COURSE DATA

Data Subject	
Code	33192
Name	Environmental biotechnology
Cycle	Grade
ECTS Credits	4.5
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1102 - Degree in Biotechnology	Faculty of Biological Sciences	4	First term

Subject-matter

Degree	Subject-matter	Character
1102 - Degree in Biotechnology	102 - Environmental biotechnology	Optional

Coordination

Name	Department
GONZALEZ BIOSCA, ELENA	275 - Microbiology and Ecology

SUMMARY

Rapid industrialization, urbanization and development of other human activities during the nineteenth century have elevated levels of contaminants in soil, water and air, causing major environmental problems. Environmental Biotechnology can be considered as an emerging technology in the context of environmental protection. It is based on exploiting the metabolic capabilities of microorganisms to solve environmental problems. Biotechnology applications for improving the environment include the biological treatment of liquid and solid wastes, degradation or elimination of natural or xenobiotic contaminants and recovery of scarce resources. Another innovative application is biological control of pests and pathogens by using microorganisms.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

It is recommended to have passed the subjects of the modules: i) Fundamentals of Functional Biology, ii) Biochemistry, Cell Biology and Molecular Biology and iii) Instrumental methods in biotechnology.

OUTCOMES

1102 - Degree in Biotechnology

- Poseer y comprender los conocimientos en Biotecnología.
- The ability to apply this knowledge in the professional world.
- Capacidad de interpretar datos relevantes.
- Be able to convey ideas, problems and solutions in the field of biotechnology.
- Develop skills to undertake further study.
- Have abilities for teamwork and cooperation in multidisciplinary teams.
- Have abilities to disseminate and participate in the social debate on aspects related to biotechnology and its use.
- Conocer las aplicaciones de los microorganismos en biorremediación, biorrecuperación y control de plagas.
- Be able to use English to write reports and to interpret information from protocols, manuals and databases.
- Ser capaz de evaluar las aplicaciones biotecnológicas de los microorganismos.
- Analizar a nivel molecular el resultado de la manipulación de un organismo.
- Aplicar soluciones biotecnológicas a problemas medioambientales.
- Diseñar y aplicar aproximaciones biotecnológicas en el campo de la Agroalimentación.

LEARNING OUTCOMES

To understand and assimilate the concepts and terminology specific to the Environmental Biotechnology.

To understand the role of microorganisms as biogeochemical agents.

To know the tools and applications of Environmental Biotechnology.

To know microbiological indicators of environmental pollution.

To understand and integrate the knowledge of microbiology to use microorganisms in water biodepuration and soil bioremediation.

To learn the strategies for the selection and application of microorganisms in the degradation of oil and xenobiotics.

To understand the applications of microbial biotechnology in agriculture.

To understand the applications of microorganisms in controlling pests and diseases.

To be able to work in the laboratory including safety, handling, disposal and annotated record of activities.

DESCRIPTION OF CONTENTS

1. Introduction to Environmental Biotechnology

Introduction. Environmental pollution. Microbiological indicators of environmental pollution. Contribution of biotechnology to solve environmental problems.

2. Biogeochemical cycles.

The carbon cycle. The nitrogen cycle. The cycle of sulfur and other elements. Global warming. Fertilizer pollution. Acid rain.

3. Microbiological processes of wastewater treatment: clean water as a bioproduct.

Wastewater treatment.Aerobic digestion. Anaerobic digestion. Important environmental factors and microorganisms involved. Applications of bacteriophages in wastewater treatment.Microbial removal of nitrogen and phosphorus. Treated and regenerated water. Microbiological quality analysis: micro-organisms indicating faecal contamination.

4. Biodegradation of solid wastes: microbial composting.

Biodegradation of solid waste. Aerobic composting: compost as a microbial habitat. Anaerobic composting: biomethanisation and anaerobic co-digestion. Important environmental factors and micro-organisms involved. Biocontrol of bacterial pathogens in compost with bacteriophages. Biocontrol of air pollutants: biofilters and scrubbers.

5. Microbial biodegradation of pollutants: bioremediation.

Contaminants. Biomagnification. Biodegradation. Cometabolism and syntrophysm. Bioremediation.Petroleum biodegradation. Biodegradation of xenobiotic compounds. TOL catabolic plasmids. Biodegradation of xenobiotic compounds.

6. Microbial elimination of metals and radioisotopes. Phytoremediation.

Environmental contamination with heavy metals and radioisotopes. Bioavailability. Microbial interactions with metals: bioaccumulation, bioadsorption, biomineralisation and biotransformation. Microbial bioremediation of soil and water contaminated with metals. Phytoremediation.

7. Microorganisms in metal recovery.

Bacterial leaching of metals. Characteristics and diversity of leaching bacteria. Biomining processes. Recovery of copper by bacterial leaching. Leaching of uranium.

8. Microorganisms and applications for sustainable and safe agriculture.

Nitrogen-fixing micro-organisms: strategies to protect nitrogenase. Microbial biofertilisers. Biological control of microbial plant diseases: mechanisms of biocontrol agents. Control with bacteria and/or bacteriophages. Bacterial insecticides and applications: Bacillus thuringiensis and other bacteria. Baculoviruses as bioinsecticides. Entomopathogenic fungi.

9. Practical contents I

- Isolation of environmental microorganisms of biotechnological interest: hydrocarbon degrading microorganisms, nitrogen fixing bacteria, actinomycetes producing antimicrobial compounds and bacteriophages for the biocontrol of plant pathogenic bacteria.

10. Practical contents II

- PCR detection of genetic markers of degradative capacity. Assay of toluene degradation.

11. Practical contents III

Biological control assay of microbial plant diseases with bacteria and/or bacteriophages. Plate activity assays.

12. Informative note

The distribution of teaching and the relationship between classroom and non-classroom activities may be modified throughout the course if sanitary conditions require it.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	28,00	100
Laboratory practices	15,00	100
Tutorials	2,00	100
Attendance at events and external activities	3,00	0
Development of group work	7,50	0
Preparation of evaluation activities	42,00	0
Preparation of practical classes and problem	15,00	0
TOTAL	**112,50**	

TEACHING METHODOLOGY

Theoretical contents will be presented by the teacher. These contents will be developed over 20 hours, and supplemented by the items proposed for seminars (4 hours). Classes will be presented using audio-visual material and images available to students in the Virtual Classroom. Attendance at these classes is optional for the student but recommended.

Seminars will be held on topics related to the subject under the supervision of the teacher. They will be presented to the class using audiovisual and written materials.

Practical contents will be developed in the microbiology laboratory over 5 weeks, at the rate of one weekly session of 3 hours. They will include results interpretation and resolution of problems and issues related to practical contents. Attendance is considered mandatory at least at 4 out of the 5 sessions.

The **visit** to the **wastewater treatment plant** will require that students have been documented in advance to perform technical questions. Students should prepare a short memory of the visit.

Group tutorials will be held in two hour sessions in the classroom to answer questions and other issues related to the subject.

EVALUATION

THEORY: 6 out of 10.

- Class attendance: optional

- Final exam: up to 6 points (minimum 3 points).

PRACTICE: 2.5 out of 10.

- Attendance is mandatory: required for examination (at least 4 out of 5 sessions).

- Examination practice: up to 2.5 points (minimum 1.25 points).

SEMINAR: 1 out of 10**.**

- Written and audiovisual work as well as presentation are required.

WATER TREATMENT PLANT VISIT: 0.5 point on 10.

- Attendance not mandatory but evaluable

- Development of a brief report on the visit: Up to 0.5 points.

After passing each of the above mentioned parts, the marks obtained will be kept until the second round if any part is not passed in June. There will be, therefore, a second exam of theory and practice in the second call, to whose qualifications, after overcoming both independently, will be added the qualifications previously obtained for the seminar and the visit.

REFERENCES

Basic

- Basic Biotechnology. 2010. Ratledge, C. & B. Kristiansen. 3ª ed Cambridge University Press.
Biotecnología. 2009. Smith, J. 5ª ed Cambridge University Press.
Biotecnología Ambiental. 2005. Castillo Rodríguez, F. et al. Tébar.
Biotecnología del medio ambiente. Principios y Aplicaciones. 2001. Rittmann B.E. & P.L. McMarty. McGraw-Hill-Interamericana.
Biotecnología y Medioambiente. 2005. Marin, I., J.L Sanz & R. Amils, eds. Ephemera.
Biotecnología para principiantes. 2008. Renneberg R. Reverté, S.A.
Brock. Biología de los Microorganismos. Madigan, M.T., Martinko, J.M., Bender, K.S., Buckley, D.H. & D.A. Stahl. 2015. 12ª ed. Pearson. Adison Wesley.
Ecología Microbiana y Microbiología Ambiental. 2002. Atlas R.M. & R. Bartha. 4ª ed. Addison Wesley.
Environmental Microbiology: a laboratory manual. 2005. Pepper I.L.& C.P. Gerba. 2ª ed. Elsevier. Academic Press.
Introducción a la Biotecnología. 2010. Thieman & Palladino. Pearson.
Microbial Biotechnology. 2007. Glazer, A.N. & H. Nikado. 2ª ed. Cambridge University Press.
Microbial Biotechnology. Principles and Applications. 2013. Lee, Y.K. 3ª ed. World Scientific Publishing.
Prescott´s Microbiology. 2014. Willey et al. 9ª ed.

Cuadernillo de prácticas de Biotecnología Ambiental. 2018. González Biosca E. Departamento de Microbiología y Ecología. Facultad de Ciencias Biológicas. Contiene la información necesaria para

comprender y realizar las prácticas, y bibliografía específica. Está disponible en Aula Virtual.

Additional

- A critical review on the bioremoval of hazardous heavy metals from contaminated soils: issues, progress, ecoenvironmental concerns and opportunities. 2010. Wu et al. J. Hazardous Materials.174: 1-8.

Biotecnología. 2009. Smith, J. 5ª ed Cambridge University Press.

- Basic Biotechnology. 2010. Ratledge, C. & B. Kristiansen. 3ª ed Cambridge University Press.

- Bioremediation: Applied Microbial Solutions for Real-World Environmental Cleanup. 2005. Atlas R.M. ASM Press.

- Environmental Biotechnology: Theory and Application. 2003. Evans, G.G & Judy Furlong, J. John Wiley & Sons Ltd.

- Herramientas Biotecnológicas en Fitopatología. 2008. Pallás, V., C. Escobar, P. Rodríguez-Palenzuela & J.M. Marcos. Ediciones Mundi-Prensa.

- Microbial Biotechnology. 2007. Glazer, A.N. & H. Nikado. 2ª ed. Cambridge University Press.

- Microbial Biotechnology. Principles and Applications. 2013. Lee, Y.K. 3ª ed. World Scientific Publishing.