Module Descriptions

A **module** is a self-contained **learning unit** within a higher education program that includes thematically related courses and is assigned a **fixed number of credits**. It follows specific **learning objectives**, includes an **assessment component**, and contributes to achieving the qualifications of a degree program. In some countries, “modules” are also named “courses”.

Please provide a module description for each module. In addition to the compulsory and elective modules, this also includes credited internships and the final thesis.

Please summarize all module descriptions in one document (Module Handbook) and create a table of contents so that the modules can be found easily.

Module designation	Bioremediation
Semester(s) in which the module is taught	Even
Person responsible for the module	Dr. Anna Rakhmawati, M.Si
Language	Indonesian language
Relation to curriculum	Elective subject
Teaching methods	lecture, project, case study, seminar, examination
Workload (incl. contact hours, self-study hours)	Total workload is 91 hours per semester which consists of 100 minutes lectures, 120 minutes structured activities, and 120 minutes individual study per week for 16 weeks.
Credit points	2 SKS (3,2 ECTS)
Required and recommended prerequisites for joining the module	Environmental Science, Microbiology
Module objectives/intended learning outcomes	PLO-4, PLO-6, PLO-6, PLO-11
Content	Bioremediation introduces the principles and applications of using living organisms to remediate polluted environments. This course explores the biological transformation of toxic pollutants into non-toxic compounds as a sustainable approach to environmental restoration and waste treatment. Topics include the roles of microorganisms (bacteria, fungi, microbial consortia, and their symbioses), microalgae, macroalgae, macrophytes, and higher plants (phytoremediation) in the remediation of both aquatic and terrestrial ecosystems. Emphasis is placed on current developments, challenges, and innovations in bioremediation strategies within the framework of integrated environmental management.

<table>
<tr><td>Examination forms</td><td>Test, rubrics, and presentation</td></tr>
<tr><td>Study and examination requirements</td><td>Requirements for successfully passing the module
The final mark will be weight as follow:

<table>
<tr><th>NO</th><th>Assessment Techniques</th><th>Percentage Weight Assessment (%)</th><th>Information</th></tr>
<tr><td>1</td><td>Cognitive</td><td>50</td><td>Maximum assessment weight accumulation 50%</td></tr>
<tr><td rowspan="5"></td><td>Presence</td><td>5</td><td></td></tr>
<tr><td>Task</td><td>5</td><td></td></tr>
<tr><td>Quiz</td><td>5</td><td></td></tr>
<tr><td>Mid-semester exams</td><td>15</td><td></td></tr>
<tr><td>Final Semester Exam</td><td>20</td><td></td></tr>
<tr><td>2</td><td>Participatory</td><td>50</td><td>Maximum assessment weight accumulation 50%</td></tr>
<tr><td rowspan="3"></td><td>Case study</td><td>25</td><td></td></tr>
<tr><td>Team Base Project</td><td>25</td><td></td></tr>
<tr><td>Total</td><td>100</td><td></td></tr>
</table>
</td></tr>
</table>

Reading list	A. Tiodar, E.D.; et al., 2021. Phytoremediation and Microorganisms-Assisted Phytoremediation of Mercury Contaminated Soils: Challenges and Perspectives. Int. J. Environ. Res. Public Health, 18,2435. B. Khan NT. 2018. Integration of Bioinformatics in Bioremediation. Int. J. Biomed Data Min. 7:1, DOI: 10.4172/2009-4924.1000130. C. Zhu, N.; Zhang, B.; Yu, Q. Genetic engineering-facilitated coassembly of synthetic bacterial cells and magnetic nanoparticles for efficient heavy metal removal. ACS Appl. Mater. Interfaces 2020, 12, 22948–22957. D. Sun-Wook Jeong and Yong Jun Choi. 2020. Extremophilic Microorganisms for the Treatment of Toxic Pollutants in the Environment E. Amanullah Mahar et al. 2016. Challenges and opportunities in the phytoremediation of heavy metals contaminated soils: A review. Ecotoxicology and Environmental Safety 126: 111–121. F. Abid Ali Ansari et al. 2020. Phytoremediation of contaminated waters: An eco-friendly technology based on aquatic macrophytes application. Egyptian Journal of Aquatic Research 46: 371-376 G. Arun Kumal Pal. et al. 2020. The role of microorganism in bioremediation for sustainable environment management. Bioremediation of Pollutants H. Dell' Anno, F. et.al. 2021. Bacteria, Fungi and Microalgae for the Bioremediation of Marine Sediments Contaminated by Petroleum Hydrocarbons in the Omics Era. Microorganisms 9:1695. I. Sun-Wook Jeong and Yong Jun Choi. 2020. Extremophilic Microorganisms for the Treatment of Toxic Pollutants in the Environment. Molecules, 25, 4916 J. Nistha et al. 2022. Insight Into Microbes and Plants Ability for Bioremediation of Heavy Metals. Current Microbiology. 79(5). K. Jariyal et al. 2020. Microbial remediation progress and future prospects. Bioremediation of Pollutants L. Raklami, A. et al., 2022. Plants—Microorganisms-Based Bioremediation for Heavy Metal Cleanup: Recent Developments, Phytoremediation Techniques, Regulation Mechanisms, and Molecular Responses. Int. J. Mol. Sci. 23, 5031. M. Arjun Kafle et al. 2022. Phytoremediation: Mechanisms, plant selection and enhancement by natural and synthetic agents. Environmental Advances 8:15.100203 N. Yan A, et al. 2020. Phytoremediation: A Promising Approach for Revegetation of Heavy Metal-Polluted Land.Front. Plant Sci. 11:359.