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Module designation	Plant Physiology
Module level, if applicable	Undergraduate
Code, if applicable	PBIOUM6115
Subtitle, if applicable	-
Courses, if applicable	-
Semester(s) in which the module is taught	Odd semester
Person responsible for the module	Dr. Betty Lukiati,.S.
Lecturer	Dr. Betty Lukiati, M.S Prof. Dra. Herawati Susilo, Ph.D. Rahmi Masita, M.Sc Dr. Balqis, M.Si Dr. Frida Kunti Setiowati, S.T, M.Si
Language	Indonesian
Relation to curriculum	Undergraduate degree program, compulsory, 3rd semester.
Type of teaching, contact hours	Undergraduate degree program: cooperative learning, presentation, laboratory work, 2 x 50 = 100 minutes and 1 x 170 minutes
Workload	1. 2 x 50 minutes for lecture = 100 minutes (1.67 hours) per week 2. 2 x 60 minutes for structure task = 120 minutes (2 hours) per week 3. 2 x 60 minutes for independent task = 120 minutes (2 hours) per week 4. 1 x 170 minute for practice = 170 minutes (2.83 hours) per week
Credit points	3 Credit points (~5 ETCS-eq)
Requirements according to the examination regulations	A student must have attended at least 80% of the lectures to be eligible for the final examination.
Recommended prerequisites	Plant Structure and Development 1
Module objectives/intended learning outcomes	Students are able to: (LO3) Master basic biological theoretical concepts in an integrated manner using logical, critical, systematic and innovative thinking through the science and technology approach to analyze various problems in the field of biology.

Course Learning Outcome	1. Mastering the basic concepts of plant physiology integrated with cell biology, plant structure, and biochemistry carefully, critically and systematically. 2. Finding and analyzing problems in the field of plant physiology and designing investigations through a scientific approach in order to obtain accurate and accountable data. 3. Analyzing data to formulate solutions to problems in the field of plant physiology creatively, and innovatively
Content	This course covers the following main topics: ● The relationship between the structure and function of the various parts of the plant body. ● Interpretation of the relationship between the concepts of plant physiology includes absorption, transpiration, transportation and translocation of nutrients and minerals, metabolism of carbohydrates, fats and nitrogen in plants. ● The response of plants to the induction of the internal environment (genes, hormones, and secondary metabolites), as well as the external environment to growth and development, includes dormancy, aging and death, movement, and vernalization. ● Theories and concepts of plant physiology. ● Relationship of plant physiology with related sciences ● Physical and chemical properties of water, osmotic diffusion process, water flow through the roots to the central cylinder (symplast, apoplast) ● Soil and Nutrients, the process of nutrient absorption, active and passive transport, macronutrients and macronutrients, deficiency symptoms, toxicity of micronutrients ● Photosynthesis is an oxidation-reduction reaction, a light reaction (electron transfer), herbicides as an inhibitor of electron transfer in photosynthesis, carbon dioxide reduction ● Environmental factors that affect productivity ● Conversion of photoassimilate into sucrose or starch (carbon allocation), photoassimilate translocation mechanism, photoassimilate distribution and influencing factors, mobilization of starch and fructans ● Cellular respiration, degradation of starch hydrolysis into sugars, mechanism of cellular respiration,

	energy is stored in the form of ATP by chemiosmosis ● Nitrogen assimilation ● Growth and Development, the difference between growth and development, dormancy, aging and death. ● Hormones as regulators of growth and development, perception, signal transduction and response, second messengers involved in signal transduction processes, signal transduction mechanisms to modify development in plants ● Phytochromes and Photomorphogenesis Photoreceptors initiate morphogenesis Plant development is regulated by phytochromes and cryptochromes ● Photoperiodism, Vernalization and biological clocks, genetic control of flower initiation and development in shoot meristems ● Movement in plants, phototropism and graphtropism, nasti ● The task of designing an integrated practicum project includes the effect of nutrition (fertilizer), light, hormones on growth-development, and movement in plants for learning biology in junior high and high school	
Learning Activity	Week 1	Introduction to Plant Physiology Discussion: the relationship between plant physiology and several related sciences (cell biology, physics, chemistry)
	Week 2	Discussion: physical and chemical properties of water, flow from the soil through the roots in a symplast and apoplast up to the central cylinder. Practicum: osmosis diffusion process, plasmolysis in plants
	Week 3	Discussion: Plant nutrition, transport of nutrients from the soil throughout the plant through the xylem, mineral deficiency in plants. Practicum: hydroponic plant nutrition
	Week 4	Discussion: Photosynthesis process starts from the electron transport stage to the CO2 reduction reaction, Practicum: calculate the chlorophyll content in leaves based on different ages (young, medium, and old) of various plants
	Week 5	Discussion: environmental factors that affect productivity
	Week 6	Discussion: allocation, translocation and assimilate photo partitioning,

		Practicum: transport of photoassimilates in plants.
	Week 7	Discussion: cellular respiration, alternative oxidation in plants and factors that affect respiration. Practicum: plant respiration by titration method.
	Week 8	MIDTERM EXAMINATION Material: plant nutrition to cellular respiration in plants
	Week 9	Discussion: nitrogen assimilation.
	Week 10	Discussion: growth and development Practicum: combined with material on hormone regulation.
	Week 11	Discussion: hormone regulation in plants Practical: breaking dormancy chemically and mechanically.
	Week 12	Discussion: Phytochromes and Photomorphogenesis, Photoreceptors initiate morphogenesis, Plant development is regulated by phytochromes and cryptochromes. Making a concept map of the relationship between phytochromes and photomorphogenesis
	Week 13	Discussion: Photoperiodism, Vernalization and Biological Clock, genetic control of flower initiation and development in shoot meristems
	Week 14	Discussion: Movement in plants, phototropism and graphtropism, nasti, Practicum : phototropy
	Week 15	Develop an integrated practicum project design covering the effect of nutrition (fertilizer), light, hormones on growth-development, and movement in plants., for learning in junior high and high school
	Week 16	FINAL EXAMINATION Material: from Nitrogen assimilation to secondary metabolites integrated practicum project design
Study and examination requirements and forms of examination	Assignment (30%) Midterm examination (20%) Final examination (20%) Practicum group report (20%) work activities in the project group (10%)	
Media employed	LCD, whiteboard, and SIPEJAR UM	
Reading list	1. Hopkins,W.G.& Hunter, N.P.A. 2009. Introduction to Plant Physiology 4th ed. John Wiley & Sons, Inc.	

	2. Taiz, L & E. Zeiger. 2010, Plant Physiology, Sinauer Association 3. Lersten, N.R. 2004. Flowering Plant Embryology. Blackwell Publishing. 4. Opick, H. & S.A. Rolfe. 2005. The Physiology of Flowering Plants. Cambridge Univ. Press 5. M.P. Johnson. 2016. Photosynthesis. Essays in Biochemistry. 60: 255–273. DOI: 10.1042/EBC20160016 6. J.A. Silva & R. Uchida. 2000. Essential Nutrients for Plant Growth:Nutrient Functions and Deficiency Symptoms. Plant Nutrient Management in Hawaii's Soils, Approaches for Tropical and Subtropical Agriculture. College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa 7. Sharanya Tripathi, Quyen T. N. Hoang, Yun-Jeong Han and Jeong-Il Kim. 2019. Review Regulation of Photomorphogenic Development by Plant Phytochromes. International Journal of Molecular Science. 20, 6165; doi:10.3390/ijms20246165 8. Wolfgang Engelmann. Chapter 8 Photoperiodism: The Calendar of Plants. © Springer International Publishing Switzerland 2015 S. Mancuso and S. Shabala (eds.), Rhythms in Plants, DOI 10.1007/978-3-319-20517-5_8 9. Emmanuel Liscum, Scott K. Askinosie, Daniel L. Leuchtman, Johanna Morrow, Kyle T. Willenburg,a,b and Diana Roberts Coatsa, 2014. REVIEW Phototropism: Growing towards an Understanding of Plant Movement. The Plant Cell, 26: 38–55, www.plantcell.org. Society of Plant Biologists. 10. Anupama Goyal, Bogna Szarzynska, and Christian Fankhauser. 2017. Review: Phototropism: at the crossroads of light-signaling pathways. Trends in Plant Science. Vol. 18, No. 7.
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