University of Zagreb Faculty of Agriculture
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Microbial enzymatic activities in soil (146046)

Course coordinator

Prof. Mirna Mrkonjić Fuka, PhD

Course description

Microbial mediated processes through enzymatic activities in soil are fundamental for soil function and sustainable agriculture. Soil enzymes play an important role in organic matter decomposition and nutrient cycling. Soil microbial enzymes increase the reaction rate at which plant residues decompose and release plant available nutrients. Sources of microbial soil enzymes include intracellular (associated with cells) and extracellular microbial enzymes (no longer associated to cells) that could be free or stabilized in the soil matrix or form complexes with organic matter (humus), clay, and humus-clay complex. Enzymes respond to soil management changes long before other soil quality indicator changes are detectable. Some enzymes facilitate the breakdown of hazardous or resistant components as e.g. heavy metals. Soil physicochemical characteristics and seasonal variations of soil abiotic and biotic properties influence status and activity of soil microbial enzymatic activity such affecting all enzymes metidated processes in soil. All the aspects stated above will be studied in details in the frame of this course.

ECTS: **3.00**

English language: **L1**

E-learning: **L1**

Teaching hours: 30
Lectures: 26
Laboratory exercises: 4

Lecturer

- Prof. Mirna Mrkonjić Fuka, PhD
- Karin Pritsch, PhD

Associate teacher for exercises

- Asst. Prof. Irina Tanuwidjaja, PhD

Grading

Sufficient (2): 60-70 %
Good (3): 71-80 %
Very good (4): 81-90 %
Excellent (5): 91-100 %

Conditions for obtaining signature

Finished all laboratory exercises. Prepared laboratory workbook.

Type of course

- Graduate studies / Environment, agriculture and resource management (Compulsory course, 2 semester, 1 year)

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General competencies

This course introduces students to basic principles of microbial enzymatic activities. Students will be gained necessary theoretical and practical knowledge that could be applied to study influence of ecosystem's management on microbial activity and to study microbial enzymatic responses on environmental perturbations.

Types of instruction

- Lectures
  Classical lectures will be conducted to particular study problems that should be solved in small student's groups. Independent students work and argumentation will be especially encouraged.
- Laboratory practice/exercises
  Laboratory work will be conducted to measurements of soil dehydrogenase activities and proteolytic activity of soil isolates in small study groups.

Learning outcomes

Learning outcome	Evaluation methods
To explain the mechanisms of enzymes production, basic structure and main groups of enzymes	Written exam
To integrate the different knowledge in the area of soil microbiology	Written exam
To analyze the influence of physicochemical characteristics and soil management on microbial enzymatic activities	Written exam
To understand the role and significance of microbial activity in soil	Written exam
To apply procedure and methods to measure microbial enzymatic activities	Written exam
To understand the role of specific microorganisms in enzymatic processes in soil	Written exam

Working methods

Teachers' obligations

Participation in all the forms of teaching as lectures and consultation, provide teaching materials and assure active communication with the student throughout the semester

Students' obligations

Regular attendance and active participation in lectures and exercises

Methods of grading

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Evaluation elements	Maximum points or Share in evaluation	Grade rating scale	Grade	Direct teaching hours	Total number of average student workload	ECTS
Written exam	100 %	˂ 60 % 60-70 % 71-81 % 82-92 % 93-100 %	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)	30	90	3
Total	100 %		If the student is not satisfied with the grade, the oral exam can be organised.	30	90	3

Evaluation elements	Description	Deadline	Recoupment
Written exam	Written exam at the end of semester or in the exam period.	During semester	Exam period

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Weekly class schedule

1. Introduction to enzymology L - Introduction to basic principles and development of enzymology. Fungi and bacteria as the main source of enzymes in complex ecosystems. K and r- strategy
2. The structure of enzymes L - Link between genome and functional enzymes: functional genes, transcription. Enzyme composition. Primary, secondary, tertiary and quarter structure. Relationship between structure and function.
3. Classification and nomenclature L - The basic classification and nomenclature. Cellular localization of microbial enzymes.
4. The role of microbial enzymes in soil L - Degradation of organic compounds. Transformation of nutrients. Biogeochemical cycle. Respiration. Fermentation.
5. Diversity of microbial enzymes in soil L - Classification of main groups of microbial enzymes in soil. Extracellular and intracellular enzymes- correlation to microbial biomass. Relationship between taxonomic diversity, genetic diversity, functional diversity and enzymatic activity.
6. Soil properties and microbial enzymatic activity L - The physical and chemical characteristics of soil. Influence of abiotic and biotic factors on soil microbial enzymatic activities.
7. Localisation of microbial enzymes in a soil matrix L - Distribution of microbial activities in soil matrix. Free enzymes. Immobilization of enzymes in soil. Soil minerals as catalizators for biochemical reactions. Influence of humus on enzymatic processes in soil.
8. Microbiology and enzymatology of C and N cycle L - Role of microbial enzymes in C and N cycling. Transformation of N and in soil. Proteolytic activity, nitrification and denitrification. Cellulasee. Pectinases. Hemicellulases.
9. Enzymatic activities as indicator of soil fertility L - Control of secretion and activity of microbial enzymes in soil. Enzymatic activity as sensors of soil health. Soil status. Influence of soil management on microbial enzymatic activities.
10. Transformation of heavy metals/metalloides L - Microbial transformation of heavy metals. Reduction and methylation of selen, arsen, chrom and mercury.
11. Enzymatic assays P - Methods of soil enzymatology. Enzyme assays in situ and in vitro. Interpretation of results and correlation to quantitative microbial parameters.
12. Quantitative analysis of microbial populations Lab - Estimation of total number and number of proteolytic microorganisms in soil.
13. Enzymatic assay Lab - Dehidrogenase activity by TTC assay. Proteolytic activity in soil. Data interpretation and correlation of enzymatic activity to microbial number and soil properties.
14. Microbiology and enzymatology of phosphorus cycle Pe-L - Transformation of phosphorus in soil. Phosphatase activity in situ and in vitro.
15. Enzymes in the arbuscular mycorrhizal symbiosis Pe-L - Enzymatic mechanisms of formation of symbiosis. Cellulasee. Pectinases. Hemicellulases. Nutrient uptake.

Obligatory literature

1. Shukla G., Varma A.: Soil Enzymology, Springer, 2011
2. van Elsas, Trevors J.T., Wellington E.M.H.: Modern soil microbiology, Marcerl Dekker, Inc.,1997
3. Burns R., Dick R.,: Enzymes in the Environment: Activity, Ecology and Applications.Marcerl Dekker, Inc., 200

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Recommended literature

1. Dick, R.P. : Methods of Soil Enzymology. Soil Science Society of America : Madison, WI, 2011
2. Bothe H., Ferguson S., J., Newton W.E.: Biology of nitorgen cycle, Elsevier, 2007

Similar course at related universities

- Methods in soil microbiology, BOKU, Vienna, Austria
- Laboratory and Field Methods in Soil Biodiversity, School of environmental sciences, Guelph, Canada