Module Handbook of Soil and Environmental Biotechnology

Module designation	The Soil and Environmental Biotechnology course is an elective course intended for students of the Agricultural Microbiology study program, Faculty of Agriculture. In this course, you will study the technology of using microorganisms/organisms and the compounds they produce to maintain, enhance, and improve the quality of soil and the environment in order to support a better and more sustainable life.
Semester(s) in which the module is taught	Fifth Semester
Person responsible for the module	Ir. Jaka Widada, M.P., Ph.D.
Language	Bahasa Indonesia/Indonesian Language
Relation to curriculum	*Elective Course*
Teaching methods	Lecture are conducted in the class with 30-40 students. In every meeting, there will be delivered interactive lecture and discussion. In some topics there will be quizzes, individual and/or group assignment. Details: 1. Lectures 2. Assignment (Individual and Group) 3. Discussion 4. Midterm 5. Final Exam
Workload (incl. contact hours, self-study hours)	- Lectures = 2 SKS x 50 minutes x 16 meetings = 1.600 minutes = 26,67 hours = 26,67 hours/30hours = 0,89 ECTS - Assignment = 2 SKS x 60 minutes x 16 meetings = 1.920 minutes = 32 hours = 32 hours/30hours = 1,07 ECTS - Self Study = 2 SKS x 60 minutes x 16 meetings = 1.920 minutes = 32 hours = 32 hours/30hours = 1,07 ECTS Total Workload = 3,03 ECTS
Credit points	*2/0 Credit Points*
Required and recommended prerequisites for joining the module	*None*

Module objectives/intended learning outcomes	*Program Learning Outcomes (PLO):* *PLO1: Able to explain theoretical concepts of biology microorganism and develop microbial-based technology to increase plant production and environmental services..* *PLO2: Able to describe the latest methodology in the field of microbiology to create environmentally friendly and sustainable agricultural development.* *PLO3: Able to select, utilize and manage the potential of microbes and microbiomes to build industrial and agricultural systems.* *Course Learning Outcomes (CLO):* *CLO1: Able to define the scope, history and current developments regarding various innovations in the field of soil and environmental biotechnology.* *CLO2: Able to explain the cycles and transformations of elements in soil as well as the obstacles and uses in agriculture.* *CLO3: Able to identify and provide examples of various biological control and bioremediation methods to improve soil and environmental quality.*

Content	1. *Nitrogen Fixation Biotechnology: Biology and biochemistry of non-symbiotic N fixers, utilization of non-symbiotic N fixers, and genetic engineering of non-symbiotic N fixers, symbiotic N-fixer biology and biochemistry, utilization of symbiotic N-fixer, and genetic engineering of symbiotic N-fixer (2 meeting)* 2. *N Transformation Biotechnology: Control and utilization of nitrification, denitrification, and anammox for soil fertility and waste treatment (1 meeting)* 3. *Phosphate Dissolving Biotechnology: Specific characteristics of mycorrhizal species and their distribution, absorption and transfer of soil nutrients, mycorrhizal functions, and mycorrhizal production and utilization strategies, biology and biochemistry of phosphate-dissolving bacteria/fungi (non-mycorrhiza), production of phosphate-solvent bacterial/fungal inoculums, and formulation of phosphate-solvent bacterial/fungal inoculums and strategies for their utilization (2 meetings)* 4. *Biotechnology of Biological Control: Basic concepts and objectives of biological control and soil-plant-microbe balance Method of microbial recombinant assembly (1 meeting)* 5. *Biotechnology of Plant Growth Promoting Bacteria (PGPB): Mechanism of PGPB, substances that promote and support plant growth, manufacture of PGPB inoculums, and genetic engineering of PGPB Environmental Biotechnology (1 meetings)* 6. *Biotechnology of Organic Matter Decomposition: Biota decomposes organic matter and its activities, waste materials for composting, composting technology and systems, quality of compost, utilization of biogas resulting from the decomposition of organic matter (1 meeting)* 7. *Greenhouse Gas Emission Reduction Biotechnology: Greenhouse gases and their impact on global climate change, factors affecting global climate change, and the role of biotechnology in reducing greenhouse gas emissions (1 meeting)* 8. *Bioremediation of Xenobiotic Compounds: Types of xenobiotic compounds, degradation pathways, metabolism processes, and biotechnology in remediation of xenobiotic compounds (1 meeting)* 9. *Bioremediation of Heavy Metals: Definition of heavy metals, availability of heavy metals, toxicity and resistance of heavy metals to microbes, and remediation biotechnology (1 meeting)* 10. *Student Seminar (2 meetings)* 11. *Materials review (1 meeting)*
Examination forms	*High Order Thinking Skills Examination*
Study and examination requirements	*To be able to take the final exams, the minimum of student attendance is 70% out of effective meetings. From 14 meetings, students must take a minimum of 10 meetings to take the exam.*

Reading list	*Main References:* 1. *Pradeep Kumar, Jayanta Kumar Patra, Pranjal Chandra. 2019. Advances in microbial biotechnology: current trends and future prospects. Apple Academic Press, Inc* 2. *Rita Kundu and Rajiv Narula. 2019. Advances in Plant and Microbial Biotechnology. Springer Nature Singapore Pte Ltd.* 3. *Farshad Darvishi Harzevili and Hongzhang Chen. 2015. Microbial Biotechnology: Progress & Trends. CRC press.* 4. *Lala Behari Sukla, Nilotpala Pradhan, Sandeep Panda, and Barada Kanta Mishra. 2015. Environmental Microbial Biotechnology. Springer International Publishing Switzerland* 5. *Charles Vincent, Mark S. Goettel, and George Lazarovits. 2007. Biological Control: A Global Perspective. CABI Publishing.* 6. *Gareth, M. Evans, Judith C. Furlong. 2003. Environmental Biotechnology: Theory and Practices. John Wiley & Sons.* 7. *Alexander N. Glazer and Hiroshi Nikaido. 2007. Microbial Biotechnology. Cambridge University Press.* 8. *Harbhajan Singh. 2006. Mycoremediation : Fungal Bioremediation. John Wiley & Sons, Inc.* 9. *John E. Smith. 2004. Biotechnology. Cambridge University Press.* 10. *Ross E. McKinney. 2004. Environmental Pollution Control Microbiology. Marcel Dekker, Inc.* 11. *Eldor A. Paul. 2007. Soil Microbiology, Ecology, and Biochemistry. Academic Press.* 12. *Iqbal Ahmad, et. Al. 2008. Plant-Bacteria Interactions: Strategies and Techniques to Promote Plant Growth. WILEY-VCH Verlag GmbH & Co. KgaA.* 13. *Samuel S. Gnanamanickam. 2006. Plant-Associated Bacteria. Springer.* 14. *K. G. Mukerji, et. al. 2006. Microbial Activity in the Rhizosphere. Springer.* 15. *Sally E. Smith and David Read. 2008. Mycorrhizal Symbiosis. Elsevier.* *Additional References:* *Scientific journal references regarding the use of microorganisms in soil biodegradation and bioremediation processes*