UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Microbiologia Applicata

2021-1-F0802Q072

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 and in waste treatment.

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

. Metal biotransformation processes

7. Biological processes for waste treatment

8. Molecular microbiology practical

9. Technical visits to biological treatment plant

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. Metal biotransformation processes

Bioremediation of matrixes contaminated by metals: phytoremediation. The case of mercury: bacterial resistance to

mercury and possible applications to bioremediation.

7. 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 ain-situ and ex-situ biological treatment plant (half day). Teaching material will be made available to students through e-learning. During the COVID-19 restrictions the lessons will be recorded and available online, with some live events that will be planned and communicated on e-learning.

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.

During the Covid-19 restrictions, the oral exam will be carried exclusively through the WebEx platform. A public link will be posted e-learning page for the access of virtual public.

Office hours

By e-mail appointment