Subject Module
Department of Agrotechnology
Faculty of Agriculture
University of Islam Malang

Module Handbook

Module Title	Bioremediation
Module Level, if available	Undergraduate, Study Program of Agrotechnology
Subject Code	MKP60606
Headings, if available	-
Subject (MK)	Bioremediation
Semester	6
Course Coordinator	Novi Arfarita, SP, MP, M.Sc, Ph.D
Teaching Team	-
Language of instruction	Indonesian Language/English
Linkages with the Curriculum	Study Program : Agrotechnology Specialization: Biotechnology of Agriculture Type: ~~Compulsory~~/Elective
Learning Methods and Duration	1. Lecture: 100 minutes/meeting (14 meetings) 2. Research Based Learning through assigments and field observation 3. Presentation (individual and group)
Student Study Load	1. Lecture: 100 minutes/meeting (14 meetings) 2. Assignments/quiz/presentation 3. Attendance: 75% of total attendance
Credit Weight	2 credits
Requirements for Passing the Course	• Attendance >75% • The final score of all the components of the learning evaluation >44 The final score component: • 35% Midterm Exam • 35% Final Exam • 20% Assignments/Presentation (individual and group) • 10% Presence
Prerequisite Subjects	Microbiology, Biochemistry, Physiology of Plant
Learning Outcomes	The expected learning outcomes are: 1. Have an attitude of creative and innovative thinking in their work in accordance with professional ethics in the field of agriculture (ILO 1). 2. Behave according to the professional code of ethics in agriculture based on the preaching of the Islamic faith of Ahlusunnah wal Jama'ah (ILO 2).

	3. Have good and deep knowledge in the field of basic agricultural science that supports Agrotechnology (ILO 3). 4. Able to solve problems that arise in the field of agrotechnology and related fields of science (ILO 5) 5. Able to apply agricultural practices based on *Good Agricultural Practices* (ILO 8) 6. Able to manage plant production system (ILO 9) 7. Able to design enterprise opportunities in the field of plant production (ILO 10).
Learning Content	After completing this course students are able to: 1. Examines the concept of bioremediation. 2. Analyze the factors that influence success of bioremediation. 3. Understand the role of microorganisms in the field of remediation of toxic waste in environment. 4. Determine the application of techniques in bioremediation that are suitable for tackling environmental pollution. 5. Developing bioremediation studies and evaluating rationality of applications in the field. **The topics include:** **1. Introductions** • Definition • Mechanism • Remediation • Limiting Factors **2. Bioremediation Concepts** • Methods • Biodiversity, Biodegradation and Bioremediation • Bioremediation study **3. Strategy of Bioremediation 1** • Landfarming • Composting • Biopiles • Bioreactors **4. Strategy of Bioremediation 2** • Bioventing • Bioaugmentation • Biostimulation **5. Microorganisms and Enzymes in bioremediation** • The concept of remediation by microorganisms • Microbial enzymes in the transformation of pollutants **6. Techniques of Screening and Isolation of Herbicide Degrading Fungi** • Glyphosate herbicide. • Microbes in glyphosate bioremediation. • Isolation techniques, screening and identification of fungi. • Selection **7. Application of Fungi to agricultural land contaminated with herbicides (a case study)** • The herbicide effect of glyphosate. • *Trichoderma viride* FRP3 application. • Observe the survival of bioremediation agents in the fields. • Observe glyphosate degradation

	8. Concepts of Phytoremediation • Definition • Techniques • Strategy • Advantages • Limitations • Prospects and Challenges **9. Phytoremediation with aquatic plants in an aquatic environment** • Groups of aquatic plants that have the potential as phytoremediation plants • The advantages of bioremediation / phytoremediation using water plants. **10. Mechanisms of Phytoremediation** • Phytoextraction • Rhizofiltration • Phytodegradation • Phytostabilisation • Phytovolatilisation • Phytostimulation **11. Soil Pollutants from Heavy Metals** • Sumber pencemar logam berat di lingkungan • Pengaruh logam berat terhadap kesehatan manusia • Pengaruh logam berat terhadap tanaman • Sources of heavy metal pollutants in the environment. • Effects of heavy metals on human health. • Effect of heavy metals on plants **12. Phytomining** • Defenition of Phytomining • Processes in Phytomining • Factors affecting phytomining. • Advantages and Limitations **13. Metal Hyper-accumulation Mechanism** • Dissolving metals from the soil matrix. • Root absorption and transport to the canopy. • Metal distribution, detoxification and sequestration 14. **Phytoremediation application in soils contaminated with** mercury waste (a case study) • Background • Problem • Vegetation Exploration and Inventory for Phytoremediation
Test Terms and Forms	Examination requirements: A minimum of 75 % attendance to attend the final exam Forms of examination: Essay
Learning Media	Projector and screen, Zoom application, Skype, e-book, WA Group, learning cases in field (neighborhood around the residence), video and YouTube.
References	**Main References :** 1. Ali, H, et al. 2013. Phytoremediation of heavy metals-Concepts and Applications. *Chemosphere* 91:869-881.

2. Garbisu, C. and Alkorta, I., 2003. Basic concepts on heavy metal soil bioremediation. European *Journal of mineral Processing and Environmental Protection* 3(1): 58-66.
3. Handayanto, E., et al. 2017. *Fitoremediasi dan Phytomining Logam Berat Pencemar Tanah*. Malang, Indonesia: UB Press.
4. Jørgensen, KS. 2007. *In-Situ Bioremediation. Advances in Applied Microbiology.* Academic Press. 61: 285–305.
5. Kensa, VM. 2011. *Bioremediation - An Overview*. *I Control Pollution.* 27 (2): 161–168
6. Norris, R. 1993. *Handbook of Bioremediation*. CRC Press. p. 45.
7. Singh N, Kumar A, Sharma B. 2019. *Role of Fungal Enzymes for Bioremediation of Hazardous Chemicals. Fungal Biology. 3*. Cham: Springer International Publishing. pp. 237–256.

Supporting References :

1. **Arfarita, et.al. 2016.** Exploration of Indigenous Soil Bacteria Producing-Exopolysaccharides for Stabilizing of Aggregates Land Potential as Biofertilizer, *Journal of Degraded and Mining Lands Management*, 4(1), 697-702.
2. **Arfarita, et.al. 2016.** The Application of Trichoderma viride Strain FRP for Biodegradation of Glyphosate Herbicide in Contaminated Land, *Agrivita Journal of Agricultural Science*, 38(3), 275-281.
3. **Arfarita, et.al. 2014.** Potential use of soil-born fungi isolated from treated soil in Indonesia to degrade glyphosate herbicide. *Journal of Degraded and Mining Lands, Management*, 2(1), 63-68.
4. **Arfarita, et.al. 2014.** The potential use of *Trichoderma viride* strain FRP3 in biodegradation of glyphosate herbicide, *Biotechnology and Biotechnological Equipment*, 27(1), 3518-3521.
5. **Arfarita, et.al. 2011.** Screening of Soil-Born Fungi from Forest Soil Using Glyphosate Herbicide as the Sole Source of Phosphorus.*Journal of Water and Environment Technology*, 9, 391-400.
6. W.H. Utomo, Retno Suntari, **Novi Arfarita**, Suhartini, E. Handayanto. **2014**. Rehabilitation of Artisanal Small-Scale Gold Mining LandinWest Lombok, Indonesia: 3. Exploration of Indigenous Plant Species and the Associated Mycorrhiza for Phytomycoremediation of Mercury Contaminated Soils. *American-EurasianJournal of Sustainable Agriculture,* 8(1), 34-41.