

## Course guide

# 2500211 - GEA0211 - Microbiology and Environmental Biotechnology

Last modified: 01/10/2023

**Unit in charge:** Barcelona School of Civil Engineering  
**Teaching unit:** 751 - DECA - Department of Civil and Environmental Engineering.

**Degree:** BACHELOR'S DEGREE IN ENVIRONMENTAL ENGINEERING (Syllabus 2020). (Compulsory subject).

**Academic year:** 2023    **ECTS Credits:** 6.0    **Languages:** Spanish

### LECTURER

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**Coordinating lecturer:** ENRICA UGGETTI

**Others:** BEATRIZ ALTAMIRA ALGARRA, MARTA BELLVER CATALÁ, EVA GONZALEZ FLO, ETIELE GREQUE DE MORAIS, ENRICA UGGETTI

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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#### Specific:

14445. Recognize the biological bases and foundations of the plant and animal field in engineering: notions of genetics, biochemistry and metabolism, physiology, organisms and environment, population dynamics, flows of matter and energy and changes in ecosystems, biodiversity, principles of the kinetics of microbial growth and reactor theory.

14447. Obtain basic knowledge about the use and programming of computers, operating systems, databases and basic numerical calculation and applied to engineering.

14451. Apply the fundamental concepts of statistics and randomness of physical, social and economic phenomena, as well as uncertainty and decision-making techniques.

14452. Enhance the capacity of spatial vision and identify the techniques of graphic representation, topography, photogrammetry, cartography, remote sensing and Geographic Information systems.

14453. Describe and apply the techniques of analysis of physical, chemical and biological parameters; Integrate the experimental evidence found in field and / or laboratory data with the theoretical knowledge and interpret its results.

14454. Formulate the principles of fluid mechanics and the fundamentals of continuous medium mechanics.

14455. Identify the concepts and technical aspects linked to the conduit systems, both in pressure and in free sheet and apply them to the water supply transport networks; pumping systems; unit networks; separative networks; Avenues prevention systems in urban areas and analysis of tools for the recovery of altered river and coastal spaces.

14456. Describe the processes linked to the water cycle: atmospheric circulation and rain formation; rain transformation into runoff; and apply them to surface and underground hydrology associated with avenues risk, surface water pollution, aquifer management and groundwater pollution.

#### Generical:

14440. Identify, formulate and solve problems related to environmental engineering.

14441. Apply the functions of consulting, analysis, design, calculation, project, construction, maintenance, conservation and exploitation of any action in the territory in the field of environmental engineering.

14442. To use in any action in the territory proven methods and accredited technologies, in order to achieve the greatest efficiency respect for the environment and the protection of the safety and health of workers and users.

## TEACHING METHODOLOGY

2 sessions of 2 hours every week including mastery explanation on the board, slides projection, exercises resolution and practical cases presentation.

12 hours of laboratory practices over 3 weeks.

6 hours of directed activities consisting in a technical visit to a wastewater treatment plant.

Course notes and materials available in ATENEA

The language in which the course is taught will depend on the teacher. In particular, professors Enrica Uggetti, Eteie Greque and Marta Bellver will teach their classes in Spanish, professors Eva González and Beatriz Altamira will teach in Catalan

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

To do the laboratory practices you need the following personal protective equipment (PPE):

\* White lab coat UPC Chemical

\* Protection gloves - Chemical

## LEARNING OBJECTIVES OF THE SUBJECT

The objective of this subject is the acquisition by the student of the theoretical foundations and principles of biological processes that are applied in the field of Environmental Engineering. For this, the engineering of reactors and their application to the specific case of bioreactors are studied in depth. The structure and different metabolic types of microorganisms of general interest for Environmental Engineering are detailed. The laws of microbial growth are applied to reactor theory. The knowledge acquired in this subject constitutes the theoretical base necessary for the design of biotechnological and bioremediation processes that will be studied in coordination with other subjects of the degree.

1. Understand microbial kinetics for the design of bioreactors, studying industrial microbiological processes and remediation of contaminants.
2. Know the concepts of bioaccumulation, bioaugmentation, biosensors, bioindicators and study the processes of genetic modification of microorganisms and biomaterials.

Microbiology and Environmental Biotechnology. Introduce the student to microbial kinetics for the design of bioreactors, and study microbiological processes industrial and pollutant remediation, introducing concepts such as bioaccumulation, bioaugmentation, biosensors, bioindicators, modification genetics of microorganisms, biomaterials.

1. Deep knowledge of reactors theory.
2. Capacity to perform mass balances.
3. Deep knowledge of microbial kinetics.
4. Knowledge of the main microbial processes of interest in Environmental Engineering.
5. Numerical simulation of bioprocesses.
6. Analysis and evaluation capabilities of microorganism growth data.

In particular, this subject interacts directly with the following subjects: Hydrogeology and environmental geochemistry, Water treatment, Soils and aquifers remediation, Wastewater and reuse, Solid waste, Atmospheric and acoustic pollution, and Climate change and natural risks.

## STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Self study	90,0	60.00
Hours medium group	15,0	10.00
Hours small group	15,0	10.00

**Total learning time:** 150 h



## CONTENTS

### Interactions Microbial Ecology, Environmental Biotechnology and Environmental Engineering

**Description:**

Microbiomes. Microbial metacommunities. Trophic nets and Environmental Engineering. Ecological Engineering. Contamination and pollution. Concept of Environmental Engineering and of Environmental Biotechnology. Exercises

**Full-or-part-time:** 4h 48m

Theory classes: 2h

Self study : 2h 48m

### Reactor Engineering

**Description:**

Types of reactors. Theoretical hydraulic retention time. Hydraulic behavior: tracer tests. Mass balances. Complete mix reactor Tank in series model. Plug flow reactor. Mass continuity equation  
Transport equation. Diffusion. Advection. Transport equation solutions  
Convergence between complete mix reactor and plug flow. Deviations from plug flow: boundary layer effect. Hydraulic retention time distribution function  
Tracer test examples. Semi-batch reactor. Reactor scale-up  
Reactor exercises

**Full-or-part-time:** 28h 47m

Theory classes: 10h

Practical classes: 2h

Self study : 16h 47m

### Environmental bioreactors

**Description:**

Bioreactor applications: wastewater treatment, solid waste treatment, gas treatment, soil and groundwater treatment. Visit to a wastewater treatment plant

**Full-or-part-time:** 14h 23m

Theory classes: 6h

Self study : 8h 23m

### Stoichiometry of Microbial Reactions

**Description:**

Enzymatic reactions: Michaelis-Menten kinetics. Microbial growth phases. Exponential growth

**Full-or-part-time:** 4h 48m

Theory classes: 2h

Self study : 2h 48m



### Ecology and Environmental Engineering

**Description:**

Monod kinetics. Substrate kinetics. Productivity. Gross and net growth. Lysis. Temperature effect. Exercises

**Full-or-part-time:** 4h 48m

Theory classes: 2h

Self study : 2h 48m

### Microbial kinetics

**Full-or-part-time:** 4h 48m

Laboratory classes: 2h

Self study : 2h 48m

### Aerobic Degradation of Organic Matter (Aerobic Chemosynthetics)

**Description:**

Mass balances in cultures with biomass recycling. Effect of recycling on hydraulic and cellular retention time

Exercises of aerobic suspended cultures

Nitrification, denitrification and anammox. Exercises

Anaerobic cultures: anaerobic digestion. Exercises

Phosphorus removal. Exercises

**Full-or-part-time:** 24h

Theory classes: 4h

Practical classes: 6h

Self study : 14h

### N Cycle Reactions (Nitrification and Denitrification)

**Description:**

Biofilm processes and kinetics. Sulphate reduction and sulphide oxidation. Exercises

**Full-or-part-time:** 4h 48m

Theory classes: 2h

Self study : 2h 48m

### Anaerobic Degradation of Organic Matter (Anaerobic Chemosynthetics)

**Description:**

Simultaneous processes: Petersen matrix. Activated sludge models (ASM)

Anaerobic digestion model (ADM). Constructed wetland model (CWM)

**Full-or-part-time:** 9h 36m

Theory classes: 4h

Self study : 5h 36m



### Processes related to the cycle of P

**Description:**

Simulation of unsteady processes

**Full-or-part-time:** 4h 48m

Practical classes: 2h

Self study : 2h 48m

### Seminars

**Description:**

Research related to environmental biotechnology

**Full-or-part-time:** 9h 36m

Laboratory classes: 4h

Self study : 5h 36m

### Laboratory practices: photosynthetic production award

**Description:**

Preparation of culture plates. Isolation of colonies. Microscopic observation. Simulation tools: model BIO\_ALGAE. Preparation of culture medium. Inoculation. Culture monitoring: pH, DO, SST, turbidity, optical density, cell count, alkalinity, nitrate, phosphate

**Full-or-part-time:** 28h 47m

Laboratory classes: 12h

Self study : 16h 47m

## GRADING SYSTEM

Examination I (40%) + Examination II (40%) + Laboratory Practice Examination (15%) + Practice Report (5%). To pass you must get a global rating 4.9

Examinations have a part of test theory and a part of numerical exercises and problems.

5% of Examination I (of the total 40%) will refer to the technical visit to a wastewater treatment plant. Attendance to the visit is mandatory. Students who will not attend the visit will have a 0 in the part corresponding to 5%.

Attendance to all laboratory practices is mandatory in order to carry out the examination of practices and delivery of the report. Students who do not attend any of the practices will have a 0 rating on the exchequer and the report.

Students who have carried out all the evaluation acts have not approved will be able to carry out a re-evaluation examination that will be exclusively test-type. Students who have not attended any of the practices and/or the technical visit will not be able to perform the requalification examination. Approve reassessment means having a rating of 5.0

## BIBLIOGRAPHY

**Basic:**

- Levenspiel, O. Chemical reactors engineering. 3rd ed. New York etc.]: Wiley, 1999. ISBN 047125424X.

- Rittmann, B.E.; McCarty, P.L. Environmental biotechnology: principles and applications. Boston: McGraw-Hill, 2001. ISBN 0071181849.

**Complementary:**



- Kennes, C.; Veiga, M.C. (eds.). Bioreactors for waste gas treatment [on line]. Dordrecht: Springer Science+Business Media, 2001 [Consultation: 18/03/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=4712485>. ISBN 9789401709309.
- Henze, M.; van Loosdrecht, M.C.M.; Ekama, G.A.; Brdjanovic, D. Biological wastewater treatment: principles, modelling and design [on line]. London: IWA, 2008 [Consultation: 03/02/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=3120653>. ISBN 9781780401867.
- IWA task group on mathematical modelling for design and operation of biological wastewater treatment; Henze, M. [et al.]. Activated sludge models ASM1, ASM2, ASM2d and ASM3 [on line]. London: IWA Publishing, 2000 [Consultation: 03/02/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=3120732>. ISBN 9781780402369.
- IWA Task Group for Mathematical Modelling of Anaerobic Digestion Processes; Batstone, D.J. [et al.]. Anaerobic digestion model no. 1 (ADM1) [on line]. London: IWA Publishing, 2002 [Consultation: 22/01/2021]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=3120725>. ISBN 1900222787.