Course: Experimental Microbiology

Identification

Code: SOL
Credits: 4 (1 hour theory – 3 hour practice)
Level: Master and Doctorate
Professors: Sandro José Giacomini and Celso Aita
System: Annual (II Semester)

Discipline objectives

Provide students with theoretical and practical knowledge of methods related to studies in Applied Microbiology and contribute to the understanding of the role of microorganisms in biogeochemical cycles (C, N, P, and S) and environmental quality.

Syllabus

Soil and water collection for microbiological analysis; quantification of the number of microorganisms; evaluation of soil biomass and microbial activity; enzymatic activity in the soil; soil C and N biotransformations; isolation of diazotrophic bacteria; evaluation of P and S microbial biotransformations; microbial processes and the production of greenhouse gases; microbial processes applied to treating organic waste; modeling C and N biotransformations.

Methodology and/or teaching instruments

Individual seminars, scientific articles discussion, experiments conduction and interpretation of results, theoretical classes, practical classes, overhead projector, and blackboard.

Forms of evaluation

Written exams, seminars, reports, and class participation.

Program: Title and Breakdown of the Units

Unit 1

Soil and water collection for microbiological analysis
1.1 – Sample collection
1.2 – Sample handling
1.3 – Sample storage

Unit 2

Quantification of the number of microorganisms
2.1 – Employed methods
2.2 – Soil sample analysis
2.3 – Analysis of water samples
2.4 – Analysis of inoculants

Unit 3

Assessment of soil biomass and microbial activity
3.1 – Microbial biomass
    3.1.1 – Physiological methods
    3.1.2 – Chemical methods
    3.1.3 – Comparison of methods
3.2 – Microbial activity and related indicators

Unit 4

Enzyme activity in the soil
4.1 – Introduction
4.2 – Soil enzyme activity
    4.2.1 – Dehydrogenase

4.2.2 – β-glucosidase
4.2.3 – Amidhydrolases
4.2.4 – Phosphatases
4.2.5 – Aryl sulfates

Unit 5

Soil C and N biotransformations

5.1 – Methods for evaluating the decomposition of organic waste
5.1.1 – C mineralization
5.1.2 – Remaining C
5.2 – Assessment of N dynamics in soil
5.2.1 – Mineralization
5.2.2 – Immobilization
5.2.3 – Nitrification
5.2.4 – Denitrification
5.3 – Stable isotope application ($^{13,14}C$ and ^{15}N) in the study of C and N transformations

Unit 6

Isolation of diazotrophic bacteria

6.1 – Biological N fixation
6.2 – Symbiotic bacteria
6.3 – Associative bacteria
6.4 – Techniques used in the quantification of biological fixation

Unit 7

Evaluation of P and S microbial biotransformations

7.1 – Mineralization and Immobilization
7.2 – Phosphate solubilization
7.3 – Oxidation and S reduction in soil

Unit 8

Microbial processes and greenhouse gas production

8.1 – Greenhouse gases and microorganisms involved
8.2 – Factors that affect greenhouse gas production
8.3 – Greenhouse gas quantification

Unit 9

Microbial processes applied to organic waste treatment

9.1 – Composting
9.2 – Pollutant biodegradation
9.3 – Methanogenesis
9.4 – Wastewater biostabilization

Unit 10

Modeling of C and N biotransformations

10.1 – Concepts
10.2 – Importance
10.3 – Main models
10.4 – Simulation of processes

Recommended literature

ATLAS, R.M., BARTHA, R. **Microbial ecology: fundamentals and applications**. Califórnia: Benjamin Cummings Publishing Company, Inc., 1997. 533 p.

BLACK, J.G. **Microbiology: Principles and Explorations.** 7th ed. Hardcover- Wiley, 2008. 968p.

DÖBEREINER, J. et al. **Como isolar e identificar bactérias diazotróficas de plantas não leguminosas**. Brasília : Embrapa-SPI, 1995. 60p.

ELSAS, J.D.V., TREVORS, J.T., WELLINGTON, E. M.H. **Modern soil microbiology**. New York:Marcel Dekker, Inc., 1997. 693 p.

HUNGRIA, M., ARAUJO, R.S. **Manual de métodos empregados em estudos de microbiologia agrícola**. Brasília: EMBRAPA-CNPAF, 1994. 642 p.

MADIGAN, M.T., MARTINKO, J.M., DUNLAP, P.V., CLARK, D.P. **Brock: Biology of Microorganisms**. 12th. ed. Pearson: Benjamin Cummings, San Francisco, Estados Unidos, 2009. 1061 p.

MAIER, R.M., PEPPER, I.L., GERBA, C.P. **Environmental microbiology**. 2nd ed., Amsterdam, Holanda, Elsevier: Academic Press, 2009. 598p.

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

PAGE, A.L. et al. **Methods of soil analysis: Chemical and microbiological properties.** 2.ed. Madison, American Society of Agronomy, Wisconsin, SSSA, 1982. 1159p.

PAUL, E.A. **Soil Microbiology, Ecology and Biochemistry.** 3rd ed. Hardcover – Academic Press, 2007. 552p.

PAUL, E.A., CLARK, F.E. **Soil microbiology and biochemistry**. San Diego: Academic Press, Inc.,1996. 276 p.

PRESCOTT, L.M., HARLEY, J.P., KLEIN, D.A. **Microbiology**. 7th ed. Boston: McGraw-Hill, 2007. 1088p.

SYLVIA, D.M., FUHRMANN, J.J., HARTEL, P.G., et al. **Principles and applications of soil microbiology**. New Jersey: Prentice-Hall, Inc., 1998. 528 p.

TORTORA, G.J., FUNKE, B.R., CASE, C.L. **Microbiology: an introduction**. 10ª ed. Benjamin Cummings, 2009. 960p.

WEAVER, R.W.; ANGLE, J.S.; BOTTOMLEY, P.S. **Methods of soil analysis. Part 2 - Microbiological and biochemical properties.** Book Series No 5, Madison, Wisconsin, SSSA, 1994. 1121p.

WHITE, D. **The Physiology and Biochemistry of Prokaryotes**. 3rd ed. Oxford University Press, USA, Hardcover, 2006. 656p.