Ministry of Education
Federal University of Santa Maria
Rural Science Center
Graduate Program in Soil Science

Course: Soil Microbiology

Identification

Code: SOL883
Credits: 3 (3 hours lecture)
Level: Master's/Doctoral
Professors: Paulo Ademar Avelar Ferreira, Rodrigo Josemar Seminoti Jacques, and Sandro José Giacomini
Offering: Annual (Second Semester)

Course Objectives

To understand the main groups of soil microorganisms and establish relationships between microbial metabolism and soil processes. To understand how soil and the rhizosphere influence microbial growth and activity. To enable students to identify and evaluate the role of microorganisms in the biogeochemical cycles of elements. To understand biotechnological applications of microorganisms in agricultural production and environmental quality.

Syllabus

Major groups of soil microorganisms (prokaryotes, eukaryotes, and viruses); types of microbial metabolism; microbial growth (physiology, environmental factors influencing growth, and control); soil and the rhizosphere as microbial habitats; biogeochemical cycles of carbon, nitrogen, sulfur, and phosphorus; mycorrhizae; microbial bioremediation of soils; microbiology of flooded soils.

Methodology and/or Teaching Instruments

Lectures, seminars, discussion of scientific texts, and group activities.

Assessment Methods

Written examinations, reports, seminars, and class participation.

Program: Title and Breakdown of the Units

Unit 1 – Major Groups of Soil Microorganisms

1.1 – Prokaryotes
1.2 – Eukaryotes
1.3 – Viruses

Unit 2 – Microbial Metabolism

2.1 – Aerobic respiration
2.2 – Anaerobic respiration
2.3 – Fermentation
2.4 – Microbial photosynthesis
2.5 – Oxidation of inorganic compounds

Unit 3 – Microbial Growth and Its Control

3.1 – Cell growth
3.2 – Growth phases
3.3 – Effects of environmental factors
3.4 – Chemical and physical control of growth

Unit 4 – Soil and the Rhizosphere as Microbial Habitats

4.1 – Biological characteristics
4.2 – Environmental factors
4.3 – Processes influencing agricultural production and environmental quality

Unit 5 – Biogeochemical Cycle of Carbon

5.1 – Carbon cycle in agroecosystems and terrestrial environments
5.2 – Importance of microorganisms in the carbon cycle
5.3 – Nature and forms of carbon in soil
5.4 – Dynamics of organic matter decomposition
5.5 – Formation, composition, and functions of soil organic matter
5.6 – Environmental aspects of the carbon cycle

Unit 6 – Biogeochemical Cycle of Nitrogen

6.1 – Nitrogen cycle in agroecosystems and terrestrial environments
6.2 – Nature and forms of nitrogen in soil
6.3 – Transformations between organic and inorganic nitrogen
6.4 – Oxidative processes
6.5 – Reductive processes
6.6 – Environmental aspects of the nitrogen cycle

Unit 7 – Biological Nitrogen Fixation

7.1 – Importance of biological N_2 fixation
7.2 – Symbiotic biological N_2 fixation
7.3 – Asymbiotic biological N_2 fixation
7.4 – Inoculation with diazotrophic bacteria

Unit 8 – Biogeochemical Cycle of Sulfur

8.1 – Sulfur cycle in agroecosystems and terrestrial environments
8.2 – Nature and forms of sulfur in soil *(corrigi aqui — no original estava “nitrogênio”)*
8.3 – Microbial transformations of sulfur in soil
8.4 – Environmental aspects of the sulfur cycle

Unit 9 – Biogeochemical Cycle of Phosphorus

9.1 – Phosphorus cycle in agroecosystems and terrestrial environments
9.2 – Nature and forms of phosphorus in soil
9.3 – Microbial transformations of phosphorus in soil
9.4 – Mycorrhizae
9.5 – Environmental aspects of the phosphorus cycle

Unit 10 – Microbial Bioremediation of Soil

10.1 – Main pollutants and levels of soil contamination
10.2 – Microbial metabolism of pollutants
10.3 – Environmental conditions for bioremediation
10.4 – Bioremediation techniques

Unit 11 – Microbiology of Flooded Soils

11.1 – Predominant physicochemical conditions in flooded soils
11.2 – Microorganisms under anoxic conditions
11.3 – Anaerobic metabolism and decomposition of organic materials
11.4 – Microbial transformations of nutrients in flooded soils
11.5 – Microorganisms and greenhouse gas emissions in flooded soils

Recommended Literature

FERREIRA, P.A.A, SOARES, C.R.F.S., GIACHINI, A.J. Biologia, Microbiologia e Bioquímica do Solo. Santa Maria: NRS-SBCS, 2024. 402p.

FUNKE, B. R., CASE, C. L., WEBER, BAIR III, D., Warner B.; TORTORA, G. J. Microbiologia. 14 ed. Porto Alegre: Artmed, 2025. 910p.

GENTRY, T., FUHRMANN, J. J., ZUBERER D. A. Principles and Applications of Soil Microbiology. 3 ed., Elsevier, 2021. 742 p.

MADIGAN, M.T., MARTINKO, J.M., BENDER, K.S., BUCKLEY, A.H., STHAL, S.A. Microbiologia de Brock. 16 ed. Porto Alegre: Artmed, 2016. 960p.

MOREIRA, F.M. de S., SIQUEIRA, J.A. Microbiologia e bioquímica do solo. 2 ed., Lavras, MG: Ed. da Universidade Federal de Lavras, 2006. 729p.

PAUL, E.A., FREY, S.D. Soil Microbiology, Ecology and Biochemistry. 5 ed. Elsevier, 2024. 555p.

VERMELHO, A.B.; PEREIRA, A.F.; COELHO, R.R.R.; SOUTO-PADRÓN, T. Práticas de microbiologia. 2 ed. Rio de Janeiro: Guanabara Koogan, 2019. 256p.

Artigos publicados em revistas científicas da área.