COURSE DATA

DATA SUBJECT

Code: 33082
Name: Environmental microbiology
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1104 - Degree in Environmental Sciences	Facultat de Ciències Biològiques	2	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1104 - Degree in Environmental Sciences	Environmental microbiology	COMPULSORY

COORDINATION

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SUMMARY

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

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

It should be noted that of all the contents previously taught, only those included in the subject Biology are relatively related to Environmental Microbiology.

However, the descriptors of the subject Biology indicate some generic contents, so that the subject Environmental Microbiology will have to address both the basic aspects related to the structure and function of microorganisms and those aimed at identifying and understanding the bases of microbial diversity (aspect of microbial biochemistry and genetics) and its environmental importance. Because it is necessary to explain the foundations of General Microbiology before addressing the contents of the subject

specified in the Verification report of the title: "Prokaryotic and eukaryotic microorganisms in the environment. Functional diversity and participation in biogeochemical cycles. Analysis of microbial communities".

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 / LEARNING OUTCOMES

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Conocer y comprender la estructura y función de Microorganismos.

Identificar y comprender las bases de la diversidad microbiana y su importancia ambiental.

DESCRIPTION OF CONTENTS

0. Description of contents

The Environmental Microbiology subject consists of 2 blocks of theoretical concepts: General Microbiology and Environmental Microbiology, which will be developed in class for a maximum of 181 topics/lessons. The subject also consists of 4 units of practical content which will be developed in the laboratory according to 10 practices.

1. Introduction: from Microbiology to Environmental Microbiology

Concept of Microbiology. Brief history of Microbiology. The current challenges of Environmental Microbiology. Situation of microorganisms in the classification systems of living beings. Essential milestones in cell evolution. The origin of the eukaryotic cell. rRNA as a molecular clock. Universal phylogenetic tree of living beings. Nature of the microbial world: virus; bacteria; archers; fungi, algae, and other protists.

General appearance of the Prokaryotic cell. Types of membrane lipids: chemical composition. Types of Mb proteins. Structure and main functions of the cell membrane in Prokaryotes. Comparison of the processes

2. Structure and function in Prokaryotes

carried out in the cell membrane by Prokaryotes and Eukaryotes. Cell wall function. Bacterial cell wall: chemical composition and structure of murein; Gram-positive wall; Gram-negative wall. Cell wall types in archaea. Other cell envelopes: Mucosal capsules and S layer: structure and function.
Structures for the dispersion or concentration of Prokaryotes in the environment: prosthetic and adhesive discs, fimbriae: type and retractile mobility; bacterial flagellum: structure, mobility and chemotactic; Archaeal flagellum, structures for sliding mobility. Structures for the positioning of Prokaryotes in the medium: gas vesicles and magnetosomes. Cytoplasmic 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. Chemical elements, macromolecules and cellular components. Cellular energy: phototrophy and chemotrophy. Main trophic-metabolic categories. Concept of assimilation
Types of phototrophic microorganisms. Pigments. Anoxygenic photosynthesis. Oxygenic photosynthesis. Bacteriorhodopsin system.
Types of chemotrophic microorganisms. The potential for reduction. Aerobic and anaerobic respiration. Fermentation. Functional groups of chemolithotrophs. Chemoorganotrophic microorganisms (heterotrophs).
Carbon assimilation and autotrophy: biochemical pathways. Nitrogen assimilation: assimilatory reduction of nitrate; atmospheric nitrogen fixation; Synthesis of the Amina group.

5. Microbial growth

Cell division. Vegetative cell cycle. Population growth and nutrients: parameters of population growth; Growth curve of an axenic crop. Life cycles in prokaryotes. Methods of measuring microbial growth. Influence on microbial growth of physicochemical factors: temperature; Ph; oxygen; complex nutrients. Categories of microorganisms according to tolerance to physicochemical factors. Categories of microorganisms according to nutritional requirements. Adaptations to extreme conditions. Influence on microbial growth of biotic factors: microbial interactions.

Fossil record of microorganisms. Essential milestones in biological evolution. Phylogenetic tree of living beings. 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.
General information about the domain Bacteria. General characteristics of the main Phyla (Aquificae.

6. Evolution and microbial biodiversity

Fossil record of microorganisms. Essential milestones in biological evolution. Phylogenetic tree of living beings. 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.Thermotogae. "Deinococcus-Thermus", Chlorofexi, Cyanobacteria, Chlorobi, Proteobacteria, Bacterioidetes, Planctomycetes, Firmiculites, Actinobacteria) and their main genera/species.
General information about 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 (Euglenozoans, Alveolates, Estramenopyles, Cercozoans, "True Algae", Fungi, and Amoebozoas) and their main genera

7. Study of microorganisms in the environment

The microbial environment: Concept of microbial community. Type of microbial populations in the environment. Culture techniques and isolation of environmental microorganisms. Other methods of studying microbial communities: Microscopic (DAPI; acridine orange and FISH) and molecular (PCR; phyllochips and metagenomics) techniques.

8. Microorganisms as biogeochemical agents

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

9. 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, underwater fumaroles. Freshwater habitats: streams and rivers; Lakes: Physical and biological factors that affect microbial communities. Oligotrophic and hypereutrophic lakes. Microbial 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 wastewater treatment. The role of microbial activity in heavy metal pollution of aquatic environments and in their bioremediation. Microbial processes in the bioremediation of marine oil pollution.

10. Microbiology of terrestrial environments

Types of terrestrial environments: physicochemical parameters and resources. General characteristics of microorganisms native to terrestrial environments. Rocky surfaces, arid soils and waterlogged soils: characteristics and types of microorganisms. Fertile soils: carbon in the different soil horizons and microbial degradation of lignin; levels of oxygen, nitrogen and phosphorus and their influence on microbial activity; associations between soil microorganisms and vascular plants; food chains, microbial communities and symbiosis. Insects as microbial habitats: termites and leafcutter ants. The vertebrate intestine as a microbial habitat: importance of animal-microorganism symbiosis for the use of plant material in the diet of terrestrial animals. Microbial treatment of solid waste and composting. Microbial processes in the degradation of xenobiotics (pesticides and herbicides). Microbial bioinsecticides.

11. Air Microbiology

The atmosphere as a microbial habitat: Physicochemical parameters and resources. Microorganisms in the troposphere: methods of analysis. Control of airborne pathogenic microorganisms.

12. Practices_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.

13. Practices_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

14. Practices_Unit III: Counting of colony forming units: Plate count

Practice 7: Counting heterotrophs

15. Practices_Unit IV: Microbial activities: mineralization of organic matter

Practice 8: Aerobic respiration: biochemical oxygen demand (BOD5)
Practice 9: Anaerobic respiration: denitrification
Practice 10: Fermentation.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	2,00
Theory	44,00
Laboratory	14,00
Total hours	**60,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	10,00
Independent study and work	35,00
Preparation of lessons	20,00
Preparation for assessment activities	25,00
Resolution of case studies	0,00
Total hours	**90,00**

TEACHING METHODOLOGY

- **Theory classes**: Presentation of the contents in the classroom using the master class method, with a total duration of 44 hours. These contents will be developed through "power point" presentations that students will have at their disposal in the **Virtual Classroom**. Attendance is optional and can be verified by the teacher on any day of class.

- **Practical classes**: They will be taught in the Microbiology laboratory to small groups of between 16 and 20 students, with a total duration of **14** hours. The Practice Notebook will be available to students in the Virtual Classroom. Students play an important role in the development of the practice as they are the ones who carry out the experiments and obtain the results. However, it is the teacher's task to teach them to properly carry out the methodological procedures of the practice, in addition to tabulating and graphing the results obtained in the experiment, in addition to guiding them in the interpretation of the data and elaboration of conclusions. In practical classes, the blackboard will be used as an auxiliary teaching medium.

- **Regulated tutorials**: Students will attend a tutorial session (2 hours, in total), which will be held in the classroom, to small groups of 16 students, and attendance is mandatory.

EVALUATION

THEORY. 75 points out of 100. The minimum required to overcome the theory is 37.5 points out of 75 (5 out of 10). The evaluation of this part will be based on a written exam.

PRACTICE. 20 points out of 100. The minimum required to pass the practices is 10 points out of 20 (5 out of 10). The evaluation of this part of the subject will be based on a written exam. Attendance at the practical classes is mandatory, that is, the student must have completed most

of the practices to be able to take the exam. It should be noted that the grade of the 1st call is kept, in those cases in which the student has passed the internship, but not the theory and thus had to resort to the 2nd call to pass the subject.

SUPERVISED WORKING TASKS: 5 points out of 100. Through the evaluation of the exercises proposed to class. There is no minimum to overcome them.

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

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