technical-scale soil and water cleanup biotechnologies are also given.	
Lectures	1. Geotechnical, physical, chemical and biological degradation in the environment. Ways of their protection and reclamation. Degradation phenomena in nature. The general principles of reclamation of degraded areas. Methods of soil fertility increasing. **(10 h)** 2. Site programs applied in the landscape. How the term "phytotechnology" could be defined at city conditions and why do we need phytotechnologies. Evolutionary ecology of plant adaptations to the contaminated sites**. (6 h)** 3. Definition and the classification of phytoremediation strategies: phytoextracion, phytostabilization, rhizofiltration, phytovolatization, rhizodegradation, phytodegradation. Environmental pollutants as xenobiotics. Contaminants in aquatic environment. Mechanism of phytoremediation: from the molecular level to the constructed wetlands technologies.	

	Selected aquatic phytoremediators – case studies. **(8 h)** 4. Bioremediation as a strategy of microorganisms to cope with anthropogenic contaminants and a biotechnological tool to eliminate environmental pollutants. Genetic, physiological, and metabolic strategies of microorganisms adaptation to the presence of toxic xenobiotics and heavy metals. Selected metabolic pathways of biodegradation of toxic chemicals by pro- and eukaryotic microorganisms. Co-metabolism and bioremediation of heavy-metal contamination. From basic research to biotechnological applications: bioremediation of xenobiotics in industrial effluents and in soil. Examples of environmental practice: *in situ* and *ex situ* methods for soil reclamation. **(6h)**
Lab/field practicals	1. The use of macrophyte survey to assess biological water quality standard - field study. **(7h)** 2. Sewage treatment plant – field project. **(8h)** 3. Case study – exemplary pilot scale phytoremediation project. **(10h)** 4. MUT (methanol utilization) pathway of methylotrophic yeasts in environmental biotechnology – monitoring biodegradation of single-carbon (C_1) xenobiotics: methanol and formaldehyde. Isolation of autochthonous bacteria inhabiting soil polluted with petroleum products: selection of potent biodegraders of organic contaminants. **(5 h)**
Literature	1. Dhir B. Phytoremediation: Role of Aquatic Plants in Environmental Clean-Up. Springer 2013 2. Lovley D.R., Coates J.D. (1997) Bioremediation of metal contamination. *Curr Opinion Biotechnol.* 8: 285 - 289. 3. Kaszycki P., Tyszka M., Malec P., Kołoczek H. (2001) Formaldehyde and methanol biodegradation with methylotrophic yeast *Hansenula polymorpha*. An application to real wastewater treatment. *Biodegradation* 12 (3):169-177. 4. de Albergaria J. T., Nouws H. P.. Soil Remediation: Applications and New Technologies. CRC Press 2016 5. Hasegawa, Hiroshi et. al. (Eds.). Environmental Remediation Technologies for Metal-Contaminated Soils. Springer 2016 6. Muszyńska E., Hanus-Fajerska E., Ciarkowska K. (2015). Studies on Gypsophila fastigiata parameters verifying its suitability to reclamation of post-flotation Zn-Pb wastes. *Geology, Geophysics & Environment* 41(1): 17-24 5. 7. Wiszniewska A., Hanus-Fajerska E., Muszyńska E., Ciarkowska K. (2016). Natural organic amendments for improved phytoremediation of polluted soils. A review of recent progress. *Pedosphere*, 26(1):1-12

8. Wood T. K. (2008) Molecular approaches in bioremediation. *Current Opinion in Biotechnology* 19: 572–578

9. van Hamme J.D., Singh A., Ward O.P. (2003) Recent advances in petroleum microbiology. *Microbiology And Molecular Biology Reviews* 67 (4): 503–549

10. Leahy J.G., Colwell R.R. (1990) Microbial degradation of hydrocarbons in the environment. *Microbiol. Rev.* 54: 305-315.

11. van der Meer J.R., de Vos W.M., Harayama S., Zehnder A. J. B. (1992) Molecular mechanisms of genetic adaptation to xenobiotic compounds. *Microbiological Reviews* 56 (4): 677-694