Sveučilište u Zagrebu Agronomski fakultet
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Beneficial associations of plants and microorganisms (157666)

Nositelj predmeta

doc. dr. sc. Ivana Rajnović

Opis predmeta

Plants live in associations with beneficial microorganisms both in agroecosystems as well as in natural environments. Such associations have a prominent role in sustainable agricultural production system. Basic module content includes fundamental and applied research of biological nitrogen fixation and mycorrhizal symbioses as well. Symbiotic nitrogen fixation has the most important role in agriculture, therefore, the largest part of these course rely upon this issue. The main program parts of module are introduction to biological nitrogen fixation, symbiotic nitrogen fixation (partners in the symbiosis, nodulation, biochemistry of BNF, inoculation), associative and asymbiotic nitrogen fixation and mycorrhizal associations.
Main program parts include: position of BNF in the nitrogen cycle, importance of BNF for agriculture, types of symbiotic associations, isolation and identification of nodule bacteria, taxonomy of nodule bacteria, uses of legumes and their economic importance, nodule formation, structure and function of nitrogenase and hydrogenase, production of the inoculatns and inoculation of legumes). Importance and properties of main types of mycorrhizae (arbuscular, ectomycorrhizae, ericoide mycorrhizas...) will be presented.

ECTS: **3.00**

Sati nastave: 30
Predavanja: 14
Laboratorijske vježbe: 6
Seminar: 10

Izvođač predavanja

- prof. dr. sc. Sanja Sikora

Izvođač vježbi

- doc. dr. sc. Ivana Rajnović
- dr. sc. Sanja Kajić
- doc. dr. sc. Irina Tanuwidjaja

Ocjenjivanje

Dovoljan (2): 60%
Dobar (3): 71%
Vrlo dobar (4): 81%
Izvrstan (5): 91%

Vrsta predmeta

- Graduate studies / Environment, agriculture and resource management (Obvezni predmet, 2. semestar, 1. godina)

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Opće kompetencije

The modul introduces students to the processes and organisms involved in the most important associations between plants and beneficial microorganisms in sustainable agriculture. Students will gain both theoretical and practical knowledge about main beneficial plant-microbe associations. After completion of the course, they will be able to understand complex plant-microbe interactions as well as to apply their knowledge in the field of agroecology, plant production and environment protection.

Oblici nastave

- Lectures
- Laboratory practice/exercises
  Laboratory exercises allow each student participating in practical work related to use of traditional and molecular methods in isolation, identification and characterization of rhizobia as well as evaluation of their symbiotic properties.
- Seminars
  Small groups of students have to prepare and present seminar essay that is thematic correlated with particular parts of module content, mostly associated with new findings in this field or with specific agroecological conditions. In this way, teamwork is encouraged, ability to find and critical evaluate apropriate references is tested. At the same time, seminar presentation significantly contribute to development of communications skills.

Ishodi učenja i način provjere

Ishod učenja	Način provjere
to specify and to explain characteristic structures and mechanisms of establishing mutualistic relationship between microogranisms and plants	Written exam, seminars
to understand the importance and role of different associations between plants and beneficial microorganisms in sustainable agricultural production that aims on decreased application of agrochemicals through increased use of natural processes as well as in environment protection	Written exam, seminars
to evaluate the need for application of specific microbial inoculants under particular agroecological conditions	Written exam, seminars
to select the type of microbial inoculant and recommend the mode of application and utilisation of natural processes in sustainable agricultural production and environment protection	Written exam, seminars
to understand the complexity and interactions in different associations between plants and microorganisms as well as the influence of ecological conditions and anthropogenic impact on efficient establishment and functioning of beneficial associations	Written exam, seminars
to evaluate the knowledge in biochemistry, microbiology and genetics that are important fo use of molecular methods in studying microbial diversity and composition of microbial populations	Written exam, seminars
to develop skills and capacity of intergrating different methods that will contribute to understaning of new idea in the field of soil microbiology and molecular microbiology	Laboratory exercises, written exam, seminars

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Način rada

Obveze nastavnika

Organisation of all the forms of teaching, participation in lectures and seminars, providing teaching materials, the design of the written exam, performing consultations with students

Obveze studenta

Regular attendance and active participation in lectures, seminars and exercises; writing and presenting seminars

Polaganje ispita

Elementi praćenja	Maksimalno bodova ili udio u ocjeni	Bodovna skala ocjena	Ocjena	Broj sati izravne nastave	Ukupni broj sati rada prosječnog studenta	ECTS bodovi
Attending of lectures and exercises				20	30	1
Seminar papers	30%			10	30	1
Written exam	70 %	60-70 % 71-80 % 81-90 % 91-100 %	Dovoljan (2) Dobar (3) Vrlo dobar (4) Izvrstan (5)		30	1
Total	100 %			30	90	3

Elementi praćenja	Opis	Rok	Nadoknada
Seminar papers	Quality of written seminar paper and quality of presentation.		
Written exams	It is organized for students who did not pass the partial exams Students have to answer questions that cover topics of lectures.	Exam time Determined at the beginning of the semester.	

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Tjedni plan nastave

1. Introduction to biological nitrogen fixation - Definition of biological nitrogen fixation (BNF), Types of BNF- symbiotic, aasociative and free living; Significance of BNF; The position of BNF in nitrogen cycle.
2. Importance of symbiotic nitrogen fixation for sustainable agricultural production, Symbiotic nitrogen fixation – quantity of N fixed, Influence of different factors on symbiotic efficiency; Benefits from symbiotic nitrogen fixation, Main types of symbiotic associations.
3. Rhizobia- nodule bacteria - Main representatives of symbiotic nitrogen –fixing bacteria and their characteristics, Morphological, physiological and molecular characterization of nodule bacteria. Current taxonomy of rhizobia - new species and their host-plants.
4. Legumes - Diversity, distribution, importance, utilization.
5. Rhizobium-legumes symbiosis - Distribution and significance of symbiosis, Mutualistic relationship, Establishment of symbiosis- infecion and nodule development.
6. Identification of rhizobia - Isolation from soil and identification of rhizobia at the genus, species and strain level. Molecular methods in rhizobial identification I Lab - PCR – principles and modifications; DNA isolation, PCR amplification, Horizontal gel elctrophoresis, Data analysis
7. Nodulation - Types of nodules, Root infection, Nodule development, Recognition between host-plant and rhizobia, Nodulation genes
8. Biochemistry of nitrogen fixation L - Reduction of molecular nitrogen; The role of leghemoglobine, Structure and function of nitrogenase
9. Legume inoculants L - Main characteristiscs of inoculants, Tha main phases in inoculant production, Types of inoculants, Symbiotic properties of rhizobial strains in inoculant production, Requirement for legume inoculation, Benefits of inoculation, Critical factors for successfull inoculant application
10. Microbiological fertilizers and inoculants S - Different origin and types of microbial inoculants, Characteristics and application
11. Characterization and selection of indigenous rhizobial strains, Isolation of indigenous rhizobial strains L+Lab - Phenotypic and genotypic characterization, Methods for evaluation of symbiotic properties, Isolation from soil samples, Pot experiment, Isolation from nodules, Purification and verification of pure cultures, Culture collections
12. Associative and free living nitrogen fixation - Significance of associative and free living nitrogen fixation, Characteristics of the most important nitrogen fixing bacteria, Types of nitrogen fixation, Inoculation and application.
13. Characterization of associative and free living nitrogen-fixing bacteria Lab - Morphology, Physiology, Molecular characterization, Taxonomy of associative and free living nitrogen-fixing bacteria.
14. Mycorrhizae L - Mycorrhizal associations – definition, distribution, role. Diversity of mycorrhizal associations, Ecological significance of mycorrhizae, Different types of mycorrhizal associations, AM fungi, Ectomycorrizae, Physiology of mycorrhizae, Inoculant production.
15. Exam

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Obvezna literatura

1. Dilworth, M.J., James E.K. Sprent J.I., Newton W.E. Nitrogen-fixing Leguminous Symbiosis. Springer, 2008.
2. Elmerich C., Newton W.E. Associative and Endophytic Nitrogen-fixing Bacteria and Cyanobacterial Associations. Springer, 2007.
3. Pawlowski K. Prokaryotic Symbionts in Plants, Springer 2009.
4. Smith, S.E., Read D.J. Mycorrhizal Symbiosis, Academic Press, 1997

Preporučena literatura

1. Spaink, H.S., Kondorsi, A., Hooykaas, P.J.J.: The Rhizobiaceae- molecular biology of model plant-associated bacteria. Kluwer Academic Publishers, 1998.
2. Legocki, A., Bothe, H., Puhler, A.:Biological Fixation of Nitrogen for Ecology and Sustainable Agriculture. Springer-verlag Berlin Heilderberg 1997.
3. Werner D., -nerwton W.E. Nitrogen Fixation in Agriculture, Forestry, Ecology and the Environment
4. Martinez, E., Hernandez, G.: Highlights of Nitrogen Fixation Research. Kluwer Academic Publishers, 1999.