Module Handbook of Thermomicrobiology

Module designation	Thermomicrobiology is an elective course intended for students from Agricultural Microbiology study program. This course discusses the relationship between temperature on microbes, the survival mechanism of microbes at extreme temperatures, and the use of microbes at extreme temperatures. The course also provides students with practical understanding and experience about the effect of temperature on microbial life and its application to kill and inhibit bacterial growth.
Semester(s) in which the module is taught	Sixth Semester
Person responsible for the module	M. Saifur Rohman, S.P., M.Si., M.Eng., 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/27,1 hours = 0,98 ECTS - Assignment = 2 SKS x 60 minutes x 16 meetings = 1.920 minutes = 32 hours = 32 hours/27,1 hours = 1,18 ECTS - Self Study = 2 SKS x 60 minutes x 16 meetings = 1.920 minutes = 32 hours = 32 hours/27,1 hours = 1,18 ECTS Total Workload = 3,34 ECTS
Credit points	*2/0 Credit Points*
Required and recommended prerequisites for joining the module	*Biology of Microorganisms*

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<tr><td>Module objectives/intended learning outcomes</td><td>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 identify, design, implement and solve problems that arise in the field of microbiology to provide suggestions for solutions in the industrial and agricultural fields.

Course Learning Outcomes (CLO):
CLO1: Students can explain the importance of thermomicrobiology, the role of temperature in chemical and biochemical processes and the effect of temperature on microorganisms.
CLO2: Student can explain the theory of heat transfer, heat resistance kinetics, and its application in microbiology.
CLO3: Students can explain about the methods to suppress microorganism growth by high and low temperatures.</td></tr>
<tr><td>Content</td><td>Introduction: the importance of thermomicrobiology, the role of temperature in chemical and biochemical processes, the effect of temperature on microorganism (1 meeting)
Heat Transfer Theory (3 meetings)
Heat Resistance Kinetics (2 meetings)
Biology of microorganisms followed by postharvest (1 meeting)
Control of microorganism (1 meetings)
Control of microorganism with high heat method (1 meeting)
Control of microorganisms using low temperature (1 meeting)
Cryobiology (1 meeting)
Students Seminar (2 meetings)
Materials Review (1 meeting)</td></tr>
<tr><td>Examination forms</td><td>High Order Thinking Skills Examination
<table><tr><th colspan="4">Grade and Score</th></tr><tr><th>Grade</th><th>Score</th><th>Grade</th><th>Score</th></tr><tr><td>A</td><td>≥ 85</td><td>C+</td><td>64,0-66,9</td></tr><tr><td>A-</td><td>82,0-84,9</td><td>C</td><td>61,0-63,9</td></tr><tr><td>A/B</td><td>79,0-81,9</td><td>C-</td><td>58,0-60,9</td></tr><tr><td>B+</td><td>76,0-78,9</td><td>C/D</td><td>55,0-57,9</td></tr><tr><td>B</td><td>73,0-75,9</td><td>D+</td><td>52,0-54,9</td></tr><tr><td>B-</td><td>70,0-72,9</td><td>D</td><td>49,0-51,9</td></tr><tr><td>B/C</td><td>67,0-69,9</td><td>E</td><td><49</td></tr></table></td></tr>
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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. *Holdsworth, S. D. & Simpson, R., 2016. Thermal Processing of Packaged Foods. 3rd ed. Springer* 2. *Bergmen, T. L., Lavine, A. E., Incropera, F. P., & Dewitt, D. P. 2011. Fundamentals of Heat and Mass Transfer. John Wley & Sons* 3. *Lienhard, J.H. IV & V. 2003. A heat transfer textbook 3rd ed. Phlogiston Press. Cambridge* 4. *Bittar, E. E., and Willis, J. S. 1997. Advances in Molecular and Cells Biology: Thermobiology. Vol. 19: 293pp. Jai Press Inc. London.* 5. *Brock, T. D. 1978. Thermophilic Microorganisms and Life at High Temperatures. http://digital.library.wisc.edu/1711.dl/Science* 6. *Stumbo, C. R. 1973. Thermobacteriology in Food Processing. 2nd ed. 329 pp.Academic Press. New York.* *Additional References* *Scientific journals related to thermomicrobiology*