COURSE OUTLINE

1. GENERAL

SCHOOL	School of Environment and Agricultural Engineering		
ACADEMIC UNIT	Natural Resources & Agricultural Engineering		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**216**	**SEMESTER**	**6**
COURSE TITLE	**Soil Microbiology**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
	Lectures and practicals	3+2	5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background, Specialised general knowledge		
PREREQUISITE COURSES:	Soil Science -157 Soil Chemistry 1565		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES (theory only)		
COURSE WEBSITE (URL)	https://oeclass.aua.gr/eclass/courses/AFPGM131/		

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

The subject of the course 'Soil Microbiology' is to familiarize students at a theoretical and practical level with the subjects described below so that -after the completion of the courses- they will be able to:

1. Understand the importance of microorganisms in the soil environment.
2. Understand the role of microbial populations in soil and the types of interactions they develop with each other and with other categories of organisms (e.g. plants).
3. Know how microbial diversity in soil is analyzed with various methodologies-approaches, and how microorganisms are detected in agricultural and natural habitats.
4. Become familiar with concepts related to microbial metabolism and be able to describe and explain nitrogen metabolism in soil (mineralization, nitrification, denitrification), as well as sulfur, phosphorus and iron metabolism.
5. Understand the interactions of plants and soil microorganisms and especially symbiotic nitrogen fixation and mycorrhizal relationships.
6. Understand how soil microorganisms can be exploited to improve soil fertility, as well as how microbial agents are used to control soil-borne plant pathogens and improve plant abiotic stress tolerance.

7. Understand the importance and mechanisms of microbial degradation of xenobiotic compounds in soil, and how microorganisms can be exploited for the bioremediation of contaminated and upgraded contaminated soils.
8. Be able to describe and explain how the production of organic soil improvers is implemented through aerobic controlled microbial biodegradation processes of plant residues and how these can be used in agricultural applications (e.g. improvement of structure and increase of soil fertility, retention of soil-borne plant diseases, etc.).

The purpose of the laboratory course is to familiarize students with the application of microbiological techniques as well as the design and implementation of experiments. After completing the laboratory exercises students be able to:
1. Detect and study the main soil microbial communities (direct microscopic observation, sequential dilutions, genomic DNA isolation)
2. Detect and study soil microorganisms with a particular characteristic
3. Assess the contribution of microorganisms to soil fertility and physicochemical properties (aggregate stability)
4. Assess the total microbial activity of soil and organic samples (estimation of respiratory activity)
5. Acquire the necessary know-how for the management of agro-industrial by-products and the production of soil improvers with the method of composting (compost heap setup, monitoring of the composting process, mature compost criteria, uses)
6. Recognize main interactions of microorganisms and the root system of plants (mycorrhizae, symbiotic nitrogen fixation in the nodules of the legume root system)
7. Know the modes of action of competing bacteria against soil-borne phytopathogenic fungi (biological control)

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

Working independently
Team-work
Project planning and management
Decision making
Production of constructive and inductive thinking

3. SYLLABUS

Theory:
1. Introduction-The importance of microorganisms in the soil environment. Soil microorganisms.
2. Ecology of soil microbial populations - Ecological categories of interactions of soil microbial communities.
3. Methods for the determination and analysis of microbial diversity in soil.
4. Overview of microbial metabolism.

5. Nitrogen metabolism in soil (mineralization, nitrification, denitrification), Symbiotic and non-symbiotic nitrogen fixation.
6. The metabolism of sulfur, phosphorus, iron.
7. Rhizosphere and spermosphere. Production and applications of microbial inocula.
8. Interactions of plants and soil microorganisms, symbiotic and non-symbiotic bacteria, biological control of soil-borne pathogens.
9. Symbiotic and saprotrophic fungi – Mycorrhizae.
10. Detection of microorganisms in agricultural habitats.
11. Metabolism of xenobiotic compounds in soil, bioremediation of contaminated soils.
12. Production of organic soil improvers.
13. Microbiology of degraded soils - Upgrading of degraded soils.

Laboratory
1. Thermophilic biodegradation of organic materials (composting)
2. Study of microbial communities in soil with direct microscopic observation (contact slide assay)
3. The role of microorganisms in the formation of soil aggregates
4. The method of serial dilutions for the isolation and enumeration of soil microbial populations (Dilution plates)
5. The Most Probable Number method for estimating the size of free-living nitrogen-fixing populations. Symbiotic nitrogen fixation in the nodules of the root system of legumes
6. Isolation of genomic DNA from soil samples and applications.
7. Mycorrhizal structures within roots.
8. Assessment of the respiratory activity of the soil.
9. Antibiotics.
10. Modes of action of biostimulants and antagonistic bacteria against soil-borne phytopathogenic fungi.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	In the lecture room and labs – additional remote support
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	**Specialized teaching/presentation software** **Support Learning process through** **e-class electronic platform**
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	

Activity	*Semester workload*
Standard Lectures	36
Practical Exercises that focus on implementation of methodologies	26
Teamwork study or Small individual tasks for each student	20
Independent Study	43
Total Course (25 hours of workload per credit unit)	125

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Written final exam that includes combinations: - Multiple choice questions - Scenario analysis - Solving problems related to quantitative data - Benchmarking of theory elements

5. ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Weil, R.R. and Brady, N.C. (2017), The Nature and Properties of Soils. 15th Edition, Pearson, New York. (Background reading)

- Madigan MT, Aiyer J, Buckley DH, Sattley WM, Stahl DA, (2021), Brock Biology of Microorganisms", Global Edition (16th) Pearson Higher Education (Background reading)

- David L. Kirchman (2018), Processes in Microbial Ecology. Second Edition. Oxford University Press
- Gentry T, Fuhrmann JJ, Zuberer DA (2021), Principles and Applications of Soil Microbiology. 3d Edition, Elsevier
- Eldor Paul, Serita Frey (2024) Soil Microbiology, Ecology and Biochemistry. 5th Edition, Elsevier
- Robert L. Tate (2020) Soil microbiologoy, Wiley Blackwell

- Related academic journals:

Soil Biology and Biochemistry – Elsevier
Applied Soil ecology – Elsevier
European Journal of Soil Microbiology – Elsevier
Applied and Environmental Microbiology - American Society for Microbiology
FEMS Microbiology Ecology - Oxford University Press
The ISME Journal - International Society for Microbial Ecology, Springer Nature.