COURSE DATA

Data Subject	
Code	33082
Name	Environmental microbiology
Cycle	Grade
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1104 - Degree in Environmental Sciences	Faculty of Biological Sciences	2	First term

Subject-matter

Degree	Subject-matter	Character
1104 - Degree in Environmental Sciences	120 - Environmental microbiology	Obligatory

Coordination

Name	Department
ESTEVE SANCHEZ, CONSUELO	275 - Microbiology and Ecology

SUMMARY

Environmental Microbiology is part of the Degree in Environmental Sciences, University of Valencia (Plan 2009). It is a compulsory 6-credit module of part II "Scientific basis of the natural environment" along with subjects Botany, Zoology, Ecology, Soil Science, Meteorology and Climatology, Hydrology (Continental and Marine), and Physical Geography.

In the first year of the degree, students take Biology (1st semester) and the subjects of Botany and Zoology (2nd semester). Environmental Microbiology is filed in the second year (1st quarter) with Soil Science, Meteorology, Climatology, and Hydrology (Continental and Marine), while Ecology and Physical Geography is also filed in second year but during the 2nd quarter.

Note that among the contents previously taught only those included in the Biology course are relatively related to Environmental Microbiology. However, the Biology subject descriptors indicate a generic type content, so the subject Environmental Microbiology will have to meet both basic aspects (i.e. structure and function of microorganisms) as those designed to identify and understand the basic microbial diversity and its environmental importance.

Thus the contents of the subject specified in the Title Verification memory are prokaryotic and eukaryotic microorganisms in the environment. Functional diversity and participation in biogeochemical cycles. Analysis of microbial communities. The course also includes content on microbial bioremediation and the application of microorganisms in the production of goods

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

1104 - Degree in Environmental Sciences

- Identificar y comprender las bases de la diversidad microbiana y su importancia ambiental.
- Conocer y comprender la estructura y función de Microorganismos.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

SKILLS TO ACQUIRE:
• Acquire basic knowledge about the biology of microorganisms in their structural, metabolic, genetic, ecological, taxonomic, and evolutionary and applied.

• Acquire basic knowledge on microbial bioremediation and the application of microorganisms in the production of environmentally friendly goods.
• Linking Environmental Microbiology with other biological disciplines –and not biological ones- which are being enrolled in the Degree.
• Understand the application fields and the social present and future of the Environmental Microbiology
• Mastering basic microbiological techniques which are characteristics of the microbiology laboratory, with special attention to aseptic techniques, sterilization, cultivation, isolation, and microbiological analysis of waters.
• Be able to detect the approach or procedural errors committed during the laboratory work, and to discern the extent that the results will have the mistakes made.
• Understand and know how to use documentary sources of all types of Environmental Microbiology, with special attention to the basic texts of wide international acceptance and also to the sources accessible through computer networks.

SOCIAL SKILLS
• Develop the capacity for teamwork and problem solving to address collectively.
• Develop the capacity for reasoned argument and rational criticism on scientific information, both in academia and in society, with special attention to the media.

• Develop communication skills oral and written knowledge, using appropriate techniques for communication and exchange that are efficient.
• Acquisition of social and professional awareness on issues of general interest may be affected by the Environmentalist work.

DESCRIPTION OF CONTENTS

0. Description of contents

The subject Environmental Microbiology consists of 12 blocks of theoretical concepts, which will be developed in class for a maximum of 18 topics/lessons. The subject Environmental Microbiology consists of IV units of practical contents which will be developed in the laboratory according to 11 practices.

1. Introduction

Concept for Microbiology. Brief History of Environmental Microbiology. Current challenges of Environmental Microbiology. Location of microorganisms in the classification systems of living things. Key milestones in cellular evolution. The origin of the eukaryotic cell. The rRNA as a molecular clock. Universal phylogenetic tree of living things. Nature of the microbial world: viruses; bacteria; arquea; fungi, algues and other protists.

2. Structure and function in Prokaryotes

General appearance of the Prokaryote cell. Types of membrane lipids: chemical composition. Types of Mb proteins. Structure and main functions of the prokaryotic cell Mb. Comparison of the processes carried out at the cellular Mb by Prokaryotes and Eukaryotes. Role of the cell wall. Bacterial cell wall: chemical composition and structure of the murein; Gram-positive cell wall, Gram-negative cell wall. Types of archaea cell walls. Other cell envelopes: Capsules and S-layer: structure and function.
Structures for dispersion or concentration of Prokaryotes in the environment: prostecas and adhesive holdfast; fimbriae: types and Twitching motility; bacterial flagellum: structure, swimming motility and chemotaxis, flagellum in archaea; structures for gliding motility. Structures for positioning of Prokaryotes in the environment: gas vesicles and magnetosomes. Cytoplasmatic inclusions in Prokaryotes.

3. Microbial genetics

Types of genetic elements in the eukaryotic and prokaryotic cell. Genomics of microorganisms. Regulation of gene expression in prokaryotes. Mutation and recombination. Transfer of genetic information in Prokaryotes: transformation, conjugation and transduction. Bacteriophage viruses.

4. Microbial nutrition

Types of nutrients. Assimilation: assimilatory reduction concept; carbon assimilation and autotrophy; nitrogen assimilation and diazotrophy. Cellular energy: phototrophy and chemotrophy. Main trophic-metabolic categories.
Types of phototrophic microorganisms. Pigments. Anoxygenic photosyntesis. Oxygenic photosynthesis. Bacteriorhodopsin system.
Types of chemotrophic microorganisms. The reduction potential. Aerobic and anaerobic respiration. Fermentation. Main functional groups of chemolithotrophs. The chemo-organotrophic microorganisms (heterotrophs).
Carbon uptake and autotrophy: biochemical pathways. Nitrogen assimilation: nitrate assimilation reduction; fixation of atmospheric nitrogen; synthesis of the amine group.

5. Microbial populations in the Environment

Cell Division. Vegetative cell cycle. Population growth and nutrients: growth curve in the lab. Population growth in nature: adaptation to fluctuating nutrients (stringent response; VBNC state; sporulation). Influence on microbial growth of physicochemical factors: temperature; pH; oxygen; complex nutrients. Types of microorganisms according to its tolerance to physicochemical factors. Types of microorganisms according to its nutritional requirements. Adaptations to extreme conditions. Microbial habitats: concept of microbial community; types of microbial interactions. Study of microbial communities: selective enrichment culture Microscopic techniques (DAPI, acridine orange, "FISH"). Molecular techniques (PCR; filochips; metagenomics). Physicochemical techniques (radioisotope methods, microelectrodes; isotopic fractionation). Methods used to study microorganisms and their activities in the different environments.

6. Microorganisms as biogeochemical agents

Concept of biogeochemical cycle. Carbon and oxygen cycle. Main reservoirs of carbon in the earth. Carbon redox cycle: microbial processes and groups. Detail of carbon cycle processes in anoxic environments. Impact of human activity on the carbon cycle. Main nitrogen reservoirs in the soil. Nitrogen redox cycle: microbial processes and groups. Coupling of carbon and nitrogen cycles. Impact of human activity on the nitrogen cycle. Main sulfur reservoirs on earth. Redox cycles of sulfur and iron: microbial processes and groups. Impact of human activity on the sulfur cycle. Sulfur cycle and mobilization of heavy metals.

7. Evolution and microbial biodiversity

Fossil record of microorganisms. Essential milestones in biological evolution. Phylogenetic tree of living things. The origin of the eukaryotic cell. Main structural and functional characteristics of Bacteria, Archaea and Eukarya. Microbial systematics, taxonomy and nomenclature. Taxonomic categories and concept of species in Microbiology.
Generalities of the Bacteria domain. General characteristics of the main Phyla (Aquificae. Thermotogae. "Deinococcus-Thermus", Chlorofexi, Cyanobacteria, Chlorobi, Proteobacteria, Bacterioidetes, Planctomycetes, Firmiculites, Actinobacteria) and their main genera/species.
Generalities of the Archaea domain. General characteristics of the main Phyla (Crenarchaeota,

Euryarchaeota, Thaumarchaeota) and their main genera / species.
Phylogenetic tree of the Eukarya domain. General characteristics of the main groups of protists (Euglenozoos, Alveolates, Estramenopils, Cercozoos, "True Algae", Fungi, and Amoebozoos) and their main genera

8. Microbiology of aquatic environments

Types of aquatic environments. Water as a microbial habitat: physicochemical parameters and resources; native microorganisms of aquatic environments; the microbial loop. Estuaries and wetlands. Oceans: vertical and horizontal areas in the marine environment; vertical distribution of light, pressure, temperature and oxygen; carbonate and pH balance system; food chains and microbial communities; other marine habitats: zooxanthellae, bioluminescent organs of fish, and Riftia pachyptila, Fumaroles submarines. Freshwater habitats: streams and rivers; lakes: physical and biological factors that affect microbial communities. Oligotrophic and hypereutrophic lakes.

9. Microbiology of terrestrial environments

Types of terrestrial environments. General characteristics of indigenous microorganisms of terrestrial environments. Rock surfaces: characteristics and types of microorganisms. Soil: carbon content in different soil horizons and the microbial degradation of lignin; levels of oxygen, nitrogen and phosphorus and their influence in microbial activity; associations between soil microorganisms and vascular plants; food chains, microbial communities and symbiosis. Insects as microbial habitats. The intestine of vertebrates as a microbial habitat. Importance of animal-microorganism symbiosis for the use of plant material in animal feed.

10. Air Microbiology

The atmosphere as a microbial habitat. Microorganisms in the troposphere: methods of analysis.

11. Microbial bioremediation of contaminants

Concepts in microbial bioremediation. Treatment of contaminated water resources: the problem of nitrates in groundwater; eutrophication of freshwater habitats: analytical parameters: BOD and COD; wastewater and types of pollutants; microbial processes in the treatment of wastewater in EDARs (secondary and tertiary treatment). The role of microbial activity in heavy metal pollution of aquatic environments and in their bioremediation. Bioremediation of marine oil pollution.
Microbial treatment of solid waste and composting. The biomagnification process of xenobiotics. Chemical structure of the main xenobiotics and their uses. Microbial processes in the degradation of xenobiotics (pesticides and herbicides). Microbial bioinsecticides.

12. Environmental microbiology and public health

Control of airborne pathogens. Control of water-borne pathogens: microbiological parameters for assessing water quality and methods of analysis.

13. Unit I: Ubiquity of microorganisms in the environment

Practice 1: Assessment of the microbial load in the environment
Practice 2: Concepts of sterility and asepsis.

14. Unit II: Microorganisms: from the cell to the colony

Practice 3: Types of culture media according to the nutrients they contain and their uses
Practice 4: Selective and differential culture media
Practice 5: Obtention of pure cultures
Practice 6: Gram staining and KOH test

15. Unit III: Counting of colony forming units: Plate count

Practice 7: Counting heterotrophs
Practice 8: Counting coliforms by filtration

16. Unit IV: Microbial activities: mineralization of organic matter

Practice 9: Aerobic respiration: biochemical oxygen demand (BOD5)
Practice 10: Anaerobic respiration: denitrification
Practice 11: Fermentation.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	44,00	100
Laboratory practices	14,00	100
Tutorials	2,00	100
Development of individual work	10,00	0
Study and independent work	30,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	25,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	10,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

- **Lectures**: Presentation in the classroom of the most important topics using the lecture method. These contents will be developed by performances of "power point" that students will be available in Virtual Classroom. Attendance is optional, and can be verified by the teacher any day of class.

- **Practical sessions** will be taught in the microbiology laboratory to small groups of between 16 and 20 students, with a total duration of **14** hours. The booklet will be available practices of students in the Virtual Classroom. Students have an important role in the development of practice they are the experimenters and the results obtained. But the teacher's job is to teach them to perform adequately the methodological procedures of the practice, in addition to tabular and graph the results of the experiment, as well as guide them in interpreting data and drawing conclusions. In the practical classes will use the blackboard as a teaching assistant.

- **Tutoring Group**: Students attend a total of one tutoring session (**2** hours total). Tutoring sessions will be conducted in the laboratory and they will have theoretical and practical contents. Attendance is mandatory.

- **Supervised working tasks:** There will be various kinds of tasks.

EVALUATION

THEORY. 70 points out of 100. The minimum required to overcome the theory is 35 points out of 70 (5 out of 10). The evaluation of this part will be based on a written exam.

PRACTICE. 20 points out of 100. The minimum needed to overcome the practice is 10 points out of 20 (5 out of 10). Attendance at practical classes is compulsory, ie, it is mandatory to do all practices. The evaluation of this part will be based on a written exam. There will be two practical exams, one in 1st call and another in the 2nd call. Noted that the note is saved from the 1st call, in those cases where the student has passed practice but do not theory and so they had to go to the 2nd call to pass the course. These labs are mandatory, so it must have done if you want to apply for the advancement of call.

SUPERVISED WORKING TASKS. 10 points out of 100. Through the evaluation of the exercises proposed. There is not a minimum required to overcome this part. This task is mandatory and measurable, so it must have done if you want to apply for the advancement of call.

The final grade will be obtained from the sum of the grades in the previous sections. The final grade required to pass the course will be 50 points out of 100.

Second enrollment students who have passed the course practices can conserve their practical examination marks only for the next immediately following course.

REFERENCES

Basic

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- Microbiología. Prescott, Willey, J.M., L.M. Sherwood, C.J. Woolverton. 2017. 10ª ed. McGraw-Hill-Interamenicana
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- Microbe. Schaechter, M., J. L. Ingraham & F. C. Neidhardt. 2006. 1st ed. ASM Press.

Additional

- Biotecnología del medio ambiente. Principios y Aplicaciones. Rittmann B.E. & P.L. McMarty. 2001. McGraw-Hill-Interamenicana
-Bioremediation: Applied Microbial Solutions for Real-World Environmental Cleanup. Atlas R.M. 2005. ASM Press
-Encyclopedia of Environmental Microbiology. Bitton, G. 2003. John Willey & sons
-Environmental Microbiology. Maier, R.M., Pepper, I.L. & C.P. Gerba. 2000. Academic Press
-Manual of Environmental Microbiology. Hurst, C.J., Crawford, R.L., Knudsen, G.R., McInemey, M.J. and Stetzenbach, L.D. 2002. 2ª ed. ASM Press