UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Environmental Microbiology

2223-2-F7501Q087

Aims

The course aims at providing in-depth knowledge on the assessment of microbial communities in natural and anthropic environments, on the ecological processes that regulate them, and on their functions in the ecosystems.

1. Knowledge and understanding. At the end of the course the student must know: the methods for characterization of microbial communities; the principles at the basis of microbial taxonomy and related problems; the main microbial taxa found in different environmental compartments and their functions, also in terms of ecosystem services provided; the ecological processes that drive microbial communities; the main interactions of microorganisms with animals, plants and anthropic environment.

2. Applying knowledge and understanding. At the end of the course the student must be able to apply the knowledge acquired during the course demonstrating his/her ability to include microbiological aspects in the assessment of natural and anthropic ecosystems.

3. Making judgments. The student must be able to make hypotheses about ecological processes and ecosystem services due to microbial activities in a variety of natural and anthropic contexts.

4. Communication skills. At the end of the course the student will be able to describe appropriately the topics studied using the correct specific vocabulary.

5. Learning skills. At the end of the course the student will be able to consult the literature on the covered topics and to autonomously integrate the acquired knowledge with concepts related to the studied ecological processes, also with a multidisciplinary approach.

Contents

1. Characterization of bacterial communities. 2. Taxonomic diversity of microorganisms. 3. Role of bacteria in

biogeochemical cycles and climate change impact on microbial activities. 4. Bacteria of environmental compartments: soil, freshwater, cryosphere and atmosphere bacteria. 5. Ecological processes applied to microbial communities and species interactions. 6. Ecological roles of animal and plant-associated microbiomes. 7. Bacteria in cultural heritage. 8. Molecular microbiology practical 9. Bioinformatics practical

Detailed program

1. Characterization of bacterial communities.

Cultivation techniques, isolation and identification of microbial strains. Microbial taxonomy. Culturability issues. Molecular techniques for community characterization. Evaluation methods of in situ microbial activity. “Omics” methods.

2. Taxonomic diversity of microorganisms.

Main taxa of domains Bacteria and Archaea and their functions. The universal tree of life. Role of Horizontal Gene Transfer.

3. Role of bacteria in biogeochemical cycles and climate change impact on microbial activities.

The biological cycle of carbon: phototrophy/chemotrophy; autotrophy/heterotrophy; methane cycle. The biological cycles of nitrogen, sulfur, iron and minor elements. The impact of climate change on microbiological activities.

4. Bacteria of environmental compartments and their functions.

Soil bacteria. Freshwater bacteria; focus on antibiotic resistance gene transfer. Cryosphere bacteria. Airborne bacteria and their dispersal.

5. Ecological processes applied to microbial communities and species interactions.

Selection, dispersal, drift. Mutualisms, commensalisms, predation and parasitism among microorganisms and among micro- and macroorganisms.

6. Ecological roles of animal and plant-associated microbiomes.

Phyllosphere and rhizosphere bacteria. Microbiomes (particularly gut microbiomes) associated to animals and humans.

7. Bacteria in cultural heritage.

Biodeterioration and biological remediation of artwork surfaces (biocleaning).

8. Molecular microbiology practical.

DNA extraction from soil samples, analysis and quantification of taxonomic and functional markers

9. Bioinformatics practical.

High-throughput sequencing data: formats and databases. Bioinformatics data processing.

Prerequisites

Basics of Microbiology and/or Cell Biology

Teaching form

Lectures supported by PowerPoint presentations (4.5 CFU; 36 h). Practical (1.5 CFU): molecular microbiology practical (8 h) + bioinformatics practical (7 h). Teaching material will be made available to students through e-learning

Textbook and teaching resource

Slides are available at the e-learning page of the course.

Reference books:

1. Brock, Biologia dei Microrganismi: microbiologia generale, ambientale e industriale, Pearson (available at the library).

2. Biavati e Sorlini, Microbiologia agroambientale.

However, since there is no a proper textbook covering all the program contents, attending the course is highly recommended.

Scientific papers are available for supplementary study.

Semester

First semester

Assessment method

ORAL EXAMINATION ON TOPICS COVERED IN CLASS: 3 general questions on the topics covered during the lectures. The students must demonstrate to be able to clearly expose the acquired knowledge, demonstrating their complete understanding and language properties.

Optionally, it is possible to choose a topic of interest and study it in more detail through one of the available papers. In this case, one of the three questions will be replaced by the selected topic.

Office hours

By appointment (e-mail: isabella.gandolfi@unimib.it)

Sustainable Development Goals

CLIMATE ACTION | LIFE ON LAND