COURSE DATA

Data Subject	
Code	33082
Name	Environmental microbiology
Cycle	Grade
ECTS Credits	6.0
Academic year	2020 - 2021

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

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 (I)

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.

3. Structure and function in Prokaryotes (II)

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.

4.

5. Microbial nutrition (II)

Types of chemotrophic microorganisms. The reduction potential. Aerobic and anaerobic respiration. Fermentation. Main functional groups of chemolithotrophs. The chemo-organotrophic microorganisms (heterotrophs).

6. Microbial nutrition (I)

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.

7. Biodiversity of Bacteria

Taxonomic categories and species concept in Microbiology. Overview of Bacteria. General characteristics of the major Phyla (Aquificae. Thermotogae. "Deinococcus-Thermus" Chlorofexi, Cyanobacteria, Chlorobi, Proteobacteria, Bacterioidetes, Planctomycetes, Firmiculites, Actinobacteria) and major species.

8. Biodiversity of Archaea

Overview of Archaea. General characteristics of the major Phyla (Crenarchaeota, Euryarchaeota) and its major species.

9. Biodiversity of Protists

Phylogenetic tree of the domain Eukarya. General characteristics of the main groups of protists (Euglenozoos, Alveolados, Estramenópilos, Cercozoos, Algas verdaderas, Fungi, y Amoebozoos) and its main genus.

10. Microorganisms as biogeochemical agents

Biogeochemical cycle concept. Carbon and oxygen cycle. Carbon (redox) cycle: processes and microbial groups. Detail of carbon cycle processes in anoxic environments. Nitrogen (redox) cycle: processes and microbial groups. Cycles (redox) of sulfur and iron: processes and microbial groups. Overview of the microbial phototrophs role in biogeochemical cycles. Overview of the role of microbial chemolithotrophs in biogeochemical cycles. Overview of the role of microbial heterotrophs in biogeochemical cycles.

11. Microbial populations in the Environment (I)

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. Microorganisms and tolerance to physicochemical factors. Types of microorganisms according to their nutritional requirements. Adaptations to extreme conditions. Types and examples of microbial interactions. Types of microorganisms in natural environments. Concept of microbial community. Food webs and microbial loop concept. Bacterial biofilms and "quorum sensing".

12. Microbial populations in the Environment (II)

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.

13. Water microbiology

Types of aquatic environments. General characteristics of indigenous microorganisms of aquatic environments. Ocean: vertical and horizontal areas in the marine environment; vertical distribution of light, temperature and oxygen pressure; carbonate system and pH balance, food webs and microbial communities, other marine habitats: zooxanthellae bioluminescent organs of fish, and Riftia pachyptila. Freshwater habitats: estuaries, streams and rivers, lakes: physical and biological factors affecting microbial communities; other freshwater habitats: drinking water distribution networks, and cooling towers.

14. Environmental problems in aquatic environments and microbial bioremediation.

Eutrophication of freshwater habitats: analytical parameters: BOD and COD; rivers and eutrophic lakes. Waterborne microbial pathogens. Sanitary control of the water: analytical parameters: fecal contamination indicators versus total heterotrophic bacteria; counting techniques. Improving water resources: Wastewater Treatment: Concept of waste water and contaminants: Structure of a wastewater treatment plant. Microbial processes in the secondary treatment (aerobic and anaerobic). The role of microbial activity on the heavy metals pollution of aquatic environments and in its bioremediation. Bioremediation of marine oil pollution.

15. Soil Microbiology

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 and microbial communities. Animals as other terrestrial habitats. Soil microorganisms and public health.

16. Environmental problems in terrestrial environments and microbial bioremediation

Microbial treatment of solid waste and composting. The process of biomagnification of xenobiotics. Chemical structure of the main xenobiotics and their uses. Microbial processes in the degradation of xenobiotics (pesticides and herbicides). Bioremediation of soils and aquifers. Microbial control of pests.

17. Air microbiology and microbial bioremediation of air contaminants

The atmosphere as a microbial habitat. Microorganisms in the troposphere: methods of analysis. Control of airborne pathogens. Bioremediation of pollutants in the air. The role of microbial activity in the production of greenhouse gases and in its bioremediation.

18. Practice 1: Ubiquity of microorganisms in the environment

Standards of work in the microbiology laboratory. Concepts sterility and asepsis. Microbial load rating of the environment (air, people, etc.) by natural impaction.

19. Practice 2: Microorganisms: from the cell to the colony

Culture media types and their uses. Plating techniques for the isolation of colonies. Culture of bacteria, yeast and filamentous fungi colonial types. Microscopic observation of bacteria: Gram staining. Microscopic observation of filamentous fungi.

20. Practice 3: Microbial activities

Mineralization of organic matter and aerobic respiration: BOD5. Mineralization of organic matter and anaerobic respiration: denitrification, production of H2S. Mineralization of organic matter and fermentation.

21. Practice 4: Counting viable microorganisms

Conceptes de "bacteris viables" i de "bacteris totals". Paràmetres microbiològics de qualitat ambiental i tècniques de recompte. Recompte de bacteris aerobis totals per "plate count". Recompte de coliformes fecals per filtració.

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.

- Practical sessions will be taught in the microbiology laboratory to small groups of between 16 and 20 students, with a total duration of 12 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 three tutoring sessions (3 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, among these questionnaires solving, critical reading of research papers, and preparation of debates on current issues in the field of Environmental Microbiology.

EVALUATION

THEORY. 60 points out of 100. The minimum required to overcome the theory is 30 points . The evaluation of this part will be based on a written exam.

PRACTICE. 25 points out of 100. The minimum needed to overcome the practice is 12,5 points. 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. 15 points out of 100. Through the evaluation of the exercises, and

participation in other activities proposed (critical reading of research papers, and preparation of debates on current issues in the field of Environmental Microbiology). The minimum required to overcome this part is of 10 points. This task is mandatory and measurable, so it must have done if you want to apply for the advancement of call.

REFERENCES

Basic

- Brock- Biología de los Microorganismos. Madigan, M.T., J.M Martiko & J. Parker. 2003. 10ª ed. Prentice Hall.
- Microbiología. Prescott, L. M, J. P. Harley Y D. A. Klein. 2004. 5ª ed. McGraw-Hill-Interamenicana
- Ecología Microbiana y Microbiología Ambiental. Atlas, R.M., Bartha, R. 2002. 4ª ed. Addison-Wesley.
- 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

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

1. Contenidos

Tanto si la docencia es presencial, semipresencial o no presencial se mantienen todos los contenidos recogidos en la Guía Docente para las sesiones teóricas y seminarios. Las sesiones prácticas programadas en el primer cuatrimestre, por su naturaleza y finalidad, se espera que puedan ser presenciales

2. Volumen de trabajo y planificación temporal de la docencia

En el caso de que las sesiones de teoría sean semipresenciales (con el 50% del alumnado en cada sesión presencial) se optimizará el tiempo en las sesiones presenciales para explicar los conceptos que presenten mayor dificultad y facilitar las pautas y las herramientas necesarias para el estudio y adecuada compresión y asimilación de la totalidad de los contenidos contemplados en la guía docente. Las sesiones presenciales se complementarán con bibliografía básica, presentaciones en PowerPoint, videoconferencia, etc.

En el caso de que la docencia fuera no presencial y ello también afectara de forma irremediable a las sesiones de prácticas, se utilizaran las herramientas citadas anteriormente para el aprendizaje de todos los contenidos de la asignatura (teoría, seminarios y prácticas). En el caso de las prácticas el teletrabajo autónomo será apoyado con un cuaderno de laboratorio con descripción detallada de todos los protocolos, ilustraciones, videos y tutorías electrónicas.

En todos los supuestos, se mantiene el peso de las distintas actividades que suman las horas de dedicación en créditos ECTS marcadas en la guía docente original.

3. Metodología docente

1. Subida de materiales al Aula virtual
2. Propuesta de actividades por aula virtual
3. Videoconferencia síncrona BBC
4. Problemas/ejercicios resueltos (clases prácticas/laboratorios)
5. Tutorías mediante videoconferencia
6. Forum en Aula Virtual

4. Avaluación

En el caso de que la docencia fuera no presencial los exámenes de teoría y prácticas consistirán en pruebas objetivas (tipo test) en aula virtual. Si por causas técnicas, debidamente justificadas, algún estudiante no pudiera realizar algún examen, se estudiará la posibilidad de realizar una prueba alternativa que le sea viable. Además, para superar la asignatura se permitirá conservar la nota de la parte superada (teoría o prácticas) en la primera convocatoria, para la segunda convocatoria.

5. Bibliografía

La bibliografía recomendada se mantiene porque es accesible.