UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Applied Microbiology

2122-2-F7501Q090

Aims

The course aims to provide in-depth knowledge on the degradative abilities of microorganisms, with particular attention to hydrocarbons and xenobiotics, and to their possible applications in processes of bioremediation of contaminated environmental matrices.

1. Knowledge and understanding. At the end of the course the student must know: the main microbial catabolic pathways for the degradation of hydrocarbons and xenobiotics; the most common bioremediation technologies for contaminated waters and soils; the main methods of composting; the characterization and monitoring methods of contaminated sites; the characterization and monitoring methods of microbial communities.

2. Applying knowledge and understanding. At the end of the course the student must be able to apply the knowledge acquired during the course to real cases of remediation or biological treatment of contaminated matrices, highlighting the advantages and disadvantages of every possible alternative proposed.

3. Making judgments. The student must be able to design the main phases of a biological intervention on different matrices to be treated.

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 topics covered and autonomously integrate the knowledge acquired with others related to the sector of remediation and treatment of contaminated matrices, also with a multidisciplinary approach.

Contents

1. Processes and microorganisms involved in the transformations of elements

2. Microbial metabolism and redox conditions

3. Processes and microorganisms involved in the degradation of hydrocarbons

4. Characterization and monitoring of bacterial communities

5. Characterization and biological treatment of sites contaminated by hydrocarbons

6. Biological processes for waste treatment

7. Technical visits to biological treatment plant

8. Teamwork

Detailed program

1. Processes and microorganisms involved in the transformations of elements

The biological cycle of carbon: phototrophy / chemotrophy; autotrophy / heterotrophy. The biological cycle of nitrogen; nitrification and denitrification processes. The biological cycle of sulfur. Microbial reduction and oxidation of iron.

2. Microbial metabolism and redox conditions

Main electron acceptors in microbial metabolism. Dependence of microbial metabolism on the redox potential. Determination of redox conditions and availability of electron acceptors in an aquifer.

3. Processes and microorganisms involved in the degradation of hydrocarbons

Main pathways of aerobic degradation of aliphatic, mono- and polyaromatic hydrocarbons and enzymes involved. Main pathways of anaerobic degradation of aliphatic, mono- and polyaromatic hydrocarbons and enzymes involved. Degradation and cometabolism processes of halogenated organic compounds.

4. Characterization and monitoring of bacterial communities

Quantification methods. Cultivation techniques and isolation of microbial strains. Classical techniques for strain identification. Microbial taxonomy. Molecular techniques for identification of isolates. Community characterization and monitoring molecular techniques: fingerprinting; high-throughput sequencing; in situ methods. Evaluation methods of in situ microbial activity.

5. Characterization and biological treatment of sites contaminated by hydrocarbons

Operating procedures for the characterization of contaminated sites; risk analysis. Biological approaches to the treatment of contaminated matrices: biostimulation and bioaugmentation; screening and feasibility tests.

Bioremediation technologies for soil and unsaturated zone (landfarming, biopiles, bioreactors, bioventing). Bioremediation technologies of the saturated zone (biosparging, biobarriers). Innovative bioremediation technologies: bioelectrochemical systems. Monitored Natural Attenuation.

6. Biological processes for waste treatment

Composting processes of green waste and of the organic fraction of solid urban waste.

Prerequisites

Basic knowledge of Microbiology

Teaching form

Classroom lectures and practical cases supported by PowerPoint presentations (40 h). Visit to an ex-situ biological treatment plant (half day). Teaching material will be made available to students through e-learning. A teamwork activity will also be proposed for designing a monitoring plan and a biological remediation intervention.

Textbook and teaching resource

Slides available at the e-learning platform of the course.

Textbook.

Microbiologia ambientale ed elementi di ecologia microbica; Barbieri, Bestetti, Galli, Zannoni – CEA, 2008 (available in the library).

Reference books:

Brock biologia dei microrganismi: microbiologia generale, ambientale e industriale; Madigan, Martinko et al. – Pearson, 2016 (available in the library).

Ground-water microbiology and geochemistry; Chapelle – John Wiley & sons, 2001 (available from the teacher).

Bonifica di siti contaminati; Bonomo – McGraw-Hill, 2005 (available from the teacher).

Wastewater engineering. Treatment and reuse; Metcalf & Eddy – McGraw-Hill, 2004 (available from the teacher).

Compost ed energia da biorifiuti; Vismara, Grosso, Centemero – Dario Flaccovio Editore, 2009 (available from the teacher).

Semester

First semester

Assessment method

Oral examination: 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.

Office hours

By e-mail appointment