Universitat Autònoma de Barcelona

2018/2019

Functional Diversity of Microorganisms

Code: 100774
ECTS Credits: 6

Degree	Type	Year	Semester
2500250 Biology	OB	3	1

Contact

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Use of languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: Yes

Teachers

Maria Teresa Llovet Pellejero
Neus Ferrer Miralles
Marc Llirós Dupré
José Luis Corchero Nieto

Prerequisites

Although no official prerequisite exists, students are advised to review concepts that refer to the microbial world, previously studied. Likewise, it is convenient to have a good knowledge of the courses previously studied in the degree of Biology.

In order to take this course it is necessary that the student has passed the tests of Safety and Biosafety that he/she will find in the corresponding Moodle space. It is necessary to present, the first day of class, the printed pdf documents generated when passing the tests. Also, it is necessary to know and accept the operating rules of the laboratories of the Faculty of Biosciences. In addition, it is imperative that the student follows the rules of work indicated by the teaching staff. For safety reasons, if the two tests have not been passed, or the student does not wear a lab coat and safety glasses, access to the lab will not be allowed.

Objectives and Contextualisation

This is a mandatory course of the third year of the Degree in Biology, which introduces students to the basic knowledge of prokaryotic and viral diversity, with special emphasis on their structural and ecophysiological characteristics, as well as their biotechnological importance, and in the need for constant updating of information through the bibliographic databases.

The main objective of the scourse is to provide the basic training for the study of the microbial diversity, physiology and metabolism of the main groups of prokaryotes and viruses.

The specific objectives of the course are the following:

- Recognize the diversity of prokaryotic microorganisms and virus

- Understand the principles of classical and molecular taxonomy.
- Know how to distinguish the characteristics that define the different taxonomic groups, their structural particularities, their ecophysiological characteristics and their importance.
- Learn how to apply the knowledge studied to carry out the identification and characterization of the main prokaryotic and viral groups.

Skills

- Be able to analyse and synthesise
- Be able to organise and plan.
- Describe and identify the levels of organisation of living beings.
- Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
- Develop independent learning strategies.
- Identify and classify living organisms.
- Isolate, culture and modify microorganisms and cells and tissues of multicellular organisms.
- Understand the processes that determine the functioning of living beings in each of their levels of organisation.
- Work in teams.

Learning outcomes

1. Apply the conventional microbiological techniques that allow differentiation between the various microbial groups.
2. Apply the methodologies needed to characterise and identify microorganisms in pure cultures and in complex samples.
3. Be able to analyse and synthesise.
4. Be able to organise and plan.
5. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
6. Develop independent learning strategies.
7. Explain the role of microorganisms as agents of disease or toxicological problems in human beings, animals and plants.
8. Present the different groups of microorganisms, describe their differential characteristics and situate them phylogenetically.
9. Recognise the diversity of the microbial world and identify the different groups it is composed of.
10. Work in teams.

Content

Theory

Prokariotic Diversity

1. Introduction to prokaryotic diversity

What do we mean by prokayotic diversity? Phylogeny and implications in taxonomy. The concept of prokaryote.

2. **Microbial systematics**

Classification, nomenclature and identification. Classification systems. Polyphasic taxonomy: phenotypic, genotypic and phylogenetic methods. Classification units. The species concept for prokaryotes. Bergey´s Manual of Systematic Bacteriology. Culture collections.

3. Archaea domain

Structural particularities of archaea. Phylogeny and metabolism. Euyarcahaeota. Crenarchaeota. New archaeal phyla.

4. The deep-branching bacterial groups

Adaptations to life at high temperatures, and high radiation. Ecophysiological characteristics of the different groups and key genera.

5. Gram-Negative Bacteria I

Characteristics of the main groups of green phototrophic bacteria. General characteristics, ecological relevance and key genera. Main chemotrophic groups: Structure, classification and ecophysiology.

6. Gram-negative bacteria II

Proteobacteria. Morphological, physiological and metabolic diversity. Phylogenetic divisions. Main members of the group and their significance.

7. Gram-positive bacteria and mycoplasma

Morphological and ecophysiological characteristics, main phylogenetic groups and applied importance.

8. Groups of bacteria and archaea with few or not cultured species

Phylogenetic groups dominated by sequences of uncultivated organisms. Distribution and characterization. What do we know about the microbial world?

Viral diversity

9. Introduction: Virology and its origins

The hypotheses about the maintenance of life and the spontaneous generation. The works of Pasteur and the postulates of Koch. The nineteenth century: the discovery of viruses. The mosaic of tobacco: the concept of filterable poisons. Discovery of animal virus. Twentieth century: chemical, structural and genetic characterization of viruses. Relevant facts in the history of Virology. The eradication of the smallpox and the risk of re-emergence. Clinical and biotechnological aspects of Virology. Bioterrorism.

10. Virus nature and virological methodology

The world of viruses. Strict parasitism, multiplication and transmission. Viral diversity. The viral cycle: extra-intracellular phases. Sequential expression of viral genes. Obtaining viral particles. Cell cultures. Small- and medium-scale cultures. Purification. Quantitative analysis of viral particles. Detection of viral components and applications in the diagnostic methodology. The laboratory of virology. Biological security Contention levels: P1 to P4.

11. Virions: viral particles and their genomes

The viral particle: dimensions, chemical composition, morphology, nomenclature. Functions of the capsid; Stability and recognition. Morphology of viral particles: helical and icosahedral symmetries. Trans-membrane proteins in viral envelopes. Sites of union to receptors. Chemical composition, structure and organization of the viral genome: structural and non-structural genes. The polarity of nucleic acid. Principles of complexity of viral genomes and genome reduction; overlapping gens. Segmented and partite genomes. Recombination, reorganization and phenotypic mixing.

12. The viral cycle

Cellular recognition. Nature and function of the receptors. Internalization. Decapsidation. Cell shutdown. Synthesis of RNA, DNA and viral proteins: temporal sequences. Cytopathic effects. Releaseof viral particles with and without lysis. Apoptosis. Cell transformation in RNA viruses: cell oncogenes; activation and transduction. Cell transformation in DNA viruses: oncogens and viral oncoproteins. Productive and non-productive infections. Lithic cycles vs. lysogenic cycles.

13. Origin and evolution of viruses

Origin of viruses; Regressive and progressive theories. Mechanisms of diversity generation. Mutation frequencies and relative abundance of mutants. Mutation fixation. Viral replicase and copy fidelity. Variability and evolution in RNA viruses and retroviruses. Viral quasispecies. Evolution and evolutionary potential. Founder effects and bottlenecks. Genetic and antigenic divergence; influenza virus. Analysis of viral phylogeny.

14. Principles of viral taxonomy

First classifications of viruses: Baltimore classification of animal viruses. The International Committee of Virus Taxonomy and the classification system. Viral properties used in taxonomy.

15. Doubled-stranded RNA viruses

The Reovirus. Structure, union, entry and "decapsidation". Genome: transcription and translation. Assembly and coating of the reovirus. Pathogenesis: rotavirus.

16. Single-stranded RNA viruses (1)

The Picornavirus. Structure, union and entry. Genome: transcription and translation. Assembly and maturation. Medical aspects: Poliovirus, Rhinovirus and the virus of hepatitis A. Flavivirus. Structure, union and entry. Replication. Assembly and release. Medical aspects: hepatitis C virus, haemorrhagic fever virus and encephalopathy-causing viruses. The Togavirus. Structure, union and entry. Genome: transcription and translation. Assembly and maturation. Medical Aspects: Alphavirus that cause encephalitis and Alphavirus that cause arthritis. The Coronavirus. Structure, genome, assembly and release. Medical Aspects: SARS coronavirus..

17. Single-stranded RNAViruses (2)

The Rhabdovirus. Structure, union and entry. Genome: transcription and translation. Assembly and release. Medical aspects: rabies virus. Paramyxovirus. Structure, genome, assembly and release. Medical aspects: measles and mumps. The Orthomyxovirus. Structure, union and entry. HA protein. Genome: transcription and translation. Assembly and release. Medical aspects: the flu virus. The influenza epidemic of 1918. Origin of epidemics and pandemics: antigenic drift and antigenic shift. Avian flu and its transmission to humans.

18. Single-stranded DNA viruses

Parvovirus. Structure, union and entry. Genome: transcription and translation. Assembly and release. Medical aspects: Parvovirus B19.

19. Double-stranded DNA viruses (1)

The Polyomavirus. Structure, union and entry. Genome: organization and expression. Assembly and release. Medical aspects. Papilomavirus. Structure, union and entry. Genome: organization and expression. Assembly and release. Medical aspects: cell transformation and oncogenesis. Cervical carcinoma.

20. Double-stranded DNA viruses (2)

The adenovirus. Structure, union and entry. Genome: organization and expression. Assembly and release. Medical aspects: recombinant adenoviruses. Herpesvirus. Structure, union and entry. Genome: organization and expression. Assembly and release. Medical aspects: latent infections. Infertility caused by herpesvirus.

21. Double-stranded DNA viruses (3)

The Poxvirus. Structure, union and viral entry. Genome: organization and expression. Assembly and release. Medical aspects: the smallpox virus. Eradication of smallpox. The virus of the smallpox and the bioterrorism.

22. Hepadnavirus

Hepadnavirus: DNA retrovirus. Structure, union and viral entry. Genome: organization and expression. Medical aspects: the hepatitis B virus.

23. Retroviruses

The Retrovirus. Structure, union and entry. Genome: organization and expression. Reverse transcription. Virus assembly and release. Medical aspects: oncogenesis. The genus of Lentivirus: the AIDS virus.

Problems / Seminars

1. Methods of isolation of microorganisms

2. Techniques of microscopic observation

3. Methods of identification and characterization of microorganisms

4. Work sessions with scientific articles

Laboratory work

1. Isolation of microorganisms from natural environments

2. Identification: biochemical and physiological tests

3. Preparation and quantification of viral lysates

4. Neutralization of viruses

Methodology

The course consists of three modules, which have been programmed in an integrated way so that the student will have to relate throughout the course the content and activities programmed in order to achieve the skills indicated in this guide.

Several learning strategies will be combined:

Theory classes: Student must acquire the scientific and technical knowledge of this course by attending these classes and complementing them with the autonomous study of the topics explained. At the beginning of the course, students will be given a detailed calendar of the topics that will be worked on throughout the course, as well as the bibliography that they will have to consult to prepare each theory class and for the autonomous study of the topics explained. Within this module, classes will be based on master or expository lectures and in a brief discussion of the same.

Seminars/case resolution classes: The purpose of these sessions is: a) working methodological aspects, b) facilitating the understanding of the knowledge presented in the theoretical classes, c) enable the student to design basic experiments id) make a bridge between the participatory theoretical classes and the practical work of the laboratory, with the aim of integrating the theoretical knowledge with the practitioners. The student will work on specific practical cases that will have to be developed during the course. In addition, the bibliography that will be consulted and the relation of each session with the subjects treated in the participative theoretical classes will also be indicated.

Laboratory work: The objectives of these activities are: a) facilitate the understanding of the knowledge exposed to the theory classes, b) apply the knowledge developed in the sessions of seminars/case resolution, c) acquire manual skills, d) interpret results and e) acquire the ability to work with microorganisms. Class attendance is compulsory in order to be able to acquire the skills of the course. In order to take this course it is necessary that the student has passed the tests of Safety and Biosafety that he/she will find in the corresponding Moodle space. It is mandatory to present, the first day of class, the printed pdf documents generated when passing the tests. Also, it is necessary to know and accept the operating rules of the laboratories of the Faculty of Biosciences. In addition, it is imperative that the student follows the rules of work

indicated by the teaching staff. For safety reasons, if the two tests have not been passed, or the student does not wear a lab coat and safety glasses, access to the lab will not be allowed.Finally,in order to achieve good performance and acquire the competencies corresponding to this activity, it is essential that the student make a comprehensive reading of the proposed practices before their completion.

Additional information

In order to support the training activities indicated above, classroom tutoring sessions canbe programmed at the requestofthe students. Likewise, the students will be able to carry out individual tutorials in the office of the professors Jose Luis Corchero Nieto (IBF-112.1) and Maira Martínez-Alonso (C3-329).

The student will have at the Moodle space all the documentation delivered by the teacher for the good monitoring of the course. He / she will also be able to consult the teaching space of the Degree Coordination to obtain updated information.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Laboratory work	12	0.48	2, 1
Seminar/case resolution classes	8	0.32	6, 5, 3, 4, 10
Theory lectures	31	1.24	8, 7, 9
Type: Supervised			
Individual/group tutorials	2	0.08	6, 5, 8, 7, 9, 3
Type: Autonomous			
Bibliografy search	9	0.36	6, 5, 3, 10
Estudy	50	2	6, 5, 8, 7, 9, 3
Preparation and writing of works	20	0.8	6, 5, 8, 7, 9, 3, 10
Text reading	12	0.48	6, 5, 8, 7, 9, 3

Evaluation

The evaluation of the course will be individual and continued through the following tests:

Assessment of the theory classes module (60% of the global mark): During the course, two written exams of this module will be programmed. Each of the tests will have a weight of 50% of the module's mark, but the average will only be used if the test scoreis equal or superior to 5; otherwise, the student will have to carry out a second-chance examination of the failed written test.
Each test will consist of short answer questions, aimed at assessing whether the key conceptual objectives have been achieved, and/or multiple choice test questions which will allow to avaluate a large part of the contents.

Assessment of the seminar/case resolution classes module (20% of the overall mark): The evaluation will include the following aspects:

Written test (10% of the overall mark).

Oral presentation of the work done (10% of the overall mark).

Only the average will be made if the score of the tests is equal or superior to 5.

Assessment of lab work module (20% of the global mark): The evaluation will include the following aspects:

Completion of a questionnaire and monitoring of pracical skiils acquired which will consist of the delivery of different practical results to the teaching staff during the laboratory sessions (2% of the overall mark).

Oral presentation of the practical results (8% of the overall mark)

Written test (10% of the overall mark), which will consist of multiple choice test questions.

Only the average will be made if the mark of the tests is equal or superior to 5.

Final Considerations:

- To pass the course, you must obtain a score of 5 or superior in each module. Students who do not pass any of the modules will be able to retake them on the scheduled date for the final evaluation of the course.
- To be eligible for the retake process, the student should have been previously evaluated in a set of activities equalingat least twothirdsof the final score of the course. Thus, the student will be graded as **Non-evaluable** if the weighing of all conducted evaluation activities is less than 67% of the final score.
- Students who can not attend an individual assessment test for a justified cause and provide the corresponding documentation, will be entitled to take the test in question on another date.
- Students who wish to improve the grade will renunciate to that previously obtained, and she/he will have to perform the re-assessment of all the contents corresponding to the different modules of the course on the day scheduled for that purpose.
- From the second enrolment, the repeating students will not have to carry out the activities, nor the evaluations of those skills surpassed, corresponding to the modules of seminars and practices. That is, the mark obtained in these modules will be saved, as long as they have been passed.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Laboratory work assessment	20	1	0.04	2, 1
Seminar/case resolution assessment	20	1	0.04	6, 5, 3, 4, 10
Theory assessment I	30	2	0.08	8, 7, 9
Theory assessment II	30	2	0.08	8, 7, 9

Bibliography

Recommended books:

- James W. Brown. 2015. Principles of microbial diversity. 1ª ed. ASM Press.

- Madigan MT, Martinko JM, Bender KS, Buckley DH, Stahl DA. 2014. Brock Biología de los Microorganismos. 14ª ed. Pearson Education.

- Madigan MT, Bender KS, Buckley DH, Sattley WM, Stahl DA. 2017. Brock Biology of Microorganisms. 15th ed. Pearson SA.

- Ogunseitan O. 2005. Microbial diversity. Form and function in Prokaryotes. Blackwell Publishing.

- Staley JT, Reysenbach AL. 2002. Biodiversity of microbial life: foundation of earth's biosphere. Willey-Liss, Inc, New York.

- Willey J, Sherwood LM, Woolverton CJ. 2008. Microbiología de Prescott, Harley y Klein. 7ª ed. MacGraw-Hill.

- Willey JM, Sherwood LM, Woolverton CJ. 2017. Prescott's Microbiology. 10th ed. MacGraw-Hill.

- Cann A J. 2016. Principles of molecular virology. (6th Ed). Academic Press. London.

- Flint SJ i altres. 2015. Principles of virology: Molecular biology, pathogenesis and control. (4rd Ed). ASM Press. Washington.

- Wagner EK, Hewlett MJ. 2007. Basic virology (3rd Ed). Blackwell Publishing. Oxford.

- Dimmock NJ, Easton AJ, Leppard KN. 2016. Introduction to modern virology. (7th Ed). Blackwell Publishing. Oxford.

- Collier L, Kellam Pm Oxford J. 2016. Human virology. (5th Ed). Oxford University Press. Oxford.

- Shors T. 2009. VIRUS. ESTUDIO MOLECULAR CON ORIENTACION CLINICA. Editorial PANAMERICANA. Bogotà-Madrid.

- Louten J. 2016. Essential human virology. Elsevier

Complementary books:

- **The Prokaryotes.**

Rosenberg E, DeLong EF, Lory S, Stackebrandt E, Thompson F (Editors). 2013-14. The Prokaryotes. Fourth Edition. 11 vol. Springer, New York.

- Volume 1: The Prokaryotes: Prokaryotic Biology and Symbiotic Associations
- Volume 2: The Prokaryotes: Applied Bacteriology and Biotechnology
- Volume 3: The Prokaryotes: Prokaryotic Physiology and Biochemistry
- Volume 4: The Prokaryotes: Prokaryotic Communities and Ecophysiology
- Volume 5: The Prokaryotes: Medical Microbiology
- Volume 6: The Prokaryotes: Alphaproteobacteria and Betaproteobacteria
- Volume 7: The Prokaryotes: Firmicutes and Tenericutes
- Volume 8: The Prokaryotes: Actinobacteria
- Volume 9: The Prokaryotes: Gammaproteobacteria
- Volume 10: The Prokaryotes: Deltaproteobacteria and Epsilonproteobacteria
- Volume 11: The Prokaryotes: Other Major Lineages of Bacteria and the Archaea

- Bergey's Manual® of Systematic Bacteriology

Garrity G (Ed.) 2001-2012. Bergey's Manual of Systematic Bacteriology. Second Edition. 5 vol. Springer, New York.

Volume package:

- Volume 1: Boone DR, Castenholz RW (Eds.). 2001. Bergey's Manual of Systematic Bacteriology, Second Edition. Volume One : The Archaea and the Deeply Branching and Phototrophic Bacteria. Springer, New York.
- Volume 2: Brenner DJ, Krieg NR, Staley JT (Editors). 2005. Bergey's Manual of Systematic Bacteriology, Second Edition, Volume Two: Tthe Proteobacteria. Springer, New York.

- Volume 3: De Vos P, Garrity G,Jones D, Krieg NR, Ludwig W,Rainey FA, Schleifer K-H, Whitman WB (Editors). 2009. Bergey's Manual of Systematic Bacteriology: Volume 3: The Firmicutes. Springer, New York.
- Volume 4: Krieg NR, Ludwig W, Whitman WB, Hedlund BP, Paster BJ, Staley JT, Ward N, Brown D (Eds.). 2010. Bergey's Manual of Systematic Bacteriology, Second Edition. Volume 4: The Bacteroidetes, Spirochaetes, Tenericutes (Mollicutes), Acidobacteria, Fibrobacteres, Fusobacteria, Dictyoglomi, Gemmatimonadetes, Lentisphaerae, Verrucomicrobia, Chlamydiae, and Planctomycetes. Springer, New York.
- Volume 5: GoodfellowM, Kämpfer P, Busse H-J, Trujillo M, Suzuki K-I, Ludwig W, WhitmanWB (eds). 2012. Volume 5: The Actinobacteria. Springer, New York.

- Bergey's Manual® of Systematics of Archaea and Bacteria

Whitman WB (Ed.). 2015. Bergey's Manual of Systematics of Archaea and Bacteria (digital Ed.). First Edition. John Wiley & Sons, Inc. DOI: 10.1002/9781118960608

(http://wileyonlinelibrary.com/ref/bergeysmanual)

- Encyclopedia of virology

Granoff A, Webster RG. (Constantment actualitzada i ampliada). Encyclopedia of virology (on-line Ed.) Academic Press. London.

(http://www.sciencedirect.com/science/referenceworks/0122270304)

Webs of interes:

http://www.microbelibrary.org

http://microbewiki.kenyon.edu