SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş-Bolyai University of Cluj-Napoca**
1.2 Faculty	**Environmental Science and Engineering**
1.3 Department	**Environmental Analysis and Assessment**
1.4 Field of study	**Environmental Engineering**
1.5 Study cycle	**Bachelor**
1.6 Study programme / Qualification	**Environmental Engineering**

2. Information regarding the discipline

2.1 Name of the discipline		**Soil depollution technologies and biotechnologies**					
2.2 Course coordinator		Assist. Prof. PhD. Ramona Bălc					
2.3 Seminar coordinator		Assist. Prof. PhD. Ramona Bălc					
2.4. Year of study	**IV**	2.5 Semester	**VII**	2.6. Type of evaluation	**C**	2.7 Type of discipline	Optional

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	**4**	Of which: 3.2 course	**2**	3.3 seminar/laboratory	**2**
3.4 Total hours in the curriculum	**56**	Of which: 3.5 course	**28**	3.6 seminar/laboratory	**28**
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					10
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					10
Tutorship					
Evaluations					4
Other activities:					8

3.7 Total individual study hours	42
3.8 Total hours per semester	98
3.9 Number of ECTS credits	4

4. Prerequisites (if necessary)

4.1. curriculum	• Basic concepts of biology and microbiology, soil science, geology
4.2. competencies	• Environmental impact

5. Conditions (if necessary)

5.1. for the course	• Room with projection equipment • The students will turn off their mobile phones • No delay is allowed
5.2. for the seminar /lab activities	• Room with projection equipment • The students will turn off their mobile phones • No delay is allowed • Preparation of presentation/projects and active involvement during the seminar

6. Specific competencies acquired

Professional competencies	Acquiring important skills for: • Theoretical development of biotechnologies • Biological decontamination through bioremediation based on processes such as: biotransformations, biodegradations, phytostabilizations, phytoextractions; • Biodegradation of organic contaminants in soil; • Phytoremediation of inorganic contaminants in soil; • Biological mechanisms of detoxification and tolerance involved in living organisms.
Transversal competencies	Acquiring important skills for: • Development of environmental protection and engineering technologies; • Integrated vision on the management of contaminated areas, in compliance with the legislative framework; • Valorization and use of biodiversity for environmental decontamination; • Integrating sustainable environmental development concepts for the feasibility of remediation technologies.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	Accumulation of basic knowledge on physical, chemical and biological decontamination methods that underlie the development of a remediation technology. Acquiring specific knowledge of selecting biotic factors used as decontamination systems within depollution biotechnologies.
7.2 Specific objective of the discipline	Acquiring theoretical and practical knowledge regarding biological decontamination from the perspective of bioremediation of soil and groundwater, affected by industrial anthropogenic factors; Acquiring the necessary skills to analyze areas affected by soil degradation and contamination, assessing the consequences of anthropogenic impact on environmental components and developing biotechnologies specific to pollution conditions in the affected area.

8. Content

8.1 Course	Teaching methods	Remarks
1. **Anthropogenic impact on ecosystems – introductory concepts**	- lecture - explanation - conversation	2 hours
2. The legislative framework for soil pollution investigation and environmental restoration measures	- lecture - explanation - conversation	2 hours
3. The main anthropogenic activities that induce the need to develop and apply remediation technologies. Introduction in management of contaminated sites	- lecture - explanation - conversation	2 hours

4. Distribution of pollutants in the soil environmental component, types of soil pollution and classification of decontamination methods	- lecture - explanation - conversation	2 hours
5. Soil microbiota – Types of organisms in soil, distribution of organisms in soil, importance of microorganisms in soil	- lecture - explanation - conversation	2 hours
6. **Water microbiota** – Types of organisms in water, distribution of organisms in water, importance of microorganisms in water	- lecture - explanation - conversation	2 hours
7. Cellular detoxification and tolerance mechanisms involved in living organisms used in decontamination biotechnologies	- lecture - explanation - conversation	2 hours
8. Plant nutrition from a phytoremediation perspective	- lecture - explanation - conversation	2 hours
9. Plant physiology from the perspective of phytoremediation	- lecture - explanation - conversation	2 hours
10. Restoration of polluted ecosystems – basic principles (anthropogenic ecosystems, natural ecosystems), biological mechanisms involved, species of living organisms	- lecture - explanation - conversation	2 hours
11. Restoration of aquatic ecosystems – surface waters and groundwater	- lecture - explanation - conversation	2 hours
12. Restoration of terrestrial ecosystems – anthropogenic areas (urban environment, rural environment)	- lecture - explanation - conversation	2 hours
13. Biomonitoring - Methods for evaluating the degree of decontamination following the application of biotechnologies	- lecture - explanation - conversation	2 hours
14. Final evaluation	- writting exam	2 hours
8.2 Seminar / laboratory	Teaching methods	Remarks
1. Depollution of ecological systems – General notions, specialized terminology	-exposure, problematization of the exposed material - interactive discussions - case studies	2 hours
2. Analysis of the soil protection law	-exposure, problematization of the exposed material - interactive discussions - case studies	2 hours
3. Differences between natural and anthropogenic sources of soil degradation	-exposure, problematization of the exposed material - interactive discussions - case studies	2 hours
4. Classification of remediation technologies according to the place of application. Characteristics of *in situ*, *ex situ* and on-site technologies	-exposure, problematization of the exposed material - interactive discussions - case studies	2 hours

5. Conventional remediation technologies: sealing, soil washing, vitrification	-exposure, problematization of the exposed material - interactive discussions - case studies	2 hours
6. *In situ* bioremediation technologies – unsaturated zone (bioventilation, bioaspiration, passive bioaugmentation)	-exposure, problematization of the exposed material - interactive discussions - case studies	2 hours
7. *In situ* bioremediation technologies – saturated zone (bioaugmentation in active system, pumping with reinjection, bioventing-biosparging)	-exposure, problematization of the exposed material - interactive discussions - case studies	2 hours
8. *Ex situ* bioremediation technologies (bioreactor, composting, land farming, biopile, bioleaching)	-exposure, problematization of the exposed material - interactive discussions - case studies	2 hours
9. Decontamination based on plants - Phytoremediation	-exposure, problematization of the exposed material - interactive discussions - case studies	2 hours
10. The research method of living organisms for the creation of biotechnologies – Principles in conducting laboratory experiments	-exposure, problematization of the exposed material - interactive discussions - case studies	4 hours
11. Investigation of a bioremediation system. Testing the resistance of trees to the ecotoxicological effects of heavy metals	- case study	
12. Study of soil biota - Microscopic and stereomicroscopic study of mycorrhizal roots (students will have their own soil samples)	- experiment	2 hours
13.-14. Seminar evaluation	- project presentation	4 hours

Bibliography:

1. ANICĂI, L., BÂSCEANU, C., DUȚU, M., CHINEAȚĂ, S., ANICĂI, O., STĂNILOAE, D., DUMITRACHE, R., 2010, Managementul integrat al solurilor contaminate, Ed. Printech, București, ISBN 978-606-521-546-7;
2. CONSTANTIN-HORIA BARBU, CAMELIA SAND, 2004, Teoria şi practica modernă a remedierii solurilor poluate cu metale grele, Editura „ALMA MATER", Sibiu;
3. DRĂGAN-BULARDA MIHAIL, SAMUEL ALINA DORA, 2008, *Biotehnologii microbiene*, Editura Universităţii din Oradea, Oradea;
4. GAVRILESCU MARIA, 2010. *Environmental Biotechnology: Achievements, Opportunities and Challenges*, Dynamic Biochemistry, Process Biotechnology and Molecular Biology (DBPBMB), 4(1)1. In Global Science Books, 2010. http://www.globalsciencebooks. info/JournalsSup /images/Sample/DBPBMB_4(1)1-360.pdf;
5. ELENA GAVRILESCU, 2006. Evaluarea ecosistemelor acvatice. Ed. SITECH, Craiova;
6. KISS ŞTEFAN, DRAGAN-BULARDA MIHAIL, DANIELA PAŞCA, 1993. *Enzimologia mediului înconjurător. Enzimologia solurilor tehnogene.* Vol. II. Ed. CERES, Bucureşti;
7. MALSCHI DANA, 2014. Biotehnologii si depoluarea sistemelor ecologice. (Tehnologii de depoluare biologica,Tehnologii de bioremediere. Reconstructia ecologica). Note de curs si aplicatii practice. Manual in format

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9. MALSCHI DANA, 2014, Indrumar de lucrari practice pentru "Biotehnologii si depoluarea sistemelor ecologice", format electronic, http://enviro.ubbcluj.ro/cercetare/laboratoare/Laborator de biotehnologii.php/;
10. MALSCHI DANA, 2009. Elemente de biologie, ecofiziologie si microbiologie. Note de curs si aplicatii practice, Manual in format electronic. Facultatea de Stiinta Mediului, Universitatea Babes-Bolyai Cluj-Napoca. Editura Bioflux, Cluj-Napoca, ISBN 978-606-92028-4- http://www.editura.bioflux.com.ro/carti-2009 / http://www.editura.bioflux.com.ro/docs/malschi2.pdf;
11. MICLE, V., 2009, Refacerea ecologică a zonelor degradate, U.T. Press, Cluj-Napoca, ISBN 978-973-662-477-3;
12. OROS V. 2002. *Reabilitare ecologica a siturilor degradate industrial*. Ed.Univ.Transilvania, Brasov.
13. VASILE OROS, 2011, *Elemente de ecotoxicologie şi teste ecotoxicologice*, Editura RIOSOPRINT, Cluj Napoca.
14. HG 1408/2007 privind modalităţile de investigare şi evaluare a poluării solului şi subsolului;
15. HG 1403/2007 privind refacerea zonelor în care solul, subsolul si ecosistemele terestre au fost afectate;
16. OM 267/346/2021 privind aprobarea Metodologiei de remediere a siturilor contaminate;
17. OM 1423/3687/2020 privind aprobarea Metodologiei de investigare a siturilor potențial contaminate și a celor contaminate;
18. Legea 74/2019 privind gestionarea siturilor potențial contaminate și a celor contaminate.

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

The content of the discipline responds to the problems imposed by practice regarding the aspects of ecology applied in the environment and the management of contaminated areas, necessary for the development of environmental protection and engineering technologies, for the management and control of anthropogenic pollution, for the valorization and responsible use of natural resources in the context of sustainable environmental development.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Involvement in interactive discussions: accuracy of answers and correct acquisition of the concepts presented.	Written colloquium	50%
10.5 Seminar/lab activities	Involvement in seminar activities: ability to explain and interpret; complete and correct resolution of requirements.	Grading throughout the semester. Oral – supporting projects carried out by students in teams/individually.	50%
10.6 Minimum performance standards			
• Attendance at 80% of seminar hours. • Grade 5 (five) both in project submission and written exam.			

Date	Signature of course coordinator	Signature of seminar coordinator
05.12.2024	Dr. Ramona Bălc	Dr. Ramona Bălc

Date of approval

Signature of the head of department