EDUCATIONAL PLAN

Festetics Doctoral School
Hungarian University of Agriculture and Life Sciences, Georgikon Campus
Keszthely, Deák Ferenc Str. 16, H-8360 HUNGARY

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Contents

Introduction of the Doctoral School and overview of its educational possibilities

According to the reorganizations performed at the fall of 2007, the Keszthely-based Georgikon Faculty of the University of Pannonia had two entities for graduate students: the Animal and Agri-Environmental Doctoral School (ÁADI) and the Plant Production and Horticulture Doctoral School (NKTDI). In their decision - dated on December 12th, 2014, and received in March of 2015 - the Hungarian Accreditation Council (MAB) recommended that the two Doctoral Schools should be merged. This was achieved as detailed below.

The merged inter-disciplinary Festetics Doctoral School (from here FDS) intends to conduct graduate training in the following three disciplines: (i) Animal Production, (ii) Horticulture and Plant Production and (iii) Environmental Sciences. Accordingly, the educational and research program of FDI consists of three broad areas of sciences and can be divided into a number of subprograms. Basic and specialized subjects do vary among the three broad areas, we will provide the list of topics separately. As the compulsory and elective nature of the subjects depends on the research project of the students, thus personal educational plans must be designed in collaboration with the PhD supervisor. Written plans must be submitted to and approved by the Council of the Doctoral School (CDS).

Students are allowed to apply for several projects that are in different disciplines. In case of such multidisciplinary projects, the disciple that takes up the majority of the work, will be indicated in the final certificate of the student.

ANIMAL PRODUCTION SCIENCES

Supervisors working on the animal production field offer a wide variety of subjects from their own area of research for prospective students. Special attention is being paid to environmentally friendly and sustainable practices in animal production and nutrition as well as those basic subjects that help to prepare the students for those courses. The development of such capabilities is becoming more and more important as most intensive animal production technologies tend to exert substantial pressure on the environment. Projects related to sustainable technologies of animal production that offer increased protection for Lake Balaton are given priorities. The Festetics DI (FDI) provides unique opportunities for studies on the environmental relatedness of animal production based on grazing, a subject that is not widely studied in Hungary. Due to the vertical depth of the field, we have opened 12 research areas. The coherence between the research areas is indicated by bold.

Research Area #1: Genetic and environmental effects on animal production

Leader: Péter J. Polgár, CSc

The fact that **genetics and the environment determine the phenotype** together indicates the coherence between the various areas of FDI. Parallel analysis of the genetics of our farm animals and that of the environment during production will allow for the estimation of breeding values that in turn determine exact target of production. In a narrow sense, production of farm animals means the tasks of selection, whereas in wider sense it involves

the processes of keeping and feeding of the animals, as well as the special technologies required to generate the final product. The application of traditional animal breeding of pure lines has undergone substantial changes due to the rapid development of genetic and genomic technologies. The modern methods of biotechnology have been incorporated into the daily routine by many farms.

Parallel analyses of natural animal husbandry, the capacity of the field, and the environmental load will yield solutions for the development of sustainable animal production. This is especially important here in the vicinity of Natural Parks and Lake Balaton, where the protection of natural soils and waters must be kept in mind. The ecological ways of animal husbandry, the production potential and capacity of grazing farm animals, such as cattle, horse and sheep, are among our most important research projects.

Coordination of the selection programs of farm animal lines specialized for meat and milk production, requires continuous development involving frequent grading of the phenotype appropriate for the requirements of lineage and production as well. Analysis of the effects of abiotic and biotic environment on the animal production also points to a number of related areas. The ethological aspects of animal behavior in open and closed systems are essential aspects of animal husbandry. The well-being of the animals must be provided through the incorporation of requirements of animal welfare into the technological developments that in turn results in increased safety of food production and increased quality of products, offering another set of potentially valuable research projects. **Neither and experiment, nor an efficient production technology can be designed without the analyses of the environmental needs of various age groups and their incorporation into the production technologies.**

For animals kept and grown with 'closed technologies' one of the most important environmental factors if their feed. Regulation of the elements of technological systems (e.g., breeding, placement and nutrition) and the planning parameters of the artificial environment will determine the production potential of the individuals and the whole stock. The metabolic background of production processes and their physiological parameters are being analyzed in several projects.

The efficient management of resources will further improve with the incorporation of digitalization and the introduction of technologies involved in 'high precision animal production'. This will likely improve the data safety and informative capabilities of databases of production facilities.

Research Area #2: Nutrition of farm animals

Leader: Károly Dublecz, CSc

There are a number of challenges facing the nutrition of farm animals nowadays, like the effects of climatic change and its effect on the production and quality of feedstuffs, the increasing production volume of biofuels, the constraints due to the reduction of greenhouse gases, the need to improve food quality as well as increased feed and food safety.

In addition, the need to improve the efficiency and sustainability of production also creates challenges both at global and national level. Accordingly, we are focusing on the following areas: **(i) The effects of extreme environmental changes on feed production and feed quality, including the analysis of nutritional value of cereal varieties, resistant to biotic and abiotic stress; Effects of heat stress on the metabolism and nutrition of broiler**

chickens. (ii) Food safety aspects of animal nutrition with special emphasis on the mycotoxin content of feeds. (iii) Nutritional aspects to reduce the ammonia **emission of farmed animals**; (iv) Development of new feeding technologies based on industrial byproducts and **replacement of imported soybean by protein sources produced locally**; (v) Improving the quality of animal products by nutrition (vi) Improving gut health and finding alternatives of antibiotics in animal production, using next generation sequencing (NGS) to get more understandings on the feed and gut microbiota interactions.
The team lead by Prof. Dublecz has been studying various nutritional aspects of pork, poultry, beef cattle, milking cow, horse and fish production. The personal skills and the infrastructure required (laboratories, animal houses, feed mill etc.) for these studies are available at the Department of Animal Nutrition and Nutritional Physiology.

Research Area #3: Applied cell biology

Leader: Szabolcs Tamás Nagy, DSc

The cell analysis laboratory located at the Georgikon Campus is not only uniquely equipped among those in Hungarian universities with agricultural profile, but up-to-date at international level as well. The laboratory is capable of meeting the needs not only of our university, but those of the Middle European region as well.
The main fields of the laboratory are spermatology and stress-physiological, cytological studies. Modern cell analytical infrastructure, such as flow cytometry are precise tools for the analysis of spermato- and spermiogenesis, as well as that of the physiological functions of sperm cells. It can be used for the quality control of sperm samples intended for artificial insemination, the analysis of the chromatin and plasma membrane integrity of sperm cells or the functional status of their mitochondria. A new research area is the adaptation of the so-called 'new generation cytometry', automated data analyses in R-environment to spermatology studies.
In addition to the above, experiments can be performed in the lab in all three research areas of FDS, including **animal production and animal health** (cell cycle studies, udder health analyses, gut microbiome studies), **plant production** (ploidy analyses, genome size estimation, pollen analyses), **food industry** (cell counts of brewer's yeast) and **environmental studies** (water quality, ecotoxicology, soil microbiology).
The lab participates in a number of projects involving other departments of the campus, for instance the rapid, automated analysis of microbial communities, studies on the effect of heat stress on the germ cells of animals with external fertilization, or fast genome size estimation for several animal and plant species.

Research Area #4: Fisheries & aquaculture

Leader: László Orbán, CSc

The Georgikon Campus of MATE is located in the vicinity of Lake Balaton, and this fact makes our research related to native fishes and their environment relevant. Research related to fish biology and aquaculture is often connected to both animal production and environmental sciences. **Factors related to environment, water chemistry and hydrobiology affect not only the fish fauna of natural water bodies, but fish stocks produced in ponds or intensive aquaculture systems. Therefore, in projects related to fisheries and fish**

production one must pay attention to environmental conditions. Even the rapidly spreading advanced intensive aquaculture systems keep raising questions, like increased parasitosis, quality of the effluents from farms, the sustainability of feeding, the level of energy usage, production and storage of quality feeds or the reduction of stress affecting the fish, that can only be answered by integrating these two research fields.
The vicinity of Lake Balaton and the 'ramsari areas' of Little-Balaton, in addition to several hundred smaller water bodies of Western Pannonia makes it our responsibility to analyze the production and environmental aspects of aquaculture together. Moreover, we are the university campus located closest to the Adriatic Sea, teaching both agriculture and environmental sciences.
This research field has been strengthened considerably with the recent formation of the Frontline Fish Genomics Research Group. The modern, high throughput approaches used by their team open up the possibilities for such new approaches that will allow for studying new aspects of the above problems. Members of the team are involved in the education of courses related to aquaculture, thereby assuring rapid transfer of the results achieved to the students.

PLANT PRODUCTION AND HORTICULTURE

The main educational goals of Festetics Doctoral School in these project areas are as follows: (i) understanding the latest achievements of international research; (ii) performing research and applications connected to these results; and (iii) to disseminate this knowledge to the students, rendering them capable of good quality research and publications. Although our Research Areas would be able to function independently, we specifically aim for their cooperation resulting in joint research and applications.

Research Area #5: Crop production, soil fertility and environmental impact of soil management
Leader: Zoltán Tóth, PhD

Biomass production is an important task of crop production. It can be achieved and maximized through the proper management and optimization of ecological systems. Based on the long-term field experiments performed over the past decades, we have several **opportunities to increase the plant and climatic potential and that of the productivity of crop production**, to achieve more stable yields and to improve quality. In this Research Area, we are analyzing: the characteristics of the assimilation system; the process of product formation under different agrotechnical conditions; the connections between primary biomass and product yield; those among production conditions, primary biomass, soil biology and nutritional status of soils; possible replacement of certain agrotechnical conditions; **utilization of agrometeorological data; sustainable agrotechnical methods**; the patterns of soil productivity and other indicators in several decade-long experiments; certain issues of the sustainability of farming systems and soil management; and the interactions between the genotypes of plant species and the agrotechnics.
Soil is the most basic means of production of agriculture. However, its role is far more complex than that due to its ecological functions, including many ecosystem services. It is also part of the biosphere and therefore it also fulfills functions of conversion, filtering and buffering agent. The soil is not separated from other parts of the environment in its production function and as part of the biosphere. As there is a continuous flux of materials and energy among the soil, the surface-based and the subsurface water bodies as well as the atmosphere,

this system must be analyzed as a whole in when aiming for increased efficiency of production or the protection of other parts of the environment. In this Research Area we intend to prepare the students for better understanding of the interactions in the soil-plant-climate system through providing the necessary knowledge and the modern research methods.

Research Area #6: Horticulture
Leader: Zsolt Polgár, CSc

Horticulture is the most colorful and most diverse area of Hungarian agriculture. It involves production of vegetables, fruits, grapes, ornamental plants and medicinal herbs. Its diversity makes it possible for us the efficient utilization of our regional agroecological potential and all research that support this goal. In FDS, we have several decade-long expertise in **potato- and grape breeding, variety maintenance, production of propagation materials** and research on the related **production technologies**. The primary goal of our breeding programs is the collection, maintenance and utilization of genetic resources in order to develop varieties showing increased tolerance against biotic and abiotic stresses with high productivity and quality. The **students participating in the** education **can get acquainted with** the execution research methodology of pathological, nutrient and water utilization tests that are an integral part of the breeding work, the testing the inheritance of these traits and the identification and markering possibilities of the influencing genes. In case of potato, important research directions are the analysis of internal quality, storage physiology and processing and consumption quality of the tubers. Our studies related to production technology development covers the assessment of application of soil- and plant-conditioning agents, agrotechnical factors such as nutrient replenishment, plant density, applied plant protection, in connection to certain yield elements and quality (number, size distribution and consumption quality of tubers). **In our research, we can rely strongly on the utilization of the extremely wide genetic background available in our gene bank collections, which enables the breeding of new varieties that can meet the challenges of the present time** (suitability for organic farming, competitive cultivability, processing industry needs).

Research Area #7: The biology and ecology of plant pests and integrated protection against them
Leader: Gabriella P. Kazinczi, DSc

The protection of cultivated plants is exceptionally important, as the total amount of final products is reduced by an estimated 36% due to the presence of pathogens, pests and weeds. The collection of biological knowledge and development of the methodological arsenal are essential for the environmentally friendly plant protection which is considered to be one of the most important tasks for the sustainable plant production. The two main principles of practical plant protection are: 1) to understand the biology and ecology of pests; and 2) to develop innovative technics and materials for the effective control.
One of the biggest challenges of plant protection in the 21st century is to preserve the safety of agriculture and contribute to the production of high-quality food products. The use of materials expressing their effect within a narrow spectrum, are able to protect the beneficial and neutral living organisms. **Approaches based on biological protection and so-called biopesticides** may allow for reduction of traditional synthetic pesticide use. However, both **deeper knowledge of pathogens, pests and weeds and that of their environment and ecology are believed to be essential** for this process.

The exponentially increasing number of invasive alien species (IAS) creates a considerable challenge for the experts working on plant protection. The appearance of invasive species, regular follow-up of their distribution and assessment of their damage through a national monitoring network are combined with meteorological data to yield a multi-year database that in turn will allow for the development of suitable strategies of protection. **The most successful area of biological plant protection is protection against pests** that is not limited to closed system but can also be applied on the fields nowadays.
FDS has a tradition for successful projects with entomopathogen nematodes. In addition, we also analyze the **effects of traditional pesticides on beneficial and neutral insect species.** Pesticide resistance monitoring and development of alternative methods are also among our priorities.
In the area of herbology, we have developed a **unique collaboration on molecular herbology with colleagues working on Research Area #8.** The most important topics are as follows: (i) **analysis of weeds resistant to herbicides with the tools of molecular biology; (ii) rapid detection of weed biotypes resistant to herbicides**; (iii) **molecular monitoring of the distribution of weed biotypes resistant to herbicides;** and (iv) **comparative analyses of certain invasive weed species (s**ubspecies) (e.g., species and subspecies of the Panicum genus) by tools of molecular genetics. In addition to the conventional biomass production approaches, we also analyze the plant – pest relations and the responses of plants to biotic stress factors with innovative approaches, including biophoton emission as well as combined analyses with platforms of molecular biology and plant physiology, and relate them to their responses given to the abiotic stressors caused by climate change (in collaboration with researchers from the Kaposvár Campus).
One of the possibilities of environmentally friendly plant protection is **selection for lines resistant to certain pathogens**. The analysis of host-parasite connections will lead to the identification of the potential sources of resistance, what in turn might result in selection/based generation of resistant varieties. This may be especially important in case of viral pathogens, where chemical plant protection is lacking. There are a number of joint innovations aiming for the generation of resistant plant lines through selection under the umbrella of FDS.
We have unique projects aiming for the analysis of weed – virus relations, the role of weeds in the virus epidemiological chain as well as the biological decline of weeds due to viral infections. For the identification of viruses in these studies, we employ not only biological, serological and molecular (RT-PCR-based) approaches, but high throughput sequencing platforms that are capable of determining of the metagenome of the whole plant.
In the **environmentally friendly integrated plant protection system**s, the protection strategies must be based on forecasts of pests that are based on physiological and ecological data. No sustainable agriculture production can be achieved without basic and applied research supporting these goals. **Integrated plant protection** must include all types of methods: physical, mechanical, agrotechnical, chemical and biological alike. Application of an environmentally friendly chemical plant protection systems is among the primary goals of sustainable plant protection.

Research Area #8: Plant selection, genetics and agrobiotechnology
Leader: János Taller, PhD

The rapidly developing areas of molecular selection and plant biotechnology are offering new opportunities to compliment traditional selection methods. Research activities aiming to increase genetic diversity in plant selection have been intensified in order to maintain **sustainable development** and **ecological balance**. The main purpose of these research

activities is to provide modern and efficient genetic and biotechnological training both in theoretical and practical areas by building onto the foundation of successful national and international practice for the future experts of plant selection and seed production.
The primary focus of our research is selection-based increase of **tolerance against biotic and abiotic stress** that includes molecular detection of genetic diversity, Marker Assisted Selection, as well as mapping and use of resistance genes in various selection programs.
The societal and economical challenges of our era, the extremely rapid development of genetics and plant selection make the theoretical and practical education at the state-of-the-art level necessary at the universities. Our students are expected to meet these demands and to gain the knowledge necessary for the overview of the field by synthesizing the vast knowledge of genetics, selection, biotechnology and biometry.
In addition to the basic techniques of genetic engineering and plant biotechnology (e.g., PCR, gene cloning, or micropropagation) our students can also become familiar with the practice of DNA library generation, **high throughput sequencing or NGS on an Illumina NextSeq 500 machine, quantitative PCR, microarray technology (Infinium platform)** and genome engineering. These experiences, together with the bioinformatic knowledge necessary will make a substantial contribution to the improvement of the theoretical and practical readiness of our students. As most Hungarian institutions tend to outsource their NGS- and microarray-based needs to companies or labs based abroad, **the use of these 'cutting edge' technologies will have the potential to make major contributions to the international competitiveness of our students** and will help them to keep up with the technological development.

ENVIRONMENTAL SCIENCES

In the broad area of environmental sciences, there are ample possibilities for the analysis of both biotic and abiotic elements that involve all three areas. As living organisms are tightly connected to their environment and cannot be analyzed without considering their surroundings, therefor the connection of the three main areas of FDS cannot be questioned at the level of education either.

Research Area #9: The effect of environmental factors (e.g., temperature, length and spectrum of illumination) onto the development and abiotic stress tolerance of plants

Leader: Gábor Galiba, DSc

Due to their sessile nature, **plants are forced to adapt to their environment**. Perhaps the best example for this process, is the adaptation of herbaceous and woody plants of the Northern hemisphere to the harsh winters. Although the most important component of the several week-long hardening processes is the exposure to non-freezing cold temperatures, the shortening of day length and a change in the light spectrum also affect the level of **frost resistance** significantly. It is possible to increase the frost tolerance of winter wheat and barley only by the modification of the incident light spectrum without applying any additional cold treatment. The main goal of our research is to elucidate whether the modified spectrum affects the metabolism of microbes like cyanobacteria or algae similarly to the higher plants. By the investigation of the responses of organisms from different taxonomic categories, a generally applicable model could be developed to help the interpretation of the underlying

hormonal, transcriptional, and lipidomic changes of modulated light spectrum induced stress tolerance.
Light is one of the most important factors affecting the **ontogenesis of plants** (germination, growth, flowering, fruit development) as it is an essential source of energy. Development is affected by the intensity and wavelength of light, as well as the length of the day too. Plants sense the signal of light through their photoreceptors: phytochromes detect red and far-red light, whereas phototropins and cryptochromes detect blue and ultraviolet light. Sensing initiates a signal transmission process that regulates the expression pattern of many gene sets, resulting changes in growth, biomass production, development, vegetative/reproductive transition and crop yield. These processes can be experimentally manipulated in plant growth chambers equipped by modern LED light sources, because in this case both the light intensity and the spectra could be modulated. Thus, **environmental signals strictly coordinate molecular pathways controlling plant development.** This shows that **meteorological factors studied by environmental sciences do affect the growth, development and productivity of plants.**
By the elucidation of the details of light signaling could led to the application of special illumination programs what will result not only an improved plant productivity but also an improved fruit quality. In summary: the main goal of our research area is to better understand of these connections in order to **promote environmentally conscious crop production.**

Research Area #10: Toxicology
Leader: Péter Budai, PhD

Toxicological studies at FDS are performed in several directions. **Chemicals used to protect plants against pests can cause substantial environmental harm** by threatening the health of living organisms. In our ecotoxicological studies, we study the effects of individual pesticides, their combinations with each other and/or with heavy metals onto bird (chicken, pheasant) embryos developing within the eggs. **When persistent metals, such as Hg, Pb or Cd, are released into the environment**, they can enter the bodies of those animals that have not had direct contact with these metals. These **environmental pollutants can be accumulated** in the body of these animals due to biomagnification. Data collected from bird tissues/organs (e.g., feather, liver, kidney, bone and muscle) are ideal for monitoring the **heavy metal pollution of a biotope**, as birds are at higher levels of the food chain, they collect their food from a larger area, and they tend to occur at large density even at heavily contaminated areas. This is an important area of the **ecotoxicological studies**.
The main purpose for the introduction and application of **alternative toxicological methods** is to replace the widely applied *in vivo* toxicological applications. The current alternative toxicological techniques are based on irritation, and they are unable to replace the *in vivo* methods. In order to make them capable for this, the number of chemicals tested must be increased. Although *in vitro* data for the chemicals used in agriculture are limited, many of these compounds cause irritations, thus their analysis will contribute to a database that will be useful for the authorities in the future.
The third research area deals with **toxicological studies that aim to protect the health of farm animals**. Here, we have the opportunity to study the effects of toxic substances in the feeds by chronic oral toxicity studies in vertebrates.

Research Area #11: Components and effects of abiotic environment
Leader: Angéla Anda, DSc

Projects connected to the elements of abiotic environment, i.e., soil, air and water, can be selected. Water as an abiotic component plays a role in studies of evaporation (Lake Balaton). With the inclusion of **plants and transpiration**, the complex system of nature can be analyzed as whole. **These projects are tightly connected to those of plant production and horticulture**, as transpiration of produced plants is a very important issue. Connections between plants and their environment can be analyzed at several levels, including studies on the effects of global warming by simulation models. With these models, the reactions of crops onto the changes in their environment can also be analyzed. **A good example for the connections between animal production and environmental sciences is the analysis of the effect of grazing animals onto their environment.**

Research Area #12: Living organisms in the agricultural environment
Leader: Előd Kondorosy, CSc

Studies on the most important pests of plants and animals are especially important for agricultural production. They include the biology of various pests, their damage caused and the protection against them. Students can perform faunistic surveys on the fields of various crops. An important goal is the development of new methods of detection and protection that could allow for **substantial reduction of the pesticide load of the environment.**
These methodologies come from an essential part of the area of **protection of agro-environment.** An essential component of basic studies is the clarification of taxonomic issues, this can be done currently in the superfamily of seed bugs (Lygaeoidea).
Multi-level interactions of plants, animals and their environment are analyzed by quantitative ecological models (e.g., food chain networks, turnaround of elements in the environment, gene-to-gene theory, co-existential and co-evolutional phenomena). Accordingly, one of our research projects deals with infra/ and supra-individual diversity, qualitative and quantitative production as well as natural value and vegetation dynamics analyses of wet ecosystems and grasslands.
Taxonomical studies for plant protection from a **link between plant production and horticulture and environmental sciences.** However, they are also tightly linked to studies on animal production as well. The studies on seed bugs target a smaller clade that contains known pests of crops, cotton and ornamental plants. **Our ethnobotanical studies are undoubtedly interdisciplinary, as they analyze the land usage of classical plant and animal production that exists in harmony with nature and environment.**

Research Area #13: Analysis and mapping of factors affecting various functions of soils in order to support the development of strategies for climatic adaptation and damage control
Leader: András Szabolcs Makó, DSc

The most important goal of the water policy of the European Union is to improve the quality of water resources on and below the surface using the available scientific knowledge. These water resources are in close connection with various soil layers saturated with water to a different level. The **hydrophysical properties of soils** (e.g., their absorptive, transporting and holding capabilities for water) are dependent on their section structure and stratification as

well as the chemical, physical, mineralogical and biological properties. These in turn are essential factors for the water resources accessible for agricultural activities, as well as processes leading to soil degradation under extreme circumstances, such as floods and droughts. Therefore, improving our knowledge about the **hydrophysical properties of soils and methods of their quantification and/or estimation** are of increasing importance. This is one of our primary research projects, with special focus on the connection of soil structure and its porosity.

Combined environmental effects that occur on poor soils with degraded physical and biological status during droughts or those that can be experienced with soils saturated with water of poor quality and loaded with contaminants are especially important from the point of view of plant and environmental protection. Global issues with water quality include the increased nitrogen content of inland waters – often due to increased fertilizer use, animal production or irrigation with treated sewage waters – or the increased levels of toxic micropollutants caused by industrial activities. **Contaminations caused by organic liquids** are especially important factors that threaten the quality of soils and their waters. Among them the anthropogenic factors the most dangerous and most toxic ones are the chlorinated hydrocarbons that are used as solvents in the chemical industry. Although **byproducts of the petrol industry** are less pollutive than chlorinated hydrocarbons, due their sheer quantity used their risk may exceed those of the former.
Based on the above, there is an increasing need to improve our knowledge about the transport, absorption and transformation processes in soil in order to be able to make the right decisions regarding the prevention of spread of pollutions or **remediation of polluted soils**. **Various computational models** may provide help to identify the most suitable and most economical remediation and monitoring strategies. In our research we are planning to study the interactions of soils and their pollutants, to refine our models of the spreading of pollutants from the point of view of soil analysis and soil physics, and the development of methodologies allowing for the generation of maps for polluted soils at various different resolution.

Research projects offered by the Festetics Doctoral School

Students with an MSc degree can apply for PhD studies by filling and submitting the form that can be either obtained in person from the representative of the Doctoral and Habilitation Center at Georgikon Campus (Ms. Mercédesz Budai-Koncz) or downloaded as a soft copy from the website of the Hungarian University of Agriculture and Life Sciences (from here MATE). The supplement of the form contains the list of those documents that must be attached to the application. The Doctoral Rules of MATE describe the conditions of acceptance as well as the evaluation criteria (suitability, scientific achievements, grade of Thesis, etc.).

https://uni-mate.hu/hu/kepzesek/doktori-kepzes

The actual project offers can be found in the database of the National Doctoral Council (ODT).

Model curriculum with the requirement of FDI

The research and educational plan of accepted graduate students will be put together on an individual basis by keeping the specific needs of the students in mind. The supervisor of the student and the head of FDI will submit the program together to the Council of FDI at the beginning of the training. The Council will evaluate the program and will decide on acceptance. In addition to the compulsory courses required by FDI, students are allowed to obtain credits from elective courses offered by FDI or any other doctoral school in the country. Subsequent modification of the program, if any, is subject of the approval the Council of FDI.

Our model curriculum was put together based on two government decrees: one that deals with higher education (CCIV/2011) and the other that deals with doctoral schools, the process of doctoral processes and habilitation (387/2012.; XII. 19.). It describes a potential progress of development broken down into annual portions.

Trainings that started prior to September 1st, 2016

The model curriculum contains the maximum of 180 credits that can be obtained from the three different areas (i.e., education, teaching and research) broken down annually.
Students are expected to earn 50 educational credit points (*Table 1.*). Teaching credits are not compulsory, and it can be replaced by extra credits earned at the other two areas. Self-funded students are expected to gain 50 educational credits; however, they are not required to attend the lectures. Instead, they can request personal consultation from the teacher responsible for the course. The detailed list of courses can be found at the homepage of FDS.
In addition to the compulsory courses required by FDI, students are allowed to obtain credits from elective courses offered by FDI or any other doctoral school in the country (must be pre-approved by the Council of FDI).

Table 1: Minimal credits earned at FDI

I.	**Studies**	**Year #1**		**Year #2**		**Year #3**		**Sum**
		weekly	**annual**	**weekly**	**annual**	**weekly**	**annual**	
	CREDITS[o]		**28**		**20**		**2**	**50**
	Contact hours	**15**	**210**	**10**	**150**	**1**	**15**	
	Individual work (hours)	**42**	**630**	**30**	**450**	**3**	**45**	
	Total	**56**	**840**	**40**	**600**	**4**	**60**	**1500**
II./a	**Publications**	**Year #1**		**Year #2**		**Year #3**		
	CREDITS	**10**		**16**		**38**		**64**
	Total hours	**300**		**480**		**1140**		**1920**
II./b	**Essays**							
	CREDITS	**7**		**8**		**18***		**33**
	Hours	**210**		**240**		**540**		**990**
III.	**Electives (education[oo]/research)**							
	CREDITS [ooo]	**15**		**16**		**2**		**33**

	Total hours	**450**	**480**	**60**	**990**
IV.	**Sum Total**				
	CREDITS per year	**60**	**60**	**60**	**180**
	Hours per year	**1800**	**1800**	**1800**	**5400**

* Final exam
[o] One contact hour per week earns two credits; 15 weeks per semester
[oo] One-hour educational activity per weeks earns two credits
[ooo] Maximum 45 credits for educational activities

Credits for publications

Type of publication	*Credits*
a) research paper in foreign journal with impact factor	50
b) research paper in foreign, refereed journal[1]	30
Minimally required:	60
c) research paper in native language[2], in peer-reviewed journal	10
Minimally required:	10
d) paper published in full at conference proceeding	10
Minimally required:	10

[1] this can be replaced with a research paper published in a foreign journal with impact factor
[2] foreign students can use a publication in English instead

Graduate students participating in the program will obtain an absolutorium after obtaining 180 credit points and meeting the required scientific milestones. In order to obtain the degree, they must have the required number and quality of publications (at least 80 credits) or be in possession of a letter of acceptance from the Editor of a suitable journal.

Minimal criteria for the absolutorium

Educational activities min. 50 credits
Research activities min. 113 credits
Periodic reports 33 credits
Publication activity min. 64 credits

Teaching activities max. 45 credits

Minimal criteria for the PhD

1. With teaching activities (optional)

Educational activities min. 50 credits
Research activities min. 113 credits
Periodic reports 33 credits
Publication activity min. 80 credits

For teaching min. 17 credits
Grand total min. 180 credits

2. Without teaching activities

Educational activities	**min. 50 credits**
Research activities	**min. 130 credits**
Periodic reports	33 credits
Publication activity	min. 97 credits
Grand total	***min. 180 credits***

Scientific performance of the students is being judged regularly, the process contains (i) annual oral presentations in front of a committee; and (ii) the assessment of published papers. Oral presentations consist of the research data produced by the students during the previous year. In addition to the presentation, the supervisor also confirms the progress of the student at the end of the first semester by signing the progress report. The final presentation contains the progress achieved during the whole three-year period. The committee then reviews the performance of the student and makes the decision on the continuation. In case of an acceptance, the total number of credit points does not depend on the mark received. Should the committee reject the presentation, it should be repeated at a later date.

Each PhD student is required to attend three live PhD defenses per year in person or through the internet. Proofs of attendance will be part of the annual reports. Should the student have less than three proofs of attendance, the committee has the right to reduce her/his credits accordingly. Exemption will only be given in unforeseeable, serious situations (i.e., study period abroad or long-term hospitalization).

In order to meet the conditions of quality assurance, FDI pays close attention to regular publication activities and research papers published in internationally recognized, Tier 1 journals. In order to meet the criteria for publication, the paper must be peer-reviewed by a journal with a long-standing Editorial Board, it must have a Reference List and its Abstract must be in English (in case of papers written in another language). Conference papers cannot be used to replace published papers.

The student must have at least one first-authored paper published on her/his publication list. Lectures without page numbers in Proceedings cannot be claimed as published papers, they can only be considered as Abstracts.

Prior to an Open Defense, the candidate must submit her/his publication list to the Head of FDI. The list must be accompanied by a signed letter from the Supervisor, who declares that the candidate met the criteria for defense. The Council of FDI then discusses the application and makes a decision.

Trainings that started after September 1st, 2016

The research and educational plan of accepted graduate students will be put together on an individual basis by keeping the specific needs of the students in mind by 30th of September as the latest. The Supervisor of the student and the Head of FDI will submit the program together to the Council of FDI at the beginning of the training. The Council will evaluate the program and will make a decision on acceptance. In addition to the compulsory courses

required by FDS, students are allowed to obtain credits from elective courses offered by FDS or any other doctoral school in the country. Subsequent modification of the program, if any, is subject of the approval the Council of FDI.

According to our model curriculum, FDI expects students to earn 50 educational credit points (*Table 2.*). The training contains two periods of two years each. During the first (educational and research period), and during the second (research and dissertation period) a 120 credit points each (i.e., a grand total of 240 credit points) must be earned. *Table 2* shows the number of credit points of three types (educational, reports and publications) for each semester. Whereas credits earned for the reports are fixed in *Table 2*, values indicated for educational and publication credits indicate the required minimum only. Teaching credits are not compulsory and they can be replaced by extra credits earned at the other two areas. Self-funded students are expected to obtain 50 educational credits; however, they are not required to attend the lectures. Instead, they can request personal consultation from the teacher responsible for the course. The detailed list of courses can be found below (*Table 5*).
In addition to the compulsory courses required by FDI, students are allowed to obtain credits from elective courses offered by FDI or any other doctoral school in the country (the latter must be pre-approved by the Council of FDI).

Table 2: Minimal credits to be obtained at FDI

Educational and research period (120 credits; 2 years)					
Semester	I.	II.	III.	IV.	Credits
Education	20	15	10	5	50
Reports	5*	5*	5*	15*	30
Publications	5	5	10	20	40
Total					**120**
Research and Dissertation period (120 credits; 2 years)					
Reports	10*	10*	10*	20*	50
Publications	10	20	20	20	70
Total					**120**
Grand total					**240**

*Written report, plus forum
A maximum of 45 credits can be earned for educational activities.

Credits for publications

Type of publication	***Credits***
a) research paper in foreign journal with impact factor	50
b) research paper in foreign, refereed journal[1]	30
Minimally required:	60
c) research paper in native language[2], in peer-reviewed journal	10
Minimally required:	10
d) paper published in full at conference proceedings	10
Minimally required:	10
e) conference abstract published	5

[1] this can be replaced with a research paper published in a foreign journal with impact factor
[2] foreign students can use a publication in English instead

Scientific performance of the students is being judged regularly, the process contains (i) annual oral presentations in front of a committee (forum); (ii) half-yearly written progress reports signed by the Supervisor; and (iii) the assessment of published papers. Annual oral presentations consist of the most important research data produced by the student during the previous year(s). Prior to the presentation, the Supervisor also confirms the progress of the student by signing the progress report. At the end of the second year, the presentation contains the progress achieved during the whole two-year period. The committee then reviews the performance of the student and makes the decision on the continuation. In case of an acceptance, the total number of credit points does not depend on the mark received. Should the committee reject the presentation, it should be repeated within seven (7) days. In those cases, where the performance lacks essential elements that cannot be rectified within seven days, the student must submit an appeal to the Council of FDI that will make a decision on the case.

Each PhD student is required to attend three live PhD defenses per year in person or through the internet. Proofs of attendance must be presented to the Head of the Committee at the Forum and will be part of the annual reports. Should the student have less than three proofs of attendance, the Committee has the right to reduced her/his credits accordingly. Exemption will only be given in unforeseeable, serious situations (i.e., study period abroad or long-term hospitalization).

After completing the first two-year period, the students must pass a Complex Exam in front of a Committee. The exam consists of two parts: in the first (theoretical part) the knowledge of the student is assessed. During this part, the student is examined on the basis of two subjects (see *Table 3* for details). In the second (dissertation) part, the scientific progress of the student is analyzed. (Please note that the order of the two parts will be reversed at the Doctoral Exam.)

Two months before the proposed date of the Complex Exam, the Supervisor proposes the composition of the Exam Committee in writing to the Council of FDS. Special attention should be paid to the External Examiners, as they will participate in the questioning of PhD student. Before submitting suggestions on External Examiners, the Supervisor should consult them and discuss with them their role in the Exam Committee. The PhD student should contact the Examiners and ask for a consultation on exam topics and recommended literatures. The tasks of Committee members will be listed in the official letter of invitation.

The PhD student is required to send an electronic copy of a one-page summary of her/his research activities, the results achieved and the list of her/his publications to the Secretary of FDI two weeks before the Complex Exam. That summary will then be forwarded to the members of the committee.

Table 3: Courses for the theoretical part of the Complex Exam (*Animal production*, ***Environmental studies*, Plant production and Horticulture**)

Main courses	**Auxiliary courses**
Biological and ecological aspects of animal production	*Methodologies of the research area*
Physiological and biochemical foundation of sustainable animal production	*Methodologies of the research area*
The most important biotic and abiotic elements and processes of the environment	***Methodologies of the research area***

Crop production	**Methodologies of the research area**
Factors affection soil productivity	**Methodologies of the research area**
Horticulture (potato, vegetables, fruits, grapes and ornamental plants; sustainable plant production)	**Methodologies of the research area**
The biology and ecology of pests and resistance against them	**Methodologies of the research area**
Plant selection, genetics, plant biotechnology	**Methodologies of the research area**

During the second part of the Complex Exam, the student describes the background of her/his research field, presents the data collected so far, the plan for publications as well as the timeline for the Thesis and the publications. The presentation must also show the scientific relevance and innovational content of the data, the technological motivation of the research work (if applicable) and the potential applicability of the results.

A Complex Exam is successful (passed), when the majority of the Committee members accept both parts as successful. In case of an unsuccessful exam, the PhD student will be given an opportunity to repeat that part(s) once during the exam period. Should the repeated exam be unsuccessful again, the status of the student ceases to exist on that day. The result of the Complex Exam is not part of the marking of the Doctoral Degree; however, its successful passing is a pre-requisite of the entry of the second period (research and dissertation period).

After passing the Complex Exam, the student earns the right to take part in the second part of the process. The aim of that part is to earn the PhD degree. The minimal condition for obtaining the absolutorium is to earn 110 credit points from publications and 80 credit points from reports. In order to receive the degree, the student must have all her/his papers published or at least accepted by the journal (as proven by an official letter from the Editor addressed to the student or supervisor).

According to the Doctoral Rules of MATE, the student must submit her/his Thesis within three years from the date of the Complex Exam. Under special circumstances, as described by the second paragraph of Nftv. 45. §, the process can be extended by a total of one (1) year according to the rules of the doctoral process. The status of the student can only be suspended for the maximum of two years.

Summary of publication requirements

The minimal requirements for obtaining a PhD degree a student at FDS must have:

- three registered* or at least peer-reviewed** scientific publications out of which one must be in a journal with impact factor;
- one of the above publications must be a first-authored paper in an international journal (in foreign language, typically English);
- a conference lecture or poster that has been published (at least four pages of length).

* Registered journals: Scientific journals listed either by Scopus or by the Agricultural Section of the Hungarian Academy of Sciences (MTA).

** Peer-reviewed publication: A paper that has been published by a journal that (i) has a permanent Editorial Board; (ii) has the submitted manuscripts peer-reviewed by experts of the field; (iii) publishes papers with a full Reference List; and (iv) in case of a Hungarian journal has an English summary.

The detailed list of courses can be found below (*Table 5*). In addition to the compulsory courses required by FDI, students are allowed to obtain credits from elective courses offered by FDI or any other doctoral school in the country (the latter must be pre-approved by the Council of FDI).

PhD students must indicate to the teacher their interest in a particular course to ensure that the course will be advertised. It is the responsibility of the teacher to advertise the course in the Neptun system, however, the teacher has the right under special circumstances to suspend the course. Upon the request of the responsible teacher(s), the courses are introduced into the Neptun system by Edit Simáné Dolányi (Simane.Dolanyi.Edit@uni-mate.hu). Thereafter the process is the same as for graduate education with the exception that the marking here uses three grades (Did not pass, Passed and Passed with Distinction).

Table 5: The courses of FDI with the number of credits and name of responsible teacher

Courses Listed according to the research area of the responsible teacher	**Credits**	**Tantárgyfelelős**
Compulsory for all three research areas		
Data collection and analysis	8	Dr. László Menyhárt
Environmental problems and their solutions in agriculture	8	Dr. Angéla Anda, Dr. Ferenc Husvéth, Dr. Zsolt Polgár
Animal production		
Compulsory courses*		
Molecular genetic methods in animal breeding	8	Dr. István Anton
Animal nutrition	6	Dr. Károly Dublecz
Basics of cell biology	4	Dr. Szabolcs Tamás Nagy, Dr. Péter Szeglet
Phisology of animal production	6	Dr. Ferenc Husvéth
Developmental biology – basics and application in animal production	4	Dr. Szabolcs Tamás Nagy, Dr. Szilárd Bodó
Elective courses		
Physiological basis of environmental adaptation in animals	6	Dr. Ferenc Husvéth
Ornamental fish production	4	Dr. Gábor Beliczky
Environmental aspects of aniumal nutrition	4	Dr. Hedvig Fébel, Dr. László Pál
Nutritional aspects of ecologycal poultry production	4	Dr. Károly Dublecz
Poultry physiology and anatomy	4	Dr. Pál László

Poultry nutrition	6	Dr. Károly Dublecz
Ruminant nutrition	4	Dr. Hedvig Fébel
Genetics of animal breeding	4	Dr. Péter J. Polgár
Bovine production	6	Dr. Bene Szabolcs
Feed and food analytics	4	Dr. László Wágner
Scientific publication	2	Dr. Szabolcs Tamás Nagy
Experimental design	2	Dr. Szabolcs Tamás Nagy
Special methods in aquaculture	6	Dr. Gábor Beliczky
Advanced communication in science	4	Dr. László Orbán, Dr. Szabolcs Tamás Nagy
Environmental Sciences		
Compulsory courses*		
Zoo taxonomy and morphology	6	Dr. Előd Kondorosy
Environmental analytics	4	Dr. László Wágner
General principles of toxicology	4	Dr. Péter Budai
Basics of cell biology	4	Dr. Szabolcs Tamás Nagy, Dr. Péter Szeglet
Molecular basis of abiotic stress tolerance in plants	6	Dr. Gábor Galiba
Processes in the soil-plant-atmosphere system	6	Dr. Angéla Anda
Elective courses		
The basic of plant molecular biotechnology	6	Dr. Gábor Galiba
Alternative methods in toxicology	4	Dr. Péter Budai
Introduction to the 'R' programming language	4	Dr. László Menyhárt
Regulatory Ecotoxicology	4	Dr. István Somlyay
Grasses in Hungary	6	Dr. Judit Bódis
Basic concepts in plant population biology	4	Dr. Judit Bódis
Sedges in Hungary	4	Dr. Judit Bódis
Hyperspectral data processing	6	Dr. József Berke
Interactive presentation	6	Dr. József Berke
Basics of Environmental Risk Assessment	4	Dr. István Sebestyén
Environmental microbiology	4	Dr. Gábor Csitári
Rheology of agricultural materials	4	Dr. Béla Pályi
Poisonings caused by plants and animals	4	Dr. József Lehel
Insect physiology	4	Dr. Zsolt Marczali
Insect ecology	4	Dr. Zsolt Marczali
Feed toxicology	4	Dr. Péter Budai, Dr. Károly Dublecz
Microbiology of soils	4	Dr. Csitári Gábor
Processing information obtained by remote sensing	6	Dr. Berke József
Experimental methods of toxicology	4	Dr. Budai Péter
Visual data processing in the evaluation of experiments	6	Dr. Berke József
The Global Warming	8	Dr. Angela Anda

Plant production and Horticulture		
Compulsory courses*		
Plant growth and development physiology	6	Dr. Kincső Decsi
Production of field crops of higher importance	6	Dr. Sándor Hoffmann
Plant-biotechnology and research methodology I.	6	Dr. János Taller
Infectious genetic information	4	Dr. András Péter Takács
Tillage and soil use in the soil-plant-climate system	4	Dr. Tamás Kismányoky
Elective courses		
Bioethics	2	Dr. Zoltán Alföldi
Environmental Risk Assessment for Genetically Modified (GM) Crops	2	Dr. Zoltán Alföldi
Interactions between the root system and soil	4	Dr. Zoltán Tóth
Physiological basics of environmental effects investigation	6	Dr. Kincső Decsi
Theoretical and practical aspects of resistance breeding	4	Dr. Gyula Vida
Weed biology and ecology	6	Dr. Gabriella Kazinczi
Applied microbiology of soils	4	Dr. Gábor Csitári
Infectious genetic information I-II.	4	Dr. András Péter Takács
Small regulatory RNAs in plants	4	Dr. Éva Várallyay, Dr. Zoltán Havelda
Virus genetics and diagnostics	4	Dr. Éva Várallyay
Soil organic matter management	4	Dr. Sándor Hoffmann
Oranmental dendrology	2	Dr. Éva H. Baracsi
Integrated weed control	4	Dr. Gabriella Kazinczi
Insect ecology	4	Dr. Marczali Zsolt Ferenc
Insect physiology	4	Dr. Marczali Zsolt Ferenc
Oxidants and antioxidants in the stress response	2	Dr. Gábor Kocsy
Pesticide Chemistry	6	Dr. Éva Lehoczky
Physical properties of the three phase soil systems	4	Dr. András Makó
Agrochemicals, food safety and the environment	4	Dr. Erzsébet N. Ihárosi
Modern application technology of pesticides	4	Dr. Erzsébet N. Ihárosi
Mobile genetic elements	2	Dr. Ferenc Olasz
Fundamental biology in crop production: variety and seed management	4	Dr. Anita Lepossa
Seed biology	2	Dr. Anita Lepossa
Modern methods for the physical analysis of water management of soils	2	Dr. Kálmán Rajkai
Theoretical Implications in Nutrient Management and Nutrient Dynamics	4	Dr. Katalin Sárdi
Fertilizer-Soil Interactions	2	Dr. Katalin Sárdi
Methodology in Pot Experiments	4	Dr. Katalin Sárdi
Basic concepts of resistance biology to	2	Dr. András Péter Takács

pathogens I-II.		
Plant-biotechnology and research methodology II.	6	Dr. János Taller
Agro-ecological studies in a controlled environment	4	Dr. Ottó Veisz
Climate change - challenges and possibilities for safe food production	2	Dr. Ottó Veisz

***Students need to earn 10 credits from compulsory courses for each discipline.**

For detailed information on the above courses see Supplement #1.

All students must select two courses: (1) Data collection and analysis; and (2) Environmental problems and their solutions in agriculture. The latter proves the tight link among the three disciplines, as it is managed by one teacher each from the three disciplines (A. Anda – Environmental Sciences; F. Husvéth – Animal production and Zs. Polgár – Plant production). In addition to these two courses, students must select the compulsory courses of their own disciplines, plus 10 elective courses from any of the three disciplines.

The fact that several courses are being taught as a joint effort from teachers from different disciplines (e.g., Feed toxicology – K. Dublecz and P. Budai; Introduction to cell biology – Sz.T. Nagy and P. Szeglet) provides a further proof for the interdisciplinary nature of FDS.

The rest of the credits are being planned by the student and the supervisor and approved by the Council of FDI. Subsequent modification of the list can only be made with the approval of the Council.

In addition to the compulsory courses required by FDI, students are given a chance to obtain credits from elective courses offered by FDI or any other doctoral school in the country or even those obtained during a study trip abroad. However, these must be approved by the Council of FDI.

Conditions for awarding the PhD degree:

- obtaining 240 credit points;
- passing the Complex Exam;
- presenting the required peer-reviewed publications;
- writing summaries using the languages required by FDS;
- defending the Thesis on an open exam.

The degree will be awarded by the Doctoral and Habilitation Council of MATE based on the recommendation of the Council of FDS.

The infrastructure of Festetics Doctoral School

The essential conditions for the training must be provided by the departments, where the supervisors work. Should special needs arise for a project, the Head of Department must certify with his/her signature that the department will be able to meet them.

Departments providing supervisors for the FDI:

Department of Agricultural Engineering
Department of Nutrition and Nutritional Physiology
Department of Applied Fish Biology
Department of Animal Selection
Department of Precisional Animal Breeding and Animal Biotechniques
Department of Sustainable Environment
Department of Environmental Protection
Department of Plant Protection
Department of Plant Physiology and Plant Ecology
Department of Agronomy
Research Center of Crop Production

Official partner institutions:

- Centre for Agricultural Research, Martonvásár

APPENDIX

The Hungarian University of Agriculture and Life Sciences provides a general for PHD students under the following link: https://phd.uni-mate.hu/doctoral-schools/festetics-gy%C3%B6rgy-doctoral-school/introduction

The specific forms to be used for FDI students as well as supervisors were placed on the webpage of the Doctoral School.

Electronic copies of the forms of advertised courses approved by the Council of Festetics DI
(the signed originals can be found among the records of the DI):

Course title: Agrochemicals, food safety and the environment

Course type: compulsory/elective

Prerequisites:-

Responsible lecturer: **Dr. Nádasyné Dr. Iházosi Erzsébet**	**Place of work, position:** MATE retired associate professor

Lessons required: 32	**Examination type**: oral colloquium	**Credit value: 4**

Detailed content of course:

Definition of food safety. Sustainable agriculture and food safety.
Agrochemicals as a source of danger in agriculture.
Classification and characterization of agrochemicals.
Entry of fertilizers to biogeochemical circle and their interaction with the environment.
Consequences of incorrect fertilizer application, nitrate accumulation of plants.
Heavy metal contamination from fertilizers, slurry and sewage.
Characterization of pesticides, causes of pesticide contamination, analysis of pesticide residues.
Persistent pesticides in the soil and water.
Dangers of the oils, plastics, contaminated containers, packaging materials used in agriculture.
Other food safety risks: toxins, poisonous plants, veterinary medicines.
Producer responsibility in food safety: principle the "from farm to fork".

Suggested literature:

Balla, Cs. – Síró, I. (2007): Élelmiszer-biztonság és – minőség I. Alapismeretek. Mezőgazda Kiadó, Budapest.
Bálint, A. (2003): Élelmiszergazdaság, Élelmiszerbiztonság. Szent István Egyetem, Gödöllő.
Loch J.-Nosticzius Á. (2004): Agrokémia és növényvédelmi kémia. Mezőgazda Kiadó, Budapest.
Darvas B.- Székács A. 2006: Mezőgazdasági ökotoxikológia. L'Harmattan Kiadó, Budapest.
Füleky Gy. (szerk.) 1999: Tápanyag-gazdálkodás. Mezőgazda Kiadó, Budapest.
Pálmai O. 2004: Élelmiszerbiztonság- egy új kihívás az agrokemizálás gyakorlatában. Agrofórum, 15. 8. 23-26.
Nádasyné, I.E. 2000: A növények nitrátakkumulációját befolyásoló tényezők. Agrokémia és Talajtan, 49. 1-2. 277-284.

Individual/Personal tasks: written elaboration of a chosen topic

Date: 21.04.2022.

Signature: Head of Doctoral School Dr. Angela Anda Professor	Signature of lecturer: Dr. Nádasyné Dr. Iházosi Erzsébet

Course title: **Agroecological studies in a controlled environment**

Course type: compulsory/**elective**

Prerequisites:
Botany, Genetics

Responsible lecturer:	**Place of work, position:**
Dr. Ottó Veisz	Agricultural Institute, Centre for Agricultural Research, director

Lessons required:	**Examination type**:	**Credit value:** 4
30	report	

Detailed content of course:
The aim of the course is to provide information on the planning and implementation of research under controlled conditions and on the evaluation of the results and their utilisation in practice.

Topics:

- The concept and subject matter of agroecology
- The significance of controlled conditions for research
- Conception and development of the artificial regulation of the plant environment
- The climatic factors that are regulated
- Regulation of soil factors
- Biotron, phytotron, greenhouse
- Climate-controlled plant growth units and phytotrons
- The structure and operation of the Martonvásár Phytotron
- Planning, implementation and evaluation of experiments under controlled conditions
- Use of the phytotron to simulate climate change

Suggested literature:

1. Publications and other literature distributed during the course
2. Plant Environment and its Regulation (Bernáth, J., Tischner, T., Ábrányi, A.)
3. Controlled Environment for Plant Research (Robert Jack Downs)
4. A Growth Chamber Manual (Robert W. Langhans)
5. Agroecology: the Science of Sustainable Agriculture (Altieri Miguel A.)

Individual/Personal tasks:
Literature review related to the research topic; participation in one of the climate change research programmes underway in the Agricultural Institute, Centre for Agricultural Research.

Date:

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Veisz Ottó

Course title: Alternative methods in toxicology

Course type: compulsory/<u>elective</u>

Prerequisites:-

Responsible lecturer:	**Place of work, position:**
Dr. Péter Budai Dr. Rita Szabó	MATE, Georgikon Campus, Department of Plant Protection, associate professor

Lessons required:	**Examination type**:	**Credit value: 4**
30	oral or written exam	

Detailed content of course:

- Introduction, basic terminologies
- Making permanent preparations on the 1-4 day of embryonic development
- Investigation of early teratogenic effects in bird embryos
- Investigation of late teratogenic effects in bird embryos
- Concept and grouping of alternative methods
- In vitro assessment of primary eye irritation
- In vitro assessment of primary skin irritation
- In vitro methods for teratology testing

Suggested literature:

Atterwill, C.K. – Steele, C.E.: In vitro methods in toxicology. Cambridge University Press. Cambridge, 1987.
Salem, H. – Katz, S.A. (eds): Alternative Toxicological Methods. CRC Press. Boca Raton, 2003.
Hayes, A. W. (ed): Principles and Methods of Toxicology. 5th Edition. CRC Press. Boca Raton, 2008.

Individual/Personal tasks:-

Date: 12.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angéla Anda professor	Dr. Péter Budai associate professor

Course title: Animal nutrition		
Course type: compulsory/elective		
Prerequisites:		
Responsible lecturer: Prof. Károly Dublecz	**Place of work, position:** Georgikon Campus Keszthely	
Lessons required: 60 hours	**Examination type**: oral exam	**Credit value:** 6
Detailed content of course: Energy evaluation systems in the nutrition of farm animals, protein and amino acid evaluation systems, Recent challenges and developments of animal nutrition (feed safety, environmental aspects of animal production, nutrition and animal health, animal welfare and its nutritional aspects, using alternative feedstuffs, by-products in animal nutrition, nutrition and product quality		
Suggested literature: Mc'Donald, P., Edwards, R. A., Greenhalgh, J. F D., Morgan, C.A..: Animal nutrition. Pearson Education Limited, Harlow, 2002. Richards, O., K., Church, D.C.: Livestock feeds and feeding. Pearson Education, 2010		
Individual/Personal tasks:		
Date: 22.04.2022		
Signature: Head of Doctoral School Dr. Angela Anda Professor	Signature of lecturer: Dr. Karoly Dublecz professor	

Course title: Applied microbiology of soils

Course type: compulsory/elective
(*Plant production and Horticulture*)

Prerequisites:
-

Responsible lecturer:	**Place of work, position:**	
Dr. Csitári Gábor	MATE, Georgikon Campus, associate professor	
Lessons required:	**Examination type**:	**Credit value: 4**
30	oral exam	

Detailed content of course:

Soil sampling, storage and processing of samples.
Soil organic matter (SOM) content, composition, methods for determining SOM fractions. Relationships between SOM fractions and biological distribution of organic matter.
Principles of microbial enrichment, isolation and culture.
Principles of enrichment of physiological groups, e.g. cellulose decomposers, oligotrophic bacteria, nitrifying bacteria.
Description and comparison of methods for the quantification of microorganisms.
Advantages and disadvantages of using biomarkers.
Measurement of microbial activities: soil respiration, different enzyme activities (e.g. FDA, dehydrogenase activity).
Measurement of microbial processes of the nitrogen cycle in soil: methods for measuring ammonification, nitrification and denitrification.
Measurement of soil microbial biomass by chloroform fumigation methods.
Parameters suitable for the characterization of the microbial community.
Describe and compare methods for measuring soil microbial community diversity.
From soil sampling to data interpretation.
Statistical evaluation of the results, limits of validity of the conclusions.

Suggested literature:

Alef K. and Nannipieri P. (eds. 1998.): Methods in applied soil microbiology and biochemistry. Academic Press, London.
Bloem J., Hopkins D.W. and Benedetti A. (2005): Microbiological methods for assessing soil quality. CAB International, UK.
Paul A.E. (ed. 20): Soil microbiology, ecology and biochemistry, 4th Edition. Academic Press, USA.

Individual/Personal tasks:

Submission of a dissertation on the advantages and disadvantages of a selected measurement method, the determination of the critical points of the measurement, and the scope of the conclusions drawn from the data.

Date: Apr 10, 2022

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda professor	Dr. Gábor Csitári associate professor

Course title:
Basic concepts in plant population biology

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer:	**Place of work, position:**
Judit Bódis	Department of Conservation Biology, Institute for Wildlife Management and Nature Conservation, Georgikon Campus

Lessons required:	**Examination type**:	**Credit value:**
40	colloquium	4

Detailed content of course:
This course is an introduction to the field methodology of plant population biology, mainly through the study of perennial polycarpic geophytes. Field survey methods include recording in permanent quadrats, followed by processing of collected data and simple data analysis and visualization.

Suggested literature:
Harper, J. L. 1977: Population biology of plants. Academic Press, London. (new edition and online version also available)
Rabotnov, T. A. 1969: On coenopopulations of perennial herbaceous plants in natural coenoses. Vegetatio 19:87-95.
Case studies, e.g.:
Kalapos T. 1998: A magyarföldi husáng (*Ferula sadleriana* Ledeb.) pilistetői populációjának dinamikája. In: Csontos P. (szerk.): Sziklagyepek szünbotanikai kutatása. Scientia Kiadó, Budapest, pp. 41-54.
Kindlmann, P., Willems, J., Whigham, D. F. (eds.): Trends and fluctuations and underlying mechanisms in terrestrial orchid populations. Backhuys Publishers, Leiden.

Individual/Personal tasks:
An individual study on a selected plant species
Field data recording, creation a transition matrix
Simple data evaluation and visualisation

Date (first announcement): October 26, 2021.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angéla Anda Professor	Dr. Judit Bódis Assistant professor

Course title:
Basic concepts of resistance biology to pathogens I-II.

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer:	**Place of work, position:**
András Takács, PhD	MATE, Plant Protection Institute, associate professor

Lessons required: 16	**Examination type**: report	**Credit value: 2**

Detailed content of course: The study of the molecular background of resistance in host-parasite (virus, bacteria, fungi) reactions. The Concept of Genetic Inheritance of Resistance and Pathogenicity. Types of Plant Resistance to Pathogens. Genetics of Virulence in Pathogens and of Resistance in Host Plants. Breeding for Disease Resistance Sources of Genes for Resistance. Induced Biochemical Defenses in: Non-Host Resistance
Function of Gene Products

Suggested literature:

Agrios N. (2005). Plant Pathology. Elsevier Academic Press, Amsterdam
Király, Z. and Szalay-Marzsó, L. (editors) (1971): Biochemical and Ecological Aspects of Plant Parasite Relations. Akadémiai Kiadó, Budapest, pp. 1-425.
Goodman, R.N., Király, Z. and Wood, K.R. (1986): The Biochemistry and Physiology of Plant Disease. Missouri Univ. Press, Columbia, Mo., USA, pp. 1-448.
Jones JD and Dangl JL. 2006 The plant immune system . Nature 444:323-329.

Individual/Personal tasks: -

Date: August 26, 2023.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. András Takács

Course title: Basics of cell biology

Course type: compulsory/elective

Prerequisites:

Responsible lecturers: Dr. Dr. Szabolcs Tamás Nagy, Dr. Péter Szeglet	**Place of work, position:** MATE

Lessons required: 28	**Examination type**: oral	**Credit value:** **4**

Detailed content of course:

Plant sciences:

Structure and cell organs of plant cell. Structure and function of cell wall. Structure and function of chloroplast. Membrane mechanisms within the photosynthesis. Connection of cell organs within photorespiration. Photosynthetic processes in C3 type, in C4 type, and CAM type plants. Organs of biological oxidation in plant cell. Structure, function and membrane processes of mitochondria (terminal oxidation). Water management of the plant cell, aquaporin system. Nutrient uptake of the plant, membrane transport.

Animal sciences:

Prokaryotic, eukaryotic cell. Animal, plant cell. The nucleus, the genome, the chromatin.
The cell cycle, mitosis, DNA replication. Transcription, translation. Regulation of gene function in prokaryotes and eukaryotes. Endoplasmic reticulum, Golgi complex. Vesicular transport. Cytoskeleton, plasma membrane. Membrane transport. Mitochondria, their origin, structure, function. Basics of cell biology for reproduction. Meiosis. Fundamentals of developmental biology. Cell death: apoptosis and necrosis. Signaling, intercellular communication.

Suggested literature:

.Bray A., Johnson H., Raff L., Walter R. 2009: Esserntial cell biology
GM Cooper, RE Hausman. The Cell. A Molecular Approach. ASM Press, 2007

Individual/Personal tasks:

Date: August 26, 2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Szabolcs Tamás Nagy Professor

Course title: Bovine production

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer:	**Place of work, position:**
Dr. Szabolcs Bene	Hungarian University of Agriculture and Life Sciences Institute of Animal Sciences Georgikon Campus, associate professor

Lessons required:	**Examination type**:	**Credit value:**
30 hour	colloquium	6

Detailed content of course:

- Introduction, importance and situation of cattle production.
- The history of cattle breeding. Domestication and genealogy of cattle.
- General traits, traits related to milk production.
- Traits related to meat production.
- Classification of cattle breeds. Native and dual utilization breeds.
- Milk and meat utilization breeds.
- Cattle breeding. Breeding objects. Herd books.
- Selection and breeding value estimation in cattle breeding.
- Breeding methods in cattle breeding.
- Milking technology.
- Technology of beef cattle breeding.
- Calf nursing, bull and heifer nursing technology.
- Fattening technology.
- Organization of cattle production

Suggested literature:

- Szabó F. (edit.): Állattenyésztéstan. University note, Keszthely, 2006.
- Horn P. (edit.): Állattenyésztés I. Mezőgazda Publisher, Budapest, 1995.
- Szabó F. (edit.): Húsmarhatenyésztés. Mezőgazda Publisher, Budapest, 1998, 2005.

Individual/Personal tasks:

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Date: 07 April 7, 2022

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Szabolcs Bene associate professor

Course title: Breeding of vegetables and horticultural plants		
Course type: compulsory/elective		
Prerequisites: -		
Responsible lecturer: Dr. János Kovács	**Place of work, position:** Department of Vegetable and Mushroom Growing, associate professor	
Lessons required: 16	**Examination type**: oral report (three-stage)	**Credit value:** **2**
Detailed content of course: **Vegetable origins; Hybridization and selection; F1 hybrids; Special breeding and selection techniques: Crossbreeding of species and genera, Genetic engineering; Selecting cultivars; Experimental design in plant breeding; Special issues in pepper breeding**		
Suggested literature: **Kuckuck-Kobabe-Wenzel: A növénynemesítés alapjai. Mezőgazdasági Kiadó** **Bos-Caligari: Selection Methods in Plant Breeding. Chapman & Hall** **Belea A.: Faj és nemzetségkeresztezések a növényvilágban. Mezőgazdasági Kiadó** **Hajósné Novák M.: Genetikai variabilitás a növénynemesítésben Mezőgazda** **Velich I: Válság vagy egyensúly? : Mezőgazdasági Kiadó** **Preece, J.E. – Read, P.E.: The biology of horticulture. John Wiley& Sons. Inc.**		
Individual/Personal tasks: -		
Date: August 26, 2022.		
Signature: Head of Doctoral School Dr. Angela Anda Professor	Signature of lecturer: Dr. János Kovács associate professor	

Course title: Climate change - challenges and possibilities for safe food production

Course type: compulsory/**elective**

Prerequisites:
Agrometeorology, Genetics, Plant breeding

Responsible lecturer: **Dr. Ottó Veisz**	**Place of work, position: Agricultural Institute Centre for Agricultural Research, director**	
Lessons required: **15**	**Examination type**: report	**Credit value: 2**

Detailed content of course:
The aim of this course is to give fact-based information on the global climate change currently endangering life on earth, to evaluate the probability of expected changes, and to show how they will affect agricultural crop production and how unfavourable effects can be reduced.
Topics:

- Causes, components and origin of global climate change and the magnitude of the changes.
- Changes expected in the future on a global, regional and local scale.
- Effect of expected changes on agricultural crops.
- Model experiments aimed at simulating changes.
- Ways of moderating unfavourable effects.
- Theory and practice of breeding for resistance to abiotic stress.
- Theory and practice of breeding for resistance to biotic stress.
- Special breeding and selection techniques.
- Variety maintenance and the spread of cultivars in farm practice.

Suggested literature:

1. Publications and other literature distributed during the course.
2. National Climate Change Strategy (NCCS)*
3. Climate change scenarios for NCCS*
4. Summary of the results of the VAHAVA (Change - effect - response) programme*
5. Background materials for NCCS*

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Individual/Personal tasks:
Literature review related to the research topic; participation in one of the climate change research programmes underway in the Agricultural Institute, Centre for Agricultural Research.

Date: August 26, 2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Ottó Veisz

Course title: Plant growth and development		
Course type: **compulsory**/elective		
Prerequisites: **agrobotany**		
Responsible lecturer: **Kincső Decsi PhD.**	**Place of work, position:** **Hungarian University of Agriculture and Life Sciences** **Georgikon Faculty Keszthely** **Department of Plant Physiology and Plant Ecology** **senior lecturer**	
Lessons required: **6+0**	**Examination type**: **written test**	**Credit value: 6**

Detailed content of course:

1. Growth and environmental factors affecting growth

2. Germination

3. Flowering

4. Sex characteristics

5. Pollination, fruit set, fruit ripening

6. Aging

7. - special training module: General stress physiology

8. - special training module: Physiological aspects of abiotic and biotic stress effects

Suggested literature:

Lalit M. Srivastava: Plant Growth and Development, Elsevier, 2002.
Charles B. Beck: An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century 2nd Edition, ISBN-13: 978-0521518055
ISBN-10: 0521518059

Individual/Personal tasks:

The method of examination is a test system, which is implemented in writing with a personal presence, or online, depending on the student's place of training.

Date: Keszthely,04. 06. 2022.

Signature: Head of Doctoral School Dr. Angela Anda Professor	Signature of lecturer: Dr. Kincső Decsi

Course title:
Data collection and analysis

Course type: compulsory/elective

Prerequisites:
None

Responsible lecturer:	**Place of work, position:**
Dr. László Menyhárt	Institute of Mathematics and Basic Science, Associate Professor

Lessons required:	**Examination type**:	**Credit value:**
60	Project work	**8**

Detailed content of course:
Design and Analysis of Experiments: Block designs; Factorial designs; Split-plot design
Linear Models: Univariate and Multivariate Regression; One-way and two-way ANOVA; Multiple Comparisons; Family-Wise Error Rate; False Discovery Rate
Power Analysis: Power of Hypothesis Testing; Determination of the Number of Replications
Generalized Linear Models: Link Functions; Response Variable from Binomial, Poisson Distributions
Linear Mixed Models: Fixed, Random and Mixed Effects; Intraclass Correlation; Covariance Matrices; Estimation and Interpretation of Random Effects
Dimension Reduction: Principal Component Analysis and Exploratory Factor Analysis; Factor Scores; Loadings; Rotation Matrix; Biplot; Multidimensional Scaling

Suggested literature:

Schabenberger, Oliver, and Francis J. Pierce. *Contemporary statistical models for the plant and soil sciences*. CRC press, 2001.

Venables, William N., and Brian D. Ripley. *Modern applied statistics with S-PLUS*. Springer Science & Business Media, 2013

Greenacre, Michael, and Raul Primicerio. *Multivariate analysis of ecological data*. Fundacion BBVA, 2014.

Clewer, Alan G., and David H. Scarisbrick. *Practical statistics and experimental design for plant and crop science*. John Wiley & Sons, 2013.

Individual/Personal tasks:

Date:

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Menyhárt László

Course title: Developmental biology – basics and applications in animal breeding

Course type: compulsory/elective

Prerequisites:-

Responsible lecturer:	**Place of work, position:**
Dr. Szabolcs T. Nagy Dr. Szilard Bodo	MATE, Institute of Animal Sciences

Lessons required:	**Examination type**:	**Credit value:**
28	oral/written	**4**

Detailed content of course:

1. Basics of developmental biology
2. Germ cell formation - spermatogenesis
3. Germ cell formation - oogenesis
4. Fertilization - external fertilizing species
5. Fertilization - internal fertilizing species
6. Early embryonic development
7. Pregnancy, parturition
8. Genetics, epigenetics during embryonic development
9. Semen quality control for in vitro fertilization
10. In vitro oocyte maturation in different species
11. In vitro fertilization in different species
12. In vitro embryo culture in different species
13. Embryo implantation methods
14. Micromanipulation - how and why

Suggested literature:

. S.F. Gilbert: Developmental Biology, Ninth Edition, Sinauer Associates, 2010

Individual/Personal tasks:

Date: 21.04.2021.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Szabolcs T. Nagy Professor

Course title:
Environmental analytics

Course type: compulsory/elective

Prerequisites:
-

Responsible lecturer:	**Place of work, position:**	
Dr. Wágner László	MATE, Institute of Physiology and Nutrition, associate professor	
Lessons required:	**Examination type**:	**Credit value:**
30 h	kollokvium	4 credit

Detailed content of course:

1. Historic Perspectives and Scopes of Environmental Analytical Chemistry
2. Environmental Sampling: Purpose, Design Strategy and Techniques
3. Sample Preparation for Environmental Analysis
3.1. Purposes of Environmental Sample Preparations
3.2 Types of Environmental Sample Preparation
4. Instrumental Analysis of Environmental Chemicals
4.1. Classical Methods vs. Instrumental Methods in Environmental Analysis
4.2. Molecular Spectroscopy in Environmental Analysis
4.3. Atomic Spectroscopy in Environmental Analysis
4.4. Chromatography in Environmental Analysis
4.5. Mass Spectrometry in Environmental Analysis
4.6. Electroanalytical Methods in Environmental Analysis
4.7. Thermal Methods in Environmental Analysis
4.8. Radiochemical Methods in Environmental Analysis
5. Bioanalysis of Environmental Chemicals
5.1. Immunoassay
5.2 Biosensors

Suggested literature:

.- Semih Ötles (2005): Methods of Analysis of Food Components and additives, Taylor & Francis, Boca Baton
- A. van Amerongen – D. Barug – M. Lauwaars (2005): Rapid methods for biological and chemical contaminants in food and feed, Wageningen Academic Publishers
- Semih Ötles (2009): Handbook of food analysis instruments, CRC Press, Boca Baton

Individual/Personal tasks:
-

Date:

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Wágner László Associate Professor

Course title: Environmental aspects of animal nutrition

Course type: compulsory/<u>elective</u>

Prerequisites: -

Responsible lecturer:	**Place of work, position:**
Dr. Hedvig Fébel (1) Dr. László Pál (2)	MATE Institute of Physiology and Nutrition, (1) research fellow (2) associate professor

Lessons required:	**Examination type**:	**Credit value:**
20 hours	written exam	4

Detailed content of course:

The course is focused on the concepts and practice of sustainable animal nutrition and its role in the management of current environmental problems. The course discusses in detail the trends in animal production, the role of animal nutrition in ecological footprint, nutritional means to reduce the various emissions (N, P, methan, trace elements) of animal production. Special attention will be paid to use of by-products and alternative protein sources in animal feeding as well as feeding strategies to reduce environmental load of a livestock farm.

Outline of knowledge :

- Trends in animal production, gobal warming, environmental footprint, sustainability
- N- and P-excretion in monogastrics and ruminants
- Environmental load of trace elements
- Nutritional methods for reduction of methan production
- Use of by-products and alternative protein sources in animal feeding
- Organic vs. conventional farming

Project work: development of feeding strategies to reduce environmental load of a livestock farm

Suggested literature:

Handouts and materials of the lectures, scientific papers given by the lecturers

Individual/Personal tasks:

Date: 11 April, 2022

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Hedvig Fébel

Course title: Environmental effects of agrochemicals

Course type: compulsory/elective

Prerequisites:-

Responsible lecturer: **Dr. Nádasyné Dr. Ihárosi Erzsébet**	**Place of work, position:** MATE retired associate professor

Lessons required: 30	**Examination type**: oral colloquium	**Credit value: 4**

Detailed content of course:

Classification and characterization of agrochemicals.
Characterization of pesticides, and their physical and chemical properties which can determine their appearance in the environment.
Pesticide application, soil-water-pesticide interactions.
Causes of pesticide contamination, pesticide residues.
Entry of fertilizers to biogeochemical circle and their interaction with the environment.
Consequences of incorrect fertilizer application on environment: leaching, acidification, nitrate accumulation.
Effect of slurry and sewage sludge application on the environment.
Heavy metal contamination from fertilizers, slurry and sewage.

Suggested literature:

- Loch J.-Nosticzius Á. (2004): Agrokémia és növényvédelmi kémia. Mezőgazda Kiadó, Budapest.
- Láng István 2003: Agrártermelés és globális környezetgazdálkodás. Mezőgazda Kiadó, Budapest.
- Balla, Cs. – Síró, I. (2007): Élelmiszer-biztonság és – minőség I. Alapismeretek. Mezőgazda Kiadó, Budapest.
- Darvas Béla.- Székács András. 2006: Mezőgazdasági ökotoxikológia. L'Harmattan Kiadó, Budapest. 0
- Nádasyné Ihárosi Erzsébet 2000: A növények nitrátakkumulációját befolyásoló tényezők. Agrokémia és Talajtan, 49. 1-2. 277-284.

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Individual/Personal tasks: written elaboration of a chosen topic

Date: 21.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Nádasyné Dr. Ihárosi Erzsébet

Course title: Environmental microbiology

Course type: compulsory/elective
(Environmental Sciences)

Prerequisites:
-

Responsible lecturer:	**Place of work, position:**
Dr. Csitári Gábor	MATE, Georgikon Campus, associate professor

Lessons required:	**Examination type**:	**Credit value: 4**
30	oral exam	

Detailed content of course:
General characterization of microorganisms.
Microbial metabolic processes.
Microbial interactions with the living environment. Antibiotic resistance of microorganisms, the spread of resistance factors in the environment.
Microbiology of the carbon cycle.
Microbiology of the nitrogen cycle.
Microbiology of the sulfur cycle.
Biogeochemical cycle of phosphorus, iron, silicon and toxic elements.
Microbiology and technologies of soil remediation - basics of soil microbiology, types of contaminants, their movement, accessibility, mobilization and biodegradation in soil, detection and analysis of soil contaminants.
Technologies for the biological treatment of solid waste - biotechnologies combined with waste recovery, sludge treatment, biogas production technology and microbiology. Assessment of the impact of pollutants on the environment, risk assessment and risk analysis methods.
Ecotoxicological tests, analytical possibilities.

Suggested literature:
Kim, M-B. (2008): Progress in Environmental Microbiology. Nova Science Publishers, New York
Mitchell, R., Gu, J-D (2010): Environmental microbiology. John Wiley & Sons, New Jersey.

Individual/Personal tasks:
Preparing a literature review of a freely chosen topic.

Date: 21.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Gábor Csitári associate professor

Course title:
Equine Nutrition

Course type: compulsory/elective

Prerequisites:
Basics of animal nutrition

Responsible lecturer:	**Place of work, position:**	
Adam Sandor Bartos, PhD	associate professor	
Lessons required:	**Examination type**:	**Credit value:**
10	oral exam	**4**

Detailed content of course:
On this course students will learn about the different types and utilisation of horses, speciality of equine digestion, modern principle of the dietary management. Students get acquainted with the relation between the equine performance and different energy sourses as well as with the main nutritional disorders.

Suggested literature:
Kenneth W. Hinchcliff, Raymond J., Geor and Andris J. Kaneps (2008): Equine Exersice Physiology. Saunders Elsevier
Raymond J. Geor, Pat Harris, Manfred Coenen (2013): Equine applied and clinic nutrition. Saunders Elsevier
J. D. Pagan (1998): Advanced in Equine Nutrition. Nottingham University Press

Individual/Personal tasks:
Feed composition for horses of different ages and types of utilisation

Date: 21.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Adam Sandor Bartos

Course title: Experimental design

Course type: compulsory/elective

Prerequisites:-

Responsible lecturer:	**Place of work, position:**
Dr. Szabolcs T. Nagy	MATE, Institute of Animal Sciences

Lessons required:	**Examination type**:	**Credit value:**
14	oral/written	**2**

Detailed content of course:

- the need for experimental design
- the relationship between experimental design and statistics
- hypothesis
- preliminary experiment, pilot study
- replication, pseudo-replication
- randomization
- different designs
- laboratory or field experiment?
- calibration
- accuracy – precision
- data recording and storage

Suggested literature:

. GD Ruxton, N Colegrave: Experimental design for the life sciences. Oxford University Press, 2017.

Individual/Personal tasks:

Date: 21.04.2021.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Szabolcs T. Nagy Professor

Course title: General principles of toxicology

Course type: compulsory/elective
(Environmental Sciences)

Prerequisites:-

Responsible lecturer:	**Place of work, position:**
Dr. Péter Budai	MATE, Georgikon Campus, Department of Plant Protection, associate professor

Lessons required:	**Examination type**:	**Credit value: 4**
40	oral or written exam	

Detailed content of course:

- Basic terminology: poison, poisoning, toxicity, sub disciplines of toxicology, forms of poisoning: 4 hours
- Essential concepts of toxicology: 2 hours
- Dose-response relationship: 2 hours
- The fate of poison in the organism (absorption, distribution, metabolism, excretion): 12 hours
- The effects of a poison on a biological system: 4 hours
- Factors affecting toxicity: 2 hours
- Specific toxic effects: genotoxicity, carcinogenicity, teratogenicity: 12 hours
- Pesticide authorization: 2 hours

Suggested literature:

Hayes, A.W. (ed).: Principles and Methods of Toxicology. Raven Press, New York, 1986.
Casarett, L.J.: Casarett and Doull's Toxicology: The Basic Science of Poisons. Macmillan Publ. Co., In.., New York, 1980.
Landis, W. G., Ming-Ho Yu.: Introduction to Environmental Toxicology. CRC Press, 1995.
Hoffman, D. J., Rattner, B. A. (eds). Handbook of Ecotoxicology. CRC Press Inc., 1994.
Marrs, T. C., Ballantyne, B. (eds): Pesticide Toxicology and Intenational Regulation. Wiley, 2003.
Krieger, R. (ed): Handbook of Pesticide Toxicology. Third edition. Academic Press, 2010.

Individual/Personal tasks:-

Date: 12.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angéla Anda professor	Dr. Péter Budai associate professor

Course title:
Grasses in Hungary

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer:	**Place of work, position:**
Judit Bódis	Department of Conservation Biology, Institute for Wildlife Management and Nature Conservation, Georgikon Campus

Lessons required:	**Examination type**:	**Credit value:**
45	colloquium	6

Detailed content of course:
Morphological features of the sedges.
An overview of the different classification options.
Systematic overview of the species of the 72 genera occurring in Hungary, with special emphasis on the most frequent species.
Genera discussed in detail: *Festuca, Poa, Puccinellia, Sesleria, Melica, Glyceria, Bromus, Brachypodium, Elymus, Hordeum, Helictotrichon, Arrhenatherum, Koeleria, Deschampsia, Hierochloë, Holcus, Corynephorus, Agrostis, Calamagrostis, Phleum, Alopecurus, Piptatherum, Stipa, Phragmites, Danthonia, Molinia, Nardus, Cleistogenes, Eragrostis, Crypsis, Eleusine, Cynodon, Tragus, Leersia, Panicum, Echinochloa, Digitaria, Setaria, Cenchrus, Sorghum, Chrysopogon, Botriochloa.*

Suggested literature:
Dahlgren, R. M. T., Clifford, H. T. & Yeo, P. F. 1985. The Families of the Monocotyledons. Structure, Evolution and Taxonomy. Springer-Verlag, Berlin.
Tutin, T.G., Heywood, V.H., Burges, N.A., Valentine, D.H., Walters, S.M., Webb, D.A. (eds.) 1980: Flora Europaea V. Alismataceae to Orchidaceae. Cambridge University Press.
Conert, H. J., Hamann U., Schultze-Motel, W., Wagenitz, G. (eds.) 1992: Hegi, G. Illustrierte Flora von Mitteleuropa. I./3. Parey Verlag. Berlin, Hamburg.
Király G. (szerk.) 2009: Új magyar füvészkönyv Magyarország hajtásos növényei. Határozókulcsok. Aggteleki Nemezeti Park Igazgatóság. Jósvafő.
Király G., Virók V., Molnár V.A. (szerk.) 2011: Új magyar füvészkönyv Magyarország hajtásos növényei. Ábrák. Aggteleki Nemezeti Park Igazgatóság. Jósvafő.
Jávorka S., Csapody V. 1975: Iconographia florae partis austro-orientalis Europae Centralis. (Közép-Európa délkeleti részének flórája képekben). Akadémiai Kiadó. Budapest.
Darók J. 2011: Növényanatómiai-botanikai terminológiai szótár. Akadémiai Kiadó, Budapest.

Individual/Personal tasks: Project work may include an oral presentation of a selected genera and herbarium preparation. Field identification exercises.

Date (first announcement): March 2, 2021.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angéla Anda Professor	Dr. Judit Bódis Assistant professor

Course title:
Infectious genetic information

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer:	**Place of work, position:**
András Takács, PhD	MATE, Plant Protection Institute, associate professor

Lessons required: 32	**Examination type**: report	**Credit value: 4**

Detailed content of course: Introduction to plant virology. History of plant virology. Symptomatology. Characteristics and taxonomy of plant pathogenic viruses. Transmission of plant pathogen viruses. Molecular characteristics of plant pathogenic viruses Diagnostic methods in the plant virology.

Suggested literature:

Agrios N. (2005). Plant Pathology. Elsevier Academic Press, Amsterdam
Goodman, R.N., Király, Z. and Wood, K.R. (1986): The Biochemistry and Physiology of Plant Disease. Missouri Univ. Press, Columbia, Mo., USA, pp. 1-448.
Jones JD and Dangl JL. 2006 The plant immune system . Nature 444:323-329.
Henry, R.J. (1997): Practical Applications of Molecular Biology. Chapman and Hall. London.
Vasil, I.K. (ed.) (2002): Plant Biotechnology. Kluwer Academic Publishers, Dordrecht, Boston, London.
Smith C. J. (Ed.) (1991): Biochemistry and Molecular Biology of Plant Pathogen Interactions. Clarendon Press, Oxford.

Individual/Personal tasks: -

Date: March 2, 2021.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. András Takács

Course title:
Introduction to the 'R' programming language

Course type: compulsory/elective

Prerequisites:
None

Responsible lecturer:	**Place of work, position:**
Dr. László Menyhárt	Institute of Mathematics and Basic Science, Associate Professor

Lessons required:	**Examination type**:	**Credit value:**
30	Project work	**4**

Detailed content of course:
• Installing R and packages, GUI
•Numeric, boolean, character and factor data types. Vectors, matrices and dataframes
• Data import, export, selecting, grouping by, data clensing
• Descriptive statistics
• R visualization
• Normality and homogeneity
• Compare means with parametric and non-parametric tests
• ANOVA, Post-hoc tests
• Two and multiple variable regression
• General linear models
• Modell diagnostics
• Modell selection

Suggested literature:
Venables, William N., and Brian D. Ripley. *Modern applied statistics with S-PLUS*. Springer Science & Business Media, 2013

Wickham, Hadley, and Garrett Grolemund. *R for data science: import, tidy, transform, visualize, and model data.* " O'Reilly Media, Inc.", 2016., online available: https://r4ds.had.co.nz

Individual/Personal tasks:

Date: April 2, 2021.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Menyhárt László

Course title:
Poisonings caused by plants and animals

Course type: compulsory/elective

Prerequisites:
-

Responsible lecturer:	**Place of work, position:**
dr. habil. József Lehel DVM, PhD	University of Veterinary Medicine, Budapest

Lessons required: 30 hs	**Examination type**: oral	**Credit value: 4**

Detailed content of course:
The poisonings caused by plants will be discussed based on the damaged organs/organ system, including the occurrence of plants by area, poisonous part and toxins of plants, clinical signs caused by them, and the general treatment possibility.
Topics of plant poisoning include plants that damage the skin, digestive tract, nervous system, heart function, liver, kidney, blood clotting, and respiration.
The poisonous and venomous animals, and poisonings caused by them will be summarized based on the taxonomy order: coelenterate, molluscs, arthropods, vertebrates (fish, amphibians, reptiles, mammals).

Suggested literature:

1. Lehel J. – Vetter J. (2008): Növényi eredetű méreganyagok és mérgezések állatokban. A/3 Nyomdaipari és Kiadói Szolgáltató Kft.. Budapest.
2. Lehel J.: Mérgező állatok, állati mérgek, egyetemi jegyzet, 1998, Budapest
3. Lehel, J.-Vetter, J.: Gyakoribb növényi eredetű mérgezések a kisállatpraxisban. Magy. Áo. Lapja, 2002. 124. 597-606.
4. Lehel, J.-Vetter, J.: Növényi eredetű mérgezések. 1. Szoba- és kerti növények. Magy. Áo. Lapja, 2005. 127. 43-50.
5. Lehel, J.-Vetter, J.: Növényi eredetű mérgezések. 2. Fák-bokrok-cserjék. Magy. Áo. Lapja, 2005. 127. 684-692.
6. Lehel, J.: Állati eredetű mérgezések. 1. Általános rész Magy. Áo. Lapja, 2002. 124. 754-760.
7. Lehel, J.: Állati eredetű mérgezések. 2. Szivacsok, Csalánozók, Gyűrűsférgek, Puhatestűek, Tüskésbőrűek. Magy. Áo. Lapja, 2003. 125. 244-251.
8. Lehel, J.: Állati eredetű mérgezések. 3. Ízeltlábúak (Arthropoda) okozta mérgezések, 1. Ezerlábúak, százlábúak, rovarok. Magy. Áo. Lapja, 2003. 125. 434-443.
9. Lehel, J.: Állati eredetű mérgezések. 3. Ízeltlábúak (Arthropoda) okozta mérgezések, 2. Pókszabásúak. Magy. Áo. Lapja, 2003. 125. 490-497.
10. Lehel, J.: Állati eredetű mérgezések. 4. Halak és kétéltűek okozta mérgezések. Magy. Áo. Lapja, 2004. 126. 176-185.
11. Lehel, J.: Állati eredetű mérgezések. 5. Hüllők okozta mérgezések. Magy. Áo. Lapja, 2005. 127. 113-121.

Individual/Personal tasks: -

Date: April 2, 2021.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. József Lehel

Course title: Microbiology of soils

Course type: compulsory/elective
(Environmental Sciences)

Prerequisites:
-

Responsible lecturer:	**Place of work, position:**
Dr. Csitári Gábor	MATE, Georgikon Campus, associate professor

Lessons required:	**Examination type**:	**Credit value: 4**
30	oral exam	

Detailed content of course:
The aim of the course is to introduce the role of microorganisms living in the soil in the formation of soil, the maintenance of soil fertility, and the decomposition of contaminants in the soil.
Physical and chemical characteristics of the soil.
Organisms/microorganisms in the soil. Biologically controlled and uncontrolled biochemical processes in soil. Soil enzymology. Biological activity.
The biogeochemical cycle of carbon. Microbial processes of carbon cycle in soil: cellulose degradation, lignin transformation, degradation of other organic polymers (e.g. hemicelluloses and pectin). Methane production and methane oxidation.
The biogeochemical cycle of nitrogen. Microbial processes of the nitrogen cycle in soil: N-fixation, nitrification, denitrification and ammonification processes.
Soil biological aspects of the sulfur, iron and manganese cycle.
Relationship between plants and soil microorganisms. The rhizosphere and its functions.
Microbiological transformation of organic plant residues in soil. Effects of chemization (pesticide using) on soil biology. Fate and detoxification of contaminants entering the soil. Soil biological effects of fertilizers. Soil biological effects of agrotechnical processes (e.g. plowing).
Methods for quantitative analysis of soil microorganisms, separation of individual physiological groups. Investigation of soil enzymes: theory and methodology of measurement of enzyme activities (e.g. invertase, catalase, dehydrogenases and phosphatases).
Biological indicators of soil pollution.

Suggested literature:
Shukla, G., Varma, A. (2011): Soil Enzimology. Springer-Verlag, Berlin
Tate, R.L. (2020): Soil Microbiology. 3rd edition. John Wiley & Sons, New York

Individual/Personal tasks:
Preparing a literature review of a freely chosen topic.

Date: April 2, 2021.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Gábor Csitári associate professor

Course title:
Mobile genetic elements

Course type: compulsory/elective

Prerequisites:
no

Responsible lecturer:	**Place of work, position:**
Dr. Ferenc Olasz	MATE Institute for Genetics and Biotechnology, scientific advisor

Lessons required:	**Examination type**:	**Credit value:**
12	Oral colloquium	**2**

Detailed content of course:

1. Discovery, classification and role of mobile elements in the genome
2. General structure of the elements
3. The role of the ends of the element in transposition and duplication of the target sequence
4. Molecular biology of transposition mechanisms
5. Transposition and the host cell, regulation of transposition
6 Horizontal gene transfer
7. Genomic islands and their translocation
8. Site-specific recombination and transposition
9. Prokaryotic mobile elements
10. Eukaryotic mobile elements in the flora
11 Eukaryotic mobile elements in fauna
12. Retroviruses, retrotransposons
13. Mobile elements as genetic tools

Suggested literature:

Siguier, P., Perochon, J., Lestrade, L., Mahillon, J. & Chandler, M. (2006). IS-finder: the reference centre for bacterial insertion sequences. Nucleic Acids Res. (Database issue) 34, D32-36.

Chandler, M. & Mahillon, J. (2002). Insertion sequences revisited. In Mobile DNA II. (Craig, N.L., Craigie, R., Gellert, M. & Lambowitz, A.M., eds). pp. 305-366. American Society for Microbiology Washington, D.C.

Nagy Z. & Chandler, M. (2004). Regulation of transposition in bacteria. Res. Microbiol. 155, 387-398.

Individual/Personal tasks:
in frame of consultation

Date: April 2, 2021.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Ferenc Olasz scientific advisor

Course title: Modern application technology of pesticides

Course type: compulsory/elective

Prerequisites:-

Responsible lecturer: **Dr. Nádasyné Dr. Iházosi Erzsébet**	**Place of work, position:** MATE retired associate professor

Lessons required: 32	**Examination type**: oral colloquium	**Credit value: 4**

Detailed content of course:

- Definition and components of pesticides
- Areas of pesticides usage
- Physical and chemical properties of pesticides playing an important role in the application.
- Classification of pesticides according to biological effect.
- Environmental effect of pesticides, and risks of application.
- Methods of pesticide application, principles of professional use.
- Pesticide application in integrated pest management.
- Importance and forms of pesticide selectivity
- Danger and avoidance of pesticide resistance.
- Development trends, and transformation of pesticide market supply

Suggested literature:

György. Matolcsy, Miklós Nádasy, Viktor Andriska: Pesticide chemistry. Akadémiai Kiadó, Budapest 1988.

- Kádár Aurél: Vegyszeres gyomirtás és termésszabályozás. Magánkiadás, 2016.
- Földművelésügyi Minisztérium: Növényvédő szerek, termésnövelő anyagok. Agrinex Bt., Budapest, 2019.
- Graham Matthews: Pesticides: Health, Safety and the Environment. Wiley-Blackwell, 2006.
- Növényvédelem folyóirat

Individual/Personal tasks: written elaboration of a chosen topic

Date: 21.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Nádasyné Dr. Iházosi Erzsébet

Course title: Modern methods for the physical analysis of water management of soils

Course type: compulsory/elective

Prerequisites: basic soil scientific knowledge and soil survey practice

Responsible lecturer:	**Place of work, position:**
Kálmán Rajkai	Agricultural Research Centre Institute for Soil Sciences, research professor emeritus

Lessons required:	**Examination type**:	**Credit value: 2**
	colloquium	

Detailed content of course:

Electrical soil moisture measurement methods (TDR, and capacitive sensors) and instruments (Trime FM3, Campbell CS616, Delta-T PRI/6, Decagon Gr1), their advances, limitation of use and accuracy. Temperature dependence of sensed moisture contents.
In situ hydraulic conductivity tests by Double-ring infiltrometer, Guelph permeaméter, Mini Disk infiltrometer, and Rainfall simulator of Eijkelkamp. Calculation of soil water conductivity from the test results. Areal applicability of conductivity data derived from measurements.
Determination of soil water repellency by the Mini Disk infiltrometer.
Measurement of soil water potential by tensiometers.

Suggested literature:

IAEA: Field Estimation of Soil Water Content. A Practical Guide to Methods, Instrumentation and Sensor Technology. TRAINING COURSE SERIES No. 30, Vienna, 2008.

N. Fodor, R. Sándor, T. Orfanus, L. Lichner, K. Rajkai Evaluation method dependency of measured saturated hydraulic conductivity. Geoderma. 165. 60-68. 2011.

Zhang, R. 1997. Determination of soil sorptivity and hydraulic conductivity from the disk infiltrometer. Soil Sci. Soc. Am. J. 61:1024-1030.

Individual/Personal tasks:

Date: 21.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Kálmán Rajkai research professor emeritus

Course title:
Molecular basis of the abiotic stress tolerance in plants

Course type: compulsory/elective

Prerequisites:-

Responsible lecturer:
Gábor Ottó Galiba, DSc

Place of work, position: Professor
Institute of Agronomy, Hungarian University of Agriculture and Life Sciences, 8360 Keszthely, Hungary; Agricultural Institute
Centre for Agricultural Research, ELKH, H-2462 Martonvásár, Hungary

Lessons required: 45	**Examination type**:oral or written	**Credit value:6**

Detailed content of course:
This course will contains 3 main topics:
1) Genetic and Molecular Background of Frost Tolerance in Cereals
The discovery of QTLs affecting frost tolerance will be presented. The role of CBF-regulon in cold acclimation will be described, as well. Methods to select frost tolerant genotypes will be introduced.
2) Genes Involved in Regulating Flowering Time in Arabidopsis thaliana and Cereals
The four major pathways controlling flowering time will be described. The vernalization pathway in relation with the developmental dependence of frost tolerance will be presented.
3) Modulated Light Dependent Regulation of Freezing Tolerance
Plant growth and development is depending on the surrounding environment, of which light and temperature are the most important. Interactions among modified light spectrum, light intensity and temperature affecting freezing tolerance together with light signaling pathways will be described. Temperature and light spectrum dependent hormonal and lipidome alterations during cold hardening in cereals will be presented.

Suggested literature:

1) Galiba, G ; Vágujfalvi, A ; Li, C ; Soltész, A ; Dubcovsky, J Regulatory genes involved in the determination of frost tolerance in temperate cereals PLANT SCIENCE 176 : 1 pp. 12-19. , 8 p. (2009)
2) Jessica Hyles,Maxwell T. Bloomfield, James R. Hunt, Richard M. Trethowan, Ben Trevaskis. Phenology and related traits for wheat adaptation. Heredity (2020) 125:417–430 https://doi.org/10.1038/s41437-020-0320-1
3) Ahres, Mohamed ; Pálmai, Tamás ; Gierczik, Krisztián ; Dobrev, Petre ; Vanková, Radomíra ; Galiba, Gábor The Impact of Far-Red Light Supplementation on Hormonal Responses to Cold Acclimation in Barley BIOMOLECULES 11 : 3 Paper: 450 (2021)
4) Kennedy A and Geuten K (2020) The Role of FLOWERING LOCUS C Relatives in Cereals. Front. Plant Sci. 11:617340. doi: 10.3389/fpls.2020.617340
5) Kovács, Terézia; Ahres, Mohamed ; Pálmai, Tamás ; Kovács, László ; Uemura, Matsuo ; Crosatti, Cristina ; Galiba, Gabor. Decreased R:FR Ratio in Incident White Light Affects the Composition of Barley Leaf Lipidome and Freezing Tolerance in a Temperature-Dependent Manner. INTERNATIONAL JOURNAL OF MOLECULAR SCIENCES 21 : 20 Paper: 7557 , 23 p. (2020)

Individual/Personal tasks:-

Date: 21.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Gábor Otto Galiba

Course title:
Molecular genetic methods applied in animal breeding

Course type: compulsory/elective

Prerequisites: Animal breeding, Genetics

Responsible lecturer:	**Place of work, position:**	
Dr. István Anton	MATE, Herceghalom, scientific advisor	
Lessons required:	**Examination type**:	**Credit value:**
60 hours	colloquium	8

Detailed content of course: At present there is considerable interest in the application of molecular technologies for specific DNA markers associated with various QTL (Quantitative Trait Loci) to promote more efficient and relatively easy selection in farm animals. Recent advances in molecular genetics have enabled the application of MAS (Marker Assisted Selection) and GWAS (Genome-Wide Association Study) in achieving different breeding objectives. The course gives a summary of the main molecular markers and methods used in livestock improvement programmes.

Suggested literature:

Általános állattenyésztés (szerk. Szabó Ferenc), Mezőgazda Kiadó, Bp. 2015.
Egypontos nukleotid-polimorfizmusok szelekciós felhasználásának lehetősége hazai szarvasmarha- és sertésállományokban. MTA doktori értekezés, Anton István (2021).

Individual/Personal tasks:

Date: 21.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. István Anton

Course title: Nutritional aspects of ecological poultry production

Course type: compulsory/elective

Prerequisites:

Responsible lecturer:	**Place of work, position:**
Prof. Károly Dublecz	Georgikon Campus Keszthely

Lessons required:	**Examination type**:	**Credit value:** 4
40 hours	oral exam	

Detailed content of course: Agriculture – environmental programs, alternative poultry products, basics of ecological poultry production systems, ecological layer, turkey, guinea fowl, duck, geese production, quality of ecological poultry products, quality control systems, marketing of these alternative products

Suggested literature:

1. Gordon, S.H., Charles, D.R. (2002): Niche and organic chicken products. Nottingham University Press. Nottingham
2. Larbier; M. and B. Leclercq (1994): Nutrition and feeding of poultry. Nottingham University Press. Loughborough, Leicestershire, UK.
3. Leeson, S. and J.D. Summers (2001): Scott's nutrition of the chicken. University Books, Guelph, Ontario, Canada.
4. Leeson, S. and J.D. Summers (1997): Commercial poultry nutrition. University Books, Guelph, Ontario, Canada

Individual/Personal tasks:
Diet formulation for different poultry species by linear programing

Date: 22.04.2022

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Karoly Dublecz professor

Course title: Ornamental dendrology

Course type: compulsory/elective

Prerequisites:-

Responsible lecturer:	**Place of work, position:**	
Horváthné Dr. Baracsi Éva	MATE Georgikon Campus, docent	
Lessons required:	**Examination type**:	**Credit value: 2**
2+0	oral report	

Detailed content of course:
Characteristics of the most important coniferous and deciduous woody evergreen species.
Characteristics of major deciduous ornamental trees and shrubs.
Possibilities of application of woody ornamental plants.

Suggested literature:
Schmidt G. (szerk.)(2006): Kertészeti dendrológia. Mezőgazda Kiadó, Budapest.
Schmidt G. (szerk.) (2003): Növények a kertépítészetben. Mezőgazda Kiadó, Budapest.
Tóth I. (2012): Lomblevelű díszfák, díszcserjék kézikönyve. Tarkavirág Kft, Dunaharaszti
Dirr, M.A (1983): Manual of Woody Landscape Plants. Stipes Publ. Company, Champaign
Phillips, B. (2000): Garden Design. Parragon, Bath

Individual/Personal tasks:

Date: 2022.04.21.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Éva Baracsi

Course title: Oxidants and antioxidants in the stress response

Course type: compulsory/elective

Prerequisites: plant physiology, genetics, biochemistry

Responsible lecturer:	**Place of work, position:**
Dr. Gábor Kocsy	ATK Agricultural Institute, Martonvásár, head of the Department of Biological Resources

Lessons required:	**Examination type**:	**Credit value:**
16	oral examination	**2**

Detailed content of course:

The reactive oxygen species, formed from the ground-state oxygen necessary for the aerobic life, are important regulators of plant growth and development under optimal and stress conditions. However, in high concentrations they are toxic. Their level is controlled by the antioxidant system. The aim of the seminars is the presentation of the role of reactive oxygen species and antioxidants in the regulation of various physiological and biochemical processes in plants. In the frame of the subject the students will have an introduction in the molecular regulatory processes in which the reactive oxygen species participate. The subject is based on the knowledge obtained in plant physiology, genetics and biochemistry, and have a direct connection with these subjects.

Theory (8 x 45 minutes):

1. Formation, biochemistry and effects of reactive oxygen species (45 min)
2. The antioxidant system (45 min)
3. The redox signalling (45 min)
4. Redox regulation of metabolism (2 x 45 min)
5. Redox control of growth and development (45 min)
6. The role of the redox system in the stress response (2 x45 min)

Practical course (8 x 45 min)

1. Spectrophotometric measurement of the activity of antioxidant enzymes (ascorbate peroxidase, glutathione peroxidase, glutathione S-transferase) (4 x 45 min)
2. Gene expression analysis of antioxidants (mRNA-isolation, reverse transcription, polymerase chain reaction) (4 x 45 min).

Suggested literature:

Dumanović J, Nepovimova E, Natić M, Kuča K and Jaćević V (2021): The significance of reactive oxygen species and antioxidant defense system in plants: a concise overview. Front. Plant Sci., 11:552969

Munné-Bosch S., Queval G., Foyer C.H. (2013): The impact of global change factors on redox signalling underpinning stress tolerance. Plant Physiol., 161:5-19.

Kocsy G., Tari I., Vanková R., Zechmann B., Gulyás Z., Poór P., Galiba G. (2013): Redox control of plant growth and development. Plant Sci., 211: 77-91.

Individual/Personal tasks:

Preparation of an experimental plan for the investigation of oxidants and antioxidants. Presentation of an English publication related to the subject.

Date: 22nd April 2022

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angéla Anda Professor	Dr. Gábor Kocsy

Course title:
Physiological basis of environmental adaptation

Course type: elective

Prerequisites:
Basics of animal physiology

Responsible lecturer:	**Place of work, position:**
Dr. Ferenc Husveth	Department of Nutritional Physiology

Lessons required:	**Examination type**:	**Credit value:**
correspondence corses	written essay	6

Detailed content of course:

- Fundamental mechanisms of adaptation
- Neuroendocrine control of environmental adaptations in farm animals
- Effect of environment on the metabolism of domestic animals
- Temperature and its effects: Thermoregulation of farm animals
- From heat tolerance to heat stress in animal farming
- Environment and animal well-being
- Effect of environment on nutrition requirements

Suggested literature:

- Collier, R. J.,Collier, J. L. (eds), 2021: Environmental physiology of livestock, John Wiely & Son Inc., https//doi.org/10.1002/9781119949091.fmatter
- Willmer Pat, 2004: Environmental physiology of animals, John Wiely & Son, ISBN10: 1405107243
- Aggarwal, A., Upadhyay, R., 2013: Heat stress and animal productivity, Springer, ISBN: 798-81-322-0879-2

Individual/Personal tasks:
written essay in a chosen topic

Date: 21.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Ferenc Husveth

Course title:
Physiology of animal production

Course type: compulsory for animal production

Prerequisites:
Basics of animal physiology

Responsible lecturer:	**Place of work, position:**
Dr. Ferenc Husveth	Department of Nutritional Physiology, emeritus professor

Lessons required:	**Examination type**:	**Credit value:**
Correspondence courses	written essay	6

Detailed content of course:

- Neuroendocrine adaptations in domestic animals
- Gastrointestinal absorption and intermediary metabolism of nutrients in farm animals
- Physiology of meat production – Control and manipulation of animal growth
- Regulation of reproduction of male and female farm animals
- Physiology of mammary gland and milk production
- Equine exercise physiology
- Physiology of egg production

Suggested literature:

- Akers R. M. and D. M. Denbow, 2008. Anatomy and Physiology of Domestic Animals, 1st edition, Blackwell Publishing, Ames, Iowa.
- Marlin D., K. Nankervis, 2008. Equine Exercise Physiology, Blackwell Science Ltd, A Blackwwell Publishing Company, Oxford - Ames, Iowa – Carlton.
- Reece W. O., 2004. Dukes' Physiology of Domestic Animals, 12th edition, Comstock Publishing Associates, Cornell University Press, Ithaca-London.
- Husveth F., 2010: Physiological and reproductional aspects of animal production, University of Debrecen, University of Western Hungary, University of Pannonia http://dtk.tankonyvtar.hu/xmlui/handle/123456789/7396
- Senger P. L., 2004. Pathways to Pregnancy and Parturition, 2nd edition, Current Conceptions, Inc., Washington.

Individual/Personal tasks:
written essay in a chosen topic

Date:

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Ferenc Hustveth

Course title: Poultry nutrition

Course type: compulsory/elective

Prerequisites:

Responsible lecturer:	**Place of work, position:**
Prof. Károly Dublecz	Georgikon Campus Keszthely

Lessons required:	**Examination type**:	**Credit value:** 6
60 hours	oral exam	

Detailed content of course: Energy and protein metabolism, mineral and vitamin requirements, nutrition of growing birds, layers and breeders, feedstuffs of poultry nutrition, feed additives, the changing nutrient requirements with age and across genotypes, nutrition and product quality, nutritional aspects of gut health

Suggested literature:

1. Larbier; M. and B. Leclercq (1994): Nutrition and feeding of poultry. Nottingham University Press. Loughborough, Leicestershire, UK.
2. Leeson, S. and J.D. Summers (2001): Scott's nutrition of the chicken. University Books, Guelph, Ontario, Canada
3. Cole D.J.A. and W. Haresign (1989): Recent developments in poultry nutrition. Butterworths, London
4. Gransworthy, P.C. and J. Wiseman (1999): Recent developments in poultry nutrition II. Nottingham University Press. Loughborough, Leicestershire, UK.
5. Leeson, S. and J.D. Summers (1997): Commercial poultry nutrition. University Books, Guelph, Ontario, Canada

Individual/Personal tasks:

Date: 22.04.2022

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Karoly Dublecz professor

Course title: Poultry physiology and anatomy

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer:	**Place of work, position:**
Dr. László Pál	MATE Institute of Physiology and Nutrition, associate professor

Lessons required:	**Examination type**:	**Credit value:**
20 hours	oral exam	4

Detailed content of course:

The course introduces the anatomical and physiological characteristics of poultry. It highlights areas where the physiological functions of birds are special and different from those of mammals. Accordingly, it provides a basic knowledge of the physiological issues of poultry products (eggs, meat, etc.), highlighting the main correlations that determine the quality of products.
Outline of knowledge :
- Structure of the skeletal and muscular system of poultry
- Blood, circulation, respiration and gas exchange in birds
- Characteristics of neurohormonal regulation
- Structure of the digestive apparatus of poultry and characteristics of digestion
- Carbohydrate, protein and lipid metabolism in poultry
- The physiology of egg and meat production
- Physiological processes determining the quality of poultry products

Suggested literature:

Nickel, R. A., Schummer, E., Seiferle, E.: Anatomy of Domestic Birds, P. Parey Verlag, Berlin, 1986.
Causey Whittow, G. (szerk.): Sturkie,s Avian Physiology, Academic Press, California, 2000.

Individual/Personal tasks:

Date: 11 April, 2022

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. László Pál

Course title:
Project management in research

Course type: compulsory/**elective**

Prerequisites: ---

Responsible lecturer:	**Place of work, position:**	
Dr. habil. Gabor Pinter	associate professor	
Lessons required:	**Examination type**:	**Credit value:**
2 hours / week	oral+written examination	**3**

Detailed content of course:
This course builds on the significantly complements of project management knowledge acquired during the BSc and MSc courses. The aim is for the doctoral student to acquire knowledge that can be used in his/her own research.
The various experiments, research, studies or even tenders can be understood as projects. The course will show students the techniques and tools they can use to manage science projects. Quality, one of the most important "pillars" of projects, is also emphasised: TQM, JIT. Students will review the different time planning techniques (Gantt, CPM, MPM, PERT), learn how to link time planning with resource planning (human, mechanical, material, resource and financial). The problems of multiple dependencies and risky activities will be taught. The possibility of applying different reserve times and the method of determining the critical path and the consequences of its possible change, as well as the prediction of the change of the critical path, will be part of the material to be taught. The types of contracts and accounting methods to be used for each project are also part of the seminar.
By the end of the semester, the student should be able to put the project management toolkit at the service of writing his/her own PhD dissertation.

Suggested literature:
Dr. Henczi Lajos – Dr. Murvai László: projekttervezés és projektmenedzsment, Saldo, Budapest, 2012.
Dr. Harold Kerzner: A system approach to planning, scheduling, and controlling, John Wiley & Sons, USA, New-York, 2009.

Individual/Personal tasks:

Date: 21.04.2021.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Gabor Pinter

Course title: Ruminant Nutrition		
Course type: compulsory/elective		
Prerequisites: -		
Responsible lecturer: **Dr. Hedvig FÉBEL**	**Place of work, position: Hungarian University of Agricultural and Life Sciences** **2053 Herceghalom Gesztenyés str. 1.** **Scientific advisor, private professor**	
Lessons required: 30	**Examination type**: oral exam	**Credit value: 4**

Detailed content of course:

Energy evaluation system in ruminants
Protein evaluation system in ruminants
Specific aspects of nutrition in newborn ruminants
Nutritional aspects of high yielding dairy cows
Additives used in nutrition of ruminants
Nutrition, milk and meat quality
Connection between nutrition and reproduction in ruminants
Digestion physiological investigation techniques for evaluation feedstuffs

Suggested literature:

-Haresign, W., and Cole, D.J. (Editors). 1990.Recent Advances in Animal Nutrition. Butterworth
-National Research Council. 2007. Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids. Washington, DC: The National Academies Press. https://doi.org/10.17226/11654.
-National Research Council. 2001. Nutrient Requirements of Dairy Cattle: Seventh Revised Edition, 2001. Washington, DC: The National Academies Press. https://doi.org/10.17226/9825.
-National Research Council. 2016. Nutrient Requirements of Beef Cattle: Eighth Revised Edition. Washington, DC: The National Academies Press.

Individual/Personal tasks: project work

Date: 21.04.2022.

Signature: Head of Doctoral School Dr. Angela Anda Professor	Signature of lecturer: Dr. Hedvig Fébel

Course title: Scientific publication		
Course type: compulsory/elective		
Prerequisites:-		
Responsible lecturer: Dr. Szabolcs T. Nagy	**Place of work, position:** MATE, Institute of Animal Sciences	
Lessons required: 14	**Examination type**: oral/written	**Credit value:** **4**

Detailed content of course:

1. Why to publish?
2. where to publish?
3. how not to publish?
4. preparation of the manuscript - text, references
5. preparation of the manuscript - experimental design, related knowledge of statistics
6. preparation of the manuscript - tables, figures
7. submission and revision of the manuscript, answers to the reviewers
8. writing a review
9. Useful Accessories - Endnote, Viper, etc.
10. appearance, visibility - databases, search engines (Pubmed, Highwire, etc.)
11. MTMT
12. poster
13. presentation at a conference
14. Exercise - Joint review of a manuscript

Suggested literature:

. Robert Day, Barbara Gastel: How to Write and Publish a Scientific Paper. Cambridge University Press, 8th Edition. 2016.

Individual/Personal tasks:

Date: 21.04.2021.

Signature: Head of Doctoral School Dr. Angela Anda Professor	Signature of lecturer: Dr. Szabolcs T. Nagy Professor

Course title:
Sedges in Hungary

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer:	**Place of work, position:**
Judit Bódis	Department of Conservation Biology, Institute for Wildlife Management and Nature Conservation, Georgikon Campus

Lessons required:	**Examination type**:	**Credit value:**
30	colloquium	4

Detailed content of course:
Morphological features of the sedges.
An overview of the different classification options.
Systematic overview of the species of the 14 genera occurring in Hungary, with special emphasis on the most frequent species.
Genera discussed in detail: *Scirpoides, Schoenoplectus, Bolboschoenus, Scirpus, Blysmus, Eriophorum, Eleocharis, Cyperus, Cladium, Schoenus, Carex*

Suggested literature:
Conert, H. J., Hamann U., Schultze-Motel, W., Wagenitz, G. (eds.) 1992: Hegi, G. Illustrierte Flora von Mitteleuropa. II./1. Parey Verlag. Berlin, Hamburg.
Dahlgren, R. M. T., Clifford, H. T. & Yeo, P. F. 1985: The Families of the Monocotyledons. Structure, Evolution and Taxonomy. Springer-Verlag, Berlin.
Darók J. 2011: Növényanatómiai-botanikai terminológiai szótár. Akadémiai Kiadó, Budapest.
Felföldi L. 2002: Sás-határozó. Kitaibelia 7(1):1-100.
Jávorka S., Csapody V. 1975: Iconographia florae partis austro-orientalis Europae Centralis. (Közép-Európa délkeleti részének flórája képekben). Akadémiai Kiadó. Budapest.
Király G. (szerk.) 2009: Új magyar füvészkönyv Magyarország hajtásos növényei. Határozókulcsok. Aggteleki Nemzeti Park Igazgatóság. Jósvafő.
Király G., Virók V., Molnár V.A. (szerk.) 2011: Új magyar füvészkönyv Magyarország hajtásos növényei. Ábrák. Aggteleki Nemzeti Park Igazgatóság. Jósvafő.
Tutin, T.G., Heywood, V.H., Burges, N.A., Valentine, D.H., Walters, S.M., Webb, D.A. (eds.) 1980: Flora Europaea V. Alismataceae to Orchidaceae. Cambridge University Press.

Individual/Personal tasks: Project work may include an oral presentation of a selected genera and herbarium preparation. Field identification exercises.

Date (first announcement): March 2, 2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angéla Anda Professor	Dr. Judit Bódis Assistant professor

Course title:
The basis of plant molecular biotechnology

Course type: compulsory/elective

Prerequisites:-

Responsible lecturer: **Gábor Ottó Galiba, DSc**	**Place of work, position: Professor** Institute of Agronomy, Hungarian University of Agriculture and Life Sciences, 8360 Keszthely, Hungary; Agricultural Institute Centre for Agricultural Research, ELKH, H-2462 Martonvásár, Hungary

Lessons required: 45	**Examination type**: oral or written	**Credit value: 6**

Detailed content of course:
This course will cover the brief history of plant biotechnology more over the application of the molecular biotechnology methods at the recent modern agriculture. Plant biotechnology is founded on the principles of cellular totipotency and genetic transformation, which can be traced back to the Cell Theory of Matthias Jakob Schleiden and Theodor Schwann, and the discovery of genetic transformation in bacteria by Frederick Griffith, respectively. This course will elucidate a historical account of the evolution of the theoretical concepts and experimental strategies that led to the production and commercialization of biotech (transformed or transgenic) plants expressing many useful genes, and emphasizes the beneficial effects of plant biotechnology on food security, human health, the environment, and conservation of biodiversity. Finally, the many debates and controversies will also be highlighted concerning the human acceptance of the application of the gene technology in the plant breeding and production.

Suggested literature:

1) Part I INTRODUCTION TO PLANT BIOTECHNOLOGY Le Bui Van University of Science Plant Biotechnology, Vietnam, OpenCourseWare, April 2009,
2) Indra K. Vasil A history of plant biotechnology: from the Cell Theory of Schleiden and Schwann to biotech crops. Plant Cell Rep (2008) 27:1423–1440. DOI 10.1007/s00299-008-0571-4
3) Soltész, A ; Harwood, W ; Kalapos, B ; Vágújfalvi, A ; Galiba, G Key Molecular and Metabolic Processes Used for Genetic Engineering to Improve Freezing Tolerance in Cereals. In: Jones, HD Biotechnology of Major Cereals; Wallingford, Anglia : CABI Publishing, (2016) pp. 194-205. , 12 p
4) Alexandra Soltész, Mark Smedley, Ildikó Vashegyi, Gábor Galiba, Wendy Harwood and Attila Vágújfalvi: Transgenic barley lines prove the involvement of TaCBF14 and TaCBF15 in the cold acclimation process and in frost tolerance, Journal of Experimental Botany, Vol. 64, No. 7, pp. 1849-1862, 2013 doi:10.1093/jxb/ert050
5) Genome Edited Crops Touch the Market: A View on the Global Development and Regulatory Environment Jochen Menz, Dominik Modrzejewski, Frank Hartung, Ralf Wilhelm* and Thorben Sprink. Frontiers in Plant Science, REVIEW published: 09 October 2020 doi: 10.3389/fpls.2020.586027

Individual/Personal tasks:-

Date: 2022.04.04.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Gábor Ottó Galiba

Course title:
Theoretical and practical aspects of resistance breeding

Course type: compulsory/<u>elective</u>

Prerequisites:
Basics of plant breeding

Responsible lecturer:	**Place of work, position:**	
Dr. Gyula Vida	Centre for Agricultural Research, director-general	
Lessons required:	**Examination type**:	**Credit value:**
30 hours	essay	**4**

Detailed content of course:
In the course the types of plant biotic stress resistance and their genetic background will be presented. The relationship between types of inheritance and applicable selection methods will be discussed. Possible methods for phenotypic and genotypic evaluation of biotic stress resistance will be considered. The importance of different resistance mechanisms in breeding to produce new genetic sources will be investigated. The most important selection systems that can be used in biotic stress resistance breeding, the importance of interspecific hybridization to generate new sources of resistance, gene pyramiding and molecular marker-assisted selection will be reviewed.

Suggested literature:
Szunics L. – Szunics Lu. 2010: Rezisztencia vizsgálatok búzanemesítési tenyészkertekben
Mesterházy Á. 2000: A rezisztencianemesítés genetikai alapjai és molekuláris vonatkozásai
Gáborjányi R. – Király Z. 2007: Molekuláris növénykórtan

Individual/Personal tasks:
Literature review related to the research program, laboratory practice

Date: 18/08/2022

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angela Anda Professor	Dr. Gyula Vida

Course title: Small regulatory RNAs in Plants		**NEPTUN-code:**
Course type: compulsory/elective		
Prerequisites: basic molecular biology		
Responsible lecturer: Dr Eva Varallyay	**Place of work, position:** scientific advisor, MATE, Plant Protection Institute, Plant Pathology Department, Genomics Research group	
Lessons required: 28	**Examination type**: 3 level mark	**Credit value:** 4credit
Detailed content of course: Description and features of small RNAs History of RNAi Basic mechanisms of RNAi different classes of small regulatory RNAs (their features, investigation, biogenesis and processes regulated by them): miRNAs, tasiRNAs, natsiRNAs, siRNA based epigenetic processes RNAi base defence mechanisms, role of antiviral silencing in plant defence mechanisms, description and features of viral suppressors of silencing Key molecules of RNAi (DICERs, RDRDs, AGOs, their structure basic operation) Use of RNAi in functional genetics, plant breeding and in health care		
Suggested literature: selected scientific review papers		
Individual/Personal tasks:		
Date: 2022.04.06.		
Signature: Head of Doctoral School Dr. Anda Angéla Professor	Signature: Head of Department	Signature of lecturer: Varallyay Eva Varallyay

Course title: The Global Warming		
Course type: compulsory/elective		
Prerequisites: -		
Responsible lecturer: Dr. Angela Anda	**Place of work, position:** MATE, Dept. of Agronomy, professor	
Lessons required: 4 hours weekly	**Examination type**: oral report	**Credit value: 8**
Detailed content of course: Study on the IPCC Sixth Report (short version). See also in the suggested literature. Facts, consequences based on the Report. Changes and mitigation. Overview of selected publications related to doctoral topics of the students		
Suggested literature: The Physical Science Basis Summary for Policymakers; 2021; Working Group I. Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change; pp 42. .		
Individual/Personal tasks: Individually selected actual publications belonging to the topic of PhD student		
Date: Keszthely, 2023 Mach		
Signature: Head of Doctoral School Dr. Angela Anda professor	Signature of lecturer: Dr. Angela Anda professor	

Course title:
General principles of toxicology

Course type: obligatory/optional

Prerequisites:
None

Responsible lecturer:	**Place of work, position:**	
Dr. Péter Budai	Department of Plant Protection, Institute of Plant Protection, Georgikon Campus, Hungarian University of Agriculture and Life Sciences, associate professor	
Lessons required:	**Examination type**:	**Credit value:**
40	three-level assessment	4

Detailed content of course:

- term definitions and their interpretation: poison, poisoning, poisoning potency of chemicals, branches of toxicology, forms of poisoning……..…. 4 hours
- basic principles of toxicology ..……2 hours
- toxicokinetics…….……12 hours
- toxicodynamics…….……....4 hours
- factors influencing toxicity…….…..……2 hours
- dose-response relationships..…….…… ..2 hours
- specific toxic effects, genotoxicity, carcinogenicity, teratogenicity……..12 hours
- pesticide registration…….. ……..2 hours

Total: 40 hours

Suggested literature:

Kiss I., Várnagy L.: Toxikológia. Veszprémi Egyetemi Kiadó. Veszprém, 1997.
Várnagy L., Budai P.: Mezőgazdasági vegyi anyagok higiéniája és toxikológiája. Veszprémi Egyetemi Kiadó. Veszprém, 2003.
Williams P.L., James R.C., Roberts S.M. (eds.): Principles of toxicology: Environmental and Industrial Applications. JOHN WILEY & SONS, INC., USA, 2000.
Lehel J., Laczay P.: Toxikológia. Szent István Egyetemi Kiadó, Budapest, 2011.

Individual/Personal tasks: -

Date: 22nd June 2022.

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angéla Anda professor	Dr. Péter Budai associate professor

English name of the course:
Plant-biotechnology and research methodology I.

Course type: compulsory/elective

Prerequisites:
Chemistry, Botany, Plant Physiology, Genetics, Plant Breeding

Responsible lecturer: Dr. János TALLER	**Place of work, position:** MATE, Institute of Genetics and Biotechnology, Georgikon Campus, Imre Festetics Bioinnovation Centre, Senior researcher

Lessons required: 45	**Examination type**: Oral	**Credit value:** 6

Detailed content of course:

1. Basics of experiments in molecular biology:
   - To the use of a molecular genetic laboratory
   - Dishes, flasks, plastic,- glass,- metal,- and ceramics tools
   - Purity requirements, work in a molecular lab
   - Measuring and pipetting tools and their use
   - Experimental tools, equipment and instruments, and their use
   - Distilled water, ion-exchanged water, ultra-pure water
   - About sterilization
   - Chemicals, reagents, solutions and their preparation
   - Preservation at room temperature, cooling, freezing, ultra-freezing
   - Liquid nitrogen and its use; about dry ice
   - Incubation by cooling and by heating
   - Separation techniques
   - Sterile technologies, preparation of bacterial and plant media
   - Maintenance of sterile experimental material; micropropagation
2. Basic methods in molecular genetics
   - Sampling, sample preservation, sample preparation
   - DNA,- RNA,- as well as protein extraction
   - Enzymes and their use
   - Molecular cloning
   - Southern, as well Northern hybridization
   - Sequencing and in silico analysis

Suggested literature:
Publications, studies, protocols which are handed out during the course.

Individual/personal tasks:
Joining to a running project of the Biotechnology lab, or realization of an own research program after acquiring the basic techniques.

Date: 22nd June 2023.

Signature: Head of Doctoral School **Dr. Angéla Anda**	**Signature of lecturer:** 

English name of the course:
Plant-biotechnology and research methodology II.

Course type: compulsory/elective

Prerequisites:
Chemistry, Botany, Plant Physiology, Genetics, Plant Breeding

Responsible lecturer: Dr. János TALLER	**Place of work, position:** MATE, Institute of Genetics and Biotechnology, Georgikon Campus, Imre Festetics Bioinnovation Centre, Senior researcher

Lessons required: 45	**Examination type**: Oral	**Credit value:** 6

Detailed content of course:

3. Polymerase chain reaction and its applications:
   - Theoretical bases, materials, types of thermal cyclers, their function and programing
   - Electrophoresis, detection and analysis of polymorphisms
   - Optimization of PCR reactions, typical reaction errors
   - Collection of data and pattern evaluation
   - Real-time PCR theoretical bases, preparation of a reaction and evaluation
4. Libraries:
   - cDNS library as well genome library preparation, storage and use
5. Gene expression analysis:
   - Subtractive hybridization
   - Microarray
   - Next generation sequencing (NGS) technologies
   - Analysis of transcription data
   - Types of vectors, vector construction
   - Transformation of plants
   - Functional analysis of genes: Agrobacterium mediated transient expressions, antisens technology, RNAi
6. Protein analyses:
   - SDS-PAGE, 2D-electrophoresis, Western-blot

Suggested literature:
Publications, studies, protocols which are handed out during the course.

Individual/personal tasks:
Joining to a running project of the Biotechnology lab, or realization of an own research program after acquiring the basic techniques.

Date: 22nd June 2023.

Signature: Head of Doctoral School **Dr. Angéla Anda**	**Signature of lecturer:**

Course title: Regulatory Ecotoxicology

Course type: compulsory/elective **elective**

Prerequisites:
Environmental Hygiene, Methods in animal toxicology

Responsible lecturer:	**Place of work, position: retired,**
Dr. habil. Istvan M. Somlyay	**affiliated professor**

Lessons required:28	**Examination type**: written test	**Credit value: 4**

Detailed content of course:

Introduction to Regulatory Ecotoxicology (global trends, international regulation and harmonization),
Fate of agrochemicals in the environment, ecological exposition, modelling,
Testing of chemical burden of aquatic community (acute, chronic),
Testing of sediments, including biotest methods,
Terrestrial ecotoxicology,
Prediction of environmental concentration of chemicals,
Testing of beneficials, pollinator,s safety , complying to Reduced Risk Category,
Avian ecotoxicology and studies wild mammals in connection to evaluation of biomonitoring data,
Regulatory test with earthworms (EPA, BBA, EU…) requirements,
Non-Target Plant (NTP) testing international methods,
Soil microflora testing,

Preparation and design of study protocols,…reporting templates,
Quality Assurance of tests,…GLP, GEP….
Ecotoxicological Risk Assessment of agrochemicals,…case studies,.

Suggested literature:

Casarett and Doull,s (1996): Toxicology. (Unit 6 Environmental Toxicology) McGraw-Hill, New York.
US EPA (1993): Wildlife Exposure Factors Handbook. EPA/600/R-93/187a.
Mark, L. Lynch (1995): Procedures for assessing the environmental fate and ecotoxicity of pesticides. SETAC-Europe 1995.
EPPO (1994): Decision making scheme for the environmental risk assessment of plant protection products. EPPO Bulletin 24: 1-87.

Individual/Personal tasks:

Date: 22nd June 2023.

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	**Dr. habil. Istvan M. Somlyay**

Course title: Ornamental fish production

Course type: **compulsory**/elective

Prerequisites: Any aquaculture related subject

Responsible lecturer: dr. Gábor Beliczky	**Place of work, position:** Hungarian University of Agriculture and Life Sciences, Institute of Aquaculture and Environmental Safety, Department of Applied Fish Biology

Lessons required: 30	**Examination type**: oral exam, three-level assessment	**Credit value: 4**

Detailed content of course:

Ornamental fish culture, introduction, history
Commercially important ornamental fishes
Fabrication of aquarium, setting up of aquarium
Aquarium accessories for small scale units
Aquarium accessories and equipments for large scale units
Aeration and filtration, water quality management
Aquarium plants
Feed and feeding management, culture of live food organisms, preparation of artificial feed
Breeding of live bearers, breeding of egg layers
Common diseases and their control measures
Application of genetics and biotechnology
Transport of ornamental fishes
Ornamental fish trade

Suggested literature:

https://www.practicalfishkeeping.co.uk/
Horn P., Zsilinszky S. (1970 or later) - Akvarisztika. Gyakorlati díszhaltenyésztés, Natura, Budapest.
http://ecoursesonline.iasri.res.in/course/view.php?id=297

Individual/Personal tasks: An overview of the latest literature in a field chosen together with the lecturer.

Date: 19.08.2023.

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	**Dr. Gábor Beliczky**

Course title: Special methods in aquaculture

Course type: compulsory/**elective**

Prerequisites: Any aquaculture related subject

Responsible lecturer: dr. Gábor Beliczky	**Place of work, position:** Hungarian University of Agriculture and Life Sciences, Institute of Aquaculture and Environmental Safety, Department of Applied Fish Biology

Lessons required: 45	**Examination type**: oral exam, three-level assessment	**Credit value: 6**

Detailed content of course:

The status of aquaculture (Hungary and the World), introduction, history, opportunities etc.
Commercially important fish species in aquaculture
Different culture technologies: extensive, semi-intensive, intensive
Pond, flow-through, cage, RAS and combined, integrated technologies, special circumstances, special devices
Fresh-, brackishwater, mariculture
The environmental impact of different technologies
Challenges in aquaculture
Genomic selections, biotechnology
Disease control
Animal welfare
Market, changing demands of consumers, large-scale future
…

Suggested literature:

Craig S. Tucker, John A. Hargreaves – 2008 - Environmental Best Management Practices for Aquaculture, Print ISBN:9780813820279 |Online., ISBN:9780813818672, DOI:10.1002/9780813818672, Copyright © 2008 John Wiley & Sons, Inc
https://haki.naik.hu/sites/default/files/uploads/2018-09/sustainaqua_handbook_en.pdf
https://www.fao.org/3/i4626e/i4626e.pdf
https://www.fao.org/3/t8598e/t8598e05.htm#TopOfPage

Individual/Personal tasks: An overview of the latest literature in a field chosen together with the lecturer.

Date: 19.08.2023.

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	**Dr. Gábor Beliczky**

Course title: Basics of Environmental Risk Assessment		
Course type: compulsory/elective		
Prerequisites: -		
Responsible lecturer: **Dr. István Sebestyén**	**Place of work, position:** **NEVEX Institute Ltd., Budapest, Scientific director**	
Lessons required: **30 hours**	**Examination type**: **three-level assessment**	**Credit value:** **4 credits**

Detailed content of course:
Overview of ecotoxicological testing methods; basics of risk assessment, definitions; key components of risk assessment; environmental risk and its measurement; process of risk management; differences between human and environmental risk assessment; characterization of risk; assessment of environmental exposure; risk assessment; reduction of environmental risk; environmental risk assessment for pesticide authorization; registration data requirements for pharmaceuticals and veterinary products for environmental risk assessment; registration requirements for industrial chemicals and the process of environmental risk assessment according to the REACH regulation; environmental risk assessment of genetically modified crops, case studies.

Suggested literature:

Dura Gyula, Gruiz Katalin, László Erzsébet, Vadász Zsolt: Szennyezett területek részletes mennyiségi kockázatfelmérése (Kármentesítési kézikönyv ; 3.) KÖM, Budapest, 2001.

Dura Gy., Horváth A.: Az emberi egészségkockázat becslése környezet- és talajszennyeződés esetén. In: Simon L. szerk.: Talajszennyeződés, talajtisztítás.2. bővített kiadás. Környezetügyi műszaki-gazdasági tájékoztatás sorozat. Budapest, 1999

C.J. van Leeuwen, J.L.M. Hermens: Risk Assessment of Chemicals: An Introduction. Kluwer Academic Publishers. Dordrecht, 1996

UNEP/IPCS Training Module No. 3, Section C, Ecological Risk Assessment, Prepared by The Edinburgh Centre for Toxicology, 2001

Gruiz Katalin, Horváth Beáta, Molnár Mónika: Környezettoxikológia, Műegyetemi kiadó, Budapest, 2001

Guidance Document on Aquatic Ecotoxicology, EUROPEAN COMMISSION HEALTH & CONSUMER PROTECTION DIRECTORATE-GENERAL Directorate E - Food Safety: plant health, animal health and welfare, international questions, Sanco/3268/2001 rev.4 (final) 17 October 2002

Guidance Document on Terrestrial Ecotoxicology EUROPEAN COMMISSION HEALTH & CONSUMER PROTECTION DIRECTORATE-GENERAL Directorate E - Food Safety: plant health, animal health and welfare, international questions, SANCO/10329/2002 rev 2 final 17 October 2002

Guidance on information requirements and chemical safety assessment, Chapter R.10: Characterisation of dose [concentration]-response for environment, European Chemicals Agency, 2008

Guideline on the environmental risk assessment of medicinal products for human use, European Medicines Agency, London, 2006 (EMEA/CHMP/EWP/4447/00 corr 1)

Revised guideline on environmental impact assessment for veterinary medicinal products in support of the vich guidelines GL6 and GL 38, European Medicines Agency, London, 2008 (EMEA/CVMP/ERA/418282/2005-Rev.1)

European Food Safety Authority; Guidance Document on Risk Assessment for Birds & Mammals on request from EFSA. EFSA Journal 2009; 7(12):1438. doi:10.2903/j.efsa.2009.1438. Available online: www.efsa.europa.eu

Individual/Personal tasks: -

Date: 2023. augusztus 15

Signature: Head of Doctoral School **Dr. Angela Anda**	**Signature of lecturer:** **Dr. István Sebestyén**

Course title: Environmental problems and their solutions in agriculture

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer: Prof. Angela Anda **Collaborative lecturers**: Em. Prof. Ferenc Husvéth and Prof. Zsolt Polgár	**Place of work, position**: MATE, Georgikon Campus, Keszthely

Lessons required: 60 hours	**Examination type**: written and oral	**Credit value**: 8

Detailed content of course:

1. Lectures with presentations

Janus faced ozone in the atmosphere. The role of the stratospheric ozone. Tropospheric ozone formation, the smog with its consequences. The acid rain.
Global warming with its physical basis. The current situation based on the last IPCC Report (international relations). Hungarian (local) relevance regarding the mitigation with the negative impacts of global warming.

Environmental aspects of animal production
· Adaptation of domestic animals to different environmental conditions
· Effect of heat and cold stress on the production and behavior of farm animals
· Stressors influencing the fertility of farm animals
· Effect of grazing on pastures with different protections from the point of view of environment conservation
· Processes for decreasing the emissions of different harmful materials in large scale animal production
· Environmental influence of animal products using for human foods
Environmental aspects of plan production
Exam: oral one

2. Personnel tasks connected to the PhD student's topic

Exam: Three written essay relating to the three subject branches, and a short presentation

Suggested literature: discussed and accepted selected publications related to the topic of the PhD student for every sub-topic (environmental, crop growing and animal husbandry ones).
6th IPCC Report, UN (2022):
https://www.un.org/en/climatechange/reports?gclid=CjwKCAjwsJ6TBhAIEiwAfl4TWAZYLkQM3180o41xv1MyhDtjIphdEvKBqC-DuNSn0qJcw4JRs-P01hoCZqAQAvD_BwE

Individual/Personal tasks: discussed by the three participating professors, preliminary.

Date: August 2023

Signature: Head of Doctoral School Dr. Angéla Anda Professor	**Signature of responsible lecturer**: Dr. Angéla Anda Professor

Course title:
Feed and food analytics

Course type: compulsory/elective

Prerequisites:
-

Responsible lecturer:	**Place of work, position:**
Dr. Wágner László	MATE, Institute of Physiology and Nutrition, associate professor

Lessons required:	**Examination type**:	**Credit value:**
30 h	kollokvium	4 credit

Detailed content of course:

1. Selection of techniques Used in Food Analysis
2. Statistical Assessment of Result of Food Analysis
3. Analysis of Drinking Water
4. Analysis of Protein, Peptides, and Amino Acids in foods
5. Extraction and Analysis of Food Lipids
6. Determination and Speciation of Trace Elements in Foods
7. Analysis of Vitamins for the Health, Pharmaceutical, and Food Sciencies
8. Analysis of Carotenoids and Chlorophylls in Foods
9. Analysis of Polyphenols in Foods
10. Determination of Pesticide Residues
11. Determination of Pollutants in Foods
12. Analysis of Chemical Preservatives in Foods

Suggested literature:

.

.- Semih Ötles (2005): Methods of Analysis of Food Components and additives, Taylor & Francis, Boca Baton
- A. van Amerongen – D. Barug – M. Lauwaars (2005): Rapid methods for biological and chemical contaminants in food and feed, Wageningen Academic Publishers
- S. Suzanne Nielsen (2003): Food Analysis, Springer, New York

Individual/Personal tasks:
-

Date: August 2023

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Anda Angéla Professor	Dr. Wágner László Associate Professor

Course title: Insect Ecology

Course type: compulsory/elective

Prerequisites: applied entomology

Responsible lecturer: Dr Zsolt Ferenc Marczali	**Place of work, position: Hungar** University of Agriculture and Life Scien Institute of Plant Protection, Department Plant Protection, associate professor

Lessons required: 28	**Examination type**: three-step evaluation	**Credit value: 4**

Detailed content of the course:

The history of ecology, its place in the system of sciences, basic concepts of ecology, levels of biological organisation, and subdivision of ecology. Basic knowledge of autecology. Abiotic environmental factors. Biotic environmental factors. Insect dormancy. Photoperiod and insect development. Basic synecological knowledge. Synecological investigation methods. Basic knowledge of population dynamics.

Suggested literature:

Begon, M., Townsend, C.R. (2021): Ecology: From Individuals to Ecosystems, 5th Edition. Wiley 864 pp. ISBN: 978-1-119-27935-8.

Speight, H.R., Hunter, M.D., Watt, A.D. (1999): Ecology of insects. Blackwell Science, 350 pp.

Schoonhoven, L.M., Jermy, T., van Loon. J.J.A. (1998): Insect-Plant Biology. London Chapman & Hall 409 pp. ISBN-13: 978-0412804809.

Schoonhoven, L.M., van Loon, J.J.A., Dicke, M. (2006): Insect-Plant Biology 2nd Edition. Oxford University Press; 440 pp. ISBN-10: 019852594X.

Individual/Personal tasks:

Determination of biological threshold temperature, e.g., potato beetle

Determination of the amount of heat required for the development of a generation, e.g. potato beetle

Investigation of the relationship between the Walter–Lieth climate diagram and pest development

Date: August 2023

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr Angela Anda	**Dr Zsolt Ferenc Marczali**

<table>
<tr><td colspan="3">Course title: Insect Physiology</td></tr>
<tr><td colspan="3">Course type: compulsory/elective</td></tr>
<tr><td colspan="3">Prerequisites: applied entomology</td></tr>
<tr><td colspan="2">Responsible lecturer: Dr Zsolt Ferenc Marczali</td><td>Place of work, position: Hungar University of Agriculture and Life Scien Institute of Plant Protection, Department Plant Protection, associate professor</td></tr>
<tr><td>Lessons required: 28</td><td>Examination type: three-step evaluation</td><td>Credit value: 4</td></tr>
<tr><td colspan="3">Detailed content of the course:
Insect vegetative life functions (integument, musculature, metabolism, respiration, circulation, excretion, osmotic regulation). Insect internal regulation and communication (endocrine system, sensory organs, semiochemicals). Insect developmental physiology (reproduction, embryonic and postembryonic development).</td></tr>
<tr><td colspan="3">Suggested literature:
Klowden, M.J. (2007): Physiological systems in insects. Second edition. Elsevier Science, 688 pp.
Nation, J.L. (2002): Insect physiology and biochemistry. CRC Press, Boca Raton–London–New York, Washington (D.C.) 485 pp.</td></tr>
<tr><td colspan="3">Individual/Personal tasks:
-</td></tr>
<tr><td colspan="3">Date: August 2023</td></tr>
<tr><td colspan="2">Signature: Head of Doctoral School

Dr Angela Anda</td><td>Signature of lecturer:

Dr Zsolt Ferenc Marczali</td></tr>
</table>

Course title: Pesticide Chemistry

Course type: compulsory/elective

Prerequisites: Organic Chemistry, Biochemistry, Plant Physiology

Responsible lecturer: Prof. Dr. Éva Lehoczky	**Place of work, position:** Department of Environmental Sustainability, Institute of Environmental Sciences, Georgikon Campus Keszthely Professor

Lessons required:	**Examination type**:	**Credit value: 6**

Detailed content of course:

- The role of pesticides in integrated plant protection. The quantitative and qualitative indicators of pesticide use in Hungary, in Europe and in the World.
- Pesticide formulation. Basic information about pesticide ingredients: active and inert ingredients. The role and types of inert ingredients (carriers, adjuvants, etc.) and their important physical and chemical properties. Types of formatting. Application methods of pesticides.
- Authorization system of plant protection products in EU, legislation, regulation.
- Pesticide groups
- Fungicides: chemical properties, mode of action, groups of active ingredients, products
- Insecticides: chemical properties, mode of action, groups of active ingredients, products, perspective trends.
- Herbicides: chemical properties, mode of action, groups of active ingredients, products
- Resistance to plant protection products
- The impact of pesticides on the environment. New development directions of pesticides

Suggested literature:

Cremlyn, R.J. (1991): Agrochemicals. Preparation and Mode of Action. John Wiley and Sons, Chichester, New York, Brisbane, Toronto, Singapore
Scientific publications
https://www.ippc.int/en/external-cooperation/regional-plant-protection-organizations/eppo/
https://www.eppo.int/ACTIVITIES/ppp_activities

Individual/Personal tasks: review report preparation – agreed topic

Date: August 2023

Signature: Head of Doctoral School **Dr. Angela Anda**	**Signature of lecturer:** **Dr. Éva Lehoczky**

Course title: Physical properties of the three phase soil systems

Course type: compulsory/**elective**

Prerequisites: basic knowledge of soil science

Responsible lecturer: András Makó	**Place of work, position:** ATK Institute of S Science, Department of Soil Physics and Wat Management, scientific advisor

Lessons required: 30	**Examination type**: oral examination, three-stage assessm	**Credit value:** 4

Detailed content of course:

1. Soil structure. Soil mineral composition. The main silicate minerals that make up soils. Classification of clay minerals, their properties.
2. Elementary soil particles. Concepts and study of particle size distribution.
3. Structure of soils. Interpretation and description of soil structure. Biological, chemical and physical factors in the formation of soil structure.
4. Soil structure and porosity. Soil pores. Soil structure and water conductivity. Stability of soil structure. Degradation of soil structure.
5. Water content of soils. Interactions of water and soil. Swelling and shrinkage of soils. Effect of soil swelling and shrinkage on soil structure. Cracking of soils.
6. Water retention of soils. Soil water potential. Capillarity of soils. Hysteresis phenomenon related to soil moisture content.
7. Field and laboratory measurement of water content and moisture potential of soils.
8. Basic laws of water movement in soils (waterlogged soils). Darcy's law. Water movement in waterlogged soils. Factors affecting hydraulic conductivity. Field and laboratory measurements of hydraulic conductivity of soils.
9. Basic laws of water movement in soils (water unsaturated soils). Capillary water movement in soils (types of water movement). Water infiltration and soil permeability. Capillary conductivity. Measurement possibilities.
10. Pedotransfer functions.
11. Groundwater. Natural and artificial drainage of soils. Methods of testing groundwater pressure and flow rate.
12. Soil water management - management of soil water content. Water balance of soils.
13. Soil physics principles of irrigation and water management.
14. Soil consistency relations. Soil strength. Soil compaction.
15. Soil physics aspects of soil erosion and control. Detrimental effects of soil erosion. Water erosion and its forms. Estimation of erosion loss by models. Wind erosion (deflation). Modelling of wind erosion. Principles of erosion control.
16. Movement of chemicals in soils (water soluble and less soluble compounds).

Suggested literature:

Daniel Hillel: Environmental Soil Physics: Fundamentals, Applications, and Environmental Considerations. Academic Press; 1st edition (September 9, 1998)
Rattan Lal: Principles of Soil Physics. CRC Press; 1st edition (September 27, 2019)

Individual/Personal tasks: -

Date: 17 July 2023.

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	**Dr. András Makó**

Course title: Rheology of agricultural materials

Course type: compulsory/elective

Prerequisites:

Responsible lecturer: Dr. Béla Pályi	**Place of work, position:** MATE**,** Institute o Technology**,** Department of Agricultural Mechanization, Georgikon Campus, associate professor

Lessons required: 30 hours	**Examination type**: three grades of evaluation	**Credit value:** 4 credit

Detailed content of course:

1. Physical properties of agricultural materials (form, size, surface area, volume and density), mechanical properties.
2. Basics of rheology: properties of biological materials, ideal materials and their properties, viscoelastic materials. Rheological models and equations. Non-Newtonian fluids. Viscosimetry.
3. Applications of rheology: force and deformation relationships, stress and relative strain relationships. Mechanics of granular materials, general laws, examples of applications: friction coefficient of agricultural materials, cutting, shredding, compaction. Soil rheology.
4. Aerodynamic and hydrodynamic characteristics: drag coefficient, floating rate, pressure loss, characteristic numbers and laws of similarity.
5. Wall pressure of tanks. Factors of lateral pressure. Leakage from tanks.

Suggested literature:

1. Sitkei György: A mezőgazdasági anyagok mechanikája. Akadémiai kiadó, Budapest 1981
2. Sitkei György (szerk): Gyakorlati áramlástan. Mezőgazdasági Szaktudás Kiadó, Budapest,1997.
3. Dr.Komándi Györgyné: A kertészeti termények agrofizikai adatai. Mezőgazdasági Kiadó, Budapest,1981

Individual/Personal tasks:

Date: August 2023

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	Dr. Béla Pályi

Course title:
Theoretical Implications in Nutrient Management and Nutrient Dynamics

Course type: obligatory/optional

Prerequisites: ---

Responsible lecturer:	**Place of work, position:**
Prof. em. Katalin SÁRDI, CSc	University of Agrar and Life Sciences, Georgikon Campus

Lessons required:	**Examination type**:	**Credit value:**
32 (22 contact hours + 10 hours individual work)	Colloquium, Oral	**4**

Detailed content of course:

Nutrient transformation processes in soils and several approaches used for studying them. Model experiments and their application. Chemical characteristics of ion exchange in soils. Nutrient adsorption and desorption. The role of soil organic matter (SOM) in soil fertility. Characteristics of Nitrogen cycling, forms of soil N and their transformation. Soil-plant-nutrient interactions and their role in N dynamics. Soil P forms and transformation processes. The role of soil characteristics in the transformation of soil P compounds. Main factors of soil P fixation and supply. Soil-plant-nutrient interactions and their role in P dynamics.

Soil K forms and transformation processes. The role of clay minerals in the soil K dynamics. Main factors of soil K fixation and supply. Soil-plant-nutrient interactions and their role in K dynamics.

Ca, Mg, S and microelement cycling and transformation. Maintaining soil fertility based on the concept of sustainable agricultural production. Methods of nutrient balance calculations. Theoretical implications of nutrient management (philosophies and approaches). Importance of nutrient deficiencies and excesses (nutrient stress) in crop pruduction. Plant responses to nutrient (macro- and microelement) imbalances. The role of ionic balance (antagonism and synergism).

Suggested literature:

SHORT-TERM TRANSFORMATION AND DYNAMICS OF MAIN NUTRIENTS IN SOIL (2017). Sárdi, K. In: Essential Plant Nutrients. Springer. ISBN:978-3-319-58840-7. pp. 379-401

NUTRIENT MANAGEMENT (2010) Sárdi, Katalin. Textbook written in the project TÁMOP-4.1.2.-08/1/A-2009-0010 127 p.

SOIL FERTILITY AND FERTILIZERS. Havlin-Beaton-Tisdale -Nelson (2014): Eighth Edition. Pearson Prentice Hall New Jersey, USA.

GROWTH and MINERAL NUTRITION of FIELD CROPS (Fageria et al.) CRC Press, **2011.**

Sumner, M.E. (Ed.) Handbook of Soil Science. CRC Press, Boca Raton, 2000. Section B: Ion Exchange. Section C: Nitrogen Transformations. Section D: Nutrient Interactions in Plant Nutrition.

Bohn, H. – McNeal, B. – O'Connor, G.: Soil Chemistry. (3rd Edition). John Wiley & Sons, Inc. New York, 2001. Chapters 5 -9.

Individual/Personal tasks: Preparation of an essay in a topic selected by the student

Date: February 2023

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Angéla Anda	Dr. Katalin Sárdi

COURSE TITLE: Fertilizer-Soil Interactions

Course type: Obligatory/optional

Prerequisites: --

Responsible lecturer:	**Place of work, position:**
Prof. Em. Dr. habil. Katalin SÁRDI	MATE Georgikon Campus

Lessons required:	**Examination type**:	**Credit value**
16 (10 contact hours + 6 hours individual)	Oral	**2**

Course content description:

Importance of fertilization, principles of environmentally sound fertilizer application. Terms and definitions. Types of fertilizers. Fertilizer generations. Environmental impact of fertilizer-soil interactions and approaches for reduction. Importance of nutrient transformation in soils, characteristics of timescal. Interactions between Nitrogen, Phosphorus, Potassium and other fertilizers and soils, depending on soil characteristics. Actual concepts in fertilization (the „4R" concept), FAO and OECD guidelines. Role and application of environmental indicators (OECD and others) related to fertilizer use. Site specific, precision nutrient management. Actual legislation and regulation on fertilizer products based on international guidelines: Good Agricultural Practice and EU Regulation. **Course requirements: Individual work:** Preparation of an essay (6-10 pages) in a topic selected by the student. Essays should be submitted both electronical and printed version before the end of the semester. Result of evaluation will be calculated in final grade.

Final grades will be calculated from the qualification of the work on an individual basis: a.) essay b.) oral examination.

SUGGESTED LITERATURE:

SHORT-TERM TRANSFORMATION AND DYNAMICS OF MAIN NUTRIENTS IN SOIL (2017). Sárdi, K. In: Essential Plant Nutrients. Springer. ISBN:978-3-319-58840-7. pp. 379-401

NUTRIENT MANAGEMENT (2010) Sárdi, Katalin. Textbook written nt he project TÁMOP-4.1.2.-08/1/A-2009-0010 127 p.

SOIL FERTILITY AND FERTILIZERS. Havlin-Beaton-Tisdale –Nelson (2014): Eighth Edition. Pearson Prentice Hall New Jersey, USA.

THE IMPACT OF FERTILIZATION ON THE ENVIRONMENT. Debreczeni Bné- Sárdi K. (1997). Columbia University Seminar Proceedings. pp. 190-210.

ENVIRONMENTAL IMPACT OF AGRICULTURAL PRODUCTION. Sárdi, K. 2014. Textbook, University of Pannonia, Georgikon Faculty. www.georgikon.hu/Moodle

HANDBOOK of SOIL SCIENCE (Sumner, M.E. (Ed.) CRC Press, Boca Raton, 2000. Section B: Ion Exchange. Section C: Nitrogen Transformations. Section D: Nutrient Interactions in Plant Nutrition.

AGRICULTURE, FERTILIZERS & THE ENVIRONMENT. Lægreid, M. – Bøckman, O.C. and O. Kaarstad. (1999), Part II: Soil productvity, fertilizer use and the env. CABI Publishing.

THE HANDBOOK OF SOIL SCIENCE (2000) M. Sumner Section D.D1-186) CRC Press, NJ, USA.

GROWTH and MINERAL NUTRITION of FIELD CROPS (Fageria et al.) CRC Press, **2011.**

EFFICIENCY of SOIL and FERTILIZER PHOSPHORUS USE. (2008), Syers, J.K. et al. FAO Fertilizer and Plant Nutrition Bulletin 18.

SUSTAINABLE SOIL MANAGEMENT (2004). P. Sullivan. www. attra.ncat.org.

PEARCE, R. (ed.) 1999. Environmental Indicators for Agriculture Vol 2. Issues and Design. The York Workshop. OECD. 213 p.

Date: February 2021

Signature of Doctoral School:	Signature of Responsible Lecturer:
Dr. Angela Anda	Dr. Katalin Sárdi

Name of the Course: Methodology in Pot Experiments

Lecturer: Dr. habil. Katalin SÁRDI, CSc
Co-lecturer:
Dr. Tibor Janda, DSc, CAR of HAS

Lessons: 32 (14 contact lessons + 8 hours practice + 10 hours individual work	Examination and Evaluation: Colloquium, Oral	**Credit: 4**

Aim of the Course:

The aim of the course is to provide information on pot experiments, methods and media commonly used in greenhouses and phytotronics, preparation and technical requirements, main aspects of evaluation and data interpretation from results.

Course Program:

Importance of pot experiments in the studies of nutrient dynamics. Methods and media commonly used in pot experiments: sand, soil, natural and artifical growing media. Greenhouses and phytotronics.

Methodological requirements in pot experiments. Planning and design of the experiments (treatments, duration, test plants, soil types etc.). Preparation of soils/growing media, pot size and types. Amounts and chemical forms of nutrients and their ratios, balanced and imbalanced supply. Sowing, number of plants per pot, phytotechnics, water supply and control. Environmental requirements of experiments conducted in greenhouses and under controlled conditions (light, temperature, humidity etc.). Technical conditions of experiments. Parameters to be measured during the experiment and requirements of the harvest. Main aspects of evaluating the results. Interpretation and application of results.

Practice: preparation, setting, conduction and harvesting of the experiments: preparation of soils and other growing media. Preparation of fertilizers and seeds. Application of phytotechnics during the experiments. Presentation of methodologies in the greenhouse. Visiting the phytotronics and experiments under controlled environments in the Center of Agricultural Research of the Hungarian Academy of Sciences (CAR of HAS) in Martonvásár.

Suggested Literature:

Bergmann, W. : Ernahrungsstörungen bei Kulturpflanzen. Gustav Fischer Verlag Jena-Stuttgart 1993.

Chouard, P. - Bilderling, N. : Phytotronics in agricultural and horticultural research. Gauthier-Villars, 1975.

Downs, R.J.: Controlled environments for plant research. Columbia Univ. Press, New York, 1975.

Ellis, C. (2002): Soilless growth of plants. New Delhi, Agrobios. 278 p.

Giesecke, F. Der Vegetationversuch . 2. Der Gefassversuch und seine Technik. Metodenbuch, Band IX. Neumann Verlag, Radebul und Berlin. 1954.

Hanan, J.J. - Holley, W.D. - Goldsberry, K.L.: Greenhouse management. Springer Verlag, Heidelberg, 1978.

Mastalerz, J.W. : The greenhouse environment. John Wiley and Sons, New York-Toronto, 1977.

Raviv, M. – Lieth,J.H. (2008): Soilless Culture. Elsevier, Oxford.

Tischner, T. - Kőszegi, B. - Veisz, O.(1997): Climatic programmes used in the Martonvásár phytotron most frequently in recent years. Acta Agron. Hung. 45: 85-104.

Yung, L. Sirguey, C. Azou-Barré, A. and Blaudez, D, (2021): Experimental Design of the Pot Experiment. Bio-protocol.org/exchange

Individual/Personal tasks and Evaluation:

Final grades will be calculated from the results of qualification of the work: on an individual basis, c.) written and oral examinations. For excellent works, efficiencies, outstanding results etc., extra points may be earned. Minimum requirement of written examinations : 55 percent.

Date: February 2019

Signature: Head of Doctoral School Dr. Angéla Anda	Signature of lecturer: Dr. Katalin Sárdi

Course title: Integrated weed control

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer: Gabriella Kazinczi	**Place of work, position:** MATE Institute of Plant Protection, Head of the Department of Plant Protection, Keszthely, univ. prof.	
Lessons required: 24	**Examination type**: oral	**Credit value:**4

Detailed content of the course

The term of integrated weed management and its important elements
Non chemical weed management methods: agrotechnical weed management
Non chemical weed management methods physical and mechanical weed management
Biological and ecological weed management
Chemical weed managements
Precision weed management
Herbicide resistant crops and weeds
Weed vegetation of arable crops and their management
Weed vegetation of horticultural crops (vegetebles, plantations) and their management
Weed vegetation of minor crops and and specialities of their management

Suggested literature:

Hunyadi K – Béres I – Kazinczi 2011. Gyomnövények, gyombiológia, gyomirtás. Mezőgazda Kiadó, Budapest
Kádár A. (szerk.) 2019. Vegyszeres gyomirtás és termésszabályozás, Kádár A., Budapest
Radics L. L. (szerk.) 2001. Ökológiai gazdálkodás. Dinasztia Kiadó, Budapest
Németh T.,Neményi M., Harnos Zs. 2007. A precíziós mezőgazdaság módszertana. JATE Press, – MTA-TAKI, Szeged
Berzsenyi Z. 2000. Gyomszabályozási stratégiák a fenntartható növénytermesztésben, Magyar Gyomkutatás és Technológia 1: 3-21.
Chauhan, B.S., Mahajan, G (eds). 2014. Recent advances in weed management. Springer
Young, S.L., Pierce, J. (eds). 2014. Automation: The future of weed control in cropping system. Springer
Növényvédő szerek, termésnövelő anyagok aktuális éves kiadványa
NÉBIH növényvédő szer adatbázis: https://novenyvedoszer.nebih.gov.hu/Engedelykereso/kereso

Periodicals:
Weed Research
Weed Science
Növényvédelem
Hungarian Weed Research and Technology

Individual/Personal tasks: The student prepares the complex weed management strategy of a freely selected field or horticultural crop (written work and oral presentation).

Date: 05.04.2022.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Anda Angéla Professor	Dr. Gabriella Kazinczi Professor

Course title: Weed biology and ecology

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer: Gabriella Kazinczi	**Place of work, position:** MATE Institute of Plant Protection, Head of the Department of Plant Protection, Keszthely, univ. prof.	
Lessons required:36	**Examination type**: oral	**Credit value: 6**

Detailed content of course:

Definition and characteristics of the weeds, harmul effects
Weed monitoring (in HU, wordwide)
Weed knowledge (seeds, seedlings, adults)
Life form of weeds
Reproduction biology of weeds (annuals, perennials)
Interference among higher plants (competition, allelopathy)
Ecological requirements of weeds in the context of climate change
Herbicide resistance
Invasive alien weeds
Biological principles of the integrated weed amnagement

Suggested literature:

Aldrich ,R.J. (1984): Weed-crop ecology. Breton Publischer, Nort Scituate, Massachuttes.
Benécsné Bárdi és mtsai . (szerk).,2005) : Veszélyes 48.Mezőföldi Agrofórum Kft.,Szekszárd.
Hegi,G. (1906): Illustrierte Flora von Mittel-Europa.J.F. Lehmanns Verlag, München.
Hunyadi K.,Béres I.és Kazinczi G. (2011): Gyomnövények gyombiológia, gyomírtás. Mezőgazda Kiadó Budapest.
Mihály B., Botta-Dukát Z.(szerk., 2004): Özönnövények. Természetbúvár Alapítvány Kiadó Budapest.
Novák R.,Dancza I., Szentey L., Karamán J.(szerk. 2011): Az ötödik országos gyomfelvételezés Magyarország szántóföldjein. Vidékfejlesztési Minisztérium Élelmiszerlánc-felügyeleti Főosztály Növény – és Talajvédelmi Osztály, Budapest
Pinke Gy., Pál R.(2005): Gyomnövényeink eredete termőhelye és védelme. Alexandra Kiadó, Budapest
Schermann Sz.(1966): Magismeret I, II. Akadémiai Kiadó, Budapest.
Simon T. (2000): A magyarországi edényes flóra határozója Nemzeti Tankönyvkiadó, Budapest.
Szabó L.Gy. (szerk., 1980). A magbiológia alapjai. Akadémiai Kiadó, Budapest
Ujvárosi M. (1973): Gyomnövények. Mezőgazdasági Kiadó, Budapest
Csiszár Á. (szerk.) (2012): Inváziós növényfajok Magyarországon. Nyugat-magyarországi Egyetem Kiadó, Sopron
Zimdahl, R.L. (2004): Weed-Crop Competition. A review. Blackwell Publishing
Rice, E.L. (1974): Allelopathy. Academic Press, New York
Harper, J.L. (1977): Population Biology of Plants. Academic Press, London
Baskin, J.M., Baskin C.C. (1998): Seeds. Ecology, Biogeography and Evolution of Seed Dormancy and Germination. Academic Press, San Diego
Hilhorst, H.W., Tooroop, P.E. (1997): Review on dormancy, germinability and germination in crop and weed seeds. Advances in Agronomy 61: 11-165.
Taylorson R.B (1987): Environmental and chemical manipulation of weed seed dormancy. Rev. Weed Sci. 3: 135-154.
Fenner, M., Thompson, K. (2005): The Ecology of Seeds. Cambridge University Press.
Vereckey K., Tóth-Csantavéri Sz. (2010): Szántóföldjeink legfontosabb gyomnövényei. Syngenta Kft.
Bayer CropScience (2004): Gyomhatározó.
Cavers, PB. (ed). (2005): The Biology of Canadian Weeds. The Agricultural Institute of Canada
Pintér Cs., Kazinczi G. (2016): Gyommagfotók. Agrofórum Kiadó Kft
Holm, L.G., Plucknett, D.L., Pancho, J.V., Herberger, J.P. (1991): The World's Worst Weeds. Krieger Publishing Company, Malabar, Florida

periodicals:

Weed Research Weed Science Növényvédelem Magyar Gyomkutatás és Technológia	
Individual/Personal tasks: The student through the example of a freely chosen weed species prepares a monography (taxonomy, morphological and biological description, spreading, harmful effect, protection possibilities).	
Date: 05.04.2022.	
Signature: Head of Doctoral School Dr. Anda Angéla Professor	Signature of lecturer: Dr. Gabriella Kazinczi Professor

Course title: Environmental microbiology

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer: Dr. Csitári Gábor, PhD	**Place of work, position:** MATE, Institute o Physiology and Nutrition, Department of Nutrition and Nutritional Physiology; assistant professor

Lessons required: 30 hours	**Examination type**: exam	**Credit value:** 4

Detailed content of course:

The aim of teaching the subject is to introduce the role of microorganisms, primarily bacteria, in the earth's element cycles, to use the biodegradation and biotransformation capacity of microbes in technologies that protect the environment and reduce the burden of waste on the environment.

General characterization of microorganisms.

Microbial metabolic processes.

Interactions of microbes with the living environment. Antibiotic resistance of microorganisms, the spread of resistance factors in the environment.

Microbiology of carbon cycle - effects of human activity, methane cycle, cycle of hydrocarbons and PAHs, detoxification processes, pesticide transformation, cellulose and lignin degradation.

Microbiology of nitrogen cycle - effects of human activity, nitrogen fixation, ammonification, nitrification, denitrification.

Microbiology of sulphur cycle – effects of human activity, H_2S producers, sulphate reducers, oxidation of inorganic sulphur compounds, characteristics of sulphur bacteria.

Biogeochemical cycles of phosphorus, iron, silicon and toxic elements.

Microbiology of soil cleaning - soil microbiological basics, types of pollutants, and their movement, accessibility, mobilization and biodegradation in the soil, detection and analysis of soil pollution.

Technologies suitable for the biological treatment of solid waste - biotechnologies combined with waste utilization, sludge treatment, microbiology of biogas production.

Evaluation of the impact of pollutants on the environment, risk assessment and risk analysis methods.

Application and evaluation of ecotoxicological tests and analytical methods.

Suggested literature:

Kim, M-B. (2008): Progress in Environmental Microbiology. Nova Science Publishers, New York

Mitchell, R., Gu, J-D (2010): Environmental microbiology. John Wiley & Sons, New Jersey.

Individual/Personal tasks:

Preparing a short literature review (~5 pages) from a chosen topic.

Date: August 15, 2023

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	Dr. Csitári Gábor

Course title: Hyperspectral Data Processing

Course type: compulsory/elective

Prerequisites: **Processing information obtained by remote sensing**

Responsible lecturer: **Dr. József Berke Phd, CSc**	**Place of work, position:** **Gábor Dénes University,** **head of department / college teacher**

Lessons required: 45	**Examination type**: **three-level**	**Credit value: 6**

Detailed content of course:

1. Physical foundations of hyperspectral sensing
2. Domestic and international practice of hyperspectral sensing
3. Laboratory, field and airborne hyperspectral devices
4. Hyperspectral information processing tools /HW, SW/
5. Field data collection, GPS technique
6. Calibration, preprocessing
7. Interpretation of hyperspectral data
8. Hyperspectral classification and image recognition
9. Hyperspectral systems based on artificial intelligence
10. GIS-RS integration, applications

Suggested literature:

- BERKE, J. - KELEMEN, D. - SZABÓ, J. (2004): Digitális képfeldolgozás és alkalmazásai. Georgikon-Kvark, Keszthely, Pictron Kft., Budapest, ISBN: 963 9096 911 – DIGKEPv6.0.
- VARSHNEY, P.K. – ARORA, M.K. (2004): Advanced Image Processing Technigues for Remotely Sensed Hyperspectral Data, Springer-Verlag, Berlin.
- SABINS, F. F. (1987): Remote Sensing Principles and Interpretation. W. H. Freeman and Company, New York.
- DI, W. – BHARDWAJ, A. – WEI, J. (2018): Deep Learning Essentials, Packt Publishing.
- Electronic information about the course is available at: http://www.digkep.hu/oktatas/PhD/OLVASS_EL.html .

Individual/Personal tasks: Students solve practical (field and laboratory) tasks related to theory and applications, within a deadline. After completing the practical tasks, the subject ends with an oral report.

Date: 22/06/2023

Signature: Head of Doctoral School **Dr. Angela Anda**	**Signature of lecturer:** **Dr. József Berke**

Course title: Interactive Presentation		
Course type: compulsory/elective		
Prerequisites: -		
Responsible lecturer: **Dr. József Berke Phd, CSc**		**Place of work, position:** **Gábor Dénes University,** **head of department / college teacher**
Lessons required: 45	**Examination type**: **three-level**	**Credit value: 6**

Detailed content of course:

• Theoretical foundations of computer image processing and graphics. The concept and characteristics of a digital image. The process of digital imaging.
• Hardware and software tools related to presentations. Basic graphics features. Graphics file formats. Basic functions and tools of programs that support presentation creation. Microsoft PowerPoint and Apple Keynote.
• Pedagogical, andragogic, didactic and educational technology aspects of presentation preparation.
• General aesthetic aspects of making presentations.
• Creating and editing digital images. Creating and editing audio files.
• Creation and editing of digital video files. Animation production.
• Presentation designer and presentation wizard. Slide layouts, text box, insert image, custom background.
• Paste sound, video and other objects. Customization of animations, animation schemes. Using action buttons. Custom slideshows. Use transition.
• Play demos. Presentation in addition to live speech, guided and showcase presentation. The timing of the projection. Lecturer's notes, musical background. Online joint work. Print presentation. Travel package. Save as web page.
• Development of interactive materials. Application of artificial intelligence-based systems.
• Possibilities of real-time messaging and video conferencing systems.
• Pedagogical, andragogical, didactic and educational technology aspects of presenting presentations.
• Technical and methodological mistakes made during presentations.
• Presentation of a practical presentation task to a professional audience.

Suggested literature:

- BERKE, J. - KELEMEN, D. - SZABÓ, J. (2004): Digitális képfeldolgozás és alkalmazásai. Kvark, Keszthely, Pictron Kft., Budapest, ISBN: 963 9096 911 – DIGKEPv6.0.
- DI, W. – BHARDWAJ, A. – WEI, J. (2018): Deep Learning Essentials, Packt Publishing.
- Electronic information about the course is available at: http://www.digkep.hu/oktatas/PhD/OLVASS_EL.html .

Individual/Personal tasks: Students solve practical tasks related to theory and applications, within a deadline. After completing the practical tasks, the subject ends with an oral presentation.

Date: 22/06/2023

Signature: Head of Doctoral School **Dr. Angela Anda**	**Signature of lecturer:** **Dr. József Berke**

Course title: Advanced communication in science

Course type: compulsory/<u>elective</u>

Prerequisites: There is no compulsory prerequisite for the course. For MATE students prior attendance at the 'Scientific Publication' course held by Professor Szabolcs Nagy is highly recommended.

Responsible lecturer:	**Place of work, position:**
László Orbán, Ph.D. Szabolcs Tamás Nagy, D.Sc.	Department of Applied Fish Biology, Institute of Aquaculture and Environmental Safety, The Georgikon Campus of Hungarian University of Agriculture and Life Sciences, Keszthely, Hungary

Lessons required: 12 hours	**Examination type**: written exam	**Credit value:** 4

Detailed content of course:

Basic rules of communication during the PhD process: written and unwritten rules
Scientific self-management, time management, communication with the supervisor
Experimental planning, data management
Modern communication within and across labs: applications, softwares, the ethical use of AI
Writing reports and thesises
Communication during the publication process: manuscripts, submissions, decisions, revisions and appeals
Communication and presentation at scientific workshops and conferences: e-posters, posters and oral presentations
Writing national and international grant applications and reports

The above topics will be discussed during a two-day online course with the participation of senior speakers from MATE and other Hungarian institutions. MSc students, graduate students and postdocs from other universities are welcome.

Suggested literature:

- Umberto Eco: How to Write a Thesis. MIT Press (2015) pp. 1-256; ISBN 9780262527132
- Jean-Luc Lebrun: Scientific writing 2.0. World Scientific, Singapore (2011) pp. 1-265
- Jen Tsi Yang: An Outline of Scientific Writing. World Scientific, Singapore (1995) pp. 1-160

Individual/Personal tasks: N/A

Date: 25th of August, 2023

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	**Dr. László Orbán**

<table>
<tr><td colspan="3">Course title: Physiological basics of environmental effects investigation</td></tr>
<tr><td colspan="3">Course type: compulsory/elective</td></tr>
<tr><td colspan="3">Prerequisites: Plant physiology</td></tr>
<tr><td colspan="2">Responsible lecturer:
Szaszkóné Dr. Decsi Éva Kincső</td><td>Place of work, position:
Hungarian University of Agriculture and Life Sciences
Georgikon Faculty Keszthely
Department of Plant Physiology and Plant Ecology
senior lecturer</td></tr>
<tr><td>Lessons required: 60</td><td>Examination type: online test</td><td>Credit value: 6</td></tr>
<tr><td colspan="3">Nowadays, the increasing of extreme environmental effects present greater challenges to agricultural producers than ever before. The goal is to equip future researchers with knowledge that provides a solid foundation for purposeful defense against environmental stressors. For this, the subject provides the basics of plant physiology. It introduces the physiological and genetic changes that occur in plants as a result of stress, and the natural, innate and inducible stress responses of plants.
1. General stress physiology concepts

2. General adaptation mechanisms

3. Abiotic stress effects and the possibilities of protection against them in the plant

4. Biotic stress effects and the possibilities of protection against them in the plant

5. Resistance breeding in the 21. century</td></tr>
<tr><td colspan="3">Suggested literature:
Szaszkóné Dr. Decsi Éva Kincső: Plant stress physiology, digital study material– English version (MATE e-learning)
E. Rami: Plant Stress Physiology, 2020
P.C. Trivedi: Advances in Plant Physiology, 2013</td></tr>
<tr><td colspan="3">Individual/Personal tasks: Processing of a current literature source belonging to the student's research field.</td></tr>
<tr><td colspan="3">Date: 26.7.2023.</td></tr>
<tr><td colspan="2">Signature: Head of Doctoral School

Dr. Angela Anda</td><td>Signature of lecturer:

Szaszkóné Dr. Decsi Éva Kincső</td></tr>
</table>

Course title: Plant growth and development physiology		
Course type: **compulsory/elective**		
Prerequisites:		
Responsible lecturer: **Szaszkóné Dr. Decsi Éva Kincső**		**Place of work, position:** **Hungarian University of Agriculture and Life Sciences** **Georgikon Faculty Keszthely** **Department of Plant Physiology and Plant Ecology** **senior lecturer**
Lessons required: 60	**Examination type: online test**	**Credit value: 6**
Detailed content of course: The subject is aimed at the additional training of PhD students a continuation of basic plant physiology studies. In addition to the compulsory curriculum, place emphasis on the special training of the student, which is determined by the doctoral topic. **1. Growth and environmental factors affecting growth** **2. Germination** **3. Flowering** **4. Sex characteristics** **5. Pollination, fruit set, fruit ripening** **6. Aging** **7. - special module: General stress physiology** **8. - special module: Physiological aspects of abiotic and biotic stress effects**		
Suggested literature: **Szaszkóné Dr. Decsi Éva Kincső: Plant growth and development physiology, digital study material – English version (MATE e-learning)** **Szaszkóné Dr. Decsi Éva Kincső: Plant stress physiology, digital study material– English version (MATE e-learning)** **E. Rami: Plant Stress Physiology, 2020** **P.C. Trivedi: Advances in Plant Physiology, 2013**		
Individual/Personal tasks: Processing of a current literature source belonging to the student's research field.		
Date: 26.7.2023.		
Signature: Head of Doctoral School **Dr. Angela Anda**		**Signature of lecturer:** **Szaszkóné Dr. Decsi Éva Kincső**

Course title: Processing information obtained by remote sensing

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer: **Dr. József Berke Phd, CSc**	**Place of work, position:** **Gábor Dénes University,** **head of department / college teacher**

Lessons required: 45	**Examination type**: **three-level**	**Credit value: 6**

Detailed content of course:

1. Introduction, historical overview
2. Physical foundations of remote sensing
3. Satellite remote sensing systems
4. UAV sensor systems and their application
5. Ground recording devices
6. Information processing tools
7. Preprocessing - image enhancement
8. Field reference and data collection
9. Classification, interpretation
10. Processing based on artificial intelligence
11. Solving practical tasks

Suggested literature:

- BERKE, J. - KELEMEN, D. - SZABÓ, J. (2004): Digitális képfeldolgozás és alkalmazásai. Kvark, Keszthely, Pictron Kft., Budapest, ISBN: 963 9096 911 – DIGKEPv6.0.
- PAINE, D. P. – KISER, J. D. (2003): Aerial Photography and Image Interpretation, John Wiley & Sons.
- SCHOWENGERDT, R. A. (2007): Remote Sensing /Third Edition/, Elsevier Inc.
- DI, W. – BHARDWAJ, A. – WEI, J. (2018): Deep Learning Essentials, Packt Publishing.
- CARVAJAL-RAMÍREZ, F. – AGÜERA-VEGA, F. – MARTINEZ-CARRICONDO, P. (2021): UAV Photogrammetry and Remote Sensing, MDPI.
- ERDAS Inc.: ERDAS FIELD GIUDE

Individual/Personal tasks: Students solve field and laboratory tasks related to theory and applications, within a deadline. After completing the practical tasks, the subject ends with an oral report.

Date: 22/06/2023

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	**Dr. József Berke**

Course title:
Production of field crops of higher importance

Course type: compulsory/elective

Prerequisites: Environmental problems and their solutions in agriculture

Responsible lecturer: Dr. Sándor Hoffmann	**Place of work, position:** Hungarian Univrsity of Agricultu and Life Sciences (MATE) Institute for Agronomy; prof. emeritus

Lessons required: 48	**Examination t** oral/written:	**Credit value:** 6

Detailed content of course:
- The course will provide an opportunity for detailed studying of one of the subsequent field crops or their groups: cereals (wheat, rye, triticale, barley, oat) maize, oil crops (oilseed rape, sunflower), arable legumes (soybean, field peas) for the PhD students according to their doctoral theses.
- Economic importance, origin, botanical description, adaptation, soil and climatic requirements, types and cultivars and the modern integrated, sustainable methods of arable cropping, preservation, storage and quality questions will be discussed.

Suggested literature:
Martin J. H.et al. Principles of field crop production PEARSON, Prentice Hall New Jersey, Colombus, Ohio
Chapmann, S. and Carter, L. P.: Crop production, principles and practices. Freeman & Co. San Francisco 1976.
Acquaah, G. Principles of Crop Production: Theory, Techniques and Technology. (Prentice-Hall) 2004
Laegreid, M.,Bockman, O.C., Kaarstad, O.: Agriculture, Fertilizers and the Environment. CAB International 1999.

Individual/Personal tasks:

Date: Keszthely, 26.07. 2023.

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	**Dr. Sándor Hoffmann**

Course title: Soil organic matter management		
Course type: compulsory/<u>elective</u>		
Prerequisites: Environmental problems and their solutions in agriculture		
Responsible lecturer Dr. Sándor Hoffmann	**Place of work, position:** Hungarian Univrsity of Agriculture and Life Sciences (MATE) Institute for Agronomy; prof. emeritus	
Lessons required: 30	**Examination type**: oral/written:	**Credit value: 4**
Detailed content of course: Importance of soil organic substances,their influence on the different soil properties and functions Conventional and recent methods for sectioning of soil organic matter. Influence of stable and decomposable fractions on soil fertility. Influence of different soil and environmental factors on the quality and quantity of soil organic matter (clay content, climate, management). The organic matter balance of soil. The importance of long-term experiments for investigating organic matter dynamic in soil. Relationship between soil organic matter content and crop yield.		
Suggested literature: Magdoff, F. és Weil, R. R.: (szerk.) Soil organic matter in sustainable agriculture CRC Press London, New York, Washington 2004 Page, A. L.; Miller, R. H.; Keeney, D. R. (ed.) Methods of soil analysis Part 2 – Chemical and microbiological properties. ASA, SSSA Madison, Wisconsin USA 1982 Kubat, J. (ed.)Humus, its structure and role ind agriculture and environment. Elsevier 1992.		
Individual/Personal tasks:		
Date: Keszthely 21. 08. 2023.		
Signature: Head of Doctoral School **Dr. Angela Anda**	**Signature of lecturer:** Dr. Sándor Hoffmann	

Course title:
Feed Toxicology

Course type: obligatory/optional

Prerequisites: None

Responsible lecturers:	**Place of work, position:**	
Dr. Péter Budai Dr. Károly Dublecz	Department of Plant Protection, Institute of Plant Protection, Georgikon Campus, Hungarian University of Agriculture and Life Sciences, associate professor; Department of Nutrition and Nutritional Physiology, Institute of Physiology and Nutrition, Georgikon Campus, Hungarian University of Agriculture and Life Sciences, professor	
Lessons required: 30	**Examination type**: three-level assessment	**Credit value:** 4

Detailed content of course:
General principles of toxicology, expression of poisoning potency, conditions of poisoning, local and systemic poisoning. Factors influencing toxicity. The fate of the poison in the body: absorption, distribution, metabolism, excretion. Special toxic effects. Chemical degradation of feed: rancidity of fats, formation of biogenic amines. Animal health significance of microbial contamination of feed. Animal health significance of mold contamination of feeds, mycotoxicoses. Toxic consequences of hypervitaminosis. Poisoning caused by compounds of metals and non-metallic elements. Poisonings caused by phytotoxins. Substances with antinutritional effects in feed. Pesticide poisoning. Rodenticide poisoning. Poisonings caused by chemotherapy drugs.

Suggested literature:

1. Várnagy L. – Budai P. (2003): Mezőgazdasági vegyi anyagok higiéniája és toxikológiája. Veszprémi Egyetemi Kiadó. Veszprém.
2. Dési I. (szerk.) (2001): Népegészségtan. Semmelweis Kiadó. Budapest.
3. Duduk V. (szerk.) (1995): Állategészségtan. Mezőgazda Kiadó. Budapest.
4. Rafai P. (2003): Állathigiénia. Agroinform Kiadó. Budapest.
5. Várnagy L. (szerk.) (2002): Állategészség-védelem. Mezőgazda Kiadó. Budapest.
6. Lehel J. – Vetter J. (2008): Növényi eredetű méreganyagok és mérgezések állatokban. A/3 Nyomdaipari és Kiadói Szolgáltató Kft.. Budapest.

Individual/Personal tasks: -

Date: 21st February 2021.

Signature: Head of Doctoral School	**Signature of lecturers:**	
Dr. Angéla Anda professor	Dr. Péter Budai associate prof.	Dr. Károly Dublecz professor

A tantárgy neve angolul:

Scientific communication II.

A tárgy jellege: kötelező/választható

Kötelező előtanulmány:---

Tantárgyfelelős neve: Dr. habil. Sárdi Katalin **Résztvevő oktatók: Dr. habil. Nagy Szabolcs Tamás**	**Munkahelye, beosztása:** MATE, prof. emerita egyetemi tanár

Óraigény: (12 óra konzultáció 8 óra egyéni)	**Számonkérés módja**: kollokvium	**Kredit értéke** (az óra-igénnyel összhangban)**: 2 + 2 = 4** **(a + b), (a + c) ill. (a + d)**

Course structure:

a.) Principles of Scientific Communication (András **Vincze**) 2 kredit
Requirements for Scientific Communication: Clear, Accurate Communication Adapted to Audience
Structure of a Scientific Publication: Major Headings (Title, Abstract, Materials and Methods, Results and Discussion, Conclusions, References)

b.) Animal Science - Consultation on terminology, main criteria for oral and written publication of original research results etc. (Prof. T. Szabolcs **Nagy**) 2 kredit

c.) Plant Science - Consultation on terminology, main criteria for oral and written publication of original research results etc. (Prof. Katalin **Sárdi**) 2 kredit

d.) Environmental Science - Communication strategies and best practices (1) how to share ideas and results? (2) scientific papers, (3) conferences, (4) resarch proposals, (5) project meetings. (Prof. G. **Tóth**) 2 kredit

Suggested literature:

Malmfors, B., Garnsworthy, P., Grossmann, M. Writing and presenting scientific papers. 2nd Edition.. Nottingham University Press. 2000.
Day, R. & Gastel, B. How to write and publish a scientific paper. Cambridge University Press. 2012.
Hengl, T., Gould, M. The unofficial guide for authors (or how to produce research articles worth citing). Office for Official Publications of the European Communities, Luxemburg. 2006.
Glossaries in Animal Sciences, Plant Sciences, Environmental Sciences
Angol-magyar növénytermesztési szakszótár. (Szerk. Dr. Petrikás Árpádné) Mezőgazda Kiadó, 1992.
Richard Lee: English for Environmental Science in Higher Education Studies, (Course Book), Garnet Education, 2009.
Martin Hewings: Cambridge Academic English, B2 Upper Intermediate Student's Book, Cambridge University Press, 2012.
Dictionary of Agriculture, A & C Black Publishers Ltd, 2006.
Adrian Wallwork: English for Writing Research Papers, Springer, 2011.
Adrian Wallwork: English for Academic Research: Grammar Exercises, Springer, 2012.
Adrian Wallwork: English for Academic Research: Vocabulary Exercises, Springer, 2012.
Adrian Wallwork: English for Academic Research: Writing Exercises, Springer, 2012.

Examination and Evaluation: Oral examination
Students must prepare a ppt presentation (approximately 5 minutes) in the required structure: a)Introduction and the importance of the research topic, b)Hypothesis, c)Planned methodology, c)Expected results
Final grades will be calculated from the results of qualification of the parts **(a + b), (a + c) or (a + d),** respectively.

Dátum:

Signature: Head of Doctoral School	**Signature of lecturers:**
Dr. Angéla Anda professor	Dr. Katalin Sárdi prof. emeritus

Course title: Experimental methods of toxicology		**Code**: PEDIGKKO58
Course type: obligatory/optional		
Prerequisites: None		
Responsible lecturer: Dr. Péter Budai	**Place of work, position:** Department of Plant Protection, Institute of Plant Protection, Georgikon Campus, Hungarian University of Agriculture and Life Sciences, associate professor	
Lessons required: 30	**Examination type**: three-level assessment	**Credit value:** 4

Detailed content of course:

1. Acute oral toxicity studies (Class method and alternative methods)
2. Acute dermal toxicity studies (Class method and alternative methods)
3. Acute inhalation toxicity study
4. In vivo acute eye and skin irritation studies
5. In vivo skin sensitisation study
6. Oral cumulative toxicity study
7. Repeated dose 28-day oral toxicity study in rodents
8. Repeated dose 90-day oral toxicity studies (rodents, non-rodents)
9. Chronic toxicity study
10. Carcinogenicity study
11. Reproduction toxicity study
12. Teratogenicity study
13. Bacterial reverse mutation test (AMES test)
14. HPRT gene mutation assay
15. In vivo rodent micronucleus assay
16. Rodent dominant lethal test
17. Toxicokinetics studies
18. Aquatic and terrestrial ecotoxicology studies

Suggested literature:

Várnagy L., Budai P.: Mezőgazdasági vegyi anyagok higiéniája és toxikológiája. Veszprémi Egyetemi Kiadó. Veszprém, 2003.
- OECD Gudilines for Testing of Chemicals. Current publications.
- Hayes A..W. (ed.): Principles and Methods of Toxicology. Raven Press. New York, 1986.

Individual/Personal tasks: -

Date: 22nd June 2022.

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angéla Anda professor	Dr. Péter Budai associate professor

Course title:
Virus genetics and diagnostics

Course type: obligatory/optional

Prerequisites:
molekuláris biológiai alaptudás

Responsible lecturer:	**Place of work, position:**
Dr Éva Várallyay	MATE, NVI, genomikai kutatócsoport, tudományos tanácsadó

Lessons required:	**Examination type**:	**Credit value:**
28	3 levels	**credit 4**

Detailed content of course:
Plant viruses, genome organization, infection strategies
Usage of viruses in biotechnology
Plant protection mechanisms against viruses: RNA interference and viral silencing suppressor proteins
Host resistance against viruses
Traditional methods for virus detection (biotest, ELISA, PCR)
New virus diagnostics methods (NGS, LAMP, RPA)
New molecular biology-based trends and aspects of virology.

Suggested literature:
Roger Hull: Plant Virology
selected scientific review papers

Individual/Personal tasks:

Date: 2022.04.06.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Anda Angéla Professor	Dr. Éva Várallyay

Course title: Visual data processing in the evaluation of experiments

Course type: compulsory/elective

Prerequisites: -

Responsible lecturer: **Dr. József Berke Phd, CSc**	**Place of work, position:** **Gábor Dénes University,** **head of department / college teacher**

Lessons required: 45	**Examination type**: **three-level**	**Credit value: 6**

Detailed content of course:

1. Introduction, historical overview
2. Basics of human and machine vision
3. Visual data processing tools
4. Digital imaging
5. Image enhancement procedures in practice
6. Segmentation, Classification
7. Image coding and compression
8. Field data collection,
9. Post-processing
10. Processing based on artificial intelligence
11. During evaluation of visual data processing experiments - sample tasks

Suggested literature:

- **BERKE, J. - KELEMEN, D. - SZABÓ, J. (2004): Digitális képfeldolgozás és alkalmazásai. Kvark, Keszthely, Pictron Kft., Budapest, ISBN: 963 9096 911 – DIGKEPv6.0.**
- **RUSS, J. C. (2007): The Image Processing Handbook, Taylor & Francis.**
- **JAIN, A. K. (1989): Fundamentals of digital image processing. Prentice Hall, Englewood Cliffs.**
- **PAINE, D. P. – KISER, J. D. (2003): Aerial Photography and Image Interpretation, John Wiley & Sons.**
- **SCHOWENGERDT, R. A. (2007): Remote Sensing /Third Edition/, Elsevier Inc.**
- **DI, W. – BHARDWAJ, A. – WEI, J. (2018): Deep Learning Essentials, Packt Publishing.**

Individual/Personal tasks: With the help of the multimedia-based framework that teaches image processing, students solve practical tasks related to theory and applications, within a deadline. After completing the practical tasks, the subject ends with an oral report.

Date: 22/06/2023

Signature: Head of Doctoral School **Dr. Angela Anda**	**Signature of lecturer:** **Dr. József Berke**

<table>
<tr><td colspan="3">Course title: Tillage and soil use in the soil-plant-climate system</td><td>NEPTUN-code:PEDIGKNK18</td></tr>
<tr><td colspan="4">Course type: compulsory/elective compulsory</td></tr>
<tr><td colspan="4">Prerequisites:</td></tr>
<tr><td>Responsible lecturer:
Kismányoky Tamás</td><td colspan="3">Place of work, position:
prof emeritus MATE, Crop production dept. Georgikon Campus</td></tr>
<tr><td>Lessons required:
32</td><td>Examination type:
written exam.</td><td colspan="2">Credit value:
4</td></tr>
<tr><td colspan="4">Detailed content of course: Sustainable agric, site production, soil fertility, climate productivity,,agroecological aspects of crop production, crop rotation ,C-N dynamic, sustainable soil management and land use,mitigation of soil degradations, the role of long term field exp. in the agric.cropping systems, farming systems</td></tr>
<tr><td colspan="4">Suggested literature: A. Shestra(ED):Cropping systems…NewYork Food Product Press 2003. Edwards,C.A.et.alSustainable agric.systems SWC Soc. Iowa,USA 1990.DebreczeninB.né.-Németh T, Az Országos Tartemkisérletek(OMTK) kisérleti eredményei 1967-2001 Akadémia Kiadó Bp.2009
.</td></tr>
<tr><td colspan="4">Individual/Personal tasks:</td></tr>
<tr><td colspan="4">Date:</td></tr>
<tr><td>Signature: Head of Doctoral School

Dr. Anda Angéla
Professor</td><td colspan="2">Signature: Head of Department</td><td>Signature of lecturer:</td></tr>
</table>

<table>
<tr><td colspan="3">Course title: Processes in the soil-plant-atmosphere system</td></tr>
<tr><td colspan="3">Course type: compulsory/<u>elective</u></td></tr>
<tr><td colspan="3">Prerequisites: -</td></tr>
<tr><td>Responsible lecturer:
Prof. Angela Anda</td><td colspan="2">Place of work, position: MATE, Georgikon Campus, Keszthely</td></tr>
<tr><td>Lessons required: 45 hours.</td><td>Examination type: written and oral</td><td>Credit value: 6</td></tr>
<tr><td colspan="3">Content of course:

Steps to fulfill requirements Personnel tasks connected to PhD student's topic
1. Preliminary discussion is necessary with each doctoral student. This coordination contains restricted subject of the written exam.
2. Titles of 5 selected publications must be sent by the PhD student for approval.
3.Submission of the essay of more than 5 pages.
4. Oral discussion about the essay

Exam: written/oral</td></tr>
<tr><td colspan="3">Suggested literature: discussed and accepted five selected publications related to the topic of each PhD student</td></tr>
<tr><td colspan="3">Individual/Personal tasks: see above</td></tr>
<tr><td colspan="3">Date: August 2023</td></tr>
<tr><td colspan="2">Signature: Head of Doctoral School

Dr. Angéla Anda
Professor</td><td>Signature of responsible lecturer:

Dr. Angéla Anda
Professor</td></tr>
</table>

Course title: Bioethics

Course type: compulsory/**elective**

Prerequisites:

Responsible lecturer: Dr. Zoltán P. ALFÖLDI	**Place of work, position: Hungarian** University of Agriculture and Life Sciences, Institute of Wildlife Management and Environmental Protection, Department of Conservation Biology, Associate Professor

Lessons required: 2 lecture hours per week = 28 lect. hours	**Examination type**: three-grade evaluation	**Credit value: 2**

Detailed content of course:

In environmental and agricultural sciences, with particular regard to plant and animal molecular genetics and biotechnology, unprecedentedly fast changes have been taken place and are still taking place today. Due to the recent and future scientific and technological developments and novel entities, and the overall environmental impact of human activities, the responsible use of various technologies, methods and instruments is essential for the experts of environmental and agricultural fields. The aim of this course is to introduce all of the relevant ethical aspects and principles of these scientific fields focusing on real societal needs, values and interests, to establish environmental and social safety in addition to economic efficiency. All of these are of primary importance for broad scale and long-term sustainability. Interactivity and open discussions about important practical issues of high ethical relevances (such as case studies) form main constituents of this course, therefore, high level of activities are required from the enrolled and participating students.

Suggested literature:

Mepham, B. (2005). Bioethics: Introduction for Biosciences. Oxford University Press
Encyclopedia of Religion and Nature. 2005. London & New York: Continuum (online/pdf)..
Farrow, R. 2016. A Framework for the Ethics of Open Education. Open Praxis, 8(2):93–109, Open Education Global Conference Selected Papers. (ISSN 2304-070X).
Relevant and actual papers and other literature.

Individual/Personal tasks:

Discussion about the ethical aspects and regulations in various scientific fields in the form of consultation (e.g., ethical aspects of experimental design; use of hazardous materials, and experimental or productional use of animals and/or GM organisms; performing experimental work in various environments and conditions; ethical rules for the preparation of scientific publications; etc.).

Date: 1 August, 2023

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	**Dr. Zoltán P. Alföldi**

Course title: Environmental Risk Assessment for Genetically Modified (GM) Crops

Course type: compulsory/**elective**

Prerequisites: Genetics and Plant Breeding.

Responsible lecturer: Dr. Zoltán P. ALFÖLDI	**Place of work, position: Hungarian** University of Agriculture and Life Sciences, Institute of Wildlife Management and Environmental Protection, Department of Conservation Biology, Associate Professor

Lessons required: 2 lecture hours per week = 28 lect. hours	**Examination type**: three-grade evaluation	**Credit value: 2**

Detailed content of course:

Very significant scientific and technical developments and changes have occurred in the fields of plant and animal molecular genetics and biotechnology, and these are further expected also in the future. Molecular marker assisted selection (MAS) and genomic evaluation methods are widely used in plant breeding, but the theory and practical implementations of genetic modification (GM) are largely disputed. Recent new genome editing techniques also highlight the importance of detailed discussions and considerations including regulations for GMOs. In addition to the growth of global production areas over the past 25 years and increasing food safety, the production of GM varieties raises a number of environmental, ecological, ethical, health, legal and economic issues. Therefore, discussions about the general and specific professional relationships between the principles and methods for environmental risk assessment and those of the novel plant biotechnology products (GMOs), as well as relevant case studies are included in the teaching program of this course.

Suggested literature:

Alfoldi, Z. Genetic modification and ethical considerations in plant breeding. University of Pannonia, Institute of English and American Studies, Vol. 1, Series I (manuscript).

EFSA, 2011. Scientific Opinion on Guidance for risk assessment of food and feed from genetically modified plants. Panel on Genetically Modified Organisms (GMO). EFSA Journal 2011, 9(5):2150-2187. Available online: www.efsa.europa.eu/efsajournal.htm

Ervin, D.E. and R. Welsh, 2006. Environmental effects of genetically modified crops: differentiated risk assessment and management. In: Ervin, D.E. and R. Welsh (Eds.) Regulating Agricultural Biotechnology: Economics and Policy. Natural Resource Management and Policy, Vol.30, Part II, Sect. II.2, 301-326. http://library.wur.nl/frontis/transgenic_crops/02a_ervin.pdf.

ECNC, 2004. Environmental risks from agriculture in Europe. European Centre for Nature Conservation.

Farrow, R. 2016. A Framework for the Ethics of Open Education. Open Praxis, 8(2):93–109, Open Education Global Conference Selected Papers. (ISSN 2304-070X).

Relevant and actual papers and other literature.

Individual/Personal tasks:

Discussion of scientific results and regulations in this specific field of biological sciences in the form of consultation (use of GM organizations; regulation of experiments and productions, monitoring, etc.).

Date: 1 August, 2023

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	**Dr. Zoltán P. Alföldi**

<table>
<tr><td colspan="3">Course title: Zootaxonomy and morphology</td></tr>
<tr><td colspan="3">Course type: compulsory/elective</td></tr>
<tr><td colspan="3">Prerequisites: -</td></tr>
<tr><td colspan="2">Responsible lecturer:
Előd Kondorosy, PhD</td><td>Place of work, position: full professor
Dept. of Conservation Biology</td></tr>
<tr><td>Lessons required: 5</td><td>Examination type: oral</td><td>Credit value: 6</td></tr>
<tr><td colspan="3">Detailed content of course: Basics of systematics, natural and artificial systems. Taxonomic categories. Rules of taxonomic descriptions. The concept of types on family, genus and species level. Nomenclature. The Principle of Priority and its consequences. International Code of Zoological Nomenclature.
The system of the animals, taxonomy and morphology of important groups (insects, vertebrates)</td></tr>
<tr><td colspan="3">Suggested literature: Hickman, CP et al. (2023): Integrated Principles of Zoology. 19th Edition. McGraw-Hill, New York. 936 pp.</td></tr>
<tr><td colspan="3">Individual/Personal tasks: completing a pdf on taxonomy and morphology of a selected group</td></tr>
<tr><td colspan="3">Date: Keszthely, 02. 09. 2023</td></tr>
<tr><td colspan="2">Signature: Head of Doctoral School

Dr. Angela Anda</td><td>Signature of lecturer:

Dr. Előd Kondorosy</td></tr>
</table>

Course title: Interactions between the root system and soil		
Course type: compulsory/elective		
Prerequisites: -		
Responsible lecturer: Dr. Zoltán Toth		**Place of work, position: Gorgikon Camp. Dept. of Agronomy associate Prof.**
Lessons required: 28	**Examination type**: oral	**Credit value: 4**

Detailed content of course:

Structure and morphology of the root system
Roles and physiological processes of the root system
The relationship between the root system and soil microorganisms
Nutrient and water uptake
Effect of soil properties on the root system
The effect of the root system on the soi
Root study methods

Suggested literature:

Waisel, Y – Eshel, A – Kafkafi, U. (2002): Plant Roots, the Hidden Half. Marcel Dekker, Inc., New York – Basel.
Gregory P. (2008): Plant Roots. Growth, activity and interaction with soils. Blackwell Publishing, Oxford, UK. ISBN 978-1-4051-1906-1
Brussard, L. – Ferrera-Cerrato, R. (1997): Soil Ecology in Sustainable Agricultural Systems. CRC Lewis Publishers, Boca Raton – New York.
Cardon, Z. G. – Whitbeck, J. L. (2007): The rhizosphere. Elsevier Academic Press, Amsterdam.

Journals: Plant and Soil, Soil and Tillage research, Agronomy Journal, Archives of Agronomy and Soil Science, European Journal of Agronomy

Individual/Personal tasks:

Completing a review of root literature related to the doctoral topic, making a presentation and discussion

Date: 18. 10. 2023.

Signature: Head of Doctoral School	**Signature of lecturer:**
Dr. Angela Anda	**Dr. Zoltán Tóth**

Course title:
Small regulatory RNAs in Plants

Course type: compulsory/elective

Prerequisites:
basic molecular biology

Responsible lecturer:	**Place of work, position:**
Dr Eva Varallyay	scientific advisor, MATE, Plant Protection Institute, Plant Pathology Department, Genomics Research group
Co-lecturer:	**Place of work, position:**
Dr. Zolatn Havelda	MATE, GBI, Department of Plant Biotechnology, Plant Developmental Biology Group

Lessons required:	**Examination type**:	**Credit value:**
28	3 level mark	4credit

Detailed content of course:
Description and features of small RNAs
History of RNAi
Basic mechanisms of RNAi
different classes of small regulatory RNAs (their features, investigation, biogenesis and processes regulated by them): miRNAs, tasiRNAs, natsiRNAs, siRNA based epigenetic processes
RNAi base defence mechanisms, role of antiviral silencing in plant defence mechanisms, description and features of viral suppressors of silencing
Key molecules of RNAi (DICERs, RDRDs, AGOs, their structure basic operation)
Use of RNAi in functional genetics, plant breeding and in health care

Suggested literature:
selected scientific review papers

Individual/Personal tasks:

Date: 2022.04.06.

Signature: Head of Doctoral School	Signature of lecturer:
Dr. Anda Angéla Professor	Eva Varallyay

Course title: Fundamental biology in crop production: variety and seed management

Course type: compulsory/elective

Prerequisites:
-

Responsible lecturer: Anita Lepossa PhD	**Place of work, position:** Hungarian University of Agriculture and Life Sciences, Institute of Agronomy, Georgikon Campus associate professor

Lessons required: 24 hours	**Examination type**: oral exam	**Credit value:** 4

Detailed content of course:

History, legal background and the main participants of a variety recognition and seed certification (systems in Hungary, in Europe and outside the EU)

Criteria of a variety registration

Technology, control and certification of a seed production process

Seed processing

Seed certification

The global seed market

Suggested literature:

Basra, A.S. (2006): Handbook of Seed Science and Technology, CRC Press, 795p.

Copeland, L.O., McDonald, M.B. (2001): Principles of Seed Science and Technology, Springer New York, NY, 467p.

Taylor, A.G. (Ed.) (2021): Modern Seed Technology. MDPI, Basel, Switzerland, 198p.

Bradford, K. – Nonogaki, H. (2007): Seed Development, Dormancy and Germination. Wiley, 388p.

EuropeanSeed www.european-seed.com

SeedNews Press – International Seed Federation (worldseed.org)

Pages of organizations representing the plant breeders' and variety owners' rights and the seed quality:

https://worldseed.org/
https://euroseeds.eu/
https://cpvo.europa.eu/en
https://www.upov.int/portal/index.html.en
https://www.oecd.org/agriculture/seeds/
https://www.seedtest.org/

Individual/Personal tasks:

Proper seed identification and laboratory seed testing methods (practical test)
Independent, critical review of the biological foundations of a selected plant species related to his/her research area: its variety supply and the critical points of its seed production (essay)

Date: 22nd November 2023

Signature: Head of Doctoral School **Dr. Angela Anda**	**Signature of lecturer:** **Ms. Anita Lepossa PhD**

Course title: Seed biology

Course type: compulsory/elective

Prerequisites:
-

Responsible lecturer: Anita Lepossa PhD	**Place of work, position:** Hungarian University of Agriculture and Life Sciences, Institute of Agronomy, Georgikon Campus associate professor

Lessons required: 12 hours	**Examination type**: written test	**Credit value:** 2

Detailed content of course:

Types of seeds and fruits, seed identification of the more important cultural and weed plants

Basics of seed production, regulation of the seed yield

Seed dormancy and its regulating factors

Seed germination and its affecting factors

The biological value of seeds

Seed testing methods

The seed health

Effect of seed treatment procedures on germination, and on the initial plant development

Seed storage options

Spread of weed seeds

Suggested literature:

Bradford, K. – Nonogaki, H. (2007): Seed Development, Dormancy and Germination. Wiley, 388p.
Taylor, A.G. (Ed.) (2021): Modern Seed Technology. MDPI, Basel, Switzerland, 198p.

Basra, A.S. (2006): Handbook of Seed Science and Technology, CRC Press, 795p.

Copeland, L.O., McDonald, M.B. (2001): Principles of Seed Science and Technology, Springer New York, NY, 467p.

EuropeanSeed www.european-seed.com

SeedNews Press – International Seed Federation (worldseed.org)

Useful links:

https://seedidguide.idseed.org/
https://www.maxapress.com/seedbio
https://www.seedtest.org/
http://www.seedbiology.de/index.html

Individual/Personal tasks:

Independent, critical review of the literature and methodology of his/her narrower research field or a chosen research topic relating to the course thematic.

Date: 22nd November 2023

Signature: Head of Doctoral School **Dr. Angela Anda**	**Signature of lecturer:** **Ms. Anita Lepossa PhD**

Course title: Genetics in the animal breeding		
Course type: elective		
Prerequisites: -		
Responsible lecturer: Dr. Peter J. Polgár		**Place of work, position: Institute for Animal Breeding, associate professor**
Lessons required: 26 hours	**Examination type**: **colloquium**	**Credit value: 4**
Detailed content of course: Application of our knowledge of genetics in animal breeding Laws of Mendelian genetics, application Application of population genetics Peculiarities of species in breeding Selection, breed selection Heritability and breeding value estimation Applications of genome selection Gene conservation in animal breeding		
Suggested literature: Animal Breeding and Genetics, https://edepot.wur.nl/365433		
Individual/Personal tasks: Essay, paper to be submitted		
Date: 16.10. 2023.		
Signature: Head of Doctoral School **Dr. Angela Anda**		**Signature of lecturer:** **Dr. Peter J. Polgár**