Course Syllabus

I. General Information

Course name in English	Bioremediation
Course name in Polish	Bioremediacja
Programme	Bioanalytical technologies
Level of studies (BA, BSc, MA, MSc, long-cycle MA)	MSc
Form of studies (full-time, part-time)	Full-time
Discipline	Biological sciences
Language of instruction	English

Course coordinator/person responsible	Dr Artur Banach/ mgr Jakub Ciepielski

Type of class *(use only the types mentioned below)*	Number of teaching hours	Semester	ECTS Points
lecture	30	III	6
tutorial			
classes	30	III	
laboratory classes			
workshops			
seminar			
introductory seminar			
foreign language classes			
practical placement			
field work			
diploma laboratory			
translation classes			
study visit			

Course pre-requisites	knowledge in chemistry, biochemistry, microbiology, plant physiology

II. Course Objectives

C1 - Acquiring knowledge of pollution mitigation methods involving living organisms
C2 – Acquiring knowledge and skills on bacteria use for contaminants degradation and removal
C3 – Acquiring knowledge and skills on plants use for contaminants degradation and removal

III. Course learning outcomes with reference to programme learning outcomes

Symbol	Description of course learning outcome	Reference to pro-gramme learning outcome
KNOWLEDGE		
W_01	knows the specific terminology used in bioremediation, under-	K_W01

	stands and is able to define complex phenomena and processes occurring in living organisms during the process	
W_02	has advanced knowledge in biochemistry, microbiology and biology necessary for practical use in bioremediation processes	K_W02
W_03	has knowledge of the principles of planning research using biotechnological research techniques and tools	K_W05
W_04	has deepen knowledge of the benefits and risks associated with the use of GMOs	K_W06
W_05	knows the fundamental principles of H&S and ergonomics	K_W07
	SKILLS	
U_01	applies advanced techniques and research tools in the life sciences, particularly in bioremediation	K_U01
U_02	can design and carry out the experiment or expertise under the guidance of tutor	K_U07
U_03	can evaluate the environmental threats related with applied bioremediation technology	K_U12
U_04	collects and interprets experimental data and on that basis formulates appropriate conclusions	K_U14
U_05	shows responsibility for the evaluation of threats arising from applied by himself research techniques and the creation of conditions for the safely work in the laboratory	K_U15
U_06	when planning a scientific experiment he/she can properly determine the priorities for the implementation of the task, can interact and work in a team undertaking different roles in it	K_U18
	SOCIAL COMPETENCIES	
K_01	is aware of the meaning, value, and need to analyse the environment	K_K01
K_02	is taking care on entrusted laboratory equipment, is able to gauge danger resulting from applied research methods	K_K03
K_03	acts in accordance with the principles of occupational health and safety	K_K05

IV. **Course Content**

Lecture

1. General terms of the topic. Problem of pollution: sources, types of pollutants, contamination or pollution
2. Current Remediation Practices
3. Microorganisms suitable for remediation: microbial groups, main characteristics, adaptations, metabolic pathways applicable in degradation and accumulation of pollutants
4. Bioremediation techniques involving microorganisms, factors affecting the process
5. Examples of application bioremediation using microorganisms: organic compounds, heavy metals
6. Application of fungi in pollutants mitigation – mycoremediation
7. Plants in remediation: hyperaccumulators, adaptations strategies against heavy metals,

plant metabolism in organics degradation, examples of application
8. Strategies of phytoremediation
9. Microbial-assisted phytoremediation, endosymbiotic relationships (plant-bacteria) – plant growth promotion (metabolites)
10. Role of GMOs, threats
11. Concluding lecture – pros and cons

Laboratory classes
1. Introduction classes, H&S Rules
2. Testing the specificity of soil microorganisms to petroleum pollution
3. Estimation kinetic parameters of catalases produced by microorganisms originating from pesticide polluted soils
4. Role of inhibition of bioremediation of sulphur compounds on example of polluted sediments
5. Determination the performance of bioremediation basing on energetic state
6. In vivo testing degradation of different commercial biopreparations
7. Comparison the performance of microorganisms from biopreparation and autochthonic microflora in bioremediation
8. Bioremediation of metals by microorganisms
9. Application of vascular plants in accumulation of heavy metals
10. Comparison the efficiency of studied systems
11. Makeup Lab

V. Didactic methods used and forms of assessment of learning outcomes

Symbol	Didactic methods *(choose from the list)*	Forms of assessment *(choose from the list)*	Documentation type *(choose from the list)*
KNOWLEDGE			
W_01	Conventional lecture	Exam / Written test	Examination card / Grade card, Evaluated test / written test
W_02	Conventional lecture	Exam / Written test	Examination card / Grade card, Evaluated test / written test
W_03	Laboratory analysis	Report	Protocol / report printout/ report file
W_04	Conventional lecture	Exam / Written test	Examination card / Grade card
W_05	Laboratory analysis	Observation	Rating card / Observation report
SKILLS			
U_01	Laboratory classes	Report	Protocol / report printout/ report file
U_02	Laboratory classes	Report	Protocol / report prin-

			tout/ report file
U_03	Laboratory classes	Report	Protocol / report printout/ report file
U_04	Laboratory classes	Report	Protocol / report printout/ report file
U_05	Laboratory classes	Observation	Rating card / Observation report
U_06	Laboratory classes	Observation	Rating card / Observation report
SOCIAL COMPETENCIES			
K_01	Conventional lecture	Exam / Written test	Examination card / Grade card
K_02	Laboratory classes	Observation	Rating card / Observation report
K_03	Laboratory classes	Observation	Rating card / Observation report

VI. Grading criteria, weighting factors

Lecture: Written exam in the form of test - 90%, participation in the lectures - 10%
Classes: Active participation in the classes - 5%, report – 5%, test – 90%

Mark	**Evaluation criteria**	
verygood (5)	the student realizes the assumed learning outcomes at a very good level	the student demonstrates knowledge of the education content at the level of 95-100%
overgood (4.5)	the student accomplishes the assumed learning outcomes an over good level	the student demonstrates knowledge of the education content at the level of 85-94 %
good(4)	the student accomplishes the assumed learning outcomes at a good level	the student demonstrates knowledge of the education content at the level of 75-84%
quitegood(3.5)	the student accomplishes the assumed learning outcomes at a quite good level	the student demonstrates knowledge of the education content at the level of 65-74%
sufficient (3)	the student accomplishes the assumed learning outcomes at a sufficient level	the student demonstrates knowledge of the education content at the level of 55-64%
insufficient (2)	the student accomplishes the assumed learning outcomes at an insufficient level	the student demonstrates knowledge of the education content below the level of 55%

VII. Student workload

Form of activity	Number of hours
Number of contact hours (with the teacher)	70 (60 + 10 individual consultation)
Number of hours of individual student work	80

VIII. Literature

Basic literature
Microbial Biodegradation and Bioremediation 1st Edition. Das S. Elsevier Insights, 2014 Phytoremediation of Environmental Pollutants 1st Edition. Chandra R., Dubey N.K., Kumar V. CRC Press, 2017
Additional literature
Current scientific articles of the topic Wise D.L., Trantolo D.J., Cichon E.J., Inyang H.I., Stottmeister U., (ed.) (2000) Bioremediation of Contaminated Soils., Marcel Dekker, Inc., New York, Basel.