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MODERN PLANT PROTECTION IN AGRICULTURE	
Field (if relevant)	Plant protection
Specializations	Integrated Pest Management for MULS, Plant protection and quarantine for KazNARU, Biotechnology for ToU
Form of delivery	Classroom and online
Core/Elective	core
Course prerequisites (if relevant)	APP320 (bachelor course: Fundamentals of Integrated Pest Management and Biological control)
Semester of the course	flexible
Credit value	4 ECTS
Pass level/grading	D
Course language	English
Course Developers	Mongolian University of Life Sciences; Kazakh National Agrarian Research University; Toraighyrov University Pavlodar

Course summary
This course introduces students to modern trends in the field of crop protection from pests, based on advanced knowledge in the field under study. It covers innovative technologies for diagnosis and plant protection applications, regulatory framework, as well as methods of pest control and decision making, . This course on Integrated Pest Management (IPM) will cover the basics of pests and their dominance in nature, , reasons for their outbreak resulting in crop loss, types of pests, modes of surveillance, sampling methods, and economic damage levels of pests populations. The course also explains the principles and concepts of pest management and different components of IPM: legal, ecological, physical, cultural, mechanical, behavioral, biological, botanical, chemical, and biotechnological approaches. This course also presents the Integration of different IPM tactics, their pros and cons, and the Implementation of AESA - Agroecosystem Analysis in pest management. Lastly, successful IPM cases in Cereals (wheat), Vegetable Crops (Cabbage, Cucumber, Tomato), and Fruit Crops (Sea buckthorn) will be discussed. The course, taught in English, employs Content 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 – 15.01.2024).
Key terms and notions
Key terms: phytophagus arthropods; plant infestation; insects; host specific insects; mites; insect morphology; insect biology; mite morphology; mite biology; mite and insect taxonomy; insect ecology; mite ecology; Key terms: Plant pathology; plant diseases; classification of diseases; etiology plant pathogens; viruses; bacteria; fungi; pest outbreak monitoring ; dynamic changes of pest populations; pest management strategies.
Course aim
This Master's course deals with the management of pests in main crops aligned with the agroecological and plant-originated food systems. Students will learn about the ecological and epidemiological features of plant pests and how to apply innovative and smart tools for their diagnosis, monitoring, and management.
Competencies

General competencies	1. Carry out diagnosis and risk assessment. 2. Be creative and independent 3. Share the knowledge acquired 4. Develop analytical skills 5. Be able to work in teams
Professional competencies	• Analyze agroecosystems and plan sustainable management of pests and diseases • Choose tools for a rapid and timely diagnosis and monitoring of pests affecting crops • Solve farm problems by using diverse methods including farm biodiversity management, cultivars/graft combination choices, phytosanitary measures, pesticides, and biological control practices • Plan and implement IPM programs for the main crops, in different contexts • Organize and manage important preventive measures for pest control, in real situations
Learning outcomes	
By the end of this course, students will be able to	
LO1	Explain the general understanding of the morphology, physiology and anatomy of pests (insects, mites and plant pathogens), in English
LO2	Diagnose plant diseases and insect/mite damages on various crops, through symptoms and signs, using classic and modern techniques
LO3	Apply various methods for pest control
LO4	Explain the IPM principles, advantages and implementation ways, in English
LO5	Define the ways to grow healthy plants and protect yield

LO6	Demonstrate various techniques for pest survey, surveillance, and methods of sampling and identifying various pests.
LO7	Explain how to identify the natural enemies of pests in the field and laboratory and their behavioral characteristic of predators and parasitoids.
LO8	Explain the integrated strategy of pest management technologies for controlling arthropod pests and plant pathogens on various crops, weeds.
LO9	Explain physical barriers used to control the arthropod pests such as traps and plastic covers for weed control.
LO10	Perform pest management through innovative approaches, by using predatory arthropods, parasitoids and microbial pesticides and botanicals.
LO11	Explain the Pros and cons of different IPM techniques and their integration
LO12	Present and discuss successful cases of IPM
LO13	Demonstrate knowledge and competence in using systems of plant protection methods

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**asynchronous**	**synchronous**	**Indep. work**	**Asynchronous. theoretical component**	**Synchronous Practical component**	**Module/Unit Learning Outcomes**
Module/Unit 1 [Major pest groups, identification and control approaches]						
1.Major groups of arthropod plant pests.	2	2	5	Theoretical materials, posters, diagrams on the structure, physiology and classification of arthropod pests	Discuss the most common pests and their habitat, in English	Explain how to use the morphology, anatomy, and physiology of arthropod pests to identify them

2.The nature and occurrence of plant pathogens and diseases.	2	2	5	Theoretical materials, posters, diagrams on symptoms and classification of diseases	Discuss the most common diseases of cultivated crops and their causing pathogens, in your region, in English	Use symptom and sing disease determinants to explain diagnosis procedures.
3. Plant protection methods	2	2	5	Understanding of plant protection methods: plant quarantine, agrotechnical, mechanical, biological, chemical.	Draw up and discuss methods to control harmful pests by example, in English	Apply various plant protection methods
4. Chemical method of plant protection	2	2	5	Understanding about the differences of chemical pesticides and the consequences of their use.	Analyze and discuss chemical pesticides for pest control by example, in English	Explain how to use pesticides properly
5. Plant protection systems	2	2	5	Understanding the principles and factors of optimization of plant protection systems from harmful organisms.	Select and explain a set of protection methods against pests, adapted to the agricultural landscape and economic conditions of production on various agricultural crops (cereals, legumes, vegetables), in English.	Choose among plant protection systems according to individual problems
Total for Module/Unit 1	Topics: 5 Asynchronous: 10 Synchronous: 10 Independent work: 25					
Module/Unit 2 [Agroecosystem analysis in pest management; Pests and their natural enemies monitoring]						
Plant health management using agrotechnological methods and plant nutrition	1	1	3	Understanding how to grow healthy plants healthy in healthy soil\ -using methods such as balanced fertilizing and crop rotation	-discuss the theoretical background of following topics -laboratory work on checking the seed infection and germination rate -seed treatment technique -laboratory work on revealing of soil infection	Estimate and demonstrate the estimation of seed infection and germination rate and apply seed treatments using chemicals, biological and physical methods.
Arthropod monitoring techniques: Survey of arthropod pests on plants and identify the pest status on damaged crops	1	1	3	Methods for observation and recording of arthropod pests on various crops	-review lecture topic -calculate the infestation rate of arthropod pests on leaves or stems -estimate the plant damage	estimate the infestation rate of arthropod pests on various organs of plants for different pests and plant damage

Observing insect natural enemies: Survey techniques for identifying rthropod natural enemies on the plants: Predatory arthropods, parasitoids and microorganisms.	1	1	3	Methods for observation and recording of natural enemies of insect pests on various crops	discuss the theoretical background of following topics -methods of revealing the predatory arthropods \insects and mites\ -methods of revealing the parasitoids on plants	Recognize and identify methods to identify predatory insects and parasitoids in the field
Observation techniques for plant pathogens and diseases on field crops: estimating infection rates by different kinds of pathogens	1	1	3	Methods on observation and recording of plant diseases on various crops	discuss the theoretical background of following topics -methods to diagnose a plant disease -recording infection rate on plants	estimate infection rates of diseases on plants, examples
Modern methods of molecular biology and biotechnology used in plant protection; to diagnose plant disease and identify plant pathogens.	1	1	3	-Molecular biological methods for identification of plant pathogens	-PCR technologies, and other diagnosis techniques	Apply PCR, ELISA test and classic standard procedures to identify pathogens
Methods for recording and forecasting arthropod pests and pathogens \on some key pests\	2	2	3	Understanding the pest forecasting methods	-key pest forecasting on perennial crops -case work on the orthoptera pests	Apply the main preventive measures against main pests.
Outbreak and dynamics of pest populations: plant injury level thresholds	2	2	3	-Pest population changes - Injury level and thresholds of pests	-case work on population changes of insects on cabbage	Explain impacting factors of outbreaks and dynamic changes of lepidoptera pest's population; gypsy moth and others
Module/Unit 3 [Pest management tactics]						
Principles and introduction of Integrated Pest Management into crop fields.	2	2	2	-main principles of IPM -integrating strategy of plant protection methods.	-case work on prevention of plant disease -case work on prevention of pests including arthropod pests, diseases, weeds.	explain the IPM principles and implementation ways

Innovations in the protection technology of agricultural crops for controlling pests: biological and biochemical products and botanical pesticides	2	2	2	-Predatory arthropods application -Parasitoid application -Biological pesticides -Botanical pesticides -biological control agents	-Application on products of biological control of arthropod pests. -Application of products of botanical pesticides for controlling pests -Application on microbial products for controlling plant pathogens	apply innovative technologies to control plant pests
Risk reducing management of chemical pesticide application	2	2	2	How to reduce the chemical pesticides as integrating other methods for controlling pests	Case work on what kind of pesticides are suitable to use with biological control agents	Choose and use botanicals, microbial preparations, pyrethroids or carbamates to control various pests
Total for Module/Unit 2	Topics: 10 Asynchronous: 15 Synchronous:15 Independent work: 27					
Module/Unit 4 Practical lesson; [implementation of Integrated Pest Management (IPM)]						
Plan IPM techniques on greenhouse crop arthropod infestation and diseases \greenhouse cucumber\	2	2	2	-list of cucumber pathogens and diseases, insect pests, and mites	-case work on planning of methods for controlling pests of greenhouse cucumber	Use various pest controlling tools to protect the yield of cucumber from various pests.
Plan IPM technique on greenhouse crop diseases \greenhouse tomato\	1	1	2	-list of tomato pathogens and disease, insect pests,and mites	-case work on planning of methods for controlling pests of greenhouse tomato.	Use various pest controlling tools to protect the yield of tomato from various pests.
Plan IPM technique on open field crop arthropod pests and diseasse \cabbage\	1	1	2	-list of cabbage pathogens and diseases, insect pests and mites	-case work on planning of methods for controlling pests as integrating.	Use various pest controlling tools to protect the yield of cabbage from various pests.
To plan IPM technique on open field crop pests and disease \perennial crops\	1	1	2	-list of perennial crops \sea thorn etc\ disease and insect pests, mites	-case work on planning of methods for controlling pests as integrating.	Use various pest controlling tools to protect the yield of different perennial crops from various pests.
Total for Module/Unit 3	Topics: 4 Asynchronous: 5 Synchronous: 5 Independent work: 8					
Total for the course	**Modules: 4** **Topics: 19** **Asynchronous: 30**					

	Synchronous: 30 **Independent work:60**

	Course learning outcomes	**Learning types and teaching methods**	**Assessment methods**
LO1	Explain the general understanding of the morphology, physiology and anatomy of pests (insects, mites and plant pathogens), in English	-watching videos and dry samples of insects and diseased plants -showing presentations, posters, diagrams	✓ written form (essay) at the end of the semester. ✓ Quizzes (after completing each module.)
LO2	Diagnose plant diseases and insect/mite damages on various crops, through symptoms and signs, using classic and modern techniques	-examining live and dry diseased samples of plants infected with various pathogens -showing presentations, posters, diagrams	✓ written form (essay) at the end of the semester. ✓ Quizzes (after completing each module.)
LO3	Apply various methods for pest control	-theoretical lecture materials -watch videos	✓ written form (essay) at the end of the semester. ✓ Quizzes (after completing each module.) ✓
LO4	Explain the IPM principles, advantages and implementation ways, in English	-showing presentations, posters, diagrams -case work	✓ written form (essay) at the end of the semester. ✓ Quizzes (after completing each module.) ✓
LO5	Define the ways to grow healthy plants and protect yield	-showing presentations, posters, diagrams -laboratory work	✓ written form (essay) at the end of the semester. ✓ Quizzes (after completing each module.) ✓
LO6	Demonstrate various techniques for pest survey, surveillance, and methods of sampling and identifying various pests.	-showing presentations, posters, diagrams -field work	✓ PP talk ✓ written form (test)

LO7	Explain how to identify the natural enemies of pests in the field and laboratory and their behavioral characteristic of predators and parasitoids.	-showing presentations, posters, diagrams -laboratory and field practice	✓ Presentations in English in front of classmates ✓ Demonstrate a identifying knowledge as working on dry insect samples in the laboratory.
LO8	Explain the integrated strategy of pest management technologies for controlling arthropod pests and plant pathogens on various crops, weeds.	-showing presentations, posters, diagram -laboratory and field practice	✓ Presentations in English in front of classmates ✓ oral exam
LO9	Explain about physical barriers to control the arthropod pests such as traps and plastic covers for weed control.	-showing presentations, posters, diagrams -laboratory and field practice	✓ Presentations in English in front of classmates ✓ oral exam
LO10	Perform pest management through innovative approaches, by using predatory arthropods, parasitoids and microbial pesticides and botanicals.	-showing presentations, posters, diagrams -case study	✓ Presentations in English in front of classmates ✓ oral exam
LO11	Explain the Pros and cons of different IPM techniques and their integration	-showing presentations, posters, diagrams -case study	✓ Presentations in English in front of classmates ✓ oral exam
LO12	Present and discuss successful cases of IPM	-showing presentations, posters, diagrams -case study	✓ Presentations in English in front of classmates ✓ oral exam
LO13	Demonstrate knowledge and competence in using systems of plant protection methods	-showing presentations, posters, diagrams -paper review	✓ Presentations in English in front of classmates ✓ oral exam

Assessment scale				
	Mark on the scale	Mark on the scale		

Assessment scale	of the higher education institution (KazNARU, ToU)	of the higher education institution (MULS)		
	95 – 100	90 – 100	A	passed
	90–94		A-	
	85 – 89		B+	
	80-84	80 – 89.9	B	
	75 – 79		B-	
	70-74		C+	
	65 – 69	70 – 79.9	C	
	60-64		C-	
	55-59		D+	
	50-54	60 – 69.9	D	
	25-49		FX	failed (for KazNARU, ToU)
	0-24	0-59	F	failed for MULS

Equipment, digital tools, and educational technologies for the course
• Classroom: PP and PDF • Online: Google classroom

Books and resources recommended for this course	
Essential Reading	1. Edward B. Radcliffe “Integrated Pest Management” 2. Анн Е. Хажек “ Natural enemies”,2004 3. Man George G. Kennedy, Turner B. Sutton *Emerging Technologies for Integrated Pest Management* 2000, USA 4. Aglave. B. (2018) Handbook of Plant Disease Identification and Management 1st Edition, Boca Raton 619 p. 5. Plant Pathogens & Principles of Plant Pathology ICAR e-Course For B.Sc (Agriculture) and B.Tech (Agriculture) 6. Dr. P. Kishore varma, Principles of plant pathology

	7. Foundations of crop protection, 2019
Recommended Reading	• Agrios, George N. – Plant pathology / George Agrios. — 6th ed., 2023 • Gu Dejiu Huang Zhangxin, Gao Xue Biao"Insect pests and Diseases Management and application of pesticides"2004 • Man George G. Kennedy, Turner B. Sutton Larry P.Pedigo, The science of Entomology, 2010 • Marlin E.Rice ' Entomology and pest management, 2009 • Ch. Chuluunjav, D.Undarmaa 'Agricultural entomology' , 2015 • Ann Hajek 'Natural enemies', 2004
Internet resources	1. https://agrimoon.com/wp-content/uploads/Plant-Pathogens-Principles-of-Plant-Pathology.pdf 2.https://books.google.kz/books?id=rHXME-UkHRQC&printsec=frontcover&dq=bibliogroup:%22Plant+protection%22&hl=ru&sa=X&redir_esc=y#v=onepage&q&f=false 3.https://books.google.kz/books?id=XZPSBQAAQBAJ&printsec=frontcover&dq=bibliogroup:%22Plant+protection%22&hl=ru&sa=X&redir_esc=y#v=onepage&q&f=false 4. https://paperpile.com/s/plant-disease-citation-style/ 5. https://www.ipm.iastate.edu/files/curriculum/05%20Introduction%20to%20Plant%20Pathology_0.pdf
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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Phytosanitary monitoring	
Field (if relevant)	Plant protection
Specializations	Plant quarantine for MULS, Plant protection and quarantine for KazNARU, Biotechnology for ToU
Form of delivery	Classroom and online
Core/Elective	core
Course prerequisites (if relevant)	APP320 (bachelor course: Fundamentals of Integrated Pest Management and Biological control)
Semester of the course	flexible
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)
Course language	English
Course Developers	Mongolian University of Life Sciences. Kazakh National Agrarian Research University

Course summary
This course aims to give a knowledge regarding to spread of quarantine pests, their severity, geographical distribution and preventing tools from their entry and establishment into country or area, and eradication or suppression of plant quarantine measures and keep them in the limited area, through compulsory legislation. 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
Regulated pests; non-regulated pests; plant health; plant quarantine regulation
Course aim
This master course aims to provide students with information about regulations and systems of plant quarantine in a national and international level, provide comprehensive knowledge on preventing from spread of quarantine pests into the country during the international trades.

Competencies	
General competencies	- Proficiency in foreign language skills - Drawing conclusions based on relevant data - Understanding and interpreting of data and other information
Professional competencies	- Achieve the principles of plant health and phytosanitary measures in real situations. - Interpret and comprehend phytosanitary regulations and their implications. - Assess the potential risks and impacts of pests and diseases on plant health. - Evaluate the compliance of phytosanitary operations with regulatory requirements.

Learning outcomes	
By the end of this course, students will be able to	
LO1	Explain the principles and analyze the importance of phytosanitary monitoring
LO2	Apply appropriate monitoring methods and techniques to detect and identify invasive and other pests
LO3	Demonstrate proficiency in conducting visual inspections, surveys and sampling procedures from plants or plant commodities at border.
LO4	Use the international and national regulations on phytosanitary measures and monitoring of quarantine pests.
LO5	Name activities to prevent from spread of plant pests newly, importance of phytosanitary certificates for import and export plant commodities and all regulations relating to quarantine protocols.
LO6	Analyze complex phytosanitary issues, make informed decisions, and develop effective strategies for pest control and prevention.

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**asynchronous**	**synchronous**	**Indep. work**	**Asynchronous. theoretical component**	**Synchronous Practical component**	**Module Learning Outcomes**
Module 1 [Introduction to plant health and quarantine]						

1. Principles of plant health and quarantine	1	2	2	Learn the core concepts of plant health and quarantine. Establishment of international cooperation and coordination in plant health and quarantine.	Describe the International agreements and regulations related to international trade of plant and plant products trade.	Interpret the historical establishment of plant health and quarantine measures and its development stages.
2. International standards for Phytosanitary measures	1	2	2	Informed the phytosanitary principles for the protection of plants that are embodied in the International Plant Protection Convention (IPPC)	Explain the definitions of international standards on phytosanitary measures on international trading plant and plant products.	Define what the International Standards of Phytosanitary Measure are and their objectives, and explain the International Plant Protection Convention (PPC), Regional Plant Protection Organizations (RPPO), World Trade Organization- Sanitary Phytosanitary Agreement (WTO-SPS) and Convention of Biological Diversity (CBD) and certain other agreements and conventions of the International phytosanitary activities.
3. Operation of International and National Plant Protection Organizations	2	4	4	Responsibilities of contracting parties to the IPPC, NPPOs or other responsible authorities, importers and exporters.	Presentation and discussion on the activities of national, regional and international plant protection organizations	Interpret the risk management related to the export, shipment, import and release of biological control agents and other beneficial organisms.
4. The phytosanitary import regulatory system.	2	4	4	Plant quarantine import inspection, Phytosanitary Import Permits and special considerations in importation of some items	case work of general inspection procedures - document verification, - identity checking and phytosanitary verification. - specific inspection procedures of different classes of commodities	Demonstrate knowledge of the specific operational aspects involved in the regulation of Plant Quarantine importations and the proper use of Phytosanitary Import Permits by identifying the samples of quarantine and working case studies with some quarantine pests .
5. Plant quarantine export certification	2	4	4	Presentation of the export Certification Framework, inspection procedure and end point export certification	Revision of topics execution of case work of General Inspection Procedures for Exports and Operating procedures -Methods and procedures	Explain how to ensure that plants, plant products and other regulated articles exported from Mongolia are in conformity with the phytosanitary requirements of the relevant importing country and with international norms.
Total for Module/Unit 1	Topics: 5 Asynchronous: 8 Synchronous: 16 Independent work: 16					
Module 2 [Pest surveillance]						

6.Glossary of Phytosanitary terms	1	2	2	Presentation of terms and their definitions. Explanation of specific meaning of some terms in phytosanitary systems.	Case work of internationally agreed vocabulary associated with the implementation of the IPPC and International Standards Phytosanitary Measures (ISPMs)	Explain the terms and definitions of harmonized internationally agreed vocabulary associated with the implementation of the International Plant Protection Convention and International Standards for Phytosanitary Measures.
7. Guidelines for surveillance	1	2	2	Presentation of the National surveillance systems relate to both general surveillance and specific surveillance.	Explanation of the national surveillance system function and importance. Presentation of the surveillance programmes, and methods of the surveillance (Case work)	Determine the ISPMs №06 guidelines for surveillance, collect the necessary information on pests and the presence or absence of pests in the area or in the host or commodity based on the reliable information obtained
8. Determination of pest status in an area	2	4	4	Presentation of the use of pest records and other information to determine pest status in an area	Explanation of the purpose of pest status determination. Information used to determine and describe the pest status in an area	Assess the present situation based on the pest records and information from current and historical records according to the ISPMs №08 guidelines.
9. Requirements for the establishment of pest free places of production and pest free production sites	2	4	4	Presenting the importance of providing assurance to importing countries that plants, plant products are free from a specific pest or pests.	Definition of the concept of a pest free place of production or pest free production site. -General requirements -Establishment and maintenance -Documentation	Define the ISPMs №10 guidelines and explain the general requirements for the establishment and maintenance of pest-free places of production or pest free production sites for meeting phytosanitary import requirements.
10. Regulated non-quarantine pests: concept and application	2	4	4	Presentation of the regulated non-quarantine pests and identifies their characteristics.	Review on the regulated non-quarantine pests to do case work of comparison between Regulated Non Quarantine Pests (RNQP)s and other Pests	Define the concept of regulated non-quarantine pests and identify their characteristics the according to ISPMs №16 guidelines, and apply the concept in practice, and the relevant elements for regulatory systems.
Total for Module/Unit 2	Topics: 5 Asynchronous: 8 Synchronous: 16 Independent work: 16					
Module 3 [Phytosanitary measures]						
11. The use of integrated measures in a systems approach for pest risk management	2	4	4	Analysis of the purpose and characteristics of systems approaches	Review lectures on the relationship with Pest Risk Analysis (PRA) options and their importance.	Explain the development and evaluation of integrated measures in a systems approach as an option for pest risk management under the relevant international standards designed to

					to do case study on independent and dependent measures.	meet phytosanitary import requirements for plants, plant products and other regulated articles.
12. Notification of non-compliance and emergency action	2	4	4	Analysis of the purpose of Notifications and usage of notification information.	Presentation of a case study on required information for notification	Explain the activities of notification and emergency action to be taken in case of detection of specially regulated pests on imported goods and non-compliance with document requirements.
13. Eradication and Containment	2	4	4	Description of the eradication process and its main activities.	Presentation of a case study on eradication process	Explain how to maintain plant health by the active eradication or control of plant pests when pests are detected in imported material, or a new pest is detected as a replicating population.
14. Hygiene and Precautionary Measures	2	4	4	Description of the handling of plants, plant material, plant products or various kinds of plant pests or pest situations and preventing their unintentional spread and good hygiene practices.	Presentation of a case study on -field crop hygiene -crop hygiene in protected environments	Explain the importance of cropland hygiene and additional hygiene precautions, implementation measures and waste management
Total for Module/Unit 3	Topics: 4 Asynchronous: 8 Synchronous: 16 Independent work: 16					
Total for the course	**Modules:** 3 **Topics:** 14 **Asynchronous:** 24 **Synchronous:** 48 **Independent work:** 48					

	Course learning outcomes	Learning types and teaching methods	Assessment methods

LO1	Explain the principles and analyze the importance of phytosanitary monitoring	- Video presentations - Literature review - Discussions in groups	Written form (essay) at the end of the semester. Quizzes (after completing each module.)
LO2	Apply appropriate monitoring methods and techniques to detect and identify invasive and other pests	- Video presentations - Literature review - Group work	Written form (essay) at the end of the semester.
LO3	Demonstrate proficiency in conducting visual inspections, surveys and sampling procedures from plants or plant commodities at border.	- Video presentations - Literature review	Quizzes (after completing each module.)
LO4	Use the international and national regulations on phytosanitary measures and monitoring of quarantine pests.	- Video presentations - Literature review - Discussions in groups	Written form (essay) at the end of the semester.
LO5	Name activities to prevent from spread of plant pests newly, importance of phytosanitary certificates for import and export plant commodities and all regulations relating to quarantine protocols.	- Video presentations - Project Based Learning - Delivery of group presentation	Quizzes (after completing each module.)
LO6	Analyze complex phytosanitary issues, make informed decisions, and develop effective strategies for pest control and prevention.	- Video presentations - Literature review - Discussions in groups	Written form (essay) at the end of the semester.

Assessment scale				
	Mark on the scale	Mark on the scale		

Assessment scale	of the higher education institution (KazNARU, ToU)	of the higher education institution (MULS)		
	95 – 100	90 – 100	A	passed
	90–94		A-	
	85 – 89		B+	
	80-84	80 – 89.9	B	
	75 – 79		B-	
	70-74		C+	
	65 – 69	70 – 79.9	C	
	60-64		C-	
	55-59		D+	
	50-54	60 – 69.9	D	
	25-49		FX	failed (KazNARU, ToU)
	0-24	0-59	F	failed for MULS

Equipment, digital tools, and educational technologies for the course
● Classroom: PP and PDF ● Online: Google classroom

Books and resources recommended for this course	
Essential Reading	- David L. Ebbels “PRINCIPLES OF PLANT HEALTH AND QUARANTINE” CABI Publishing - “PLANT QUARANTINE PROCEDURES MANUAL” FAO 2014 - International Standards for Phytosanitary Measures (ISPMs) ISPM 1. Phytosanitary principles for the protection of plant and the application of phytosanitary measures in international trade ISPM 3. Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms ISPM 5. Glossary of phytosanitary terms ISPM 6. Surveillance ISPM 8. Determination of pest status in an area ISPM 10. Requirements for the establishment of pest free places of production and pest free production sites

	ISPM 13. Guidelines for the notification of non-compliance and emergency action ISPM 14. The use of integrated measures in a systems approach for pest risk management ISPM 16. Regulated non-quarantine pests: concept and application ISPM 17. Pest reporting ISPM 18. Guidelines for the use of irradiation as a phytosanitary measure ISPM 19. Guidelines on lists of regulated pests
Recommended Reading	- Law on State boundary quarantine control of animals, plants, raw materials and products of animal and plant origin /2002-11-28/ - Phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade, International Plant Protection Convention (IPPC)
Internet resources	- https://www.wto.org/ - https://www.fao.org/home/en/ - https://www.ippc.int/en/ - https://estandard.gov.mn/ - https://caps.gaali.mn/
Course quality monitoring	

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PLANT-MICROBE INTERACTION AND PLANT DEFENSE MECHANISMS AGAINST PHYTOPATHOGENS.	
Field (if relevant)	Agronomy, biotechnology and plant protection
Specializations	Plant protection and quarantine for MULS, biotechnology for TU
Form of delivery	Online and in classroom
Core/Elective	Elective
Course prerequisites (if relevant)	Plant quarantine and risk analysis
Semester of the course	I, II period
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D) / Failed (F)
Course language	English, Mongolian

Course Developers	Mongolian University of Life Sciences.

Course summary

Plants are confronted with pathogens for this reason they have evolved resistance mechanisms. Plants were successful in developing complicated defense mechanisms against pathogen infections during the process of evolution. This course will introduce the main plant resistance mechanisms, their major components and the methods of introducing these mechanisms in plant breeding. Pre-formed or induced structure features and metabolites, hypersensitive response, systemic resistance form the major defense mechanisms in plants. Genes and molecules taking part in these mechanisms will be analyzed. In addition, students will learn how to determine, confirm and apply the results of the above methods at the genetic level.

Key terms and notions

Plant resistance mechanisms; structural aspects of defense; genetics of plant resistance to pathogens; Crosstalk between elicitors and receptors; hypersensitive response; antimicrobial metabolites; Pathogenesis-related proteins; systemic acquired resistance; induced systemic resistance; non-host resistance.

Course aim

This master course aims to provide students with an understanding of complicated plants' defense mechanisms against pathogen infections. It will provide an insight to the mechanisms through which plants resist the infection of pathogens or to establish an effective defense response, and a thorough apprehension of the molecular mechanisms of such interactions that ultimately confer minimization of the impact of the most devastating plant diseases.

The course, taught in English, employs Content 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).

Competencies

General competencies	- Base knowledge of plant resistance mechanisms; - Base knowledge of plant-pathogen cross-talk - Base knowledge of molecular tools to breed for disease resistance - Skill of laboratory work
Professional competencies	- Recognition of plant resistance mechanisms and pathogen organisms interactions in various pathosystems - Selection and use of methods to determine pathogenesis - Unraveling the genetic characteristics of plant pathogenic organisms, to breed plants resistant to them - Using methods of detection of plant pathogen infections by molecular diagnostic tools
Learning outcomes	
By the end of this course, students will be able to	
LO1	Name the different types of plant defense mechanisms.
LO2	Divide plant structural aspects of defense in various categories and explain their function
LO3	Give a definition of antimicrobial metabolites and name their general categories
LO4	Name the types of resistance and respective categories of genes and the tools for gene mapping
LO5	List the major categories of elicitors and receptors in plant-microbe interactions
LO6	Define hypersensitive response and name its major physiological, biochemical and molecular components
LO7	Define systemic resistance in plants and name the major metabolites that play a key role to its expression
LO8	Define antimicrobial proteins and name their general categories

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**asyn chro nous**	**sync hron ous**	**Indep work**	**Asynchronous. theoretical component**	**Synchronous Practical component**	**Module/Unit Learning Outcomes**
Module/Unit 1 [Plant microbe interaction and plant defense mechanisms against pathogens]						
1. Introduction to mechanisms of plant resistance to diseases	4	4	12	Theoretical of plant resistance to diseases	Definition of plant resistance to diseases and type of resistance	Define disease in plants, disease resistance. Describe known resistance types and key components of disease resistance in plants.
2. Structural aspects of defense	2	2	6	Theoretical of structural aspects of defense	Discussion on the plant structural aspects of defense	Describe the structure of plant cell including pre-existing and induced barriers against pathogens. Describe the step-by-step process of enzymatic lysis of plant cells.
3. Antimicrobial metabolites	2	2	6	Theoretical of antimicrobial metabolites	Discussion on the antimicrobial metabolites	Categorize antimicrobial metabolites in chemical groups. Give a broad definition of phytoanticipins and phytoalexins.
4. Genetics of plant resistance to pathogens	4	4	12	Theoretical of genetics of plant resistance to pathogens	Discussion on genetics of plant resistance to pathogens	Name the resistance genes categories; Define horizontal vertical resistance, durable resistance and mechanisms of resistance breaking in the field; Analyze the gene to gene theory Describe the organization of resistance genes on the plant's genome; Define the terms QTLS, genetic mapping, genetic markers, molecular markers, Apply gene mapping techniques like RFLP's, RAPDs, SSR, SNPs etc.
5. Crosstalk between elicitors and receptors	4	4	12	Theoretical of characteristics of crosstalk between elicitors and receptors.	Discussion on crosstalk between elicitors and receptors	Name the major elicitor and receptor categories; Define MAMPS, PAMPS, DAMPS Draw and describe the Danghl and Jones zig-zag model List key reactions of plants upon elicitor reception (plasma membrane depolarization, phosphorylation of proteins, lipid oxidation, salicylic acid accumulation, oxidative burst). Define the function of hpr genes and describe the type-III secretion system in bacteria and its role in resistance reactions in plant.
6. Hypersensitive response	2	2	6	Theoretical of hypersensitive response	Discussion on hypersensitive response	Name the various phases of HR Name the characteristics of cells that undergo HR

						Give a brief description of signal cascade upon HR activation; Analyze the role of ROI, NO and SA in HR Compare the components of HR in plant and PCD in animals. Explain the mechanisms of HR/PCD control in plants and animals (mitochondrial PT and caspases) Connect HR with other plant defense responses.
7. Antimicrobial proteins and Pathogenesis-related proteins	2	2	6	Theoretical of antimicrobial proteins and Pathogenesis-related proteins	Discussion on antimicrobial proteins and Pathogenesis-related proteins	Name the differences between antimicrobial and PR proteins; List the major PR families and their mode of action; Give examples of PR peptide analogy with defense peptides from other organisms (insects, mammals).
8. Mechanisms of pathogenesis	4	4	12	Theoretical of mechanisms of pathogenesis	Discussion on mechanisms of pathogenesis	Describe the host recognition process and name the common pathogen (mainly fungal and bacteria) entry points.
Total for the course	**Modules: 1** **Topics: 8** **Asynchronous: 24** **Synchronous: 24** **Independent work: 72** **Total:120**					

	Course learning outcomes	**Learning types and teaching methods**	**Assessment methods**
LO1	Divide plant structural aspects of defense in various categories and explain their function	- Video presentations - Literature review - Papers review	Class participation and preparation for discussions

		- Discuss at groups	
LO2	Divide plant structural aspects of defense in various categories and explain their function	- Video presentations - Literature review - Papers review - Discuss at groups	Class participation and preparation for discussions
LO3	Give a definition of antimicrobial metabolites and name their general categories	- Figure presentations - Literature review - Quizzes assignments - Presentation	Score of quizzes and assignments
LO4	Name the types of resistance and respective categories of genes and the tools for gene mapping	- Figure presentations - Literature review - Discuss at groups - Quizzes assignments - Presentation	Score of quizzes and assignments, answering questions and make group presentations
LO5	Give a definition of hypersensitive response and name its major physiological, biochemical and molecular components	- Figure presentations - Literature review - Discuss at groups - Quizzes assignments - Presentation	Score of quizzes and assignments, answering questions and make group presentations
LO6	Give a definition of hypersensitive response and name its major physiological, biochemical and molecular components	- Video presentations - Literature review - Discuss at groups - Written articles/essay	Class participation, creative and active contribution to discussions
LO7	Give a definition of systemic resistance in plants and name the major metabolites that play a key role to its expression	- Video presentations - Literature review - Papers review - Discuss at groups - Written articles/essay	Class participation, creative and active contribution to discussions
LO8	Give a definition of antimicrobial proteins and name their general categories	- Video presentations - Literature review - Papers review - Discuss at groups	Quality of answer to questions and group presentations

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	
	0-59	F	failed

Equipment, digital tools, and educational technologies for the course	
Video and audio recordings, Computers, Google Classroom, standards,	
Books and resources recommended for this course	
Essential Reading	- Shabir hussain wani “Disease resistance in crop plants”, 2019 - Vanderplank “Disease resistance in plants”, 1984 - Dan pal singh and Arti singh “Disease and insect resistance in plants”, 2005 - Sambrook J, Russell D.W “Molecular cloning – A laboratory manual” third edition, 2001 - George M.Malacinski “Essentials of Molecular Biology”, 2003 - Gerald keryp “Experiments in Molecular Biology”, 2001 - James D.Watson at all “Molecular Biology of the Gene”, 1993 - Robert J.Slater “Experiments in Molecular Biology” 1996 - J.M.Walker, R.Rapley “Molecular Biology and Biotechnology”, 2002 - Robert Schleif “Genetics and Molecular Biology”, 1993
Recommended Reading	-Scientific publications related to plant-microbe interactions and plant defense mechanisms against pathogens
Internet resources	- Web sites related to plant-microbe interactions and plant defense mechanisms against pathogens

Course quality monitoring
End of the semester, the Office of Academic Affairs of the Graduate School will get the questionnaire from master students.