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

Course: Soil Microbiology II

Identification

Code: SOL887
Credits: 5 (2 hours lecture – 3 hours practical)
Level: Master's/Doctoral
Professors: Rodrigo Josemar Seminoti Jacques and Sandro José Giacomini
Offering: Annual (First Semester)

Course Objectives

To deepen theoretical and practical knowledge of the concepts underlying soil microbiology and to discuss the state of the art in soil microbiology research.

Syllabus

Microbial metabolism applied to soil processes; soil microorganisms as agricultural bioinputs; enzymes as indicators of soil biological quality; soil pollution, legislation, and bioremediation; planning, preparation, and execution of experiments involving isolation, purification, staining, preservation, and growth of microorganisms, as well as soil enzymatic activity; biotransformations of carbon and nitrogen in soil; microbial biomass; microbial processes and greenhouse gas production; microorganisms and aggregate stability; planning, preparation, and execution of experiments for studying carbon and nitrogen biotransformations and greenhouse gas emissions.

Methodology and/or Teaching Instruments

Lectures, laboratory practical classes, seminar presentations, discussion of scientific texts, and group activities.

Assessment Methods

Written examination, seminar presentation, laboratory reports, and class participation.

Program: Title and Breakdown of the Units

Unit 1 – Microbial Metabolism in Soil Processes

1.1 – Respiration and its effects on soil processes
1.2 – Fermentation and its effects on soil processes
1.3 – Chemotrophy and its effects on soil processes
1.4 – Laboratory techniques for handling microorganisms

Unit 2 – Soil Microorganisms as Agricultural Bioinputs

2.1 – Microbial prospecting
2.2 – Selection of microorganisms
2.3 – Main groups of microorganisms used in bioinputs
2.4 – Microbial growth for bioinput production

Unit 3 – Enzymes as Bioindicators of Soil Quality

3.1 – Main enzymes used as bioindicators
3.2 – Soil sampling and preparation for enzymatic analysis
3.3 – Laboratory determination of enzymatic activity
3.4 – Interpretation of results and soil quality assessment

Unit 4 – Soil Pollution, Legislation, and Bioremediation

4.1 – Main soil pollutants
4.2 – Legislation on contaminated and polluted soils
4.3 – Pollutant-degrading microorganisms
4.4 – Soil bioremediation techniques

Unit 5 – Carbon Biotransformations in Soil

5.1 – Decomposition and microbial carbon use efficiency
5.2 – Formation and persistence of soil carbon
5.3 – Methanogenesis and methanotrophy
5.4 – Methods for studying carbon biotransformations in soil

Unit 6 – Soil Microbial Biomass

6.1 – Sampling, preparation, and storage
6.2 – Physiological and chemical methods
6.3 – Comparison of methods
6.4 – Microbial activity and related indicators
6.5 – Phospholipid fatty acids (PLFA)

Unit 7 – Nitrogen Biotransformations in Soil

7.1 – Mineralization and immobilization (net and gross)
7.2 – Nitrification
7.3 – Denitrification
7.4 – Methods for studying nitrogen biotransformations in soil

Unit 8 – Microbial Processes and Greenhouse Gas Production

8.1 – Gases emitted from soils
8.2 – Processes and microorganisms involved
8.3 – Factors affecting greenhouse gas production
8.4 – Quantification of greenhouse gas emissions

Unit 9 – Microorganisms and Aggregate Stability

9.1 – Role of microorganisms in soil aggregation
9.2 – Microbial metabolites involved in soil aggregation
9.3 – Microbial mechanisms of aggregate formation and stabilization
9.4 – Factors influencing microbially mediated aggregation

Recommended Literature

BAVER, L.D; GARDNER, W.H.; GARNER, W.R. **Soil physics.** 4 ed. Ney York: John Wiley & Sons, 1972. 498p.

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. 14 ed. Porto Alegre: Artmed, 2016. 960p.

MADIGAN, M., SATTLEY, W., AIYER, J., STAHL, D., BUCKLEY, D. Brock Biology of Microorganisms,

Global Edition (16th ed.). Pearson International. 2021. 1128p.

MOREIRA, F.M.S., SIQUEIRA, J.A. Microbiologia e bioquímica do solo. 2 ed., Lavras, MG: Ed. 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.