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Seed production	
Field (if relevant)	7M05 Natural sciences, mathematics and statistics
Specializations	7M05102 Biotechnology
Form of delivery	Full-time
Core/Elective	Elective course
Course prerequisites (if relevant)	Objects of Biotechnology, Introduction to Biotechnology
Semester of the course	Year 1, Semester 2
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)
Course language	English

Course Developers	Toraighyrov University Pavlodar (Kazakhstan)

Course summary
The course "Seed production" focuses on the application of biotechnological techniques in seed production, aiming to enhancing the quality, yield, and traits of seeds for agricultural purposes. It provides master students with an in-depth understanding of the principles, methods, and ethical considerations associated with biotechnology in seed production. The course, taught in English, employs Content and Language Integrated Learning (CLIL) and English Medium Instruction (EMI) methodology intended for integrated learning of both content and language. The course has been developed within the international Erasmus+ project "Project Erasmus+ 609563-EPP-1 -2019-1-DE-EPPKA2-CBHEJP 'lnternationalizing Master Programmes in Agriculture via English Medium instruction (IMPROvE _AGRO)"

Key terms and notions
Germination; Seed viability; Seed dormancy; Seed purity; Seed treatment; Seed certification; Genetic purity

Course aim
The aim of a course on seed production is to provide master students with the knowledge and skills necessary to produce, manage, and ensure the quality of seeds, contributing to improved agricultural productivity, food safety, and sustainable farming practices.

Competencies	
General competencies	-get familiar with traditional and modern breeding techniques used in seed production, such as hybridization, selection, and genetic modification, to develop improved crop varieties. - develop self-motivation, collaborative learning, problem solving, self-directed and independent learning skills. - plan, conduct research, report results according to academic standards - study the literary sources and writing in English

Professional competencies	-use quality control and testing: Conduct seed quality control measures, including sampling, testing, and analysis to ensure compliance with industry standards and regulatory requirements. - perform seed certification and documentation: Efficiently apply seed certification processes, including the application, inspection, and documentation required for obtaining official seed certification. - select and use traditional and modern breeding techniques in seed production, such as hybridization, selection, and genetic modification, to develop improved crop varieties. - explore biotechnology in seed selection and breeding. -Use genetic engineering to introduce or modify specific traits in plants, such as disease resistance, herbicide tolerance, and improved nutritional content.
Learning outcomes	
By the end of this course, students will be able to	
LO1	Apply theoretical and practical knowledge of the principles of primary seed production to solve educational, practical and professional tasks in the field of agricultural crop production
LO2	Apply knowledge and understanding of ways to increase the reproduction rate of plants, formulate arguments and solve problems in a specific situation
LO3	Teach techniques and methods for obtaining initial seed material based on biotechnology, necessary for independent activity in this field
LO4	Apply methods of scientific research and academic writing in English when performing experimental work

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**Asynchronous**	**Synchronous**	**Independent work**	**Asynchronous theoretical component**	**Synchronous practical component**	**Module Learning Outcomes**
Module 1/Unit The importance of seed production for the agro-industrial complex, as well as the traits and qualities of seeds						
1. Introduction. Problems and objectives of seed production of agricultural plants	2	2	4	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Discuss about the problems and objectives of seed production of agricultural plants	Describe the problems and objectives of seed production in agricultural plants.
2. Impact of heredity and variability on the quality of seed material	2	3	3	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Instruct student groups to search for and gather additional information about the assigned plant varieties, focusing on seed quality factors such as germination rate, vigour, disease resistance, or specific quality traits relevant to the plants. Facilitate a class discussion after each group presentation, allowing other students to ask questions, share additional insights, or provide alternative perspectives on the impact of heredity and variability on seed material quality.	Assess and compare the impact on the quality of seed material in different plant varieties
3. Features of seed formation	2	3	3	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Present to the student groups how to find resources or references to gather information about the assigned plant species. Encourage them to explore scientific literature, textbooks, or online databases to enhance their understanding of the seed formation processes. Facilitate a class discussion after each group presentation, allowing other students to ask questions, provide feedback, or share additional insights related to seed formation processes in different plant species.	List the features and processes involved in seed formation.

4. Breaking seed dormancy	4	6	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Instruct the student groups to search for and identify strategies and techniques used to brake seed dormancy in their assigned plant species. Encourage them to explore both natural and artificial methods, such as scarification, stratification, chemical treatments, and seed priming. Facilitate a class discussion after each group presentation, allowing other students to ask questions, provide feedback, or share additional insights related to seed dormancy and the presented strategies to break it.	Select and apply strategies to break seed dormancy in order to promote germination and seedling establishment.
Total hours for Unit/module 1	Topics:4 Asynchronous:10 Synchronous:14 Independent work:16					
Module 2/Unit Using of biotechnology in seed production to obtain healthy planting material						
5. Phytohormones. Hormonal regulation in crop production	4	6	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Show case studies or examples on successful application of phytohormones in different crops or agricultural practices. Discuss practical considerations, such as dosage, timing, and interactions with other factors, in using phytohormones for specific purposes. Encourage participants to analyze critically the potential impacts and challenges associated with the use of phytohormones in crop production.	Describe the role of phytohormones in hormonal regulation and their impact on crop production
6. Use of tissue culture in seed production	4	6	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Instruct the student groups to search for and identify the tissue culture techniques, such as micropropagation, embryo rescue, or somatic embryogenesis that are relevant to their assigned crop. Encourage them to explore the steps involved in each technique, including explant selection, culture media preparation, sterilization methods, and growth regulation. Provide time specifically for group discussions and research (e.g., 20-30 minutes) to allow students to analyze and synthesize the information they have gathered. Facilitate a class discussion after each group presentation, allowing other students to ask questions, provide feedback, or share additional insights related to tissue culture and its applications in seed production.	Apply tissue culture techniques to improve seed production in agricultural crops.
7. Accelerated plant propagation	4	6	6	Recorded video lectures, literature, a short description of the lecture, video	Share case studies or examples showing the applications of micropropagation in different plant species. Discuss the practical uses of micropropagation, such as mass	Describe the principles and techniques of micropropagation and its

				conferencing, virtual classrooms.	production of disease-free plants, genetic preservation, and plant breeding. Encourage participants to analyze critically the potential benefits and challenges of using micropropagation in specific plant propagation scenarios.	applications in plant propagation
Total hours for Module/Unit 2	Topics: 3 Asynchronous: 12 Synchronous: 18 Independent work: 18					
Module 3/Unit Varietal control and seed quality requirements						
8. Varietal control	4	6	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Instruct the student groups to research and identify the seed sorting techniques and quality control measures relevant to their assigned crop. Encourage them to explore both manual and mechanical sorting methods, such as sieving, gravity separation, air classification, and electronic sorting based on size, shape, weight, and color. Facilitate a class discussion after each group presentation, allowing other students to ask questions, provide feedback, or share additional insights related to seed sorting and quality control in seed production.	Select and apply varietal control techniques to ensure quality control in seed production.
9. Organization and methodology of primary seed production of agricultural plants	4	6	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, and virtual classrooms.	Instruct the student groups to develop a seed production plan for their assigned crop. The plan should include the following elements: selection of suitable land and climate conditions, choice of seed source and variety, determination of sowing time and density, pest and disease management strategies, pollination control, harvesting and post-harvest handling procedures, and quality assurance measures. Facilitate a class discussion after each group presentation, allowing other students to ask questions, provide feedback, or share additional insights related to the organization and methodology of primary seed production.	Organize the methodology to plan and execute a seed production project for an agricultural crop.
Total for Module/Unit 3	Topics: 2 Asynchronous:8 Synchronous: 12 Independent work:12					
Total for the course	**Modules: 3** **Topics: 9** **Asynchronous: 30** **Synchronous: 44** **Independent work: 46**					

	Course learning outcomes	Learning types and teaching methods	Assessment methods
LO1	Apply theoretical and practical knowledge of the principles of primary seed production to solve educational, practical and professional tasks in the field of agricultural crop production	Analyze current seed production practices for a particular crop or group of crops. Students need to research articles, books and textbooks to learn the principles and methods used in seed production. Based on their knowledge, students should prepare presentations with recommendations for improving seed production practices, including changing cultivation methods, using new technologies, or implementing effective measures to improve seed quality.	Participation of master's students in discussions at seminars, and defense of individual students' presentations.
LO2	Apply knowledge and understanding of ways to increase the reproduction rate of plants, formulate arguments and solve problems in a specific situation	Analyze a situation in which it is necessary to increase the reproduction rate of a particular plant. Students should analyze the factors limiting multiplication and propose solutions to speed up the process. Solutions may include changing growing conditions, using growth stimulants, using plant engineering techniques, etc. Students should explain their choices and how these measures will help increase the rate of plant multiplication. Present your answer in the format of a presentation and defend it.	Defense of individual students' presentations.
LO3	Teach techniques and methods for obtaining initial seed material based on biotechnology, necessary for independent activity in this field	Create a presentation in which students describe the different methods of obtaining initial seed material based on biotechnology. Students should describe each method; explain its principles and advantages, and present examples of its application in agricultural crop production practices.	Participation of master's students in discussions at seminars, and defense of individual students' presentations.
LO4	Apply methods of scientific research and academic writing in English when performing experimental work	Students must analyze and synthesize research, identify the most relevant theories and results, and highlight problems that require further research. Students should present their findings as a scientific academic writing in English.	A review of the scientific literature in English on the chosen research topic.

Assessment scale			
Assessment scale	Mark on the scale of the higher education institution		
	90 – 100	A	passed
	80 – 89	B	
	70 – 79	C	
	60 – 69	D	
	50 – 59	E	
	0-49	F	failed

Equipment, digital tools, and educational technologies for the course	
Internet, smart board and the manuals developed within the IMPROvE _AGRO project	
Books and resources recommended for this course	
Essential Reading	1. A.B.M. Sharif Hossain. Plant Physiology and Biotechnology: Fundamental and Applied Research : OmniScriptum Publishing KS. – 2014. – 612 p. 2. Dhaubhadel S., Marsolais F.. Seed Development: OMICS Technologies toward Improvement of Seed Quality and Crop Yield. 2012. - 129 p. 3. Vanangamudi K., Kavitha S., Raja K. Objective Seed Science and Technology. N.p.: Scientific Publishers - Competition Tutor. - 2017. – 514 p. 4. Bhaskaran, M. 2002. Principles of Seed Production and Quality Control. Department of SeedScience and Technology, Tamil Nadu Agricultural University, Coimbatore. - 365 p. 5. Padmavathi, S., Prakash, M.., Kumar, S. Ezhil. A Textbook Of Seed Science And Technology. Индия: NEW INDIA PUBLISHING AGENCY-NIPA, 2020. - 286 p.
Recommended Reading	1 Bhojwani S. S., Dantu P. K. Plant Tissue Culture. Springer . New Delhi.- 2013.- 318 p. 2 Lawrence O. Copeland, Miller B. Mcdonald. Principles of Seed Science and Technology. Boston, Springer MA. – 2001. 469 p. 3 Plant Cell Culture Protocols. Second Edition. Edited by Victor M. Loyola-Vargas and Felipe Vázquez-Flota Plant cell culture / edited by Victor M. Loyola-Vargas and Felipe Vázquez-Flota. – 2nd. ed. Totowa, New Jersey.- 2006. - 388 p. 4 Protocols for In Vitro Propagation of Ornamental Plants. Edited by S. Mohan Jain and Sergio J. Ochatt. 2010. - Humana Press. Springer New York.- 400 c. 5 Stewart, C. Neal. Plant biotechnology and genetics: principles, techniques and applications/ C. Neal Stewart, Jr. // John Wiley & Sons, Inc., Hoboken, New Jersey. - 416 p. 6 George, Raymond AT. Agricultural seed production. Cabi, 2011. – 215 p. 7 McDonald M. F., Copeland L. O. Seed production: principles and practices. – Springer Science & Business Media, 2012. – 754 p.

Internet resources	https://www.youtube.com/watch?v=Bi9wgy5Gr-8 https://www.youtube.com/watch?v=fKdqSyZF4XQ https://www.youtube.com/watch?v=Gl3jk3f3q-4 https://www.youtube.com/watch?v=NuH_FMwzmYU https://www.youtube.com/watch?v=P8b4VTDdk3o https://youtu.be/0SylARrhEZY https://youtu.be/16OBgsGo1fM https://youtu.be/8xxfjaURos4 https://youtu.be/9VHO-uiiwp8 https://youtu.be/cZLMq8ccSGs https://youtu.be/F8PU2GTJwwg https://youtu.be/iTj6D2VJtE4 https://youtu.be/pX_oPJZSWt8

Course quality monitoring

1.Syllabus feedback from internal and external peer-reviewers.
2.Feedback from students who attend the course.
3.Students' performance in the course.

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Applied plant virology	
Field (if relevant)	7M05 Natural sciences, mathematics and statistics
Specializations	7M05102 Biotechnology
Form of delivery	Full-time
Core/Elective	Elective course
Course prerequisites (if relevant)	Objects of Biotechnology, Introduction to Biotechnology, Plant biotechnology
Semester of the course	Year 1, Semester 2
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)
Course language	English

Course Developers	Toraighyrov University (Pavlodar, Kazakhstan)

Course summary

Applied Plant Virology is a comprehensive course designed to provide master students with a solid foundation in the study of plant viruses and their impact on agricultural systems. The course combines theoretical knowledge with practical skills to equip students with the tools necessary to diagnose, prevent, and control viral infections in plants.

This course introduces students to the basic properties of plant pathogenic viruses, as well as the respective methods of diagnosis, prevention, and control of viral plant diseases. The course, taught in English, employs Content and Language Integrated Learning (CLIL) and English Medium Instruction (EMI) methodology intended for integrated learning of both content and language. The course has been developed within the international Erasmus+ project "Project Erasmus+ 609563-EPP-1 -2019-1-DE-EPPKA2-CBHEJP 'lnternationalizing Master Programmes in Agriculture via English Medium instruction (IMPROvE _AGRO)"

Key terms and notions

Inoculum; virulence; antigen; bacteriophage; thermotherapy; tolerance; viroids.

Course aim

The course aims to provide master students with knowledge and skills in the fundamental properties of plant viruses, along with the corresponding techniques for diagnosing, preventing, and controlling viral infections.

Competencies

General competencies	- ability to identify and characterize plant viruses using a range of diagnostic techniques such as serological assays, molecular methods, and bioassays; - develop self-motivation, collaborative learning, problem solving, self-directed and independent learning skills. - study literature sources and write scientific papers, in English

Professional competencies	- detect and diagnose viral infections in plants by interpreting symptoms, conducting laboratory tests, and applying appropriate diagnostic tools - designing and implementing strategies for the prevention and control of viral diseases in plants in real situations - applying molecular biology techniques used in plant virology research - plan, conduct research and report results according to academic standards
Learning outcomes	
By the end of this course, students will be able to	
LO1	Demonstrate understanding of the basic properties of plant viruses, including their structure, classification, and genomic organization.
LO2	Apply appropriate diagnostic techniques to identify and characterize plant viruses, including serological assays, molecular methods, and bioassays.
LO3	Interpret symptoms and laboratory results to accurately diagnose viral infections in plants and differentiate them from other plant pathogen infections.
LO4	Explain the mechanisms of virus-host interactions, including viral entry, replication, and the plant's defense responses, and evaluate the impact of these interactions on disease development.
LO5	Design and implement effective strategies for the prevention and control of viral infections in plants, considering factors such as quarantine measures, vector management, cultural practices, and resistant crop varieties.
LO6	Apply methods of scientific research and academic writing in English when performing experimental work

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**Asynchronous**	**Synchronous**	**Independent work**	**Asynchronous theoretical component**	**Synchronous practical component**	**Module Learning Outcomes**
Module/Unit 1 Composition, morphology, structure, properties and characteristics of phytoviruses						
1. Reproduction of plant viruses and their transmission	3	3	2	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Select a research paper or case study (published within the last five years) that focuses on the reproduction of plant viruses and their transmission. The chosen study should provide insights into specific aspects of plant virus reproduction and transmission mechanisms. Prepare a presentation summarizing your analysis and present it to the class. Highlight the key points of the research paper, your critical evaluation, and engage in a discussion with your peers about the implications and significance of the findings.	Describe the process of plant virus transmission through grafting and its implications for disease management.
2. Spread of plant viruses	5	5	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Lecture on the different modes of viral transmission, such as insect vectors, nematodes, seed-borne transmission, and vegetative propagation, relevant to the agricultural systems.	Apply knowledge of viral spread to develop strategies for disease prevention and control in plant populations.
3. Plant virus vectors	6	6	4	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Lecture on the major vectors involved in the transmission of plant viruses, such as insects, nematodes, fungi, and other organisms.	Analyse the life cycle, feeding habits, and behaviour of vectors relevant to plant virus transmission.
4. Physiological and histological changes in plants under the influence of viral infection	5	5	6	Recorded video lectures, literature, a short transcript of the lecture, video conferencing, virtual classrooms.	Lecture on the histological changes observed in infected plants, including alterations in cell structure, cell wall composition, and tissue damage.	Describe the histological alterations observed in virus-infected plants and their impact on plant structure and function.
5. Harmfulness of viral diseases	5	5	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Lecture on the symptoms and signs associated with viral infections in plants, such as leaf discoloration, stunting, necrosis, and deformities.	Recognize the symptoms and signs associated with viral infections in plants and explain their diagnostic significance.
Total for Module/Unit 1	Topics: 5 Asynchronous: 24 Synchronous: 24 Independent work: 24					

Module/Unit 2 Methods of diagnosis and control of plant viruses						
6. Diagnostic methods for viral infection	6	6	4	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Laboratory work.	Describe and apply the various diagnostic methods and techniques used for the detection and quantification of viral pathogens.
7. Methods of controlling plant viral pathology	6	6	4	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Present the design a comprehensive disease management plan to control plant viral pathology in a specific crop of your choice.	Develop and present ways to get rid of some plant viruses
8. Methods of prevention of viral plant diseases	5	5	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Lecture on research on identification of the most common viral diseases affecting plants in your chosen agricultural setting, and the modes of viral transmission relevant to your chosen plants and region.	Apply knowledge of cultural practices to develop effective strategies for preventing various viral diseases in various plants.
Total hours for Module/Unit 2	Topics: 3 Asynchronous: 17 Synchronous: 17 Independent work:14					
Total hours for the course	**Modules: 2** **Topics: 8** **Asynchronous: 41** **Synchronous: 41** **Independent work: 38**					

	Course learning outcomes	Learning types and teaching methods	Assessment methods
LO1	Demonstrate understanding of the basic properties of plant viruses, including their structure, classification, and genomic organization.	Create a presentation about plant viruses. In the presentation, students describe the structure of plant viruses, classification, and genomic organization. Also, information about typical symptoms, modes of transmission, and the effects of viruses on plants.	Participation of master's students in discussions at seminars, and defense of individual students' presentations.
LO2	Apply appropriate diagnostic techniques to identify and characterize plant viruses, including serological assays, molecular methods, and bioassays.	Students do practical laboratory work using various diagnostic methods to identify and characterize plant viruses. Students will review research articles related to the diagnosis of plant viruses and analyze the methods.	Laboratory work. Write and defend a report on the research articles, in which they will summarize and explain the main principles and advantages of each diagnostic method, and discuss its application in specific situations.
LO3	Interpret symptoms and laboratory results to accurately diagnose viral infections in plants and differentiate them from other plant pathogen infections.	Compare symptoms caused by plant viral infections and other pathogens. They are given a set of symptoms by which students must determine which symptoms are typical of viral infections	Compare the symptoms caused by viral plant infections with other pathogens.

		and which may be associated with other causes of the disease.	
LO4	Explain the mechanisms of virus-host interactions, including viral entry, replication, and the plant's defense responses, and evaluate the impact of these interactions on disease development.	Create a presentation in which students explain the mechanisms of virus-host interaction in plant infections. In the presentation, they should describe each stage of the interaction and give examples of specific plant viruses and plant responses to infection. Also, the factors that influence the development of the disease and strategies to control viruses.	Participation of master's students in discussions at seminars, and defense of individual students' presentations.
LO5	Design and implement effective strategies for the prevention and control of viral infections in plants, considering factors such as quarantine measures, vector management, cultural practices, and resistant crop varieties.	Develop a quarantine plan to prevent the spread of viral plant infections. Students should research and describe effective quarantine methods and regulations that will help prevent the transmission of viruses through infected plants, seeds, soil, or other materials. Students should also explain how a quarantine plan can be put into practice and what organizational measures are necessary for its successful implementation.	Presentation and defense of a quarantine plan to prevent the spread of viral plant infections
LO6	Apply methods of scientific research and academic writing in English when performing experimental work	Students must analyze and synthesize research, identify the most relevant theories and results, and highlight problems that require further research. Students should present their findings as a scientific academic writing in English.	A review of the scientific literature in English on the chosen research topic.

Assessment scale			
Assessment scale	Mark on the scale of the higher education institution		
	90 – 100	A	passed
	80 – 89	B	
	70 – 79	C	
	60 – 69	D	
	50 – 59	E	
	0-49	F	failed

Equipment, digital tools, and educational technologies for the course
Internet, smart board and the manuals developed within the IMPROvE _AGRO project
Books and resources recommended for this course

Essential Reading	1. Awasthi L. P. Applied plant virology: advances, detection, and antiviral strategies. Academic Press.- 2020. – 682 p. 2. A.B.M. Sharif Hossain. Plant Physiology and Biotechnology: Fundamental and Applied Research : OmniScriptum Publishing KS. – 2014. – 612 p. 2. Khan J., Dijkstra J. Handbook of Plant Virology. CRC Press. – 2008. – 476 p. 3. Walkey, D.G.A. (1991). Plant virology: An Introduction. In: Applied Plant Virology. Springer, Dordrecht. https://doi.org/10.1007/978-94-011-3090-5_1 4. Wilson, C. R. (2014) Applied Plant Virology, CABI Books. CABI. doi: 10.1079/9781780644257.0001.
Recommended Reading	1. Loebenstein, G., & Katis, N. (Eds.). (2014). Control of plant virus diseases: seed-propagated crops. Academic Press. 2. Lawrence O. Copeland, Miller B. Mcdonald. Principles of Seed Science and Technology. Boston, Springer MA. – 2001. 469 p.
Internet resources	https://www.youtube.com/watch?v=FP7ee62L3go https://www.youtube.com/watch?v=ueHGeIstdWk https://www.youtube.com/watch?v=RwGqu57WGAI https://www.youtube.com/watch?v=_119qRrlehk https://www.youtube.com/watch?v=ties2250mwU https://www.youtube.com/watch?v=l92RFHeJBbA https://www.youtube.com/watch?v=_aQUm5J-E3o https://www.youtube.com/watch?v=tqzSdOjjVYA https://www.youtube.com/watch?v=nR9e7eXm7gk https://www.youtube.com/watch?v=Pq3lGWPEXgw https://www.youtube.com/watch?v=mDBlp-ziPjU https://www.youtube.com/watch?v=QHHrph7zDLw https://www.youtube.com/watch?v=QHHrph7zDLw https://www.youtube.com/watch?v=O1TetEto1Is https://www.youtube.com/watch?v=-UdYZMZSAPI&list=PLB0gLXK35J1WgAya93h98LeoqGAf3gc5x https://www.youtube.com/watch?v=Zw7oY80cv5I https://www.youtube.com/watch?v=HOHczdglqHI&list=PL3n3HHNAyfIYKy7sLgxW3w3QMC_V4HM7T https://www.youtube.com/watch?v=iQsu3Kz9NYo https://www.youtube.com/watch?v=iQsu3Kz9NYo

Course quality monitoring

1. Syllabus feedback from internal and external peer-reviewers.
2. Feedback from students who attend the course. 3. Students' performance in the course.

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Industrial Agrobiotechnology	
Field (if relevant)	7M05 Natural sciences, mathematics and statistic
Specializations	7M05102 Biotechnology
Form of delivery	Full-time
Core/Elective	Professional elective course
Course prerequisites (if relevant)	Objects of Biotechnology, Fundamentals of Biotechnology, Plant biotechnology
Semester of the course	Year 2, Semester 1
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)
Course language	English

Course Developers	Toraighyrov University Pavlodar (Kazakhstan)

Course summary

Industrial agrobiotechnology studies the use of biotechnological methods to improve production processes in agriculture and the food industry. This includes improving the quality and yield of cultivated plants, the development of new hybrids and varieties, the creation of dietary supplements and preparations for plants, as well as the production of biofuels and bioenergy. In addition, industrial agrobiotechnology also explores the impact of the use of genetically modified organisms on the environment and public health.

The course, taught in English, employs Content and Language Integrated Learning (CLIL) methodology intended for integrated learning of both content and language. The course has been developed within the international Erasmus+ project "Internationalizing Master Programmes in Agriculture via English Medium Instruction (IMPROvE _AGRO)", No 609563-EPP-1-2019-1-DE-EPPKA2-CBHE-JP (15.01.2020 – 15.01.2023).

Key terms and notions

Phytosanitary; soil pathogenic microflora; bioinsecticides; biological products; bacterial diseases; pesticides; genetically modified organisms; DNA ligation and repair; genetic engineering; somatic hybridization; biofortification and cryopreservation

Course aim

The aim of the course is to contribute to a broad-minded master's degree in agro-biotechnology providing knowledge of theoretical and applied aspects of plant biotechnology, enabling capabilities of planning, conducting biotechnological research and effectively using the results to increase the competitiveness of work.

Competencies

General competencies	- acquire fundamental knowledge about the types of microorganisms used to produce biopesticides, - know the basic requirements for the conditions of cultivation of the microorganisms used, - be familiar with the requirements for biopesticides, - be familiar with the technology of preparing biofertilizers

	- efficient use of international databases to expand knowledge in the direction of industrial agrobiotechnology, - ability to interpret and process the results of scientific experiments, - critical thinking for the presentation of the experiment, - possess basic skills of professional and scientific communication, including in English (level B1, B2, C 1).
Professional competencies	- prepare of nutrient substrates for the production of biofertilizers, - analyze modern problems of biotechnology, scientific and technological policy in the field of safe crop production, in real situations - apply innovative methods in the agro-industrial complex in the development and implementation of environmentally safe and cost-effective technologies for the production of crop production and reproduction of soil fertility of various agricultural landscapes, - ensure the ecological safety of agricultural landscapes in the cultivation of agricultural crops and the economic efficiency of production within the framework of scientific developments - define the goals of professional activity, use adequate methods and means to achieve them, carry out scientific, innovative activities to obtain new knowledge, make decisions and demonstrate responsibility - demonstrate leadership qualities in creating an organic society in the field of business, professional, and scientific world. - analysis of the finished product - carry out professional, scientific and scientific-pedagogical activities, as well as the activities of the team; predict the results of professional and scientific activities; - individual activties, as well as the activities in a team; predict the results of professional and scientific activities.

Learning outcomes	
By the end of this course, students will be able to	
LO1	Demonstrate and use the acquired knowledge in the field of biotechnology in industry and agriculture;
LO2	Formulate arguments and solve problems of the studied area, plan and independently carry out biotechnological scientific experiments;

LO3	Generalize and justify the results obtained and make decisions based on them;
LO4	Collect specialized scientific literature on the Internet and databases, use specialized computer programs to process the obtained results, prepare scientific publications, create and present scientific reports;
LO5	Implement the possibility of increasing the productivity of agricultural crops and the quality of products obtained by biotechnological methods and to manage programs of genetic determination in the areas of crop production;
LO6	Apply modern research methods in the field of biotechnological processing of industrial and household waste;
LO7	Apply technologies of utilization and processing of organic and industrial and agricultural waste;
LO8	Use industrial and household waste to produce biotechnological products;

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**Asynchronous.**	**Synchronous**	**Indep. work**	**Asynchronous. theoretical component**	**Synchronous Practical component**	**Module Learning Outcomes**
Module/Unit 1[Introduction]						
1. Current stage and prospects for the development of industrial agrobiotechnology	4	5	6	Recorded video lecture on the topic: "Development of agrobiotechnologies at the present stage". Links to electronic resources.	Select a publication (for the last five years) devoted to aspects of the development of agrobiotechnology in any country or in the world. Give a comparison with the development of agrobiotechnology in Kazakhstan.	Explain the advantages and disadvantages of biotechnological production compared to chemical technologies. Analyze the development of individual branches of agrobiotechnologies.
2. The importance of biological products in crop production	4	5	6	Video conferencing on the topic: «The importance of biological products for various directions of agricultural crop production». Textbooks. Links to electronic resources.	Discussion on the topic "Advantages and limitations of the use of biological products in crop production". Written work: «Filling in gaps in the text on the use of biological products in English».	Discuss the advantages and limitations of the use of biological products in crop production. Analyze the safety and effectiveness of biological products, the principles of action of biological drugs
3. Biofungicides. Characteristic. Production technology.	4	5	9	Video slides on the topic: "Types and	Preparation of reports on the topic "Peculiarities of the technology of preparation and application	List the biological products for the control of pathogens of agricultural

				characteristics of biofungicides, technology of their production". Electronic educational materials.	of biofungicides" and discussion. Written work in English: "To compare the name of the biofungicide with the description".	crops. Explain the role of biofungicides and their impact on crop production.
4. Entomopathogenic preparations. Characteristic. Production technology.	8	9	20	Recorded video lectures: «Types and features of the action of entomopathogenic preparations». Links to electronic resources. Textbooks.	Preparation of presentations on the topic: "The role of bacterial entomopathogenic drugs and their effect on crop production. Characteristics, methods of obtaining". Discussion. Written work in English: "To compare the type of the entomopathogenic preparations with the description". Written work in English: «Arrange the stages of obtaining biologics in the correct order».	Analyze the effectiveness of biological products for the control of pests in agricultural crops. Describe the technology of production and application, as well as the principles of action of biological bacterial, fungal and viral pesticides.
5. Growth regulators	4	5	9	Video slides on the topic: "Types of plant growth regulators, technology of their production".	Preparation of reports on the topic: "Biostimulators of plant growth". Discussion. Written work in English: «Compare the type of stimulator with its description». Written work: "Characteristics of producers of biological products, nutrient media and technology of product production"	Analysis of the effectiveness of biostimulants to increase crop yields. Describe the technology of production of plant growth bioregulators.
6. Vermicompost organic fertilizer	4	5	8	Video conferencing on the topic: «The importance of biological products for various directions of agricultural crop production». Textbooks. Links to electronic resources.	Discussion on the topic "Advantages and limitations of the use of biological products in crop production". Written work: «Filling in gaps in the text on the use of biological products in English».	Discuss the advantages and limitations of the use of biological products in crop production. Analyze the safety and effectiveness of biological products, the principles of action of biological drugs
Total for Module 1	Topics: 6 Asynchronous: 28 Synchronous: 34 Independent work: 58					
Total for the Course	**Topics: 6** **Asynchronous: 28** **Synchronous: 34** **Independent work: 58** **Total: 120**					

	Course learning outcomes	Learning types and teaching methods	Assessment methods
LO1	Demonstrate and use the acquired knowledge in the field of biotechnology in industry and agriculture;	Master's make a presentation using the necessary software tools, solving the tasks set by the teacher in the presentation. The student makes a presentation in class or submits it electronically to the teacher. The possession of the material on the topic of the presentation, logic, informativeness, ways of presenting information, solving the tasks are evaluated.	Master's participation in communication events, individual master's presentations, an online test on the main points of the content and mastery of the theme. Vocabulary practice test
LO2	Formulate arguments and solve problems of the studied area, plan and independently carry out biotechnological scientific experiments;	Master's make a presentation using the necessary software tools, solving the tasks set by the teacher in the presentation. The student makes a presentation in class or submits it electronically to the teacher. The possession of the material on the topic of the presentation, logic, informativeness, ways of presenting information, solving the tasks are evaluated.	Master's participation in communication events, individual master's presentations, an online test on the main points of the content and mastery of the theme. Vocabulary practice test
LO3	Generalize and justify the results obtained and make decisions based on them;	Master's make a presentation using the necessary software tools, solving the tasks set by the teacher in the presentation. The student makes a presentation in class or submits it electronically to the teacher. The possession of the material on the topic of the presentation, logic, informativeness, ways of presenting information, solving the tasks are evaluated.	Master's participation in communication events, individual master's presentations, an online test on the main points of the content and mastery of the theme. Vocabulary practice test
LO4	Collect specialized scientific literature on the Internet and databases, use specialized computer programs to process the obtained results, prepare scientific publications, create and present scientific reports;	Master's make a presentation using the necessary software tools, solving the tasks set by the teacher in the presentation. The student makes a presentation in class or submits it electronically to the teacher. The possession of the material on the topic of the presentation, logic, informativeness, ways of presenting information, solving the tasks are evaluated.	Master's participation in communication events, individual master's presentations, an online test on the main points of the content and mastery of the theme. Vocabulary practice test
LO5	Implement the possibility of increasing the productivity of agricultural crops and the quality of products obtained by Biotechnological methods and to manage programs of genetic determination in the areas of crop production;	Master's make a presentation using the necessary software tools, solving the tasks set by the teacher in the presentation. The student makes a presentation in class or submits it electronically to the teacher. The possession of the material on the topic of the presentation, logic, informativeness, ways of presenting information, solving the tasks are evaluated.	Master's participation in communication events, individual master's presentations, an online test on the main points of the content and mastery of the theme. Vocabulary practice test
LO6	Apply modern research methods in the field of biotechnological processing of industrial and household waste;	Master's make a presentation using the necessary software tools, solving the tasks set by the teacher in the presentation. The student makes a presentation in class	Master's participation in communication events, individual master's presentations, an online test on the main points of the content and mastery of the

		or submits it electronically to the teacher. The possession of the material on the topic of the presentation, logic, informativeness, ways of presenting information, solving the tasks are evaluated.	theme. Vocabulary practice test
LO7	Apply technologies of utilization and processing of organic and industrial and agricultural waste;	Master's make a presentation using the necessary software tools, solving the tasks set by the teacher in the presentation. The student makes a presentation in class or submits it electronically to the teacher. The possession of the material on the topic of the presentation, logic, informativeness, ways of presenting information, solving the tasks are evaluated.	Master's participation in communication events, individual master's presentations, an online test on the main points of the content and mastery of the theme. Vocabulary practice test
LO8	Use industrial and household waste to produce biotechnological products;	Master's make a presentation using the necessary software tools, solving the tasks set by the teacher in the presentation. The student makes a presentation in class or submits it electronically to the teacher. The possession of the material on the topic of the presentation, logic, in formativeness, ways of presenting information, solving the tasks are evaluated.	Master's participation in communication events, individual master's presentations, an online test on the main points of the content and mastery of the theme. Vocabulary practice test

Assessment scale			
Assessment scale	Mark on the scale of the higher education institution		
	90 – 100	A	passed
	80 – 89	B	
	70 – 79	C	
	60 – 69	D	
	50 – 59	E	
	0-49	F	failed

Equipment, digital tools, and educational technologies for the course
Books and resources recommended for this course

Essential Reading	1. Zayadan B.K. Basics of Biotechnology: textbook / B.K. Zayadan, L.B. Dzhansugu-rova, S.K. Turasheva. – Ster. pub. – Almaty: Qazaq University, 2020. – 428 p. ISSBN 978-601-04-4230-6 2. Zakaria Z.A., Boopathy R., Dib J.R. (Eds.) Valorisation of Agro-industrial Residues - Volume I: Biological Approaches // Springer, 2020. — 313 p. — (Applied Environmental Science and Engineering for a Sustainable Future). — ISBN: 978-3-030-39136-2 3. Jacob-Lopes E. et al. (Eds.) Handbook of Microalgae-Based Processes and Products: Fundamentals and Advances in Energy, Food, Feed, Fertilizer, and Bioactive Compounds // Academic Press, 2020. — 897 p. — ISBN: 978-0-12-818536-0. 4. Motsara M.R., Roy R.N. Guide to Laboratory Establishment for Plant Nutrient Analysis: Food and Agriculture Organization of the United Nations, 2008. — 206 pp. — (FAO Fertilizer and Plant Nutrition Bulletin, 19).ISBN: 978-92-5-105981-4. 5. Singh A., Srivastava S., Rathore D., Pant D. (Eds.) Environmental Microbiology and Biotechnology. Volume 1: Biovalorization of Solid Wastes and Wastewater Treatment // Springer, 2020. — 379 p. — ISBN 978-981-15-6020-0. 6. Rakshit Amitava, Meena S.V., Parihar M., Singh H.B., Singh A.K. (eds.) Biofertilizers. Volume 1: Advances in Bio-inoculants// Woodhead Publishing, 2021. — 401 p. — (Woodhead Publishing Series in Food Science, Technology and Nutrition). — ISBN 978-0-12-821667-5. 7. Ul-Islam Shahid, Shalla A.H., Khan S.A. (eds.) Handbook of Biomass Valorization for Industrial Applications// John Wiley & Sons, 2022. — 1573 p. — ISBN 978-1-119-81881-6.
Recommended Reading	8. Panesar P.S., Marwaha S.S. (Eds.) Biotechnology in Agriculture and Food Processing: Opportunities and Challenges// CRC Press, 2013. — 637 p. 9. Saxena S. Applied Microbiology// Springer India, 2015. — 190 p. биопестициды и биоудобрения 10. Ahmad Fiaz, Sultan Muhammad (eds.) Technology in Agriculture // ITexLi, 2021. — 504 p. 11. Radhakrishnan Ramalingam (ed.) Mycorrhizal Fungi: Utilization in Agriculture and Industry// ITexLi, 2021. — 125 p. 12. Harzevili F.D., Chen H. (Eds.) Microbial Biotechnology: Progress and Trends // CRC Press, 2014. - 381 p.
Internet resources	http://abkaz.kz/biopreparaty-v-selskom-xozyajstve/ https://youtu.be/iTj6D2VJtE4 https://youtu.be/Mktxmj41cR8 https://youtu.be/pX_oPJZSWt8 https://youtu.be/qezmIV_66bE https://youtu.be/Qs8D6pWHyx8 https://youtu.be/QZ9S5HvfpmA https://youtu.be/sZrQlFBzpdM https://youtu.be/unTsu6S1Eew https://youtu.be/xuwV3ywCxW8

Course quality monitoring
1. Syllabus feedback from internal and external peer-reviewers.
2. Feedback from masters who attend the course.
3. Masters’ performance in the course.

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Cellular engineering of plants	
Field (if relevant)	7M05 Natural sciences, mathematics and statistics
Specializations	7M05102 Biotechnology
Form of delivery	Full-time
Core/Elective	Elective course
Course prerequisites (if relevant)	Objects of Biotechnology, Introduction to Biotechnology, Plant biotechnology
Semester of the course	Year 2, Semester 1
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)
Course language	English

Course Developers	Toraighyrov University Pavlodar (Kazakhstan)

Course summary

The course provides an advanced and comprehensive understanding of the principles, techniques, and applications of plant biotechnology.
The course covers topics including genetic engineering, tissue culture, plant transformation, molecular breeding, and the use of advanced molecular techniques in plant research. Students will also develop proficiency in plant tissue culture techniques, including callus induction, somatic embryogenesis, and micropropagation.
Students will learn to analyze and interpret data derived from plant biotechnology experiments and effectively communicate their findings through oral presentations and written reports, papers.

The course, taught in English, employs Content and Language Integrated Learning (CLIL) and English Medium Instruction (EMI) methodology intended for integrated learning of both content and language. The course has been developed within the international Erasmus+ project "Project Erasmus+ 609563-EPP-1 -2019-1-DE-EPPKA2-CBHEJP 'lnternationalizing Master Programmes in Agriculture via English Medium instruction (IMPROvE _AGRO)"

Key terms and notions

chromosomal variations; callus genesis; rhizogenesis; recombinant DNA; replication; immobilization; secondary metabolites; suspension cultures; isolated protoplasts; somatic hybridization; QTL mapping.

Course aim

The aim of the course is to provide an advanced and in-depth understanding of the principles, techniques, and applications of plant biotechnology. By the end of the course, master students should have developed an in-depth knowledge of the interdisciplinary nature of plant biotechnology and its potential for addressing agricultural, environmental, and societal challenges. They should also possess the ability to design and execute advanced experiments, analyze and interpret data, and effectively communicate scientific findings related to plant biotechnology.

Competencies

General competencies	-get acquainted with modern tools and methods of molecular genetics, for genetic engineering of agricultural plants; -use genomic and cellular technologies, micropropagation, and cell selection of plants; - develop self-motivation, collaborative learning, problem-solving, self-directed and independent learning skills;

	- plan and conduct research, and report results, according to academic standards; - study the literature sources and write in English.
Professional competencies	-carry out field and laboratory biological research in solving specific problems in agricultural biotechnology in an appropriate manner; -use of modern tools and methods of molecular genetics, for genetic engineering of agricultural plants according to certain practical needs; -use genomic and cellular technologies, micropropagation, and cell selection of plants, according to certain practical needs; -select and apply modern methods in plant breeding and crop production, processing industry and other fields of agriculture, under real conditions.
Learning outcomes	
By the end of this course, students will be able to	
LO1	Apply theoretical and practical knowledge of the principles of cellular engineering of plants to solve educational, practical, and professional tasks in plant biotechnology
LO2	Analyze the achievements of modern biotechnology to find ways to increase the reproduction rate of plants
LO3	Apply various tissue culture techniques, including explant selection and preparation, sterilization procedures, media preparation, callus induction, somatic embryogenesis, organogenesis, and micropropagation
LO4	Employ techniques such as protoplast fusion, somatic hybridization, and genetic transformation to introduce desired genes into plant cells and tissues
LO5	Apply methods of scientific research and academic writing in English when performing experimental work

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**Asynchronous**	**Synchronous**	**Independent work**	**Asynchronous theoretical component**	**Synchronous practical component**	**Module Learning Outcomes**
Module 1/Unit Methods of cultivation of cells, tissues and organs of plants						
1. History and development prospects of the method of cultivation of cells, tissues and organs of plants	2	3	3	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	discuss the history and development prospects of the method of cultivation of cells, tissues, and organs of plants, in the class	Describe the history and perspectives of the cultivation method of cells, tissues and organs of plants
2. Callusogenesis. Morphophysiological and genetic characteristics of callus tissue	3	3	3	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Perform a laboratory work. Preparation of explants. Students should properly prepare and sterilize explants to avoid contamination. Students should conduct an experiment on the induction of callus formation from explants. They should choose optimal cultivation conditions such as nutrient medium composition, growth regulator concentration, and lighting. Students should record and evaluate morphological changes in explants over time. Students should analyse the morphophysiological characteristics of the resulting callus tissue. They should evaluate the colour, texture, shape, and size of the callus. Students should also examine the growth and development of the callus tissue compared to the original explants.	Examine and describe the morpho-physiological and genetic characteristics of callus tissue formation.
3. Methods and conditions of cultivation of plant cells *in vitro*	3	3	3	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Perform a laboratory work on in vitro cultivation of plant cells. Students should choose a specific type of plant and specific cells to cultivate. Students should determine the optimal conditions and methods for that plant species. They should carefully record	Apply the methods and conditions for the cultivation of plant cells *in vitro*

					their observations and results and analyse the effectiveness of the experiment.	
4. Phytohormones. Hormonal regulation of morphogenesis in cell and tissue culture in vitro.	4	6	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Show case studies or examples on the successful application of phytohormones in cell and tissue culture in vitro. Discuss the practical considerations, such as dosage, timing, and interactions with other factors, in using phytohormones for specific purposes. Encourage participants to critically analyze the potential impacts and challenges associated with the use of phytohormones in crop production.	Explain the role of phytohormones in regulating morphogenesis in cell and tissue culture in vitro
5. Use of plant cells for Biopharmaceutical Active Substances (BAS) production	4	6	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Show case studies or examples on successful applications of plant cell-based bio-production for BAS. Discuss specific biopharmaceutical products derived from plant cell cultures and their significance in medical or industrial applications. Encourage participants to critically analyze the potential impact and future prospects of plant cell-based bioproduction in the biopharmaceutical industry.	Explain in English the utilization of plant cells for the production of BAS
Total hours for Unit/module 1	Topics: 5 Asynchronous: 16 Synchronous: 21 Independent work: 21					
Module 2/Unit Cell and genetic engineering techniques in plant biotechnology						
6. Cellular plant breeding. Somatic hybridization	4	6	6	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Describe the main stages of the process of somatic hybridization. Examine examples of the application of somatic hybridization in modern agriculture and crop production. Conduct research and present examples of plants obtained through somatic hybridization, which are of practical importance or economic importance.	List the principles and techniques of somatic hybridization in cellular plant breeding

7. Plant Genetic Engineering	6	6	4	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Discuss the challenges and considerations in plant genetic engineering, such as gene stability, gene expression, and potential environmental impacts. Facilitate a discussion on the potential applications and benefits of plant genetic engineering in crop improvement, such as pest resistance, disease tolerance, and enhanced nutritional content.	Name the principles and techniques of plant genetic engineering and its applications in crop improvement
8. Tissue culture methods for the clonal propagation and genetic improvement	4	6	4	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Discuss the visual changes observed in the cultured plant material, such as shoot proliferation, root formation, and overall plantlet development. Facilitate a discussion on the factors influencing successful tissue culture, such as culture media, explant types, and environmental conditions.	List the principles and techniques of tissue culture methods for clonal propagation and genetic improvement
9. Molecular methods in crop production	5	6	5	Recorded video lectures, literature, a short description of the lecture, video conferencing, virtual classrooms.	Discuss the interpretation of molecular data, such as banding patterns, DNA sequences, or allele frequencies. Facilitate a discussion on the accuracy, reliability, and reproducibility of molecular methods in crop production.	List the principles and applications of molecular methods in crop production
Total hours for Module/Unit 2	Topics: 4 Asynchronous: 19 Synchronous: 24 Independent work:19					
Total hours for the course	**Modules: 2** **Topics: 9** **Asynchronous: 35** **Synchronous: 45** **Independent work:40**					

	Course learning outcomes	Learning types and teaching methods	Assessment methods
LO1	Apply theoretical and practical knowledge of the principles of cellular engineering of plants to solve educational, practical, and professional tasks in plant biotechnology	Research the existing literature concerning the application of cellular engineering in plant biotechnology. They should review research articles, reports, and publications to gain an understanding of the various principles and methods used in this field. Students should prepare a literature review, draw conclusions, and identify the most promising areas of research.	Write a literature review
LO2	Analyze the achievements of modern biotechnology to find ways to increase the reproduction rate of plants	Research and analyze existing literature related to advances in biotechnology aimed at increasing the rate of plant propagation. Students should review research articles, reviews, and other publications related to this topic. They should identify various methods and approaches used to accelerate plant propagation, such as in vitro culture, shoot stimulation, micropropagation, etc.	Write an essay
LO3	Apply various tissue culture techniques, including explant selection and preparation, sterilization procedures, media preparation, callus induction, somatic embryogenesis, organogenesis, and micropropagation	Experiment on tissue culture using selected plant explants. Students will select a specific plant material and determine the appropriate tissue culture methods for that material. They should consider sterilization procedures, optimal incubation conditions, media composition, and length of cultivation. Students should evaluate the effectiveness of each method and the results obtained, and analyze possible factors affecting the success of tissue culture.	Laboratory work.
LO4	Employ techniques such as protoplast fusion, somatic hybridization, and genetic transformation to introduce desired genes into plant cells and tissues	Create a presentation in which students describe the methods of protoplast fusion and somatic hybridization. Students can explain the principles of each method, the procedures and tools used in the experiment, and present examples of successful hybridization. They can also discuss the advantages and limitations of each method and its application in plant biotechnology practice.	Defense of individual students' presentations.
LO5	Apply methods of scientific research and academic writing in English when performing experimental work	Students must analyze and synthesize research, identify the most relevant theories and results, and highlight problems that require further research. Students should present their findings as a scientific academic writing in English.	A review of the scientific literature in English on the chosen research topic.

Assessment scale			
Assessment scale	Mark on the scale of the higher education institution		
	90 – 100	A	passed
	80 – 89	B	
	70 – 79	C	
	60 – 69	D	
	50 – 59	E	
	0-49	F	failed

Equipment, digital tools, and educational technologies for the course
Internet, smart board and the manuals developed within the IMPROvE _AGRO project. Chemicals, 1 L flasks or beakers, friction-fit jars for storing master batch solutions (1L, 100L), measuring jars (20-50L), and measuring pipettes (10-1l), 1L and 100ml jars, 20-50ml jars, 10ml and 1ml pipettes, technical scales, electric stove, autoclave, laminar box.

Books and resources recommended for this course	
Essential Reading	1. Sharif Hossain A.B.M.. Plant Physiology and Biotechnology: Fundamental and Applied Research : OmniScriptum Publishing KS. – 2014. – 612 p. 2 Protocols for In Vitro Propagation of Ornamental Plants. Edited by S. Mohan Jain and Sergio 10 J. Ochatt. 2010. - Humana Press. Springer New York.- 400 c. 3. Hajare S.and Genene B. Tura. Principles of Plant Biotechnology : OmniScriptum Publishing KS.- 2016. - 168 p. 4 Vázquez-Flota Plant cell culture / edited by Victor M. Loyola-Vargas and Felipe Vázquez-Flota. – 2nd. ed. Totowa, New Jersey.- 2006. - 388 p 5 Nicholl, D. An Introduction to Genetic Engineering (4th ed.). Cambridge: Cambridge University Press.– 2023. - 466 p.
Recommended Reading	1 Bhojwani S. S., Dantu P. K. Plant Tissue Culture. Springer . New Delhi.- 2013.- 318 p. 2 Chen, Tony & Li, P. (2018). Cryopreservation of Plant Cells and Organs. 10.1201/9781351074186-11. 3 Loyola-Vargas and Felipe Vázquez-Flota. Plant Cell Culture Protocols. Second Edition. Edited by Victor M. Loyola-Vargas and Felipe – 2nd. ed. Totowa, New Jersey. - 2006. - 388 p. 4 Seitz, U. & Banspach, D. & Göldner, E. & Reinhard, E.. (1990). Cryopreservation of Plant Cell Cultures. 10.1007/978-94-009-0587-0_28. 5 Smetanska I. Production of Secondary Metabolites Using Plant Cell Cultures. Advances in biochemical engineering/biotechnology. 111. – 2008. C. 187-228.

Internet resources	https://biocyclopedia.com/index/plant_pathways/cell_culture_and_metabolite_production.php https://www.intechopen.com/chapters/60723 https://www.researchgate.net/publication/345518795_Cryopreservation_of_Plant_Cells_and_Organshttps://www.youtube.com/watch?v=A6EX2zUqemA https://youtu.be/0SylARrhEZY https://youtu.be/16OBgsGo1fM https://youtu.be/6NIOjgHxQo0 https://youtu.be/7rI-Lyftpd0 https://youtu.be/8xxfjaURos4 https://youtu.be/9VHO-uiiwp8 https://youtu.be/bGF1h36zyFQ https://youtu.be/cD9CFtpLL2s https://youtu.be/cZLMq8ccSGs https://youtu.be/D3fYFh41MM0 https://youtu.be/D5aEKiez_nw https://youtu.be/dFrx-t5J0PA https://youtu.be/eG_RfZLkeQA https://youtu.be/F8PU2GTJwwg https://youtu.be/iTj6D2VJtE4 https://youtu.be/Mktxmj41cR8 https://youtu.be/pX_oPJZSWt8 https://youtu.be/qezmIV_66bE https://youtu.be/Qs8D6pWHyx8 https://youtu.be/QZ9S5HvfpmA https://youtu.be/sZrQlFBzpdM https://youtu.be/unTsu6S1Eew https://youtu.be/xuwV3ywCxW8 https://youtu.be/yesNHd9h8k0

Course quality monitoring

1. Syllabus feedback from internal and external peer-reviewers.
2. Feedback from students who attend the course.
3. Students' performance in the course.

SUSTAINABILITY ISSUES IN AGRICULTURE AND FOOD PRODUCTION	
Field (if relevant)	
Specializations	Biotechnology
Form of delivery	Mixed with online and classroom
Core/Elective	Introductory course
Course prerequisites (if relevant)	None
Semester of the course	I
Credit value	4 ECTS (120h)
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)

Course language	English
Course Developers	Aristotle University Thessaloniki, Toraighyrov University Pavlodar

Course summary

This in an introductory and comprehensive course focusing on specific topics related to sustainable agriculture and food production.

This course equips students with the knowledge and skills needed to promote and implement sustainable practices in the agriculture and food production sectors, contributing to a more environmentally friendly and socially responsible food system.

This course introduces students into global food security challenges, environmental impacts of agriculture, climate change and food security (SDGs) by providing the appropriate theoritical and also practical background.

The course, is taught in English, employs Content and Language Integrated Learning (CLIL) and English Medium Instruction (EMI) methodology intended for integrated learning of both content and language. The course has been developed within the international Erasmus+ project "Project Erasmus+ 609563-EPP-1 -2019-1-DE-EPPKA2-CBHEJP 'Internationalizing Master Programmes in Agriculture via English Medium instruction (IMPROvE _AGRO)"

Key terms and notions

Sustainable Development, Food security, climate impacts in agriculture, water depletion, soil erosion

Course aim

The aim of the course is to prepare students to contribute to the development and implementation of sustainable solutions in food production, recognizing the importance of balancing economic viability, environmental responsibility, and social equity. Additionally, students will understand the complex and interconnected nature of sustainability issues in agriculture and food production.

Competencies

General competencies	Carry out field work, process results. Write research proposal, report, draw conclusions, in English. Work in teams Apply ethics, logical thinking, computer skills
Professional competencies	Select topics of research, develop methodologies, and make decisions based on scientifically grounded conclusions. Review, compare, and consult other researchers' research materials.
Learning outcomes	
By the end of this course, students will be able to	
LO1	Discuss the global challenges and complexities of sustanable agriculture, food production and consumption
LO2	Assess the impact of climate change on sustainable agriculture, food security and adaptation strategies.
LO3	Examine the role of technology, innovation, and biotechnology in sustainable agriculture and food production.
LO4	Engage in practical exercises and projects focused on sustainable agriculture and food systems.

LO5	Present critical thinking and problem-solving skills for real-world agriculture and environmental challenges.

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**asynchronous**	**Synchronous**	**Indepth work**	**Asynchronous. theoretical component**	**Synchronous Practical component**	**Module/Unit Learning Outcomes**
Module 1: Introduction to Sustainability issues in agriculture and food production						
• Global food security challenges	2	3	5	Reports and web links from international organizations (FAO, EU etc.) concerning the: Significance of water and agriculture on food security Interconnection of environment, economy and society in food security & the role of sustainable resource management.	Explain the role of environment in development and food security.	• Interdisciplinary thinking by exploring the connections between food security, economics, environmental science, and social sciences. • Promote a holistic understanding of food security challenges.
• Sustainable development goals related to agriculture, food and the environment	2	3	5	Reading Assignments: Assign students relevant articles, reports, and research papers covering the challenges to resource sustainability in agriculture.	Discuss the details of the relevant SDGs and their global impacts	Identify and describe major challenges and threats related to relevant SDGs.
• Analyse the governance	2	3	5	Reports on food system activities to drive	Discuss the importance of behavior change in relation to	• Promote a holistic understanding of food security challenges.

mechanisms among diverse stakeholders of the food system.				stakeholders' behavior Online fórums	governance issues	
• Total for Module 1/Unit 1	Topics 3 Asynchronous: 6 Synchronous: 9 Independent work: 30					
Module 2: Environmental Impacts of Agriculture						
• Water pollution and depletion	2	3	5	Reading Assignments: Assign students relevant articles, reports, and research papers covering the challenges to resource sustainability in agriculture. Presentations and Video Lectures on: Water Scarcity in Agriculture Climate Change and Agriculture	Use a virtual simulation to demonstrate the challenges of water scarcity in agriculture. Discuss strategies for efficient water use and irrigation techniques. Discuss the impacts of climate change on agriculture and strategies for adaptation.	Assess the surface and groundwater quality and risks according to relevant indicators. Assess the impact of water scarcity in agriculture and food production.
• Soil erosion and degradation	2	3	5	Presentations and Video Lectures on: Soil Erosion and Degradation	Discussion of reforestation strategies and the importance of sustainable vegetation management	Assess soil erosion risk. Select and apply soil erosion control methods
•	Topics: 2 Asynchronous: 4					

	Synchronous: 6 Independent work: 15					
Module 3: Climate Change and Food Security						
• Impact of climate change on crop yields	2	3	5	Videos and reports on droughts, floods and heatwaves and their impact to crop yields	Discussion on the environmental, social, and economic impact of climate change. Group discussions of the effectiveness of adaptation and mitigation strategies,	Describe the climate crisis and its impact on agriculture and forestry. Assess vulnerability and risks from climate change.
• Climate-smart agriculture and adaptation strategies	2	3	5	Reports and presentations on: Climate Adaptation Strategies Sensor technologies in precision agriculture	Presentation of water-saving technologies and digitalizing water irrigation systems to achieve more efficient use of land and water resources and increasing land fertility.	Evaluate future challenges and scenarios related to climate change and propose “smart” technologies
•	Topics: 2 Asynchronous: 4 Synchronous: 6 Independent work: 15					
Module 4: Practical Applications and Case Studies						
• Group projects on designing sustainable food systems	2	3	5	Best practices Bad practices	Discussion on sustainable food systems and field visits	Identify best practices and bad practices
• Analyzing real-world examples	2	3	5	Best practices Examples from “water	Discussion on transboundary water problems related to food	Explain the challenges of food systems and food security in transboundary catchments.

of successful sustainable food initiatives				diplomacy" for countries which have transboundary river basins. Food systems frameworks and agreements must reflect transboundary catchments	security	
	Topics: 2 Asynchronous: 4 Synchronous: 6 Independent work: 15					

	Course learning outcomes	Learning types and teaching methods	Assessment methods
LO1	Discuss the global challenges and complexities of sustanable agriculture, food production and consumption	- Video presentations - Literature review - Assignments	Written assignments Papers & Reports
LO2	Assess the impact of climate change on sustainable agriculture, food security and adaptation strategies.	- Video presentations - Literature review - Discussions in groups	Class participation and group discussions
LO3	Examine the role of technology, innovation, and biotechnology in sustainable agriculture and food production.	- Video presentations - Literature review - Assignments	Written assignments Case study analyses

LO4	Engage in practical exercises and projects focused on sustainable agriculture and food systems	- Literature review - Written articles/essay	Class participation and group discussions
LO5	Present critical thinking and problem-solving skills for real-world agriculture and environmental challenges.	- Discussions in groups - Group presentations - Online forums in environmental topics	Written assignments Case study analyses

Assessment scale			
Assessment scale	Mark on the scale of the higher education institution		
	90 – 100	A	Passed
	80 – 89.9	B	
	70 – 79.9	C	
	60 – 69.9	D	Failed
	0-59.9	F	

Equipment, digital tools, and educational technologies for the course
Guided video tours of sustainable food production and projects can provide real-world context for discussion. **Google Classroom** for sharing documents, assignments, and conducting discussions.
Books and resources recommended for this course

Essential Reading	JulesPretty (2008), Agricultural sustainability:concepts, principles and evidence https://royalsocietypublishing.org/doi/full/10.1098/rstb.2007.2163
Recommended Reading	Intergovernmental Panel on Climate Change (IPCC). 2019. *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*. Geneva. United Nations Environment Programme (UNEP). 2016. Food Systems and Natural Resources. A Report of the Working Group on Food Systems of the International Resource Panel. Nairobi, Kenya. OVERVIEW OF MONGOLIA'S WATER RESOURCES SYSTEM AND MANAGEMENT A COUNTRY WATER SECURITY ASSESSMENT JULY 2020, ADB
Internet resources	https://www.unep.org/news-and-stories/story/rethinking-food-systems?gclid=Cj0KCQiAuqKqBhDxARIsAFZELmIbn55CFTZxGS0VQOwXmv3hL_eAqrv40a7zD0DEUrWlLK5R92FblXwaAi2iEALw_wcB S. Young et al. (2023, October 16), *Nature Water Talks: Water and Food* https://cassyni.com/events/FHEVheEyoz6YQPCpzusyid Global crop production data (FAOSTAT; http://www.fao.org/faostat/en/#data/QC) https://www.who.int/westernpacific/news-room/feature-stories/item/mongolia-transforms-food-system-to-ensure-safer-food--increase-

	health-security Asia Development Bank: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.adb.org/sites/default/files/publication/614221/adb-brief-140-making-water-available-mongolia.pdf
Course quality monitoring	
Students' evaluation Questionnaire	