SZÉCHENYI EGYETEM
UNIVERSITY OF GYŐR

FACULTY OF AGRICULTURAL AND FOOD SCIENCES

WITTMANN ANTAL MULTIDISCIPLINARY DOCTORAL SCHOOL IN PLANT, ANIMAL, AND FOOD SCIENCES

TRAINING PROGRAM

Head of Doctoral School:
Prof. Dr. László Varga DSc

MOSONMAGYARÓVÁR
2021

The study points system (credit system) for higher education institutions, which is regulated according to Government Decree 200/2000 (XI. 29.) regarding self-financed and state scholarship-sponsored PhD students who started their doctoral programs in or after September 2016, consists of two phases. The first is the study and research phase that encompasses the first two years which is followed by a research and dissertation phase which comprises the third and fourth years following the completion of a successful complex examination. A total number of 240 credits are to be completed in the fulfilment of academic and research obligations for doctoral students during their Doctoral Program.

By the end of the first phase (at the end of Academic Year 2 – until 31st August included) 120 credit points are to be completed. During the summer examination period of Year 2 a complex examination is to be organised for the doctoral student and it must be concluded successfully by him/her. The successful complex examination does not have a credit value. If the doctoral student fails to succeed the theoretical part of the complex examination (major or minor course/subject), he/she can retake the exam during the summer examination period once.

- Regarding the course/subject examinations a minimum of 40 credit points are to be completed and a maximum of 45 credit points are added to the compulsory 120 credits;
- Studying the Literature of the Dissertation, making a Literature Review on the topic, 25 points;
- Holding a lecture at the seminar organised by the Doctoral School at the end of Year 1. The summary of the lecture including its slides are displayed on the website of the Doctoral School, 8 points;
- Further credit points can be gained as described in the "Publications, seminars" section and with the completion of the research work prescribed for the first phase of the studies.
- 45 credit points are the minimum to be gained by the end of the first academic year.

One credit is equivalent to 30 individual study hours or 30 hours of doing research. Study work can be realised by attendinglectures and practical classes (contact lessons) and meeting the requirements of the given course/subject.

In the second phase

The research related credit points cannot only be gained by reviewing the literature of the research, carrying out experiments, evaluating their results, but also by doing publication activities, delivering conference presentations (workshop etc.), and completing the dissertation itself.

- Completing the Literature chapter 20 points
- Topic related experimental work and data processing 50 points
- Preparation of the dissertation 20 points

Publication, seminar

- Article in a foreign scientific journal* 15 points

Article in a Hungarian scientific journal*

- In a foreign language 10 points
- In Hungarian 8 points

Presentation at a scientific conference

- Conference abroad 6 points
- Conference in Hungary 5 points
- Presented poster 3 points

* If the article is published in a journal with an impact factor, 5 extra credit points are awarded.

A total of four professional seminars organised by the Doctoral School provide 4-5 credit points each. The credit points can be divided, meaning that if at a given area a maximum 20 credit points are obtainable but the PhD student manages to gain only 10 in the given semester, the rest of the credit points can be obtained during the subsequent semester(s). Over the training doctoral students are given the opportunity to hold practical lessons or seminars, through which they can join the educational activities of a department. Three (3) credit points can be given for teaching 1 contact lesson a week throughout a semester. The doctoral student can only participate in the first four semesters of the training and the total number of credits obtainable with teaching activities cannot be more than 10 per semester. In the four semesters of the second phase, 30 credit points are to be gained. In the second phase, the PhD

student can apply for a maximum of 1-academic year-long passive status if (s)he – up to the date of the application – has fulfilled the credit point requirements *pro rata temporis*.
PhD students can gain a part of their credit points by completing cross-faculty or cross-institutional course/subject(s), which must be initiated by the student. The cross-institutional/faculty study is permitted by the Doctoral School's Council if the course/subjects in question at the two institutions/faculties have an at least 75% matching rate in the curriculum. Furthermore, PhD students can apply for the approval of their formerly completed course/subjects and research credit points that are relevant to the doctoral program. However, only 30% of the credit points can thus be gained. The approval of the former studies can be permitted by the Council of the Doctoral School.

"Haberlandt Gottlieb Doctoral Program" for Plant Science Program Leader: Prof. Dr. Vince Ördög, DSc				
Course	Course leader	Hours**	Credit	Semes-ter
Compulsory				
Biological, technological, and technical basics of precision crop production and plant protection *	Miklós Neményi MHAS Rezső Schmidt CSc Gyula Pinke PhD	30 + 120	5	1
Methodology of research *	Zoltán Varga PhD László Varga DSc Zoltán Berzsenyi DSc	30 + 120	5	1
Microalgae biology and biotechnology	Vince Ördög DSc Lajos Vörös DSc	30 + 120	5	2
Plant protection ***	Gyula Pinke PhD Tibor Érsek DSc Benedek Pál DSc	30 + 120	5	2
Plant biotechnology	Beáta Barnabás MHAS Zoltán Molnár PhD	30 + 120	5	3
GIS and remote sensing	Gábor Milics PhD	30 + 120	5	3
Facultative				
Macro and micronutrients in the soil-plant system	Pál Szakál CSc	30 + 90	4	1
Crop growth models and plant physiological analysis	Miklós Neményi MHAS Vince Ördög DSc	30 + 90	4	2
Taxonomy of plants in anthropogenic vegetation	Gyula Pinke PhD	30 + 90	4	1
Biotic and abiotic stress resistance of crops	Dénes Dudits MHAS Zoltán Molnár PhD	30 + 90	4	3
Ecology of soil seed banks	Péter Csontos DSc	30 + 60	3	2
Biological background of horticultural production	Borbála Pólyáné Hanusz PhD	30 + 60	3	1
Effects of macro- and microclimate on crop production	Zoltán Varga PhD	30 + 90	4	3
Soil moisture regime and the environment	András Makó CSc	30 + 90	4	2
Plant protection chemistry	Tamás Kőmíves MHAS	30 + 90	4	3
Operation of agricultural machinery in a system	Attila József Kovács PhD	30 + 90	4	2
Special aspects of crop production technologies	Rezső Schmidt CSc	30 + 90	4	4
Soil biology, rhizobiology, biofertilizer applications	Borbála Bíró DSc	30 + 90	4	4
Basic concepts of macro- and microeconomics for plant production	Imre Tell CSc Nóra Gombkötő PhD	30 + 90	4	4

* Compulsory for all students of the doctoral program

** 30 contact hours = 1 Credit, 120 hours = 4 Credit

*** For the "Plant Protection" course students can choose from one of the following topics:

a) Plant pathology **b) Plant protection zoology** **c) Herbology**

Course title:	**Biological, technological, and technical basics of precision crop production and plant protection**
Course type:	Compulsory
Lecturers:	**Miklós Neményi**, professor emeritus, MHAS **Rezső Schmidt** professor, CSc **Gyula Pinke** professor, CSc
No. of classes:	30+120
Credits:	5

Summary of the course:

The aim of the course is to familiarize students with the relationship between natural ecology and agricultural ecology in order to show the different characteristics of the two systems using different models. It presents the characteristics of nature conservation and environmental protection. Within agricultural ecology, it focuses primarily on the growth and development of plants, detailing the GIS (remote sensing) and technical conditions of precision, site-specific crop production systems. It covers the different sensory processes and their technical conditions. The programme analyses how to make crop production technologies sustainable.
The so-called decision support models will be presented that describe the growth and development of plants and their relationship with precision plant production. These models can also be linked to climate change models.
It analyses different energy input-output models. This allows optimum energy input to be used to exploit soil potential. The course specifically covers the alternatives of using renewable energies for fossil-neutral crop production technologies.

1. Characteristics of natural and agro-ecological systems. What is the difference between nature protection and environmental protection?
2. Characteristics of a sustainable agricultural ecology. Thermodynamic modelling of ecology.
3. The preconditioning, location-specific crop production technologies for geospatial conditions.
4. The technical conditions of precision, site-specific crop production technologies (tillage, sowing, plant protection).
5. The technical conditions of precision, site-specific crop production technologies (chemical pest control, nutrition supplements).
6. The technical conditions of precision, site-specific crop production technologies (harvesting).
7. On-the-go sensing techniques.
8. Creating maps that provide different information (yield maps, weed maps, nutrition maps, etc.).
9. Method for the creating of management zones (fuzzy logic, neural networks).
10. The role of renewable energy sources in fossil-neutral crop production technologies.
11. Structure of plant growth models and their data requirements. Implementation of arable field measurements required for the data requirements of models and the validation of models.
12. Case studies related to the growth and development of a given hybrid of maize and of wheat in addition to different inputs.

Required and recommended readings:

Brase, T. A. (2006) Precision Agriculture. Thomson Delmar Learning.
Csiba, M., Kovács, A. J., Virág, I., Neményi, M. (2012): The most common errors of capacitance grain moisture sensors: effect of volume change during harvest. Precision Agriculture. Vol. 14, pp. 215-223.
Fluck, R. C. (1992) Energy in Farm Production. Elsevier.
Jorgensen, S. E. (2001) Thermodynamics and Ecological Modelling. CRC Press.
Margulis, L. (1998): The symbiotic planet. Weidenfeld and Nicolson, London
Mesterházi, P. Á. (2003): Development of measurement technique for GPS-aided plant production. PhD Thesis. Supervisor: Prof. Dr. Miklos Neményi. University of West Hungary, Mosonmagyaróvár.
Mike - Hegedűs, F. (2006): Applying fuzzy logic and neural networks to database evaluation in precision agriculture. PhD Thesis. Supervisor: Prof. Dr. Miklós Neményi. University of West Hungary. Mosonmagyaróvár.
Morowitz, H. J. (1968): Energy flow in biology. Academic Press
Nag, A. (2009) Biosystems Engineering. McGraw Hill.
Nagy, V., Milics, G. ,Smuk, N., Kovács, A. J., Balla, I., Jolánkai, M., Deákvári, J., Szalay, K. D., Fenyvesi, L., Štekauerová, V., Wilhelm, Z., Rajkai, K., Németh, T., Neményi, M. (2013): Continuous field soil moisture content mapping by means of apparent electrical conductivity (ECa) measurement. Hydrology and Hydromechanics. Vol. 61, No. 4, pp. 305, 312.

Neményi, M. (2012): Anthropogenic impacts on nature with special regard to agricultural technologies. The impact of urbanization, industrial, agricultural and forest technologies on the natural environment, edited by: M. Neményi, B. Heil. Nemzeti Tankönyvkiadó, Budapest. Pp 13-

Neményi, M., Mesterházi, P. Á., Milics, G. (2006a): An Application of Tillage force Mapping as a Cropping Management Tool. Biosystems Engineering. Vol. 94, 3, pp. 351-357.

Neményi, M., Mesterházi, P. Á., Pecze, Zs., Stépán, Zs. (2003): The role of GIS and GPS in precision farming. Computers and Electronics in Agriculture. Vol. 40, 1-3. pp. 45-55

Neményi, M., Milics, G. (2009): Thermodynamic modeling of agro-ecological systems especially regarding the cost and efficiency of the technological energy input. 10th IAEE European Conference. Energy, Policies and Technologies for Sustainable Economies, Vienna, 2009. 09. 07.-10., pp. 37-38., ISSN 1559-792X

Neményi, M., Milics, G. (2010): Optimalization of biomass production by thermodynamic approach. In: Conference AgEng2010. Internationale Conference on Agricultural Engineering. Clermont-Ferrand, France

Neményi, M., Milics, G., Mesterházi, P. Á. (2006b): Precision, site specific crop production, possibilities on water regime control. In: Proceedings of 6th International Conference on Influence of Anthropogenic Activity of Water Regime of Lowland Territory, edited by J. Ivanko, D. Pavelková, M Gombos, A. Tall, Michalovce, Slovakia, Slovak Academy of Sciences, CD.

Németh, T. – Neményi, M. – Harnos, Zs. (2007) A precíziós mezőgazdaság módszertana. JATE Press.

Nyéki, A., Milics, G., Kovács, A. J., Neményi, M. (2013): Improving yield advisory models for precision agriculture with special regards to soil compaction in maize production. Precision Agriculture ’13 (edited by John V. Stafford). Leida, Spain, July 7-11 2013.Wageningen Academic Publishers, pp. 443-451.

Pimentel, D. (1980) Handbook of Energy Utilization in Agriculture. CRC Press.

Srinivasan, A. (2006) Handbook of Precision Agriculture. Food Products Press.

Course title: **Methodology of research**
Course type: Compulsory
Lecturers: **Zoltán Varga** associate professor, PhD
László Varga professor, DSc
Zoltán Berzsenyi professor, DSc
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The objective of this course is to teach the PhD students about the theoretical, practical and methodological questions of scientific research. The students get up-to-date knowledge of the most important issues of science and research methodology and of the forms of scientific activity. They can learn about the conceptual and methodological tools in their own field of science. They can also understand the methods to solve a problem (observation, experimentation) and be able to design and carry out research.
The course gives information about the special methodological issues of plant cultivation sciences; the principles and basic concepts of arable experiments; the methods of designing, setting and evaluating experiments.
The following issues are also important parts of the course: the different types of plant cultivation experiments (single-factor-, bi- and multifactorial experiments, factorial experiments, experiment sequences, duration experiments, technological development experiments); the principles and models of analysis of variance, correlation calculations and regression analyses (linear and non-linear, multiple); and use of special computer programs (GenStat, SPSS, MSTAT-C) in designing and evaluating experiments. Students of the course should understand the use of multivariate biometric methods (main component analysis, cluster analysis, discriminant analysis) and they are able to decide about which different analytical and synthesizing methods they need to use.
The students can learn the steps of making scientific publications. They have to be able to distinguish between scientific and non-scientific work, and to recognize pseudo-scientific activity. They must be aware of the ethical rules regarding scientific publications and the important parameters of scientometrics.

1. The importance and history of science and the methodology of research.
2. Comparative analysis of common knowledge and scientific knowledge.
3. Parallel examination of theoretical knowledge and empirical knowledge.
4. Practice of scientific research; the basic steps of scientific knowledge; designing and conducting scientific research.
5. Principles and basic concepts of arable experiments; experimental layouts and computer design of experiments; types, advantages, disadvantages and use of plant cultivation experiments.
6. The principles, models of analysis of variance (ANOVA) and use of computer programs to evaluate different types of experiments.
7. Use of non-parametric probes, correlation calculations and regression analysis in the evaluation of crop experiments.
8. Use of multivariate biometric methods in the synthesis of experimental results.
9. Basic rules of searching for scientific literature, use of internet databases; search for articles and quotations, query techniques.
10. Types of scientific and non-scientific publications, conditions of publication; strategies for publishing and selecting journals; ethical issues of scientific research and publishing.
11. Creating scientific publications (from title to references; content and form requirements).
12. Scientometrics, measurement of scientific performance; interpretation of the used performance rating factors, their advantages and disadvantages (impact factor, quotation, Hirsch index, etc.).

Required and recommended readings:
Berzsenyi, Z. (2014): Növénytermesztési kísérletek tervezése és értékelése. Kézirat, MTA ATK Mezőgazdasági Intézet, Martonvásár.
Bujdosó E. (1986): Bibliometria és tudománymetria, Budapest, MTA Könyvtára
Csermely P., Gergely P., Koltay T., Tóth J. (1999): Kutatás és közlés a természettudományokban. Budapest. Osiris Kiadó
Ireland, C.I. (2010): Experimental Statistics for Agriculture and Horticulture. CABI, Cambridge.
Popper, K. (2002): The logic of scientific discovery. Routledge Classics, Taylor and Francis Group. 513 oldal.
Sváb, J. (1981): Biometriai módszerek a kutatásban. Mezőgazdasági Kiadó, Budapest.
Varga-Haszonits Z., Varga Z. (2006): Kutatásmódszertani ismeretek. Oktatási segédanyag. NYmE-MÉK, Mosonmagyaróvár, 159 oldal.

Course title: **Microalgae biology and biotechnology**
Course type: Compulsory
Lecturers: **Vince Ördög**, professor, DSc
Lajos Vörös, scientific advisor, DSc
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The course gives an introduction into macro- and microalgae taxonomy based on traditional and molecular biological methods. The description of the prokaryotic (cyanobacteria) and eukaryotic divisions includes the main physiological characteristics, which significantly influence laboratory cultivation of microalgae, such as: photosynthetic pigments, photosynthesis, heterotrophic growth, regulation of buoyancy, nitrogen and phosphorus metabolism, and nitrogen fixation. The biotechnology component focuses on valuable compounds of microalgae and their possible use in the agriculture and renewable energy production. Microalgae compounds, which are useful in plant production and protection, like: (1) plant hormones, (2) antimicrobial compounds, (3) volatile organic compounds, and (4) toxins are highlighted. Evidence is presented showing that microalgae composition depends on environmental factors, which is the basis of biofuel production with microalgae.

1. Concept of algae. Characterisation of the prokaryotic algae (cyanobacteria).
2. Occurrence, reproduction, nitrogen fixation and photosynthesis of cyanobacteria.
3. Eukaryotic algae divisions: rhodophyta and heterokontophyta.
4. Eukaryotic algae divisions: cryptophyta, dinophyta and euglenophyta.
5. Eukaryotic algae division: chlorophyta and it's main classes.
6. Occurrence, reproduction, photosynthesis, as well as nitrogen and phosphorus metabolism of green algae.
7. Establishment and maintenance of algal culture collections.
8. Plant hormone production and plant biostimulating activity of microalgae.
9. Cyanobacterial toxins and antimicrobial compounds of microalgae.
10. Volatile organic compounds of microalgae and their potential use.
11. Influence of environmental conditions on lipid content, lipid production and the fatty acid composition of microalgae.
12. Algal mass culture techniques.

Required and recommended readings:
Graham, L. E., J. M. Graham, L. W. Wilcox (2009): Algae. Benjamin Cummings. pp.616.
Kiss K. T. (1998): Bevezetés az algológiába. ELTE Eötvös Kiadó, Budapest. pp.283.
Ács É. és Kiss K. T. (2004): Algológiai praktikum. ELTE Eötvös Kiadó, Budapest. pp.361.
Richmond, A. (Edit.) (2004): Handbook of microalgal culture: biotechnology and applied phycology. Blackwell Science, Oxford. pp.566.
Borowitzka, M. A. & L. J. Borowitzka (Eds.) (1989): Micro-algal biotechnology. Cambridge University Press, Cambridge. pp.477.
Ördög V. (2014): Mikroalgák biotechnológiai alkalmazása a növénytermesztésben és növényvédelemben. MTA Doktori Értekezés, Mosonmagyaróvár. pp.172.

Course title: **Plant protection – Plant pathology**
Course type: Compulsory
Lecturer: **Tibor Érsek** professor emeritus, DSc
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The goal of this course is to introduce students to the most important plant pathogens and the diseases they cause. The introductory part outlines the modes of parasitism and the plant–microbe interactions such compatibility and incompatibility. A major part of the course deals with the unique features of plant pathogenic microorganisms of various evolutionary levels, that is, with viroids, viruses, phytoplasmas, bacteria, as well as fungi and fungus-like microbes. Furthermore, it discusses the mechanism of infection of the aforementioned parasites and the various disease symptoms they cause. In addition emphasis is put on the identification processes based upon morphological and molecular traits, and the alternatives of disease control. After the general part of the course the most important diseases of major crop plants are summarized in specified sections.

1. Introduction to plant pathology.
2. Parasite type: viroids.
3. Parasite type: viruses.
4. Parasite type: phytoplasmas.
5. Parasite type: bacteria.
6. Parasite type: fungus-like organisms (Plasmodiophoromycota, Oomycota).
7. Parasite type: true fungi (Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota).
8. Identification of pathogens (conventional and molecular diagnostics).
9. Disease control.

Specified section
Pathogens, diseases and disease control of arable plants
Pathogens, diseases and disease control of vegetable
Pathogens, diseases and disease control of fruit plants

Required and recommended readings:
Érsek T., Németh L. (2013): Növénykórtan (Agrár-felsőoktatási tananyag). Mosonmagyaróvár, ISBN 978-963-08-6283-7.
Agrios, G.N. (2005): Plant Pathology (5th ed.). Academic Press, London
Trigiano, R.N., Windham, M.T., Windham, A.S. (2004): Plant Pathology: concepts and laboratory exercises. CRC Press, London

Course title: **Plant protection – Plant protection zoology**
Course type: Compulsory
Lecturer: **Pál Benedek** professor emeritus, DSc
Gyula Pinke professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The objectives of this course are to understand the results of treatments and experiments applied in plant protection, to influence the development of populations, and to utilize the results in the practice of integrated pest management. The conditions of economical production and the production of quality goods play a role in the protection of plant, soil and plant treatments. Each treatment provides multiple options for designing the experiments, the results of which give one the opportunity to develop practical procedures. The main purpose of integrated protection is to mitigate the use of pesticides harmful to the environment and health and, therefore, we attach particular importance to agrotechnical, mechanical, physical, biological, biotechnological, resistance-generating procedures, forecast monitoring, remote sensing, and aerial photography. It is important to study biotic and abiotic factors that influence the fate of agrobiococonoses on agrobiotics.

1. Organizing injurious species on morphological and molecular biological bases.
2. Dominance, abundance, and population dynamics of damaging species based on autecologycal and synecologycal knowledge.
3. Insect nutrition physiology, chemical communication (sex pheromones and attractants).
4. The relationship between plant quality, plant microclimate and the number of pests.
5. Forecasting methods to define the optimal time of defeat.
6. Pests of cereals and maize.
7. Pests of potatoes and sugar beets and their role as a virus vector.
8. Pests of leguminous plants.
9. Pests of oil and fiber plants.
10. Pests of vegetable crops grown on arable land.
11. Pests of fruit orchards (apple, pome or grape).
12. Alternatives and benefits of precision technologies.

Required and recommended readings:
Demeter A., Kovács Gy. (1991): Állatpopulációk nagyságának és sűrűségének becslése, Akadémiai Kiadó, Budapest
Glits M., Horváth J., Kuroli G., Petroczi I. (szerk.) (1997): Növényvédelem. Mezőgazda Kiadó, Budapest.
Jermy T., Balázs K. (1988-1996): A növényvédelmi állattan kézikönyve1-6. kötet. Akadémiai Kiadó, Budapest.
Kozár F., Samu F., Jermy T. (1992): Az állatok populációdinamikája, Akadémiai Kiadó Budapest
Kuroli G. (2010): Fenntartható szemléletű növényvédelem. In.: Radics L. (szerk.): A fenntartható szemléletű szántóföldi növénytermesztéstan 1. AGROINFORM Kiadó. Budapest, 265-271. p.
Kuroli G. (2010): Védelem a kárt okozó állatok ellen. In.: Radics L. (szerk.): A fenntartható szemléletű szántóföldi növénytermesztéstan 1. AGROINFORM Kiadó. Budapest, 305-327. p.
Minks A. K., Harrewijn P. (1987-1988-19889): Aphids their Biology, natural enemies and control A, B, C. Amsterdam-Oxford-New York-Tokio
Schwerdtfeger F. (1968-1975-1977): Aut-, dem-, synökologie. Verlag Paul Parey. Hamburg-Berlin
Szentesi Á., Török J. (1997): Állatökológia, ELTE TTK egyetemi jegyzet Kovásznai Kiadó, Budapest

Course title: **Plant protection – Herbology**
Course type: Compulsory
Lecturer: **Gyula Pinke** professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The aim of the course is to present the latest scientific principles, methods and results related to the regulation of weeds. We deal with damage caused by weeds and we also deal with their beneficial properties. To understand these we need to explain the economic conditions and biological properties of weeds. The course gives a good overview about various weed control methods, especially herbicide-resistant crops. We will detail the extensive knowledge of precision weed control and the latest national and international developments in this field.

1. The concept of weed, the significance of weeds, tendencies of changes in weed flora.
2. Competition and indirect damage.
3. The ecology and lifestyle of weeds.
4. Reproduction biology of weeds.
5. Weed-collection methods.
6. The principle and practice of integrated weed control.
7. Non-chemical weed control methods.
8. Chemical weed control.
9. Herbicide resistance of weeds.
10. Weed control of herbicide-resistant crops.
11. Weed management of the main cultures (grain cereals, maize, sunflower, oilseed rape).
12. Precision weed control.

Required and recommended readings:
Weed Research. (Wiley-Blackwell) Kéthavonta megjelenő angol nyelvű folyóirat elmúlt 10 évben megjelenő számai.
Ujvárosi (1973): Gyomnövények, Gyomirtás Mezőgazdasági Kiadó 1973. Budapest
Hunyadi K., Béres I., Kazinczi G. (szerk.): Gyomnövények, gyombiológia, gyomirtás. Mezőgazda Kiadó, Budapest. 630 (Második javított és átdolgozott kiadás) 2011.
Magyar Gyomkutatás és Technológia (Hungarian Weed Research and Technology) Magyar Gyomkutató Társaság (Hungarian Weed Research Society évente kétszer megjelenő szakfolyóirata. Agroinform Kiadó. Budapest.

Course title: **Plant biotechnology**
Course type: Compulsory
Lecturers: **Zoltán Molnár**, associate professor, PhD
Beáta Barnabás, MHAS
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The aim of the course is to review the biotechnology of plant biology, beginning with the history, methods and results of plant cell and tissue culture. After describing the somatic cells and tissue production *in vitro*, the biotechnological alternatives related to the growth of plants are described in detail. The exploration of spontaneous and induced genetic changes, the alternatives of using the cells, tissues, regenerated plants with modified genetic background are also discussed. The theoretical and methodological basis of plant gene technology are described. The possibilities of producing genetically modified (GM) plant varieties are explained. The characteristics of the transgenic (GM) species and cultivars grown in public cultivation and the risks of their cultivation and consumption are discussed. Briefly, the introduction of legal regulations related to plant gene technology are explained.

1. Metabolism of plant cells and tissue cultures, nutrient media.
2. Plant somatic cell cultures. Plant regeneration, somatic embryogenesis.
3. Biotechnology of sexual reproduction (embryo cultures, haploid and triploid cultures, *in vitro* fertilization, biotechnology of apomixis).
4. Biotechnology of asexual reproduction (*in vitro* cultures of vegetative organs, meristem cultures, *in vitro* gene bank).
5. The theory and practice of *in vitro* vegetative micro propagation.
6. Plant protoplasts. Somaclonal and gametoclonal variability.
7. Theoretical and methodological basis of gene technology.
8. Genetically modified (GM) plants (biotic stress resistant transgenic plants, transgenic modified plants in metabolism).
9. Genetically modified (GM) plants (abiotic stress-resistant transgenic plants, developmentally modified transgenic plants).
10. Cultivation of transgenic (GM) varieties.
11. Risks of cultivation and consumption of transgenic (GM) varieties.
12. Legislative regulation of plant gene technology.

Required and recommended readings:
Christou P., Klee H. (Eds.) (2004): Handbook of Plant Biotechnology – Wiley-Blackwell, Oxford-Hoboken, UK and USA.
Davey, R.M., Anthony P. (Eds.) (2010): Plant Cell Cultures. Essential Methods – Wiley-Blackwell, Oxford-Hoboken, UK and USA.
George, E.F., Hall, M.A., De Klerk, G.-J. (2008): Plant Propagation by Tissue Culture
3rd Edition – Springer-Verlag Berlin Heidelberg.
Neumann, K.H., Kumar, A., Imani, J. (2009): Plant Cell and Tissue Culture - A Tool in Biotechnology – Springer-Verlag Berlin Heidelberg.
Stewart, C.N., Jr. (Ed.) (2016): Plant Biotechnology and Genetics: Principles, Techniques, and Applications, 2nd Edition – Wiley-Blackwell, Oxford-Hoboken, UK and USA.

Course Title: **GIS and remote sensing**
Course Type: Compulsory
Lecturer: **Gábor Milics**, associate professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The aim of the course is to introduce Geographical Information Science and Remote Sensing to the students. During the contact hours student have to learn to view data and information in a spatial context. General GIS and specific Agro-GIS software are introduced. Practical exercises on data collection, data storage and analysis will be carried out during the semester. Due to the study program students will be able to produce digital maps, and analyse data, which have spatial relations in agriculture. During the program remote sensing platforms and sensor technology is also introduced including satellite and airborne technologies. The leading RS platforms such as UAV technology and compatible sensors are also introduced to the students. The aim of the course is to teach students how to be part of the decision making cycle, as well as interpret spatial data and understand the decision making process.

1. Development of GIS, raster and vector based systems, hybrid GIS systems.
2. Basics of digital mapping, requirements for digital maps, thematic map creation.
3. Creation and development of digital databases on-line GIS.
4. ArcGIS.
5. Coordinate transformations, georeferencing.
6. Creating AgGIS databases.
7. Geostatistics, outlier detection and filtering, interpolation methods.
8. Interpretation of digital map.
9. Basics of remote sensing.
10. RS systems, satellite, airborne and UAVs.
11. Sensors in RS.
12. Application of RS based data in agriculture.

Required and recommended readings:
Paul A. Longley, David J. Maguire, Michael F. Goodchild, Michael Goodchild, David Maguire, David Rhind (2005): Geographic Information Systems and Science, John Wiley & Sons, 2nd Edition, 517 pp. (ISBN13: 9780470870013)
Stanley Aronoff (2005): Remote Sensing for GIS managers, (ISBN-13:978-1589480810)

Digitally available literature:
http://www.itc.nl/library/papers_2009/general/PrinciplesGIS.pdf
http://fac.ksu.edu.sa/sites/default/files/gis_cartography.pdf

Course title: **Macro and micronutrients in the soil-plant system**
Course type: Facultative
Lecturer: **Pál Szakál**, professor CSc
No. of classes: 30 + 90
Credits: 4

Short Description of the Course:
The goal of this course is to teach the students with the importance of macro- and microelement contents of plants and its role in biochemical pathways in particular regarding production quality. During the lesson they will gain knowledge on the quantity and compound-variants of the macro- and microelements, which are important in regards to feeding. The introduction of the soil systems also has particular importance, which includes their adsorption specialities and their ability of cation changing. Having knowledge on the nutrient- service of the soils, the uptakes of plants and nutrient-dynamics we will examine the salt-complexes uptake facilities of the different types of compounds in regards to their stability-constants. In addition special attention will be given to the role of the enzyms and metaloenzyms.

1. Soil structure, adsorption, ion exchange.
2. Chemical elements, acid-base processes.
3. Key macro- and microelements, compounds, electronegativity, redoxi processes, properties, creation.
4. Complex compounds.
5. The micronutrients, enzymes and their relationship.
6. The role of macroelements in the biochemical processes.
7. The role of microelements in the biochemical processes.
8. Macro- and microelements role in plant nutrition.
9. Elements and their interactions
10. Plant nutrient uptake and its dynamics.
11. Macro- and micronutrients deficiency symptoms.
12. Analytical detection methods of macro- and micronutrients.

Required and recommended readings:
Clayden, Greeves, Warren and Wothers (2001): Organic Chemistry, Oxford, University Press
Darrel D. Ebbing (1984): General Chemistry, HoughtonMifflin Company Boston
Stefanovits P. (1999): Talajtan. Mezőgazda Kiadó. Budapest.
Pais I. (1999): A mikroelemek jelentősége az életben.
Loch J., Nosticzius Á. (1992): Agrokémia és növényvédelmi kémia. Mezőgazda Kiadó. Budapest.
Ádám V. (szerk.) (2006): Orvosi biokémia. Medicina könyvkiadó zRt. Budapest.

Course title: **Crop growth models and plant physiological analysis**
Course type: Facultative
Lecturers: **Miklós Neményi** professzor emeritus, MHAS
Vince Ördög professor, DSc
No. of classes: 30+90
Credit: 4

Short Description of the Course:
The course will cover the basic principles and applications of crop growth simulation models. Crop growth simulation modelling is a systematic approach and powerful tool for gaining quantitative and mechanistic understanding of crop-weather-soil-management relationships and interactions, as well as for helping improve and optimize crop management based on growing season characteristics and management options. Simulation models are traditionally carried out by using conventional experience-based agronomic research in which soil-plant-atmosphere system functions are derived from statistical analysis. The structure of crop models and simulation techniques will be illustrated (e.g., data request, models structure and application of models). In the course, principles of theoretical crop production ecology will be explained. Applications of crop simulation models will also be demonstrated using practical examples. This course will provide an introduction to the basic concepts, issues, opportunities and difficulties involved with using some of the model tools with management information. Students will have the opportunity to gain first-hand experience of running simulations on a wide range of scenarios for corn and wheat yields. In the most satisfactory crop growth models the validation of the models are used to predict crop response to different climate change models or agricultural management (e.g., hybrids or dates of seeding) and offers great potential to make good decisions.

1. Overview of physical and biological systems in the soil-plant-atmosphere system.
2. Simulation of solar radiation (accumulation of dry matter in soil), photosynthesis, evaporation and water demand on cultivars.
3. Overview of crop systems models (historic background and general); importance of decision support models in agriculture.
4. Structure of crop growth models (structure, data request, etc.).
5. Fields experiments and data requirements for adapting and using crop models and validation of models.
6. Climate change and plant growth: adaption and use of different climate models.
7. Decision support models in precision agriculture.
8. Case study: simulation of maize hybrid growth and development with various input data.
9. Case study: simulation of wheat hybrid growth and development with various input data.
10. Genetic factors of winter and summer cereals, ecological and nutrient demand, physiological responses.
11. Maize production for different utilization; phenological development and environmental demand under various management practices (in particular for sustainable crop production).
12. Oil seed phenology and development in Hungarian environmental conditions.
13. Analysis of effects on soil cultivation, seeding, harvesting and the physiological growth and development of cultivars.

Required and recommended readings:
Fischer, G., Shah, M., Tubiello, N. F., Velhuizen, H. (2005): Socio-economic and climate change impacts on agriculture: an integrated assessment, 1990-2080. Philosophical Transaction of the Royal Society. 360, pp. 2067-2083. (doi: 10.1098/rstb.2005.1744)
Fischer, G., Shah, M., Velthuizen, H., Nachtergaele, F. (2006): Agro-ecological zones assessment. EOLSS Publishers. Oxford, UK.
Hoogenboom, G., Jones, J. W., Porter, C. H., Wilkens, P. W., Boote, K. J., Hunt, L. A. ,Tsuji, G. Y. (2010): Decision Support System for Agrotechnology Tranfer (DSSAT) Version 4.5 (CD-ROM), volume 1. Overview. University of Hawaii, Honolulu.
Hoogenboom, G., Jones, J., Porter, C. H., Wilkens, P. W., Boote, K. J., Batchelor, W. D., Hunt, L. A., Tsuji, G. Y. (2003): Decision Support System for Agrotechnology Transfer (DSSAT) Version 4.0, volume 1. Overview. University of Hawaii, Honolulu.
Radics L. (szerk.) (2010): Fenntartható szemléletű szántóföldi növénytermesztés I., II., III. Budapest, Agroinform Kiadó
Nagy J. (2008): Maize Production. Budapest, Akadémiai Kiadó

Course title: **Taxonomy of plants in anthropogenic vegetation**
Course type: Facultative
Lecturer: **Gyula Pinke**, professor, PhD.
No. of classes: 30+90
Credits: 4

Short Description of the course:
The aim of the course is (1) to present the current principles of classification and (2) to review the taxonomic positions of plants occurring in anthropogenic vegetation. Special attention is provided towards the taxonomic aspects of crops and weeds using classical-morphological, economic botanical and molecular genetic features. The origin and history of crop and weed species are also discussed on the basis of archaeobotanical records. This course also enables students to learn the main principles and potential applications of ethnobotany. The synsystematic classifications of anthropogenic vegetation in Central-Europe is also presented. Some approaches of studying the variables influencing the species composition of anthropogenic plant communities are also discussed.

1. The history of crops and weeds based on archaeobotanical records, and the co-evolution between crops and weeds.
2. Ethnobotany and the traditional knowledge of species and cultivars.
3. The system of crop varieties and the bases of economic botany.
4. The taxonomy of arable crops and their weeds.
5. The taxonomy of vegetables and their weeds.
6. The taxonomy of medicinal plants and their weeds.
7. The taxonomy of weeds in rice fields.
8. The synsystematic classifications of anthropogenic vegetation in Central-Europe.
9. Field surveys in arable land (fieldworks in different soil types).
10. Surveys in semi-natural vegetation (fieldwork in different soil types).
11. The effects of abiotic and management variables influencing the species composition in weed communities.
12. Using plant traits in studying the organisation of weed communities.

Required and recommended readings:
Borhidi A, Kevey B & Lendvay G (2012): Plant communities of Hungary. Akadémiai Kiadó, Budapest, Hungary.
Briggs D, Walters SM (2016): Plant Variation and Evolution, 4th Edition. Cambridge University Press
Gyulai F. (2001): Archaeobotanika. A kultúrnövények története a Kárpát-medencében a régészeti-növénytani vizsgálatok alapján. Jószöveg Műhely Kiadó, Budapest.
Hunyadi K., Béres I., Kazinczi G. (2011): Gyomnövények, gyombiológia, gyomirtás. Mezőgazda Kiadó, Budapest.
Pinke Gy., Pál R. (2005): Gyomnövényeink eredete, termőhelye és védelme. Alexandra Kiadó, Pécs.
Podani J. (2003): A szárazföldi növények evolúciója és rendszertana. ELTE, Eötvös Kiadó, Budapest.
Terpó A. (1986): Növényrendszertan az ökonómbotanika alapjaival. Mezőgazdasági Kiadó, Budapest.
Tuba Z., Szerdahelyi T., Engloner A., Nagy J. (2007): Botanika II. Bevezetés a növénytanba, algológiába, gombatanba és a funkcionális növényökológiába. Rendszertan. Nemzeti Tankönyvkiadó, Budapest.

Course title: **Biotic and abiotic stress resistance of crops**
Course type: Facultative
Lecturers: **Zoltán Molnár,** associate professor, PhD
Dénes Dudits, MHAS
No. of classes: 30+90
Credits: 4

Short Description of the Course:
Plant growth and development is influenced by several biotic and abiotic environmental factors. Their intense and frequent appearance are perceived stressors. Within certain limits, plants can adapt to different living conditions in different ways. This is due to the ruggedness and possible change of the plant genetic program. Within the course first we deal with stress phenomena then with the specific and aspecific reactions. Traditional plant breeding does not always lead to an altered genetic background that would provide stress tolerance / resistance to crop production. As a result, there is a need to increase abiotic and biotic stress resistance using gene technology methods. Therefore, the description of plant gene technology and its results are also part of the curriculum.

1. The basic phenomena of plant stress (definitions, determination of stress, phases, stress responses).
2. Signal transduction processes (detection of environmental signal, reactive oxygen species (ROS) and their role in signal transduction, and calcium ion as a secondary messenger).
3. Temperature stress and protection (low and high temperature stresses, temperature sensing).
4. Stress caused by visible light (photo inhibition).
5. Heavy metals stress (physiological effects of heavy metals, signal transduction of heavy metal effects).
6. Oxidative stress and prevention (activation of oxygen, formation of activated oxygen species, oxidative stress mechanisms).
7. Protective mechanisms against insect pests and plant pathogens (pathogen-linked proteins, systemic acquired resistance).
8. Genetically modified (GM) plants (plant gene technology, production of transgenic plants, gene technology strategies).
9. Biotic stress resistant GM plants (resistance to pathogens).
10. Biotic stress resistant GM plants (pest resistance).
11. Abiotic stress tolerant / resistant GM plants (herbicide tolerant plants).
12. Abiotic stress tolerant / resistant GM plants (crops affecting extreme environmental impacts).

Required and Recommended Readings:
Gaur, R.K., Sharma, P. (Eds.) (2014): Approaches to Plant Stress and their Management – Springer-Verlag Berlin Heidelberg.
Hopkins W.G., Hüner, N.P.A. (2009): Introduction to Plant Physiology – John Wiley and Sons, Inc., Hoboken, USA.
Pessarakli, M. (Eds.) (2010): Handbook of Plant and Crop Stress, 3rd Edition – CRC Press, Taylor and Francis Group, Boca Raton, London, New York.
Ricroch, A., Chopra, S., Fleischer, S.J. (Eds.) (2014): Plant Biotechnology - Experience and Future Prospects – Springer-Verlag Berlin Heidelberg.

Course title: **Ecology of soil seed banks**
Course type: Facultative
Lecturer: **Péter Csontos** DSc, principal research fellow
No. of classes: 30 + 60
Credits: 3

Short Description of the Course:
Students are introduced to definitions and sampling methods of natural seed banks. The course discusses seed longevity studies and further issues regarding seed (fruit) viability, and deals with soil seed bank types, and their classification. A second part of the course offers a comprehensive overview of the recent knowledge on the role and importance of natural seed banks in the dynamic processes of agricultural and natural vegetation types. At the end of the course students are presented with seed bank databases, seed ecological databases and their applicability.

1. Definitions of seed bank.
2. What species have a seed bank?
3. Seed bank sampling methods: sampling depth, sample number, timing of sampling.
4. The concept and significance of the minimal soil volume.
5. Pre-treatments of soil seed bank samples (cold stratification, concentrated soil samples)
6. Detection of seed bank using the seedling emergence method.
7. Detection of seed bank based on the seeds' physical properties.
8. Further methods for detecting soil seed bank and seed longevity.
9. Seed viability tests.
10. Transient seed bank, persistent seed bank, seed bank classification systems.
11. Density of seed bank in the soils of various agricultural and natural vegetation types.
12. Similarities and dissimilarities between soil seed bank and standing vegetation.
13. Change in the significance of seed bank along geographical gradients.
14. Change in the significance of seed bank along ecological gradients.
15. Role of soil seed bank in the context of weed control and habitat restoration.
16. Seed bank databases, seed ecological databases.
17. Case studies on the applicability of seed bank and seed ecological databases.

Required and recommended readings:
Csontos P. & Tamás J. (2003): Comparisons of soil seed bank classification systems. Seed Science Research 13(2): 101-111.
Fenner, M. & Thompson, K. (2005): The ecology of seeds. Cambridge University Press, Cambridge.
Csontos P. (2007): Seed banks: ecological definitions and sampling considerations. Community Ecology 8(1): 75-85.
Baskin, C. C. & Baskin, J. M. (2014): Seeds: ecology, biogeography, and evolution of dormancy and germination. Academic Press, San Diego. (or its 1st edition from 1998)
Csontos P., Kalapos T., Tamás J. (2016): Comparison of seed longevity for thirty forest, grassland and weed species of the Central European flora: results of a seed burial experiment. Polish Journal of Ecology 64(3): 313-326.

Course title: **Biological background of horticultural production**
Course type: Facultative
Lecturer: **Borbála Polyáné Hanusz** associate professor, PhD
No. of classes: 30 + 60
Credits: 3

Short Description of the Course:
The aim of the course is to build on the tasks of engineering training and provide detailed information and an adequate basis for scientific work for those graduated engineers who are retraining themselves. The course presents some important connections of horticultural production, sectors of horticultures and specifically examines their biological backgrounds. It pursues to convey scientific and encyclopaedic knowledge. The education period is divided as follows: vegetable production 40%, fruit and nursery cultivation 30% and vine growing and winery 30%. The biological background of horticulture is most evident in the everyday use of new and older varieties. The cultivation of varieties as well as the circulation and collection of varieties are maintained in research institutes and gene banks. The educational courses related to research institutes deal in the tiniest of instalments: including the health problems of important plants, isolation and controls, and some essential particulars of the disinfection program.

1. General issues of horticultural production.
2. The morphology of vegetables (temperate zone).
3. The flowering and fertilization of vegetables.
4. Growing important vegetables, (iteration).
5. Morphology of fruits (temperate zone).
6. Flowering biology of important fruits.
7. The propagation of fruit varieties.
8. Issues of breeding maintenance.
9. Morphology and propagation of vine varieties.
10. Maintenance of vine varieties.
11. Health problems of plants and disinfection in horticulture.

Required and recommended readings:
E., Jámborné Benczúr – J., Dobránszki (2005): Micro propagation of horticultural plants. Mezőgazda Kiadó, Budapest
S., Balázs (1994): Handbook of Vegetable Producers. Mezőgazda Kiadó, Budapest
J., Papp (2003): Basic knowledge of fruit production 1. Mezőgazda Kiadó, Budapest
M., Soltész (1998): Knowledge and Use of Fruit Characteristics. Mezőgazda Kiadó, Budapest
M., G. Tóth (1997): Varieties of fruits. Primom, Nyíregyháza. Hrotkó K. (1999): Fruit Tree School. Mezőgazda Kiadó, Budapest
P., Csepregi and J., Zilai (1988): Vine variety knowledge and use. Agricultural Publishing House, Budapest
M., Németh (1967): Ampelographic album. Agricultural Publishing House, Budapest
J., Nyéki J. and M., Soltész (1996): Floral Biology of Temperate Zone Fruit Trees and Small Fuits. Akadémiai Kiadó, Budapest
I., Seprős (2001): Plant Therapy in Horticulture. Agricultural Expertise Publishing, Budapest

Course title: **Effects of macro- and microclimate on crop production**
Course type: Facultative
Lecturers: **Zoltán Varga** associate professor, PhD
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The aim of the course is to teach the PhD students how meteorological factors influence plant life, which methods are available to examine these effects, and finally, how to use this knowledge in practice. In this course we demonstrate the theoretical basis for examining the impact of meteorological factors on plants and we show how these impacts prevail. Sensitivity analyses show the most relevant periods of time and meteorological elements in the case of different crops. In addition to describing the general climate-plant relationships this course focuses on agrometeorological impacts during the growing season of four important crops (winter wheat, winter barley, maize and potato). Finally the use of agrometeorological information is demonstrated using the DSSAT (Decision Support System for Agrotechnology Transfer) and the CGMS (Crop Growth Monitoring System) models.

1. The principles of climate-crop relationship studies.
2. Modelling of the climate-crop relationships.
3. The climate of soils (soil temperature, the water balance of soils).
4. The climate of plant stands: solar radiation and plants.
5. The climate of plant stands: temperature and plants.
6. The climate of plant stands: water balance and plants.
7. The climate of plant stands: wind and plants.
8. The effect of the relief on the microclimate.
9. The phenoclimatological characteristics of plants.
10. The relationship between climate and plant productivity.
11. The relationship between climate and some of the most important crops.
12. The use of agrometeorological information.

Required and recommended readings:
Allen, R.G., Pereira, L.S., Raes, D., Smith, M. (1998): Crop Evapotranspiration (guidelines for computing water requirements). FAO Irrigation and Drainage Paper. No. 56. Rome.
Campbell, G.S., Norman, J.M. (1998): An Introduction to Environmental Biophysics. Second Edition. Spriger Verlag. Berlin.
Geiger,R., R.H., Todhunter, A.P. (2003): The Climate Near the Ground. Sixth Edition. Rowman & Littlefield Publisher, Inc. Lanham, Boulder.
van Keulen, H., Wolf, J. (1986): Modelling of agricultural production: weather, soils and crops. Pudoc, Wageningen.
Larcher, W. (2003): Physiological Plant Ecology. Springer Verlag, Berlin.
Mavi, H.S., Tupper, G.J. (2004): Agrometeorology. Priciples and Applications of Climate Studies in Agriculture. Food Product Press. New York.
Steduto,P., Hsiao, T.C., Fereres, E., Raes, D. (2012): Crop Yield Response to Water. FAO, Rome.
Supit, L., van der Groot, N. (2013): Description of WOFOST crop growth simulation model. Supit.net. Wageningen.
Varga-Haszonits Z., Varga Z., Lantos Zs., Vámos O., Schmidt R. (2000): Magyarország éghajlati erőforrásainak agroklimatológiai elemzése. Lóriprint. Mosonmagyaróvár..
Varga-Haszonits Z., Varga Z., Lantos Zs. (2004): Az éghajlati változékonyság és az extrém jelenségek agroklimatológiai elemzése. Monocopy Kft., Mosonmagyaróvár.
Varga-Haszonits Z., Varga Z., Lantos Zs., Enzsölné Gerencsér E. (2006): Az éghajlati változékonyság és az agroökoszisztémák. Monocopy Kft. Mosonmagyaróvár.

Course title: **Soil moisture regime and the environment**
Course type: Facultative
Lecturer: **György Várallyay**, research professor, MHAS
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The hydro(geo)logically and practically closed Carpathian Basin, particularly its deepest part Hungary and especially the Hungarian Plains have generally and relatively favourable agroecological potential conditions for multipurpose biomass production. However it does show high spatial and time variability, irregularity, and often extremes. Soil conditions have great (sometimes decisive) significance in the development of extreme hydrological situations (floods, water-logging, over moistening – droughts, over drying) and their economical, ecological, environmental and social consequences. The control of the soil moisture regime has an increasing importance from the viewpoints of multipurpose biomass production (moisture supply of plants) and environmental impacts. Rational and efficient soil moisture control is based on the comprehensive knowledge on the soil-water-plant system. During the course the participants are presented with a scientific basis of soil, in particular soil moisture control: getting information on soil, its physical/hydrophysical properties; soil moisture and substance regimes; agronomical and environmental relationships; reasons and consequences of extreme hydrological situations; alternatives; and limitations and methods of soil moisture control.

1. Soil and sustainable development.
2. Soil as the most important multifunctional natural resource.
3. Soil as the basic element of agricultural water management.
4. Physical properties of soil (texture, structure, porosity; compaction).
5. The significance of soil structure in the fertility, productivity and environmental sensitivity of soil.
6. Moisture content, dynamism and energy relations, pF (water availability).
7. Movement of soil water (vapour transfer; saturated and unsaturated flow).
8. Category systems, mapping and monitoring of physical/hydrophysical properties, moisture and substance regimes of soil.
9. Soil reasons and consequences of extreme hydrological situations (flood, water-logging, over moistening – drought, over drying).
10. Limiting factors of water-supply of plants.
11. Relationships between the moisture regime and substance regime of soil (regime of plant nutrients, soil, groundwater and environmental pollution).
12. Role of water in soil degradation processes (erosion, salinisation/alkalisation, structure destruction, compaction).
13. Alternatives and limitations of soil moisture control (agrotechnics, amelioration, irrigation, drainage).
14. Soil moisture control as important element of rational, sustainable and efficient land-use, environment control and harmonized rural development.

Required and recommended readings:
Várallyay, Gy. (2003): A mezőgazdasági vízgazdálkodás talajtani alapjai. Egyetemi jegyzet. FVM Vízgazd. Osztály, Budapest–Gödöllő. 167 p.
Várallyay, Gy. (2009): Soil degradation processes and extreme soil moisture regime as environmental problems in the Carpathian Basin. In: Scientific and Social-Institutional Aspect of Central Europe and USA. Vol. XXXVIII-XXXIX. Pollution and Water Resources, Columbia University Seminars Proceedings. (Ed.: Halasi-Kun, G. J.) pp. 181–208.
Várallyay Gy., (2010): Increasing importance of the water storage function of soils under climate change. Agrokémia és Talajtan, 59. (1) 7–18.
Várallyay, Gy., Szabóné Kele, G.; Berényi Üveges, J., Marth, P., Karkalik, A., Thury, I. (2010): Soil Conditions in Hungary based on the data from the Soil Conservation Information and Monitoring System (SIMS). Ministry of Agriculture and Rural Development. Budapest. ISBN 978-963-06-6861-3.
Várallyay, Gy. (2011): Environmental aspects of soil–water relationships in the Carpathian Basin. In: Pollution and Water Resources (Ed.: Halasi-Kun, J.) Columbia University Seminar Proceedings. Vol. XL. 2010–2011. Environmental Protection of Central Europe and USA. pp. 237–270.
Várallyay, Gy. (2011): Water storage capacity of Hungarian soils. Agrokémia és Talajtan. 60. Supplementum (online) (ATON) pp. 7–26.
Várallyay, Gy. (2013): Soil scientific basis for agricultural water management. *TÁMOP jegyzet, Debrecen.* I. Demonstrációs anyagok: 102. p.
Várallyay Gy. (2015): Soil as a multifunctional natural resource. Columella, Vol. 2, No. 1. pp. 7-17.

Course title: **Plant protection chemistry**
Course type: facultative
Lecturer: **Tamás Kőmíves**, research professor, MHAS
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The aim of the course is to describe the chemical system of pests and pathogens of crops grown in order to evaluate the most important results and look to future research and development.

Topics
Pesticide formulations
Insecticides
Weed control agents
Fungicides
Antibacterial agents
Other uses

The lectures describe important characteristics of the active ingredients of the different plant protection chemicals, such as
- Chemical structures
- Biological modes of action and mechanisms of action
- Environmental stability and toxicology
- Paying particular attention to the limitations of the applicability of the products in integrated pest management

1. The basics of plant protection chemistry.
2. Different forms and different goals of pesticide formulations.
3. Insecticides.
4. Weed control agents.
5. Antifungal agents.
6. Antibacterial agents.
7. Side effects of pesticides.
8. Residues and degradation products of pesticides in foods and in the environment.
9. Human and environmental toxicology of pesticides.
10. Applicability of pesticides in integrated crop production.
11. Alternatives to the use of pesticides.
12. Rules for the authorization of pesticides.

Required and recommended readings: (downloadable or read free of charge on the Internet):
Ohkawa, Hideo; Miyagawa, Hisashi; Lee, Philip W. (2007): Pesticide Chemistry. Crop Protection, Public Health, Environmental Safety, Wiley-VCH Verlag, Weinheim, p. 542 (2007)
Russell L. Jones et al. (2000): Pesticides in soil. Pesticide Outlook 174-179 (2000)
NG Ntalli, U Spiroudi. (2011): Pesticides of botanical origin, pp. 3-24, InChem (2011)
M. Stoycheva (Ed.) (2011): Pesticides, formulations, effects, fate; p. 822. InTech (2011)

Course title: **Operation of agricultural machinery in a system**
Course type: Facultative
Lecturer: **Attila József Kovács** associate professor, PhD
No. of classes: 30+90
Credits: 4

Short Description of the Course:

The aim of the course is to briefly describe the operational alternatives of agricultural machinery including power-machines as well as working units. The course focuses on energy saving issues and environmental questions in order to minimize loss in the energy utilization cycle. Within the course all machinery systems are introduced, focusing on setup, regulation and operation. It is important to emphasize the system approach in that individual machines, machine groups and tasks are investigated while keeping in mind the entire plant production system of harvesting, storage, as well as post-harvest technologies. The optimization keeps in mind economical and sustainability requirements as well.

1. Energetic parameters of agricultural power machines.
2. Running gears of agricultural machinery and the stability of the machinery systems.
3. Technical services for agricultural machinery.
4. Engineering, energetic and agro technological aspects of machinery systems.
5. Soil cultivation in sustainable agriculture.
6. Operation of fertilizing and plantation equipment.
7. Environmentally friendly and reduced-chemical plant protection technologies.
8. Harvesting machines and operational characteristics.
9. Energy efficient dryers and their operational properties.
10. Biogas production agricultural farms and their operational issues.
11. Biofuel production and utilization alternatives.
12. Alternative energy systems and their applications in agriculture.

Required and recommended readings:
Tibold V.(szerk.) (1977): Gépek üzemeltetése a mezőgazdaságban. Mg. Kiadó, ISBN 963-230-274-5
Janik J.- Remsei N. (1979): Mezőgazdasági gépek üzemfenntartása. Mg. Kiadó, ISBN 963-230-045-9
Szendrő P. (szerk.) (2000): Mezőgazdasági géptan. Mezőgazda, ISBN 963-9239-54-2
Birkás M. (szerk.) (2001): Talajművelés a fenntartható gazdálkodásban. ISBN 963 9256 307
Csizmazia Z. (2007): A korszerű tápanyag-gazdálkodás műszaki feltételei. ISBN 978-963-473-050-7
Kacz K. (2008): Utilization of Biomass as Biogas. Renewable Energy Textbooks, ISBN 978-963-9364-99-8

Course title: **Special aspects of crop production technologies**
Course type: Facultative
Lecturers: **Rezső Schmidt** professor, CSc
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The course includes the newest elements of crop production technologies of the most important cultivated crops, their environmental requirements and soil fertility aspects. During the course the most important ecological and soil fertility relationships will be discussed that are essential for successful crop production in our country and in the region. The curriculum deals with environmental factors that influence crop production and successful strategies that harmonize with a particular environment and exploit the natural conditions in an efficient and environmentally sound way. The realization of technologies corresponding with the described principles is also part of the curriculum.

1. Soil fertility and crop production.
2. Climatic and edaphic conditions of Hungary and crop production.
3. Soil as the basic medium of crop production. Crop production on different types of soils.
4. Soil degradation and crop production. Soil management alternatives in reducing soil degradation.
5. Nutrition management and crop production.
6. Nutrient replacement technologies.
7. Latest crop production aspects of the agricultural economy. The modified CAP and its effects on crop production.
8. New methods and technologies in cereal production.
9. New methods and technologies in maize production.
10. New methods and technologies in the production of oil plants.
11. New methods and technologies in the production of root and tuber crops.
12. New methods and technologies in the production of alternative plants.

Required and recommended readings:
Birkás Márta (2006): Környezetkímélő és alkalmazkodó talajművelés
Kádár Imre (1997): A növénytáplálás alapelvei és módszerei. MTA Talajtani és Agrokémiai Kutatóintézete
Nyle C. Brady (1990): The Nature and Property of Soils. Macmillan Publishing Company, New York
Nagy János (2007): Kukorica termesztés. Budapest, Akadémai Kiadó, ISBN: 9789630583299
Radics László (2010): Fenntartható szemléletű szántóföldi növénytermesztés I., II., III. Budapest Agroinform Kiadó
Nagy János (2008): Maize Production. Akadémiai Kiadó

Course title: **Soil biology, rhizobiology, biofertilizer applications**
Course type: Facultative
Lecturer: **Borbála Biró** professor, DSc.
No. of classes: 30+60
Credits: 3

Short Description of the Course:
The aim of the course is to understand the biological processes in any type of soil-plant-microbe-climate system. The soil-functioning and the role of the soil-food web (SFW) are the most important soil-characteristics. An ecological way of thinking will be developed and the role of soil flora and soil fauna in this process will be followed. Differences in soil-fertility and soil health, and the role of soil functions in the agri-, horti-, silvi- and viticulture will be addressed. The indication of soil characteristics such as, soil fertility, soil buffer ability, soil resilience power and other functions will be assessed. The course will present: various ecophysiological soil biological groups in the rhizosphere environment; the rhizosphere effect and distribution of soil-biota in different soil-plant systems; soil-microorganisms, biofertilizers and biopesticides; the role and type of biological nitrogen-fixing bacteria and their potential activities and tolerance to environmental stress conditions; the importance of P-mobilization for plant growth and development; beneficial and harmful organisms in soil; the environmental stress-factors; short and long-term effects of stress and the adaptation processes; natural and anthropogenic stress in soil-plant systems; differences in environmental management techniques; amelioration, recultivation, resaturation and remediation processes; soil bio-phyto-rhizo-technologies; the practice and applicability of microbial inoculation; and the living and non-living bioeffectors and their role in soil-environment-human health, etc.

1. The soil and its properties (fertility, buffer ability, resilience and soil power).
2. The soil-food web, ecophysiological groups of soil biota. Interrelations and trophic levels.
3. Soil-biological processes and soil-nutrient supply of plants.
4. Beneficial and harmful organisms in the soil-plant systems.
5. Microbial and plant-physiological stratagem. Adaptation to permanent and changeable environmental parameters.
6. Short and long-term environmental stress. Surviving mechanisms of microorganisms.
7. Soil quality and soil health. Role of soil biota. Soil monitoring.
8. Microbial strain selection and characterization, strain collection, and maintenance, in vitro stress tolerance tests.
9. Precision and intensive agricultural practices and the soil-biological properties. Conservation agriculture.
10. Soil-biota and soil-physical, -chemical, biological properties.
11. Artificial soil and isolated soil-plant systems. Vertical agriculture.
12. Practical and current trends in soil (micro) biology.

Required and recommended readings:
Sylvia DM, Furhman JJ, Hartel PG, Zuberer DA (2005): Principles and applications of Soil Microbiology. Pearson Prentice Hall. Upper Sadle River, New Jersey. ISBN 0-13-094117-4.
Biró B, Köves-Péchy K, Tsimilli-Michael M, Strasser RJ (2005): Role of the beneficial microsymbionts on the plant performance and plant fitness. In: Soil Biology; Vol. 7; *Microbial Activity in the Rhizosphere* (eds: KG MUKERJI; C MANOHARACHARY; J SINGH). Springer-Verlag Berlin; Heidelberg; 2006. p. 265-296. ISBN 10 3-540-29182-2
Biró B. (2006): Bacterial numbers. Root dilution analysis. p. 378-379. In: Understanding and modelling plant soil interactions in the rhizosphere environment. Handbook of methods used in rhizosphere research. Chapter 4.1. *Microbial growth and visualization of bacteria and fungi* (eds: P. SCHWEIGER and R. FINLAY). Swiss Federal Research Institute WSL; Birmensdorf. ISBN 3-905621-35-5
David C. Coleman, D. A. Crossley, Paul F. Hendrix (2004): Fundamentals of Soil Ecology. Second Edition. Elsevier Academic Press. http://www.amazon.com/Fundamentals-Soil-Ecology-Second-Edition/dp/0121797260
Ingham: Soil biology primer book. http://soils.usda.gov/squi/concepts/soil-biology/biology.html.
Khan Towhid Osman (2013): Soil, Principles, properties and Management. Springer, pp. 296. (E-book)

Course title: **Basic concepts of macro- and microeconomics for plant production**
Course type: Facultative
Lecturers: **Imre Tell** associate professor, CSc
Nóra Gombkötő assistant professor, PhD
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The educational objective of this course is to explore the economic aspects of plant production; to learn factors and relationships affecting business (including means and methods, etc.); to be able to apply all of these in practice to manage efficiently. Besides the economic specialities of the plant production system, the course revolves around planning, organizing and analysing tasks of plant production. Due to the unfavourable conditions concerning profitability of plant production there is a particular focus on macro- and microeconomic factors that determine the earning ability (profit yielding) – hence competitiveness.

1. Economic aspects of plant production.
2. Macroeconomic and market conditions (domestic and international) of plant production.
3. Different aspects of the organizational/corporate structure of plant production – sizes of enterprises and business units.
4. Characteristics of the main resources (land, production tools, labour) in plant production.
5. Planning and organizing. The question of strategy in the plant production of enterprises.
6. Effectiveness of resources in plant production, cost and profit calculations.
7. Analysis of plant production. Branch and functional analysis.
8. Comparative analysis of different plant production technologies.
9. Decision making system in branches of plant production.
10. Innovation, product and technology development in plant production.
11. The regulatory system and its application in practice in plant production. Market information systems and how it functions.
12. Possibilities of alternative product manufacturing in agriculture. Bio-energy production in plant production.

Required and recommended readings:
Emery N. Castle, Manning H. Becker, A. Gene Nelson (1992): Farmgazdálkodás (Farm Business Management), Budapest, Mezőgazda Kiadó
Peter L. Nuthall (2010): Farm Business Management, The Core Skills, CABI, 2010. ISBN: 1845937368, 9781845937362
Peter L. Nuthall (2010): Farm Business Management, The Human Factor, CABI, 2010. ISBM: 9781845935986

"Ujhelyi Imre Doctoral Program" for Animal Science Program Leader: Prof. Dr. Ferenc Szabó, DSc				
Course	Course leader	Hours**	Credit	Semes-ter
Compulsory				
Genetic Basics of Animal Husbandry	Ágnes Bali Papp PhD Károly Tempfli PhD	30 + 120	5	1.
Physiology of Animal Production	Borisz Egri, DSc, MRANH Erika Lencsés-Varga PhD	30 + 120	5	1.
Theoretical foundation of livestock nutrition	Eszter Zsédely PhD	30 + 120	5	2.
Breeding and selection of farm animals	Ferenc Szabó DSc László Gulyás PhD	30 + 120	5	2.
Methodology of research *	Zoltán Varga PhD László Varga PhD	30 + 120	5	1.
Special research methodology in animal breeding *	Tamás Tóth PhD Károly Tempfli PhD	30 + 120	5	2.
Facultative				
Biotechnology in animal husbandry	Ágnes Bali Papp PhD Erika Lencsés-Varga PhD	30 + 90	4	2-3.
Molecular genetics	Ágnes Bali Papp PhD Károly Tempfli PhD	30 + 90	4	2-3.
Epidemiological relations of food production of animal origin	Borisz Egri, DSc, MRANH	30 + 90	4	3-4.
Diseases of game animals	Borisz Egri, DSc, MRANH	30 + 90	4	3-4.
New trends in animal nutrition	Tamás Tóth PhD Eszter Zsédely PhD	30 + 90	4	3-4.
New theories and modern methods in horse breeding	László Pongrácz PhD	30 + 60	3	3-4.
Sustainable cattle production	Ferenc Szabó DSc László Pongrácz PhD	30 + 60	3	3-4.
Modern sheep and goat production	Kukovics Sándor PhD	30 + 60	3	3-4.
Novel methods in pig breeding	Tamás Tóth PhD Károly Tempfli PhD	30 + 60	3	3-4.
Traditional and new methods of poultry breeding and farming	Eszter Zsédely	30 + 60	3	3-4.
Modern fish production systems	László Szathmári PhD	30+ 60	3	3-4.
Basic concepts of macro- and micro economics for animal husbandry	Imre Tell CSc Nóra Gombkötő PhD	30 + 90	4	3-4.

* Compulsory for all students of the doctoral program

** 30 contact hours = 1 Credit, 120 hours = 4 Credit

Course title: **Genetic basics of animal husbandry**
Course type: Compulsory
Lecturers: **Ágnes Bali Papp** professor, PhD
Károly Tempfli assistant professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
Genetic discoveries are studied concerning domestic animal breading, generally and species-specific. Our aim is to concentrate on genetic discoveries that could be used efficiently in the student's further research. The applicability of genetic methods and statistical analysis is emphasized. This course is based on genetic discoveries acquired in the graduate studies course and is connected to molecular genetics and animal breeding.

1. The structure of nucleic acids. DNA replication and the RNA transcription from DNA sample. Central dogma. The initiation, process and finishing of transcription.
2. The process of translation. The genetic code.
3. Contemporary gene definition, the structure of genes and its transcription.
4. Gene and genome of prokaryotes and eukaryotes
5. The ideal population, the Hardy-Weinberg Balance. The effect of migration and its influence on gene frequency.
6. Mutation as source of variability and its influence on gene frequency.
7. Genetic drift. Bottleneck effect. Effective size of population. Genetic distribution of population.
8. Definition of fitness. Absolute and relative fitness.
9. The role and significance of the h^2 rate, and usefulness in animal breeding. Correlation and regression
10. Selection: levels and types of selection. Selection models. Connection of selection and drift.
11. Genetic polymorphism of natural population.
12. Quantitative genetics. Precalculation of genetic variance, artificial selection.

Required and recommended readings:
Fésüs L., Komlósi I., Varga L., Zsolnai A. (2000) Molekuláris genetikai módszerek alkalmazása az állattenyésztésben (Use of the molecular genetics methods in animal husbandry), Agroinform Kiadó és Nyomda Kft, Budapest
Török P., Maróy P. (2011) Genetika BS.(Genetics) JATE Press, Szeged
R.F. Weaver, P.W. Hedrick (2000): Genetika(Genetics), Panem Kiadó, Budapest,
A.J.F. Griffiths, R.C. Lewontin, W.M.G. Jeffrey, H. Miller (2002) Modern Genetic Analysis: Integrating Genes and Genomes,
W H Freeman & Co, New York A.J.F. Griffiths (2004) An Introduction To Genetic Analysis, W H Freeman & Co, New York
Relevance foreign an Hungarian papers

Course title: **Physiology of animal production**
Course type: Compulsory
Lecturers: **Borisz Egri** professor, DSc, MRANH
Erika Lencsés-Varga, associate professor, PhD.
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The aim of the course is to analyse the most important fields of physiology of animal production. In accordance with this the course covers the principles of the physiological regularity of production. A study will be made of the domestic and international specialized literature.

1. Reproduction I.: anatomy and physiology and species specificity of male genitalia.
2. Reproduction II: anatomy and physiology and species specificity of female genitalia.
3. The sexual cycle of females. Conception and pregnancy.
4. Physiology and species specificity of parturition.
5. Anatomy and species specificity of mammary glands.
6. Physiology of milk production.
7. Biochemistry, microbiology and species specificity of milk composition.
8. Biochemical relations of muscular contractions.
9. Biochemical relations of meat processing.
10. Anatomical relations of eggs.
11. Formation and physiological relations of eggs.
12. The structure, composition and species specificity of fish meat .

Required and recommended readings:
Bárdos, L., Husvéth, F., Kovács, M. (2007): Gazdasági állatok anatómiájának és élettanának alapjai. Mezőgazda Kiadó, Budapest
Dyce, K.M., Sack, W.O., Wensing, C.J.G. (1987): Textbook of Veterinary Anatomy. W.B. Saunders Co., Philadelphia etc.
De Lahunta, A., Habel, R.E. (1986): Applied Veterinary Anatomy. W.B.Saunders Co. Philadelphia etc.
Fonyó, A. (szerk.) (1999): Az orvosi élettan tankönyve. Medicina, Budapest
O'Neill, R. Murphy, R. (2015) Endocrinology. Mosby Elsevier. Edinburgh, London.
Rudas, P., Frenyó, V. (szerk.) (1995): Az állatorvosi élettan alapjai. Springer Hungarica

Course title: **Theoretical foundation of livestock nutrition**
Course type: Compulsory
Lecturers: **Eszter Zsédely** associate professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The purpose of teaching the course is to extend students' knowledge of biochemistry, physiology and animal nutrition, which is necessary to acquire a high level of knowledge concerning animal breeding and nutrition during their PhD studies. Teaching the course is also justified by the fact that students who were not admitted with MSc degrees in animal breeding will be able to acquire the knowledge of animal breeding and nutrition studies more easily during the PhD training.

1. The N-metabolism in the animal organism. Specialties of N-metabolism in ruminants.
2. Lipid metabolism. Lipid metabolism in the rumen.
3. Carbohydrate metabolism. The role of starch and row fibre in the nutrition of monogastric animals and ruminants.
4. Carbon metabolism of livestock animals.
5. Energy metabolism of livestock animals. Direct and indirect calorimetry methods to determine energy metabolism.
6. Acid base balance and cation-anion ratios in livestock animals
7. Antinutritional factors in the feed ingredients.
8. Determination of energy value with digestible and metabolizable energy
9. Determination of energy value with net energy. National net energy system.
10. Measuring the protein value in the nutrition of monogastric animals and ruminants. National metabolizable protein system
11. Nutrition requirements of milk production and reproduction
12. Nutrition requirements of fattening animals and egg production

Required and recommended readings:
Kakuk T., Schmidt J. (1988): Takarmányozástan. Mezőgazdasági Könyvkiadó, Budapest
Schmidt J. (2015): A takarmányozás alapjai. Mezőgazda Kiadó, Budapest
Schmidt J., Várhegyi J-né, Várhegyi J., Cenkvári É. (2000): Kérődzők takarmányainak energia- és fehérjeértékelése. Mezőgazda Kiadó, Budapest
D.A. Tisch (2006): Animal feeds, feeding and nutrition and ration evaluation. Delmar Cengage Learning, USA
W.G.Pond, D.C. Church, K.R. Pond, P.A. Schoknecht (2005): Basic animal nutrition and feeding. WILEY, USA
Relevant journal articles

Course title: **Breeding and selection of farm animals**
Course type: Compulsory
Lecturers: **Ferenc Szabó** professor, DSc
László Gulyás, associate professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The course is based on the knowledge and approach of basic and animal genetics. The aim of the course is to show the possibilities and methods, which can be used for the genetic improvement of farm animals including their production, adaptation and competitiveness. During the course new and up-to-date information will be provided on traits, breeding goals, breeding value estimation and selection methods.

1. Qualitative and quantitative traits and their inheritance.
2. Methods of measuring and evaluation of different traits.
3. Homozygosity, heterozygosity, inbreeding, heterosis.
4. Phenotypic, genetic and environmental variance and using them in the breeding.
5. Genotype and environment interaction.
6. Heritability, repeatability, correlation of traits.
7. The breeding value and its estimation methods.
8. Ways of selection.
9. Factors influencing genetic gain.
10. Mating systems for improving homozygocy or heterozygocy.
11. Genomic breeding value estimation and genomic selection.
12. Integrating breeding programmes and their validity.

Required and recommended readings:
Szabó F. (szerk.) (2016): Általános állattenyésztéstan, (Animal breeding) Mezőgazda Kiadó, Budapest
Szabó F., Komlósi I., Posta J. (2011): Population genetics TÁMOP tanagyag, Debrecen, Keszthely, Mosonmagyaróvár
Szabó F., Bokor Á., Bene Sz., Polgár P. (2012): Animal breeding, TÁMOP tanagyag, Kaposvár, Keszthely
Blakely J., Bade, H.D (1994): The science of animal husbandry: Prentice Hall International, UK, London, sixth edition
Cunningham, M, Latour, M.A., Acker, D. (2005): Animal science and industry. Pearson Education, Prentice Hall, seventh edition
Bourdon R.M. (2000): Understanding animal breeding. Pearson Education, Prentice Hall, seventh edition

Course title: M**ethodology of research**
Course type: Compulsory
Lecturers: **László Varga** professor, DSc
Zoltán Varga associate professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The objective of this course is to teach the PhD students about the theoretical, practical and methodological questions of scientific research. The students get up-to-date knowledge of the most important issues of science and research methodology and of the forms of scientific activity; and they can know the conceptual and methodological tools of their own field of science. They can also understand the methods to solve a problem (observation, experiment), and be able to design and carry out the research.
The course gives information about the special methodological issues of plant cultivation sciences; the principles and basic concepts of arable experiments; the methods of designing, setting and evaluating experiments.
The following issues are also important parts of the course: the different types of plant cultivation experiments (single-factor-, bi- and multifactorial experiments, factorial experiments, experiment sequences, duration experiments, technological development experiments); the principles and models of analysis of variance, correlation calculations and regression analyzes (linear and non-linear, multiple); and use of special computer programs (GenStat, SPSS, MSTAT-C) in designing and evaluating experiments. Students of the course should understand the use of multivariate biometric methods (main component analysis, cluster analysis, discriminant analysis) and they are able to decide on the use of different analytical and synthesizing methods.
The students can learn the steps to make scientific publications. They have to be able to distinguish between scientific and non-scientific work, and to recognize the pseudo-scientific activity. They must be aware of the ethical rules of making scientific publications and the important parameters of scientometrics.

1. The importance and history of science and the methodology of research
2. Comparative analysis of common knowledge and scientific knowledge
3. Parallel examination of theoretical knowledge and empirical knowledge
4. Practice of scientific research; the basic steps of scientific knowledge; designing and conducting scientific research
5. Principles and basic concepts of arable experiments; experimental layouts and computer design of experiments; types, advantages, disadvantages and use of plant cultivation experiments
6. The principles, models of analysis of variance (ANOVA) and use of computer programs to evaluate different types of experiments
7. Use of non-parametric probes, correlation calculations and regression analysis in the evaluation of crop experiments
8. Use of multivariate biometric methods in the synthesis of experimental results
9. Basic rules of searching for scientific literature, use of internet databases; search for articles and quotations, query techniques
10. Types of scientific and non-scientific publications, conditions of publication; strategies for publishing and selecting journals; ethical issues of scientific research and publishing
11. Creating scientific publications (from title to references; content and form requirements)
12. Scientometrics, measurement of scientific performance; interpretation of the used performance rating factors, their advantages and disadvantages (impact factor, quotation, Hirsch index, etc.)

Required and recommended readings:
Berzsenyi, Z. (2014): Növénytermesztési kísérletek tervezése és értékelése. Kézirat, MTA ATK Mezőgazdasági Intézet, Martonvásár.
Bujdosó E. (1986): Bibliometria és tudománymetria, Budapest, MTA Könyvtára
Csermely P., Gergely P., Koltay T., Tóth J. (1999): Kutatás és közlés a természettudományokban. Budapest. Osiris Kiadó
Ireland, C.l. (2010): Experimental Statistics for Agriculture and Horticulture. CABI, Cambridge.
Popper, K. (2002): The logic of scientific discovery. Routledge Classics, Taylor and Francis Group. 513 oldal.
Sváb, J. (1981): Biometriai módszerek a kutatásban. Mezőgazdasági Kiadó, Budapest.
Varga-Haszonits Z., Varga Z. (2006): Kutatásmódszertani ismeretek. Oktatási segédanyag. NYmE-MÉK, Mosonmagyaróvár, 159 oldal.

Course title: **Special research methodology in animal breeding**
Course type: Compulsory
Lecturer: **Tamás Tóth** associate professor, PhD
Károly Tempfli assistant professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The aim of the course is to give an overview of the main research methods applied in animal breeding. Methods of research works carried out with livestock related to feeding and digestive physiology will be evaluated. The course provides information about the main aspects of trial settings and about the methods of collecting and compiling data. The latest evaluation techniques will be demonstrated using actual experimental data. The course deals with the directives of publication in national and international scientific literature where data observed in research work can be published.

1. General directives of scientific trial planning and trial setting.
2. Introduction of trial design (randomised block, Latin square, crossover, etc.).
3. Determination of nutrition digestibility using animal experiments and *in vivo* methods.
4. Determination the protein value of the feed in livestock feeding.
5. Presentation of *in sacco (in situ), mobil bag*, and *in vivo* experiments used in the feeding of ruminants.
6. Cannulation (T-shaped cannula, PVTC-cannula, re-entrant methods) and other techniques (post mortem inspections) in the feeding of monogastric animals.
7. Presentation of animal test sites in Mosonmagyaróvár (practical training).
8. Collection and evaluation of experimental data, preparation of descriptive statistics (practical training).
9. Evaluation of statistical significance (practical training).
10. Analysis of variance (practical training).
11. Analysis of correlation and regression (practical training).
12. Directives of scientific publications.

Required and recommended readings:
Hancz, Cs. (2004): Kísérleti statisztika I. Kísérletek tervezése és értékelése. 2004
Petrie, A. – Watson, P. (2013): Statistics for Veterinary and Animal Science. Wiley-Blackwell; 3rd edition.
Orskov, E.R. (2001): Trails and trials in livestock research. 2001.
Zagumny, M. (2001): The SPSS book. 2001. Universe.
Current articles in relevant international and national publications

Course title: **Biotechnology in animal husbandry**
Course type: Facultative
Lecturers: **Ágnes Bali Papp** professor, PhD
Erika Lencsés-Varga associate professor, PhD
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The goal of this course is to familiarize the students with the current results, position and role of biotechnology of animal husbandry. Besides the classical animal biotechnical methods (such as artificial insemination, embryo transfer, embryo cryopreservation, hormonal control of genital processes) the course presents contemporary methods of embryo manipulation and the possible applications of stem cells. This material deals with the tools of genetic manipulation and introduces the most frequently used methods in genetic engineering; the study of genetic mapping and marker assisted selection; and basic courses related to biotechnology: biochemistry, animal physiology, reproduction biology and genetics.

1. Biotechnology in animal husbandry.
2. Artificial insemination.
3. Controlling genital functions. Reproduction biology nursing.
4. Embryo transfer, Theoretical basics of cryopreservation.
5. In vitro oocyte maturation fertilization, embryo development. Regulation of IVF application in Hungary, Europe and globally.
6. Totipotent, pluripotent, multipotent inducted stem cells.
7. Possibilities and limitations of the application of different stem cells.
8. Embryo micromanipulation, Possibility of cloning.
9. Microbiome research.
10. Basics and tools of genetic manipulation, Genetic engineering methods.
11. Comparing different genetic engineering methods, specifically on domesticated animals.
12. Present and future of biotechnology.

Required and recommended readings:
J. Watson (2002): DNS, az élet titka, (DNA, the secret of life) HVG könyvek, Budapest,
H. Lodish, A. Berk, L.S. Zipursky, P. Matsudaira, D. Baltimore, Darnell, J. (2000): Molecular Cell Biology, W. H. Freeman and Company, New York
B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter (2002): Molecular Biology of the Cell, Garland Science, New York
J.M. Walker, R. Rapley (2009): Molecular Biotechnology. Royal Society of Chemistry, Oxford,
D.P. Clark N:J: Pazdernik (2015) Biotechnology Academic Cell, Elsevier,Amsterdam, New York
Relevant foreign and Hungarian papers.

Course title: **Molecular genetics**
Course type: Facultative
Lecturers: **Ágnes Bali Papp** professor, PhD
Károly Tempfli assistant professor, PhD
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The aim of the course is to describe the current position and role of molecular genetics in animal husbandry. The course looks at molecular biology and molecular genetics and its role in animal breeding. This material deals with proteomics, structural genomics and functional genomics; molecular genetics methods; mutations and their influence on gene frequency; the major genes and MAS (Marker Assisted Selection) in regards to animal husbandry; the use of the molecular genetics methods in animal husbandry and the results on different vertebrata, such as hens, horses, cattle, and pigs; as well as the basic study of molecular genetics, which includes biochemistry, genetics, animal husbandry and the genetic basis of animal husbandry.

1. Structure of genes and transcriptome in mammals. Proteomics.
2. Access to the whole genome in DNA level-structural genomics.
3. GMO, the rules on the use.
4. Experimental samples of the examination of gene expression. Microarray methods.
5. Different methods to identify mutations. Single Nucleotide Polymorphism (SNP).
6. Use of molecular genetics methods in animal husbandry. Use of QTL analysis on different domestic animals.
7. PCR methods. PCR reaction: denaturation, annealing, and elongation. Components of PCR reaction.
8. RT-PCR: use of reverse transcriptase to cDNA synthesis. Primer planning.
9. Real time detection using fluorimetric methods: real time PCR. Qualitative and quantitative qualification of PCR products.
10. Use of the CRSIPR method and the possibilities of genome manipulation.
11. Up-to-date results of genetic mapping.
12. Functional genomics.

Required and recommended readings:
Fésüs L., Komlósi I., Varga L., Zsolnai A. (2000): Molekuláris genetikai módszerek alkalmazása az állattenyésztésben (Use of the molecular genetics methods in animal husbandry), Agroinform Kiadó és Nyomda Kft, Budapest,
A.J.F. Griffiths, R.C. Lewontin, W.M.G. Jeffrey, H. Miller (2002): Modern Genetic Analysis: Integrating Genes and Genomes, W H Freeman & Co, New York
A.J.F. Griffiths (2004): An Introduction to Genetic Analysis, W H Freeman & Co, New York
Balázs Ervin-Dudits Dénes (2017) Preciziós nemesítés Kulcs az agrárinnovációhoz (Precision breeding. Key to agroinnovation) Agroinform, Budapest
Relevance foreign an Hungarian papers

Course title: **Epidemiological relations of food production of animal origin**
Course type: Facultative
Lecturer: **Borisz Egri** professor, DSc, MRANH
No. of classes: 30 + 90
Credits: 4

Short Description of the Course:
The aim of the course is to understand the epidemiological relations of food production of animal origin. In accordance with this the course will provide an evaluation and understanding of the epidemiological background of food hygiene. In addition a study will be made on the domestic and international specialized scientific literature.

1. Basics of general epidemiology I. Basic values, relationships, and progress of diseases in microbiology.
2. Principles of general epidemiology II. Methods of sampling for bacteriological and virological assays.
3. General principles of laboratory diagnosis (bacteriological analysis, agglutination-test, precipitation-test, and complement fixation test (VN, RIA, ELISA, EIA).
4. Molecular epidemiology of infectious diseases (PCR, isolation of plasmid DNA, analysis of restriction endonuclease). Hybridization (solid, (dis)solved, in situ), restricted gene-analysis, analysis of gene – RNA.
5. Interpretation of statistical values (morbidity, mortality, cohorts, case control).
6. Detailed epidemiology I: listeriosis, brucellosis, malleus, anthrax, leptospirosis.
7. Detailed epidemiology II: ornithosis, rabies 1.
8. Detailed epidemiology III: rabies 2, tularemia.
9. Detailed parasitology I: fasciolosis, larval cestodoses, larval echinococcoses, trichinellosis.
10. Detailed parasitology II: fascioloidosis, coenurosis, mange.
11. Epidemiology in food hygiene I: salmonellosis, *Cl. botulinum*, *Cl. perfringens*.
12. Epidemiology in food hygiene II: *Staphylococcus aureus*, *Listeria monocytogenes*, *Campylobacter s*p.
13. Epidemiology in food hygiene III: Shigella sp., *colibacteriosis.*

Required and recommended readings:
Bíró, G. (1999): Élelmiszer-higiénia. Agroinform, Budapest, Egri, B. (Szerk.) (2009): Az állategészség-védelem alapjai. Mezőgazda, Budapest.
Egri, B.(Szerk.)(2017): Az állategészség-védelem alapjai (Második, bővített kiadás). Mezőgazda Kiadó. Budapest.
Kumar, S. (2016): Essentials of Microbiology. Jaypee Brothers, New Delhi, London
Jerome, K. R. (2010): Lennette's Laboratory Diagnosis of Viral Infections (4th Ed.). Informa, New York, London
Day, M.J. (2014): Veterinary Immunology (2nd Ed.). CRC Press, Boca Raton, London, New York
Foreyt, W. J. (2001): Veterinary Parasitology (5th Ed.). Blackwell Publ., Iowa State

Course title: **Diseases of game animals**
Course type: Facultative
Lecturer: **Borisz Egri** professor, DSc, MRANH
No. of classes: 30 + 90
Credits: 4

Short Description of the Course:
The course provides knowledge on frequent diseases of pheasants, hares, common rabbits, foxes, wild boars and different kinds (red, roe, fallow) of deer. The course presents information on the recognition of symptomatology and pathology of different diseases of wild animals in the wild and (in the case of some species) in intensive husbandry.

1. Frequent infectious and parasitic diseases of pheasants in the wild.
2. Animal health of pheasants in intensive husbandry.
3. Frequent infectious and parasitic diseases of ducks in the wild.
4. Animal health of wild ducks in intensive husbandry.
5. Frequent infectious and parasitic diseases of hares and common rabbits.
6. Frequent infectious and parasitic diseases of foxes in the wild.
7. Frequent infectious and parasitic diseases of boars in the wild.
8. Animal health of wild boars in game parks.
9. Frequent infectious and parasitic diseases of different kinds of (red, roe, fallow) deer and moufflon in the wild.

Required and recommended readings:
Bicsérdy, Gy., Egri, B., Sugár, L., Sztojkov, V. (2007): Vadbetegségek.Budapest
Winkelmayer, R. Lebersorger, P. (2004): Wildbret-Hygienie. Zentralstelle Österreichischer Landesjagdverbände. Wien
Wobeser, G.A. (2006): Essentials of Disease in Wild Animals. Blackwell Publ.
Miller, E.R., Fowler, M.E. (2014): Fowler's Zoo and Wild Animal Medicine-Vol.8., Elsevier

Course title: **New trends in animal nutrition**
Course type: Facultative
Lecturer: **Tamás Tóth** associate professor, PhD
Eszter Zsédely associate professor, PhD
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The aim of the course is to learn about the modern approach to nutrient supply of farm animals and the transfer of the up-to-date knowledge. Further aims are to give a description of the latest chemical methods related to the determination of amino acids, fibre components, and non-structural carbohydrates. The course also draws attention to the relationship between nutrition and other professional fields in particular to environmental protection, genetics, animal health and reproductive biology. It presents the role of feeding of novel industrial by-products and the benefits of using biological agents and special fatty acids in the feed recipes for farm animals. Finally, the course gives an opportunity to be able to evaluate the effects of feeding on the quality of food of animal origin (milk, eggs, meat).

1. Novel approach to crude protein (CP) and amino acid (AA) supply in farm animal nutrition.
2. Classical and modern methods of crude fibre (CF) determination.
3. Role of the non-structural carbohydrates (NSC) in the feeding of ruminants.
4. The effects of modern heat treatment processes (e.g., expansion, extrusion) on the performance of farm animals.
5. The main correlations between nutrition and environmental protection (nitrogen and phosphorus emptying).
6. Presentation of nutrition-genetics-animal health interactions.
7. The role of non-starch-polysaccharides (NSP) enzymes in the feeding of monogastric animals.
8. Novel biological agents in the feeding of farm animals (probiotics, prebiotics, organic acids, plant extracts, essential oils, etc.)
9. Importance of feeding by-products coming from biodiesel production.
10. Importance of feeding by-products coming from bioethanol production.
11. The effect of omega-3 fatty acids and conjugated linoleic acid (CLA) on the reproductive biological performance of farm animals.
12. The effects of feeding on the quality of milk, eggs and meat.

Required and recommended readings:
Nutrient Requirements of Dairy Cattle (2001): Seventh Revised Edition
Nutrient Requirements of Swine (2012): Eleventh Revised Edition
Nutrient Requirements of Poultry (1994): Ninth Revised Edition
Richard, O.K., Church, D.C. (2009): Livestock feeds and feeding, Prentice Hall
Current articles in relevant international and national publications

Course title: **New theories and modern methods in horse breeding**
Course type: Facultative
Lecturer: **László Pongrácz** associate professor, PhD
No. of classes: 30+60
Credits: 3

Short Description of the Course:
Due to a great change in the use of horses and its industry over the past decades there is a need to understand how modern methods are to be used to achieve the new goals set forth. Based on general and specific knowledge of physiology, genetic, reproduction, feeding and economics students will focus on the complexity of constitutional and performance traits of the high performance horse. National and international trends in sport, breeding and research will also be discussed.

1. Historical role of horses.
2. Turf.
3. Equestrian sports 1.
4. Equestrian sports 2.
5. New trends in horse breeding
6. Exterior and interior value of the modern horse.
7. Up-to-date performance testing of horses.
8. Reproduction.
9. Husbandry technologies.
10. Feeding the high performance horse.
11. Economics of the horse industry.
12. Equestrian research topics.

Required and recommended readings:
Baiely, E., Brooks, S.A. (2013): Horse genetics. CABI, UK
Bodó I., Hecker W. (eds.) (2013): Lótenyésztés, lótartás, lóhasználat. Mezőgazda Kiadó, Budapest
Evans, J. W., Borton, A., Hintz, H., van Vleck, E. D. (eds.) (1990): The Horse. W.H. Freeman & Company, New York
Pongrácz L. (2005): A ló tenyésztése és genetikája. Szaktudás Kiadó Ház, Budapest

Course title: **Sustainable cattle production**
Course type: Facultative
Lecturers: **Ferenc Szabó** professor, DSC
László Pongrácz associate professor, PhD,
No. of classes: 30+60
Credits: 3

Short Description of the Course:
The aim of the course is to give up-to-date, above the MSc level, knowledge of the principle and practical methods of cattle production. Referring to the latest research results the germplasm of cattle production, breeding end selection methods and managing for sustainable milk and beef production will be presented. Moreover the role of cattle in relations to humans and its environmental impact will also be highlighted.

1. Cattle breeding and production worldwide.
2. Relationship between cattle production and the environment.
3. Factors influencing sustainability of cattle production.
4. Evolution of cattle and the development of breeds and types.
5. Breeding goals and breeding direction in cattle production.
6. Native and international breeds, gene preservation and the genetic improvement in cattle.
7. The role of dual purpose and specialized dairy and beef cattle breeds.
8. Scoring and other evaluation methods of different cattle breeds.
9. Methods to estimate the breeding value of cattle.
10. Selection and mating methods of cattle.
11. Methods of sustainable milk and beef production.
12. Breeding organization, animal welfare, and environment protection during cattle production.

Required and recommended readings:
Holló I., Szabó F. (2016): Szarvasmarhatenyésztés.Mezőazda Kiadó, Budapest
Szabó F. (szerk.) (2005): Húsmarhatenyésztés, Mezőgazda Kiadó, Budapest
Cunningham, M, Latour, M.A., Acker, D. (2005): Animal science and industry. Pearson Education, Prentice Hall, seventh edition
Fries R., Ruvinsky A. (1999)*:* The genetics of cattle. CAB International, New York, USA
Taylor R. E., Field T. G. (2002): Beef production and management decisions. Pearson Education, Prentice Hall
Phillips, C.J.C. (2001): Principles of cattle production. CAB International, New York, USA

Course title: **Modern sheep and goat production**
Course type: Facultative
Lecturer: **Kukovics Sándor** director, PhD
No. of classes: 30+60
Credits: 3

Short Description of the Course:
The main goal of the course is to introduce students to modern methods and techniques applied in Hungarian sheep and goat breeding. The current state of sheep and goat breeding and developmental potential of the sector are reviewed. Types of different breeds and breeding groups are described. In addition methods to improve sheep and goat milk, and the quality meat production are presented. Furthermore, biotechnology procedures in the reproduction of sheep and goats, breeding value estimation, selection indices, and organic animal production are also discussed.

1. Significance of sheep and goat breeding.
2. Determination of breeding goals.
3. Sheep and goat breeds.
4. Alternatives for the improvement of mutton production.
5. Alternatives for the improvement of sheep milk production.
6. Alternatives for the improvement of goat milk production.
7. Technology in different housing systems.
8. Methods of lamb fattening.
9. Up-to-date procedures in reproductive biology.
10. Methods to estimate breeding value.
11. Methods of selection. Profitability and selection indices.
12. Organic sheep and goat breeding.

Required and recommended readings:
Jávor A.-Kukovics S.-Molnár Gy. (2006): Juhtenyésztés A-tól Z-ig. Mezőgazda Kiadó, Budapest
Mucsi I. (1997): Juhtenyésztés-és tartás. Mezőgazda Kiadó, Budapest
Kukovics S.-Jávor A. (2008): A juhtenyésztés jelene és jövője az EU-ban. AMC, Herceghalom-Debrecen
Kukovics S.-Jávor A. (2010): A fejlesztés lehetőségei a juhágazatban. Juhinnov Platform, Budapest
Vahid, Y. *(*1992): Kecsketenyésztés mindenkinek. Intereuropress Kiadó és Nyomda Rt., Budapest
Mucsi I. (1997): Juhtenyésztés-és tartás. Mezőgazda Kiadó, Budapest
Field T.G, Taylor R.E (2012): Sheep and Goat Breeds and Breeding (in: Scientific Farm Animal Production, Prentice Hall
Field T.G, Taylor R.E (2012): Feeding and Managing Sheep and Goats (in: Scientific Farm Animal Production, Prentice Hall
Recent papers in relevant international and national scientific journals

Course title: **Novel methods in pig breeding**
Course type: Facultative
Lecturer: **Tamás Tóth** associate professor, PhD
Károly Tempfli assistant professor, PhD
No. of classes: 30+60
Credits: 3

Short Description of the Course:
The aims of the course are to provide knowledge about novel breeding methods applied to pig breeding, developments of housing technology, and expected challenges in pig breeding. During the course students will gain an overview about the distribution and composition of pig stock in the world; furthermore about the changes and forecasts that are taking place nowadays. Through the survey of the situation of domestic pig breeding students are given the opportunity to learn about the current difficulties afflicting the sector and on the other hand the possible solutions to these problems. In addition to breeding regulations, methods to improve pig performance in accordance with sustainability such as, novel feeding, breeding techniques, breeding value estimation and evaluation methods for testing performance will be summarized.

1. The situation of pig breeding in the world and in Europe.
2. The expected impacts of the changing environment on pig breeding.
3. Sustainability in pig breeding.
4. Modern pig breeds and hybrids in Hungary and in the world.
5. Presentation of modern feeding principles.
6. Possibilities of indigenous (native) pig breeds in domestic and international environments.
7. Importance of genomic selection and breeding based on genetic markers.
8. The latest methods of breeding value estimation and performance testing.
9. Qualification of livestock and meat testing.
10. Description of applied methods to evaluate reproductive biology.
11. Biotechnology in pig breeding and possibilities of genetic modification.
12. Changes in the field of animal protection and developments in husbandry technologies.

Required and recommended readings:
Blair, R. (2007): Nutrition and feeding of organic pigs. CAB International, Oxfordshire, UK
Mrode, R.A., Thompson, R. (2014): Linear models for the prediction of animal breeding values. CAB International, Oxfordshire, UK
Rothschild, M.F., Ruvinsky, A. (2011): The genetics of the pig. CAB International, Oxfordshire, UK
Swain, D.L., Charmley, E., Steel, J.W., Coffey, S.G. (2007): Redesigning animal agriculture – The challenge of the 21st century. CAB International, Oxfordshire, UK
Current articles in relevant international and national publications

Course title: **Traditional and new methods of poultry breeding and farming**
Course type: Facultative
Lecturer: **Eszter Zsédely** associate professor, PhD
No. of classes: 30+60
Credits: 3

Short Description of the Course:
The aim of the course is to help doctoral candidates go beyond the fundamentals of poultry breeding by getting them acquainted with modern breeding and farming technologies relevant to productive poultry species. Traditionally Hungarian poultry breeding plays an important role both in the European and the domestic poultry sector. The course will introduce the physiological specificities of various poultry species, as well as, the relevant egg, meat, liver and feather production technologies.

1. Egg as the basis for producing good quality newborn poultry.
2. Breeding techniques in hen breeding.
3. Raising and farming breeding hens.
4. Growing and fattening broiler chickens.
5. Methods and regulations of producing commercial eggs.
6. Methods of turkey farming.
7. Methods of goose farming.
8. Producing broiler type geese.
9. Regulations regarding methods and future perspectives of galvage for liver production
10. Producing broiler type ducks.
11. Perspectives of raising and farming Moulard ducks in Hungary.
12. Production and regulations of feather and down.

Required and recommended readings:
Pupos T., Sütő Z., Szőllősi L. (2013): Versenyképes tojástermelés, Szaktudás Kiadó Ház Zrt. Budapest
Aliczki K. (2014): A magyarországi pulykavertikum egy évtizedes fejlődési pályájának értékelése, AKI
Bogenfürst F., Horn P., Sütő Z., Kovácsné Gaál K., Kovács G. (2011): Baromfitenyésztés „e-tananyag" az Állattenyésztő mérnök BSc szak hallgatói számára, 399. p., On-line hozzáférés: www.tankönyvtár.hu
Lesson, S., Summers, J.D. (2000): Broiler Breeder Production, Nottingham University Press, NG110AX, England
Crawford, R.D. (1990): Poultry Breeding and Genetics, Elsevier, Amsterdam-Oxford-New York- Tokyo
Poultry Science folyóirat

Course title: **Modern fish production systems**
Course type: Facultative
Lecturer: **László Szathmári** associate professor PhD
No. of classes: 30+60
Credits: 3

Short Description of the Course:
During the lectures students learn the practical knowledge of fish production, which are based on former theoretical questions. The course deals with pond construction, management of constructed pond parts and water supply. Modern pond production applies the topics of hydrobiology and ecology concerned to aquaculture. Details are presented of up-to-date stocking, organic fertilizing and feeding practices. The course describes the harvesting technologies under full water level and drained pond conditions. It also teaches the students to elaborate on the pre-harvest final estimation of stock and biomass in the ponds on the basis of regular testing catches. Details of the post harvest pond management methods and the practices of over wintering of the fish are explained. The course also describes the method of intensive fish production systems including stocking, feeding and fish health topics.

1. Types and construction of earth fish ponds.
2. Dams, sluices, water management
3. Technologies of fish rearing.
4. Production under natural conditions.
5. Intensive fish rearing.
6. Annual activities in pond production.
7. Management of water nutrients.
8. Feeding in natural ponds.
9. Feeding in intensive systems.
10. Fish diseases and threats.
11. Harvest and over winter storage
12. Environmental protection in aquaculture and the production of bio goods

Required and recommended readings:
Horváth L. (2000): Halbiológia és halgazdálkodás Mezőgazda Kiadó Budapest
Molnár K., Szakolczai J. (1980): Halbetegségek Mezőgazdasági Kiadó Budapest
P.J.B. Hart, J.D Reynolds (2002): Handbook of Fish Biology and Fisheries Wiley-Blackwell
L. Horváth, G. Tamás (2002): Carp and Pond Fish Culture Backwell Science London UK
E.J.Noga (2002): Fish disease: diagnosis and treatment Willey-Backwell Oxford UK
Németh J. (1998): A biológiai vízminősítés módszerei. Vizi természet- és környezetvédelem 7. Kötet, Környezetgazdálkodási Intézet, Budapest
Szűcs I. (2002): A halászati ágazat gazdasági, szervezési és piaci kérdései Szaktudás Kiadó Ház Budapest

Course title: **Basic concepts of macro- and microeconomics for animal husbandry**
Course type: Facultative
Lecturers: **Imre Tell** associate professor, CSc
Nóra Gombkötő assistant professor, PhD
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The educational objective of acquiring this course is to explore the economic aspects of animal production; to learn factors and relationships affecting business (including means and methods, etc.); and to able to apply all of these in practice to manage efficiently. Due to the extremely unfavourable conditions concerning profitability of animal husbandry, there is a particular focus on macro- and microeconomic factors that are determinant for earning ability (profit yielding) – hence for competitiveness.

1. Economic aspects of animal husbandry.
2. Macroeconomic and market conditions (domestic and international) of animal production.
3. Regulatory system and its application in practice of keeping animals (breeding and fattening).
4. Organizational/corporate structure of animal production – sizes of enterprises and business units.
5. Centralisation and concentration in animal husbandry.
6. Product structure of different branches, and production chains and functioning in animal production.
7. Basics and components of production management.
8. Resources, checking effectiveness, and cost and profit calculation.
9. Analysis and decision establishment.
10. Planning, organizing and controlling.
11. Innovation, and product and technology development in animal husbandry.
12. Market information systems and functioning.

Required and recommended readings:
Emery N. Castle, Manning H. Becker, A. Gene Nelson (1992): Farmgazdálkodás (Farm Business Management), Budapest, Mezőgazda Kiadó
Peter L. Nuthall (2010): Farm Business Management, The Core Skills, CABI, 2010. ISBN: 1845937368, 9781845937362
Peter L. Nuthall (2010): Farm Business Management, The Human Factor, CABI, 2010. ISBM: 9781845935986

"Pulay Gábor Doctoral Program" for Food Science Program Leader: Prof. Dr. Jenő Szigeti, CSc				
Course	Course leader	Hours**	Credit	Semes-ter
Compulsory				
The methodology of research *	Zoltán Varga PhD László Varga DSc	30+120	5	1.
Technologies and machines in plant based food production	Attila József Kovács PhD	30+120	5	1.
Animal product processing and preservation	Péter Kovács PhD	30+120	5	1.
Special Aspects of Quality Assurance in Food Production	Balázs Ásványi PhD	30+120	5	1.
Food Hygiene and Quality Control	László Varga DSc	30+120	5	2.
Follow-up in the foodchain	Zsolt Ajtony PhD	30+120	5	2.
Facultative				
Quality management for animal product processing	Zsolt Ajtony PhD	30+90	4	2.
Applied Microbiology	Jenő Szigeti CSc	30+90	4	3.
Food Microbiology	László Varga DSc	30+90	4	1.
Dairy machinery, operations and technologies	László Varga DSc	30+90	4	1.
Meat industry operations and machinery	Péter Kovács PhD	30+90	4	1.
Food Biotechnology	Jenő Szigeti CSc	30+60	3	2.
Effects of animal infections on food safety and human health	Borisz Egri DSc MRANH	30+60	3	2.
Slaughtering and meat processing technology	Péter Kovács PhD	30+60	3	3.
Food physics	Ottó Dóka CSc	30+60	3	4.
Role of micronutrients in producing functional food and/or dietary additives	Pál Szakál PhD	30+60	3	4.
Characteristics of plant based food raw materials	Ferenc Petróczki PhD	30+60	3	4.
Food raw materials of animal origin	Borisz Egri DSc MRANH	30+60	3	4.
Fermentation industries	Balázs Ásványi PhD	30+90	4	4.

* Compulsory for all students of the doctoral program

** 30 contact hours = 1 Credit, 120 hours = 4 Credit

Course Title: **Methodology of research**
Course Type: Compulsory
Lecturers: **Zoltán Varg**a associate professor, PhD
László Varga professor, DSc
No. of Classe: 30+120
Credits: 5

Short Description of the Course:
The objective of this course is to teach the PhD students about the theoretical, practical and methodological questions of scientific research. The students get up-to-date knowledge of the most important issues of science and research methodology and of the forms of scientific activity; and they can know the conceptual and methodological tools of their own field of science. They can also understand the methods to solve a problem (observation, experiment), and be able to design and carry out the research.
The course gives information about the special methodological issues of plant cultivation sciences; the principles and basic concepts of arable experiments; the methods of designing, setting and evaluating experiments.
The following issues are also important parts of the course: the different types of plant cultivation experiments (single-factor-, bi- and multifactorial experiments, factorial experiments, experiment sequences, duration experiments, technological development experiments); the principles and models of analysis of variance, correlation calculations and regression analyzes (linear and non-linear, multiple); and use of special computer programs (GenStat, SPSS, MSTAT-C) in designing and evaluating experiments. Students of the course should understand the use of multivariate biometric methods (main component analysis, cluster analysis, discriminant analysis) and they are able to decide on the use of different analytical and synthesizing methods.
The students can learn the steps to make scientific publications. They have to be able to distinguish between scientific and non-scientific work, and to recognize the pseudo-scientific activity. They must be aware of the ethical rules of making scientific publications and the important parameters of scientometrics.

1. The importance and history of science and the methodology of research
2. Comparative analysis of common knowledge and scientific knowledge
3. Parallel examination of theoretical knowledge and empirical knowledge
4. Practice of scientific research; the basic steps of scientific knowledge; designing and conducting scientific research
5. Principles and basic concepts of arable experiments; experimental layouts and computer design of experiments; types, advantages, disadvantages and use of plant cultivation experiments
6. The principles, models of analysis of variance (ANOVA) and use of computer programs to evaluate different types of experiments
7. Use of non-parametric probes, correlation calculations and regression analysis in the evaluation of crop experiments
8. Use of multivariate biometric methods in the synthesis of experimental results
9. Basic rules of searching for scientific literature, use of internet databases; search for articles and quotations, query techniques
10. Types of scientific and non-scientific publications, conditions of publication; strategies for publishing and selecting journals; ethical issues of scientific research and publishing
11. Creating scientific publications (from title to references; content and form requirements)
12. Scientometrics, measurement of scientific performance; interpretation of the used performance rating factors, their advantages and disadvantages (impact factor, quotation, Hirsch index, etc.)

Required and recommended readings:
Berzsenyi, Z. (2014): Növénytermesztési kísérletek tervezése és értékelése. Kézirat, MTA ATK Mezőgazdasági Intézet, Martonvásár.
Bujdosó E. (1986): Bibliometria és tudománymetria, Budapest, MTA Könyvtára
Csermely P., Gergely P., Koltay T., Tóth J. (1999): Kutatás és közlés a természettudományokban. Budapest. Osiris Kiadó
Ireland, C.l. (2010): Experimental Statistics for Agriculture and Horticulture. CABI, Cambridge.
Popper, K. (2002): The logic of scientific discovery. Routledge Classics, Taylor and Francis Group. 513 oldal.
Sváb, J. (1981): Biometriai módszerek a kutatásban. Mezőgazdasági Kiadó, Budapest.
Varga-Haszonits Z., Varga Z. (2006): Kutatásmódszertani ismeretek. Oktatási segédanyag. NYmE-MÉK, Mosonmagyaróvár, 159 oldal.

Course title: **Technologies and machines in plant based food production**
Course type: Compulsory
Lecturer: **Attila József Kovács**, associate professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The purpose of the course is to describe the complex production technology of plant based food processing, focusing mainly on the trends of new development directions. During the course the production engineering tasks of machinery and equipment, the food processing operations and technological aspects, and the state-of-the art construction solutions of equipment are discussed. The introduction of food technologies are based on the applied machines and equipment. By completing the course students will gain the foundation for development and they will be able to follow and adapt with the developments of food industrial technologies. The course creates the foundation for their development. The students' stand-alone work and organized visits allow them to gain practical experience.

1. Machines and technologies in the milling industry.
2. Machines and technologies in the baking industry.
3. Machines and technologies in the confectionary industry.
4. Machines and technologies in the canning industry.
5. Machines and technologies in the refrigeration industry.
6. Machines and technologies in the winemaking industry.
7. Machines and technologies in the brewing industry.
8. Machines and technologies in the distilling industry.
9. Machines and technologies in the vegetable oil industry.
10. Machines and technologies in the sugar industry.
11. Machines and technologies in the beverage industry.
12. Machines and technologies for storage.

Required and recommended readings:
Fábry Gy. (Eds.) (1995): Élelmiszer-ipari eljárások és berendezések. Mezőgazda Kiadó.
Barta J. (2007): A gyümölcsfeldolgozás technológiái. Mezőgazda Kiadó
Biacs P., Szabó G., Szendrő P., Véha A. (2010): Élelmiszer-technológia mérnököknek. Szegedi Tudományegyetem
Albert Ibarz, G.V. Barbosa Cánovas (2003): Unit operation in food engineering. CRC Press
Geroge D. Saracovas, Zacharias B. Maroulis (2011): Food process engineering operations. CRC Press

Course title: **Animal product processing and preservation**
Course type: Compulsory
Lecturer: **Péter Kovács** director, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The course focuses on the general principles of animal product processing and preservation. The most advanced technologies will be thoroughly discussed with special emphasis being placed on sustainability.

1. Characteristics of raw materials of animal origin.
2. Grading of raw materials of animal origin (meat, milk, honey, etc.).
3. Description of the general principles of the processing process.
4. Description of physical, chemical and biological preservation processes.
5. Manufacturing technologies of major product groups.
6. The main operations of processing animal products.
7. Raw material supply and product quality.
8. Principles and practice of finished product grading.
9. Fish and game processing. Honey production.
10. Product development.
11. Cleaning, disinfection, and waste water management in the food industry.
12. New operations and technologies.

Required and recommended readings:
Szakály S. (2001): Tejgazdaságtan, Dinasztia Kiadó, Budapest
Császár G., Unger A. (2000): A minőségi tejtermelés alapjai, Magyar Tejgazdasági Kísérleti Intézet, Mosonmagyaróvár
Gárgyán Z. (1988): Húsipari technológiák I-III., Dinasztia Kft., Budapest
Horváth Gy., Simon J., Incze K. (1993): Húsfeldolgozás kisüzemben, Termelők Kiskönyvtára sorozat Integra-Projekt Kft.
Kiss A. (1991): Baromfiipari technológia I. - III. Dinasztia Kft. Budapest

Course title: **Special aspects of quality assurance in food production**
Course type: Compulsory
Lecturer: **Balázs Ásványi**, associate professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
This seminar focuses on the main elements of systems regulating, controlling and grading the quality of food raw materials and foodstuffs in Europe. Special emphasis is placed on the importance of quality assurance in food production and its legal aspects. The course is designed to help students apply the knowledge gained in the classroom to real life situations, e.g., developing or operating various food quality management systems.

1. Basic concepts of quality assurance.
2. Characterization of quality management systems.
3. Audit of quality management systems.
4. Risk factors and their handling (management).
5. Importance of the HACCP system.
6. Application of the IFS/BRC system.
7. The ISO international standard system.
8. The ISO 9000 standards package.
9. The ISO 14000 standards package.
10. The ISO 22000 standards package.
11. The applicability of TQM.
12. Evaluation of quality management systems.

Required and recommended readings:
ISO 22004:2014 Food safety management systems -- Guidance on the application of ISO 22000
ISO 22005:2007 Traceability in the feed and food chain -- General principles and basic requirements for system design and implementation
BRC global standards – Food
IFS Food, Version 6

Course title: **Food hygiene and quality control**
Course type: Compulsory
Lecturer: **László Varga**, professor, DSc
No. of classes: 30+120
Credits: 5

Short Description of the Course:
This course focuses on the general principles of food hygiene and microbiological food safety. The major goals of the seminar are to help students understand hygiene rules in food production, processing, and distribution; and develop knowledge and skills related to food quality control. "Food hygiene and quality control" is closely connected to "Food microbiology" and "Applied microbiology".

1. Food related health risk assessment.
2. Importance of zoonoses from a food hygiene point of view.
3. General hygiene rules in food production, processing, and distribution.
4. Hygiene of milk production.
5. Hygiene of milk processing.
6. General rules of meat inspection.
7. Meat inspection and hygiene in slaughterhouses.
8. Hygiene of meat processing.
9. Hygiene of egg production and processing; hygiene in fish processing and in the production of live bivalve molluscs.
10. Hygiene in production and processing of foods of plant origin.
11. Food grading and food quality control.
12. Administration of food hygiene: official food hygiene control activities.

Required and recommended readings:
Clute, M. (2008): Food industry quality control systems. CRC Press, Boca Raton, FL.
Lelieveld, H., Holah, J., Napper, D. (2014): Hygiene in food processing: principles and practice (2nd ed.). Woodhead Publishing, Cambridge, UK.
Original research papers and up-to-date reviews published in top-tier scientific journals, *e.g., Food Control, Food Microbiology, International Journal of Food Microbiology*, etc.

Course title: **Follow-up in the food chain**
Course type: Compulsory
Lecturer: **Zsolt Ajtony** associate professor, PhD
No. of classes: 30+120
Credits: 5

Short Description of the Course:
The application of the food chain monitoring system will link the product and related information; give the product's "life span"; the components of the product, additives and by-products; and serve the flow of information between each participant. The aim of the course is to educate students about the importance of follow-up at each point in the food chain. In doing so it provides information on the background to its development, the essential elements of traceability, and its legal background. The lectures will also discuss the supreme organization responsible for the official control of the food chain and their tasks. During the lessons students will learn about the tasks of tracking, and possibilities of implementation and current practices.

1. The concept and significance of follow-up.
2. The follow-up principle.
3. The general model of follow-up, the traceable product identification, and the process of follow-up.
4. Legislative background of follow-up.
5. Internal follow-up.
6. External follow-up.
7. Follow-up in crop production.
8. Follow-up in animal husbandry.
9. Documentation in follow-up and global standards.
10. Tools for automatic data collection.
11. IT tools for product follow-up.
12. Evaluation of follow-up system.

Required and recommended readings:
Kecskés K., Krázli Z. (2007): Follow-up with global standards, GS1 Hungary Kht., Budapest
Kovács F., Biró G. (2003): Food safety EU regulation. Agroinform Publisher, Budapest
Nagy F. (2002): European Union food economy, Agrárszakoktatási Intézet
Katona L., Rácz E. (2000): Standardization and the Hungarian Food Book; Agriculture Publisher, Budapest
Flynn, R.F., Dorfman, M. (1990) The automated requirements traceability system (ARTS): an experience of eight years. pp. 423–428 In: System and Software Requirements Engineering, Thayer, R.H. & Dorfman, M. (Eds). IEEE Computer Society, Washington, DC.

Course title: **Quality management for processing animal products**
Course type: Facultative
Lecturer: **Zsolt Ajtony** associate professor, PhD
No. of classes: 30+120
Credits: 4

Short Description of the Course:
The aim of the course is to introduce students to the concept of quality management for the production of animal products. Accordingly, it provides information on the points of connection between the levels of production, and on the principles and practices of the legislation on the production of animal products. The lectures also discuss the validation of the principles of quality certification for primary processing and product manufacturing plants. In addition, the course deals with the effects of the economic aspects of quality management. The course is basically related to the knowledge acquired in all courses, especially in the areas of practical implementation. The course entitled "Food hygiene and quality control" can be versatilely utilized in this course.

1. Quality requirements for pig and cattle slaughterhouses. Technological layout, premises, equipment and devices, and slaughtering activities.
2. Technological hygiene of pig slaughtering. Stunning, stinging, bleeding, scalding, plucking, scorching, body cleansing, butchering, gralloching, and body splitting.
3. Technological hygiene of cattle slaughtering. Stunning, bleeding, skinning, butchering, gralloching, and body splitting.
4. Technological hygiene of poultry slaughtering and processing. Critical procedures of food safety of poultry slaughtering.
5. Hygienic production of egg products. Requirements for establishments. Quality standards for raw materials and the production and storage of products. Evaluation of the suitability of eggs and egg products for consumption.
6. Technological hygiene of rabbit slaughtering. Critical procedures of food safety of rabbit slaughtering.
7. Quality control in meat processing technology. Technological hygiene of the production of meat products. Food hygiene criteria for the production and releasing of meat products, minced, prepared and bones mechanically separated from meats.
8. Food safety criteria for the production of fishery products.
9. Food safety requirements for wild game processing.
10. General hygiene criteria for the establishment and operation of milk processing factories. Specific aspects of technical and operational food safety requirements
11. Production hygiene of dairy products. Heat-treated milk and milk products, sour dairy products, butter and cream products, cheeses and cheese products, condensed and powdered dairy products. Authority control of milk processing.
12. Food adulteration for food raw materials of animal origin, in the case of semi-finished and finished products.

Required and recommended readings:
Anonym (2009): Guide to good hygiene practice for pig and cattle slaughtering and butchering (Útmutató a sertés- és marhavágás, bontás, darabolás jó higiéniai gyakorlatához) (GHP-11). Campden & Chaleywood Élelmiszeripari Fejlesztési Intézet Magyarország Kht., Budapest
Anonym (2008): Guide to good hygiene practice for poultry and rabbit slaughtering and butchering (Útmutató a baromfi és nyúlfélék vágásának és darabolásának jó higiéniai gyakorlatához) (GHP-12) Campden & Chaleywood Élelmiszeripari Fejlesztési Intézet Magyarország Kht., Budapest
Anonym (2009): Guide to good hygiene practice for production of food products (Útmutató a húskészítmények gyártásának jó higiéniai gyakorlatához) (GHP-13) Campden & Chaleywood Élelmiszeripari Fejlesztési Intézet Magyarország Kht., Budapest
Anonym (2009): Guide to good hygiene practice for production of sour dairy products (Útmutató a savanyított tejtermékek előállításának jó higiéniai gyakorlatához) (GHP-33/3) Campden & Chaleywood Élelmiszeripari Fejlesztési Intézet Magyarország Kht., Budapest
Anonym (2009): Guide to good hygiene practice for production of milk and dairy products (Útmutató a tej és tejtermékek előállításának jó higiéniai gyakorlatához) (GHP-51) Campden & Chaleywood Élelmiszeripari Fejlesztési Intézet Magyarország Kht., Budapest
Anonym (2006): Guide to good hygiene practice for fish production (Útmutató a halfeldolgozás jó higiéniai gyakorlatához) Campden & Chaleywood Élelmiszeripari Fejlesztési Intézet Magyarország Kht., Budapest
Dióspatonyi I.: The technology of meat processing (A húsfeldolgozás technológiája) Magyar Kémikusok Egyesülete http://www.chemonet.hu/hun/food/technol/husipar/husipar.html

Laczay P. (szerk) (2008): Food hygiene. Food Chain Safety (Élelmiszerhigénia. Élelmiszerlánc-biztonság) Mezőgazda Kiadó, Budapest

Course title: **Applied microbiology**
Course type: Facultative
Lecturer: **Jenő Szigeti** professor emeritus, CSc
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The primary purpose of this course is to help students develop an appreciation and understanding of the complex microbiological factors influencing feed and food quality during production and processing. "Applied microbiology" is closely connected to "Food microbiology" and "Food biotechnology".

1. Spoilage and pathogenic microorganisms in the microclimate, feedstuffs, and waters.
2. Feed storage, preservation, and by-product processing; microbiology of drinking water.
3. Fungal contamination of feedstuffs.
4. Fungal and bacterial spoilage of feedstuffs.
5. Microbiological aspects of storage of cereals and processed cereal products.
6. Microbial antagonism in animal keeping and husbandry.
7. Microbiological aspects of meat and egg processing.
8. Microbiological aspects of milk production and processing.
9. Protection against microbiological hazards in the food production environment.
10. Microbiological aspects of refrigeration and frozen storage of food raw materials and processed products.
11. Microbiological aspects of storing and processing cereals.
12. Microbiology of the fermentation industries.

Required and recommended readings:
Forsythe, S. J. (2010): The microbiology of safe foods (2nd ed.). Wiley-Blackwell, Oxford, UK.
Glazer, A. N., Nikaido, H. (2007): Microbial biotechnology: fundamentals of applied microbiology (2nd ed.). Cambridge University Press, Cambridge, UK.
Original research papers and up-to-date reviews published in major scientific journals such as *Applied and Environmental Microbiology*, *Journal of Applied Microbiology*, *Letters in Applied Microbiology*, etc.

Course title: **Food microbiology**
Course type: Facultative
Lecturer: **László Varga** professor, DSc
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The main objective of this course is to help students develop an understanding of environmental factors that affect the activities of microorganisms associated with food spoilage, foodborne diseases, and food fermentation. This seminar focuses on microbial ecology, metabolism, and growth conditions; thereby enabling the destruction of harmful microbes and the stimulation of beneficial ones. A detailed description and characterization of foodborne microorganisms is also provided. "Food microbiology" is closely connected to "Applied microbiology".

1. Occurrence of bacteria, yeasts, molds, viruses, and protozoa in food raw materials and food products.
2. Microbial ecology of foods.
3. Metabolism of microorganisms.
4. Growth and death of microorganisms.
5. Spore-forming bacteria and their endospores.
6. Microbial contamination and spoilage of foods of plant origin.
7. Microbial contamination and spoilage of foods of animal origin.
8. Foodborne pathogens.
9. Microbiology of food processing.
10. Microbiological aspects of food preservation.
11. Lactic acid bacteria.
12. Probiotic microorganisms.

Required and recommended readings:
Montville, T. J., Matthews, K. R. (2008): Food microbiology: an introduction (2nd ed.). ASM Press, Washington, DC.
Roberts, D., Greenwood, M. (2003): Practical food microbiology (3rd ed.). Blackwell Publishing, Oxford, UK.
Original research papers and up-to-date reviews published in top-tier scientific journals, *e.g.*, *Food Microbiology*, *International Journal of Food Microbiology*, etc.

Course title: **Dairy machinery, operations and technologies**
Course type: Facultative
Lecturer: **László Varga** professor, DSc
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The aim of the course is to introduce technologies for the production of dairy products. The object is to discuss the production technology tasks of the machinery and equipment that are essential in the dairy industry, the technological aspects of the work, and the alternatives of modern construction solutions. Through the presentation of the operations and machines the students will gain an understanding of the complex technology systems.

1. Raw materials and auxiliary materials of the dairy industry.
2. Composition and qualification of raw milk.
3. General operations of milk processing 1 (acceptance, storage, cleaning, smoothing).
4. General operations of milk processing 2.(homogenization, recombination, reemulsification).
5. Production of heat-treated consumer milk and milk products.
6. Manufacture of sour milk and cream products.
7. Manufacture of sweet (non-acidified) cream products.
8. Operations, technologies and machines for the production of the different kinds of butter.
9. Production of acidic curdled cheese and cheese products.
10. Production of rennet curdled cheese.
11. Production of processed cheese.
12. Processes, technologies and machines for the production of powdered milk products.

Required and recommended readings:
Szakály S. (2001): Dairy economics. Competence Publisher.
Biacs P., Szabó G., Szendrő P., VéhaA. (2010): Food Technology for Engineers. University of Szeged
Hoffer E. (2006): Dairy machinery and equipment. FVM Training and Consultancy Institute
Ibarz A., Barbosa Cánovas G.V. (2003): Unit operation in food engineering. CRC Press.
Saracovas G.D., Maroulis Z. (2011): Food process engineering operations. CRC Press

Course title: **Production processes and machinery in the meat industry**
Course type: Facultative
Lecturer: **Péter Kovács** director, PhD
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The purpose of this course is to help students develop an understanding of the meat industry operations and machines.

1. Primary processing operations and machines, transportation of animals during cutting, and descriptions of cutting procedures.
2. Cooling operations technology and technical procedures.
3. After-delivery breakdown, boning, cutting, and quality of shaping.
4. Secondary processing technologies and machines.
5. Technological development opportunities.
6. Waste processing machinery.
7. Packaging of meat products.
8. Separation systems.
9. Heat transfer systems.
10. Heat removal operations and the effect of heat removal on product quality.
11. Pickling techniques and machines.
12. Technical developments.

Required and recommended readings:
Fidel Toldrá (2010): Handbook of Meat Processing, Wiley-Blackwell.

Course title: **Food biotechnology**
Course type: Facultative
Lecturer: **Jenő Szigeti** professor emeritus, CSc
No. of classes: 30+60
Credits: 3

Short Description of the Course:
This seminar explores the basic reaction kinetics of food biotechnology processes. The course is closely connected to "Applied microbiology" and "Food microbiology".

1. Basic concepts in biotechnology and their practical applications.
2. Optimization of environmental conditions for microorganisms.
3. Evaluation of microbial metabolic processes from a biotechnological point of view.
4. Influencing microbial production through genetic engineering using restriction endonucleases; production kinetics of primary and secondary metabolites.
5. Modern biotechnological processes used in the food industry (types of fermenters, aeration methods, computer-aided process control, etc.).
6. Operation principles of aerobic, anaerobic, and immobilized fermentation systems.
7. Biotechnological aspects of dairy foods production.
8. Biotechnological aspects of manufacturing meat products.
9. Biotechnological processes used in fermentation industries.
10. Biotechnological aspects of waste water management.
11. Major food fermentation methods and separation techniques.
12. Genetic modification (engineering) in food production.

Required and recommended readings:
Joshi, V. K., Singh, R. S. (2012): Food biotechnology: principles and practices. I. K. International Publishing House, New Delhi, India.
Moo-Young, M. (2011): Comprehensive biotechnology (2nd ed.). Vol. 1-6. Elsevier, Oxford, UK.
Original research papers and up-to-date reviews published in international scientific journals such as *Applied Food Biotechnology*, *Food Biotechnology*, *Food Science and Biotechnology*, *Food Technology and Biotechnology*, etc.

Course title: **Effects of animal infections on food safety and human health**
Course type: Facultative
Lecturer: **Borisz Egri** professor, DSc, MRANH
No. of classes: 30 + 60
Credits: 3

Short Description of the Course:
The aim of the course is to describe what effect chronic infectious diseases of cattle, pigs and poultry has on the reproduction and feed utilization parameters of animals. The course will introduce the effects of these diseases on the quality of food and primary commodities (meat, eggs, milk) and the influence on consumer health. We present the diagnostic methods for detecting the mentioned diseases and the alternatives for prevention. We provide information on how to immunize cows with specific antigens to produce milk with therapeutic effects for human purposes.

1. The characteristics of the most important chronic diseases of bovine and alternatives prevention alternatives.
2. The characteristics of the most important chronic diseases of pigs and alternatives for prevention.
3. The characteristics of the most important chronic diseases of poultry and alternatives for prevention.
4. The effects of chronic diseases on reproduction parameters.
5. The effects of chronic diseases on feed utilization parameters.
6. The effects of chronic diseases on meat quality.
7. The effects of chronic diseases on the milk quality.
8. The effects of chronic diseases of poultry on egg quality.
9. The effects of chronic diseases on the health of the consumers (e.g., intestinal diseases, cancer, milk intolerance and other allergic diseases).
10. Diagnostic alternatives for the effects of livestock diseases on food ingredients.
11. Specialized immunization of bovine and poultry and the use of milk and eggs of animals for the treatment of certain human diseases.
12. Production of healthy animal products from the point of view of human health.

Required and recommended readings:
Tuboly S. (szerk.) (2011): Állatorvosi járványtan I. (állatorvosi mikrobiológia). Mezőgazda Kiadó
Varga J., Tuboly S., Mészáros J. (2012): A háziállatok fertőző betegségei. (Állatorvosi járványtan II.) Mezőgazda Kiadó
Egyéb: kijelölt aktuálisan megjelenő szakcikkek nyilvános adatbázisokból (EISZ, PubMed)

Course title: **Slaughtering and meat processing technology**
Course type: Facultative
Lecturer: **Péter Kovács** director, PhD
No. of classes: 30+60
Credits: 3

Short Description of the Course:
The students learn about primary and secondary meat processing technologies in this course. This course is closely connected to "Animal product processing and preservation" and "Production processes and machinery in the meat industry".

1. Slaughterhouse processing technologies I.
2. Slaughterhouse processing technologies II.
3. Stunning, thrust, exsanguination.
4. Partial and full scalding and skinning methods.
5. Ripping, cutting, and sharpening of saws.
6. Technological cooling and refrigeration.
7. Processing of slaughtering by-products.
8. Meat processing.
9. Meat product technology.
10. Filled meat products, dry goods, and marinated product technology.
11. Dietary fat technology.
12. Visit a slaughterhouse and a new processing facility.

Required and recommended readings:
Szakály S. (2001): Tejgazdaságtan, Dinasztia Kiadó, Budapest
Császár G., Unger A. (2000): A minőségi tejtermelés alapjai, Magyar Tejgazdasági Kísérleti Intézet, Mosonmagyaróvár
Gárgyán Z. (1988): Húsipari technológiák I-III., Dinasztia Kft., Budapest
Horváth Gy., Simon J., Incze K. (1993): Húsfeldolgozás kisüzemben, Termelők Kiskönyvtára sorozat Integra-Projekt Kft.
Kiss A. (1991): Baromfiipari technológia I. - III. Dinasztia Kft., Budapest

Course title: **Food physics**
Course type: Facultative
Lecturer: **Ottó Dóka** professor, CSc
No. of classes: 30+60
Credits: 3

Short Description of the Course:
The aim of the course in food physics is to introduce students to the physical properties of foodstuffs and methods of measuring them. The course will become students familiar with the physical methods used in food testing; recognize the mechanical, thermal, electrical, optical, colour and rheological characteristics of foods and food raw materials; as well as, learn their measurement methods. They should also be able to use the physical properties of food and food raw materials in quality control procedures.

1. Physical and mechanical characteristics of food products and food raw materials.
2. Measuring methods of physical and mechanical characteristics used in foods and food raw materials.
3. Optical characterization of foods: reflection, absorption, and emissions.
4. Colour measurements and colour measuring systems.
5. Determination of colour characteristics in foods.
6. Optical spectroscopy.
7. Infrared and NIR spectroscopy.
8. Thermal properties: parameters of thermal conductivity (thermal conductivity, thermal diffusivity, thermal effusivity, etc.).
9. Measuring methods and techniques of thermal properties in foods.
10. Electromagnetic properties of foods: impedance spectra of foods, electrical permittivity, and electrical conductivity.
11. Rheology and rheological models.
12. Rheological properties of foods.

Required and recommended readings:
Rahman, M. S. (2005)**:** Mechanical properties of foods. In: Food Engineering. Encyclopedia of Life Support Systems. Barbosa-Canovas, G. V. ed. UNESCO Publishing, Paris. p. 87-104.
Sitkei Gy. (1981): A mezőgazdasági anyagok mechanikája. Akadémiai Kiadó. Budapest.
Lukács Gy. (1982): Színmérés. Műszaki Könyvkiadó. Budapest
N.N. Mohsenin (1984): Electromagnetic radiation properties of foods and agricultural products. Gordon and Breach Science. New York,
J.F. Steffe (1992): Rheological methods in food process engineering. Freeman Press. East Lansing.
Ábrahám Gy. (szerk.) (1998): Optika. Panem Kft. Budapest.
L.O. Figura, A. A. Teixeira (2007): Food Physics. Springer. Berlin-Heidelberg.

Course title: **Role of micronutrients in producing functional food and/or dietary additives**
Course type: Facultative
Lecturer: **Pál Szakál** associate professor, CSc
No. of classes: 30+60
Credits: 3

Short Description of the Course:
The aim of the course is to give a comprehensive picture of functional food and dietary additives, the physiological significance of micronutrients, and the processing procedures in the food industry. This course covers the physical and chemical procedures through the production of functional food and dietary additives. The course gives high priority to the content of minerals in functional food products and dietary additives, especially their micronutrient content. The course provides basic knowledge for the courses of "Food biotechnology" and "Applied microbiology".

1. More important micro-, meso-, and macronutrients in the flora.
2. Physiological role of more important micronutrients in the flora.
3. More important micro-, meso-, and macronutrients in the fauna.
4. Physiological role of more important micronutrients in the fauna.
5. Analytical methods to determine micro-, meso-, and macronutrients.
6. Possibilities of using AAS and ICP techniques to determine micronutrients.
7. Determining nitrogen and phosphorus content in food.
8. Characteristics of functional food.
9. Role of vitamins in the production of functional food.
10. Characteristics of dietary additives.
11. Enriching the food products with micronutrients.
12. Regulating the concentration and limits of micronutrients in food products and dietary additives.

Required and recommended readings:
Biró Gy.: Funkcionális élelmiszerek, természetes antioxidánsok szerepe az egészségmegőrzésben http://chemonet.hu/osztaly/eloadas/birgyorgy.html
Biró Gy., Dworschák E., Zajkás G. (1997): Élelmiszerek az egészségmegőrzésben. Budapest. Béres Rt.113 p.
Diplock, A. T., Aggett, P. J., Ashwell, M., Bornet, F., Fern, E. B., Roberfroid, M. B. (1999): Scientific concepts of functional foods in Europe: Consensus document. *British Journal of Nutrition.* 81. S1-S27. p.
Katan, Martijn B. (1999): Functional foods. The Lancet. 354. 794. p.
Kőrös E. (1980): Bio-szervetlen kémia, Gondolat Kiadó, Budapest
http://www.oeti.hu/?m1id=1&m2id=45
Takács S. (2001): A nyomelemek nyomában, Medicina Könyvkiadó Rt., Budapest

Course title: **Characteristics of plant based food raw materials**
Course type: Facultative
Lecturer: **Petróczki Ferenc** associate professor, PhD,
No. of classes: 30+60
Credits: 3

Short Description of the Course:
The purpose of the course is to teach the characteristics of plant-based raw materials used in food technologies. During the course the most important post-harvest operations (storage after harvesting, handling, cleaning, etc.) are discussed. The preparatory operations are also listed and the most important characteristics from a technological point-of-view (moisture content, ingredients, etc.) of raw materials are also reviewed. This course can be the basis of other PhD courses such as "Technologies and machines in plant based food production" and "Fermentation industries". Moreover the course provides knowledge for students that can be applied in their measurements and examinations.

1. Introduction and overview of plant based raw materials.
2. Production of plant raw materials.
3. Physical and chemical characteristics of plant raw materials.
4. Post-harvest technologies 1.
5. Post-harvest technologies 2.
6. Preparatory unit operations 1.
7. Preparatory unit operations 2.
8. Characteristics of flour based industries
9. Corn as a raw material of distillation.
10. Raw materials of the canned food and freezing industry 1: fruits.
11. Raw materials of the canned food and freezing industry 2: vegetables.
12. Rapeseed and sunflowers as raw materials in the vegetable oil industry; sugar beets as raw materials in the sugar industry

Required and recommended readings:
Barta J., Körmendy I. (2007): Növényi nyersanyagok feldolgozástechnológiai műveletei. Mezőgazda Kiadó.
Barta J. (2007): A gyümölcsfeldolgozás technológiái. Mezőgazda Kiadó.
Biacs P., Szabó G., Szendrő P., Véha A. (2010): Élelmiszer-technológia mérnököknek. Szegedi Tudományegyetem.
Albert Ibarz, G.V. Barbosa Cánovas (2003): Unit operation in food engineering. CRC Press.
Geroge D. Saracovas, Zacharias B. Maroulis (2011): Food process engineering operations. CRC Press

Course title: **Food raw materials of animal origin**
Course type: Facultative
Lecturer: **Borisz Egri** professor, DSc, MRANH
No. of classes: 30+60
Credits: 3

Short Description of the Course:
The aim of the course is that the students learn about food raw materials, and related quality assurance and processing technologies. The most important areas covered include: food chemistry, food microbiology and physical properties of foodstuffs.

1. Milk and dairy products.
2. Raw milk characteristics and grading.
3. Flavoured and cultured milks.
4. Raw materials for consumer milk.
5. Characteristics of butter and butter preparation.
6. Characteristics of cheese and cheese products.
7. Condensed and powdered dairy products.
8. Eggs and egg products.
9. Meat and meat products.
10. Characteristics of wild game meat.
11. Fish and fish products.

Required and recommended readings:
Fábry Gy. (1995): Élelmiszer-ipari eljárások és berendezések, Mezőgazda Kiadó
Biacs P., Szabó G., Szendrő P., Véha A. (2010): Élelmiszer-technológia mérnököknek, Szegedi Tudományegyetem
Krász Á., Unger A. (1994): A termelői nyerstej mintavétele, minősítése; Tanfolyami jegyzet, Mosonmagyaróvár
Foissy H. (2003): Technologie tierischer Produkte, IMB Verlag, Universität für Bodenkultur, Wien
Szakály S. (2001): Tejgazdaságtan. Dinasztika Kiadó, Budapest

Course title: **Fermentation industries**
Course type: Facultative
Lecturer: **Balázs Ásványi** associate professor, PhD
No. of classes: 30+90
Credits: 4

Short Description of the Course:
The aim of the course is to acquire comprehensive theoretical and practical knowledge of the acidic technologies and the fermentation processes related to the industry, the operations and machines used. The course addresses the national economic problems and legal regulatory systems. In addition sensory testing methods, food failures, and the distribution of certain products are presented.

1. The theoretical basis and the operational steps of industrial alcohol production and the production of spirituous beverage production technologies.
2. Raw materials and auxiliary materials for alcohol production.
3. Mashing procedures. Seamless and continuous industrial fermentation technologies.
4. Distillation operations, one-step and two-step technology.
5. Production technology for palinka.
6. Production technology for cereal-based spirits.
7. Production technology for wine distillates.
8. Liqueur products small- and large-scale procedures.
9. Complex wine technology.
10. Brewery technology.
11. Technology for soft drinks.
12. Legal regulatory background and description of excise regulation.

Required and recommended readings:
Eperjesi I., Kállay M., Magyar I. (2000): Oenology. AgriculturePublisher.
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