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

TRAINING PROGRAM

Doctoral School leader
Prof. Dr. Vince Ördög DSc

MOSONMAGYARÓVÁR
2017
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 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 fulfillment 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 pont;
- 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 point;
- 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 equals to 30 individual study hours or 30 hours doing research. Study work can be realised by participating at lectures and practical classes (contact lessons) and meeting the requirements of the given course/subject.

In the second phase

The research related credit points can be gained not only by elaborating the literature of the research task, carrying out experiments, evaluating their results, but publication activities and conference presentations (workshop etc.), and completing the dissertation.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Credit Points</th>
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<tbody>
<tr>
<td>Completing the Literature chapter</td>
<td>20 pont</td>
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<tr>
<td>Topic related experimental work and data processing</td>
<td>50 pont</td>
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<tr>
<td>Compilation of the dissertation</td>
<td>20 pont</td>
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<tr>
<td>Publication, seminar</td>
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<tr>
<td>Article in a foreign scientific journal*</td>
<td>15 pont</td>
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<tr>
<td>Article in a Hungarian scientific journal*</td>
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<tr>
<td>In a foreign language</td>
<td>10 pont</td>
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<tr>
<td>In Hungarian</td>
<td>8 pont</td>
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<tr>
<td>Presentation at a scientific conference</td>
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<tr>
<td>Conference abroad</td>
<td>6 pont</td>
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<tr>
<td>Conference in Hungary</td>
<td>5 pont</td>
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<tr>
<td>Presented poster</td>
<td>3 pont</td>
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</table>

* In the case of the article being published in a journal with impact factor, the amount of the credit points which may be given for the article can be increased with 5 more credit points.

The professional seminars (total 4) organised by the Doctoral School provide 4-5 credit points each. The credit points can be divided, which means that if at a given area maximum 20 credit points are obtainable but the doctoral student just manages to gain 10 in the given semester, the rest of the credit points can be obtained during the oncoming semester(s). Over the training the doctoral student is given the opportunity to undertake practical lessons or seminars, through which they can join the educational work. 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 doctoral student can ask for a maximum 1-academic year-long passive status if he/she – up to the date of the application – has fulfilled the credit point requirements pro rata temporis.

The doctoral student can gain a certain part of their credit points with completing course/subjects cross-faculty or -institutional studying 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, the doctoral student can apply for the approval of their former course/subjects’ training and research credit points that are relevant to the doctoral program. However only the 30% of the credit points can be gained this way. Based on the Head of research’ proposal, the approval of the former studies can be permitted by the Council of the Doctoral School.
<table>
<thead>
<tr>
<th>Course</th>
<th>Course leader</th>
<th>Hours**</th>
<th>Credit</th>
<th>Semester</th>
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<tbody>
<tr>
<td><strong>Compulsory</strong></td>
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<tr>
<td>Biological, technological, and technical basics of precision crop</td>
<td>Miklós Neményn MHAS Rezső Schmidt CSc</td>
<td>30 + 120</td>
<td>5</td>
<td>1</td>
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<tr>
<td>production and plant protection *</td>
<td>Gyula Pinke PhD</td>
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<tr>
<td>Methodology of research *</td>
<td>Zoltán Varga PhD</td>
<td>30 + 120</td>
<td>5</td>
<td>1</td>
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<tr>
<td>Microalgae biology and biotechnology</td>
<td>Vince Ördög DSc</td>
<td>30 + 120</td>
<td>5</td>
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<tr>
<td>Plant protection ***</td>
<td>Gyula Pinke PhD</td>
<td>30 + 120</td>
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<tr>
<td>Plant biotechnology</td>
<td>Beáta Barnabás MHAS</td>
<td>30 + 120</td>
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<tr>
<td>GIS and remote sensing</td>
<td>Gábor Milics PhD</td>
<td>30 + 120</td>
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<tr>
<td><strong>Facultative</strong></td>
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<tr>
<td>Macro and micronutrients in the soil-plant system</td>
<td>Pál Szakál CSc</td>
<td>30 + 90</td>
<td>4</td>
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<tr>
<td>Crop growth models and plant physiological analysis</td>
<td>Miklós Neményny MHAS Rezső Schmidt CSc</td>
<td>30 + 90</td>
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<tr>
<td>Taxonomy of plants in anthropogenic vegetation</td>
<td>Gyula Pinke PhD</td>
<td>30 + 90</td>
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<tr>
<td>Biotic and abiotic stress resistance of crops</td>
<td>Dénès Dudits MHAS</td>
<td>30 + 90</td>
<td>4</td>
<td>3</td>
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<tr>
<td>Ecology of soil seed banks</td>
<td>Péter Csontos DSc</td>
<td>30 + 60</td>
<td>3</td>
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<tr>
<td>Biological background of horticultural production</td>
<td>Borbála Pólyáné Hanusz PhD</td>
<td>30 + 60</td>
<td>3</td>
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<tr>
<td>Effects of macro- and microclimate on crop production</td>
<td>Zoltán Varga PhD</td>
<td>30 + 90</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Soil moisture regime and the environment</td>
<td>György Várallyay MHAS</td>
<td>30 + 90</td>
<td>4</td>
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<tr>
<td>Plant protection chemistry</td>
<td>Tamás Kőmíves MHAS</td>
<td>30 + 90</td>
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<tr>
<td>Operation of agricultural machinery in a system</td>
<td>Attila József Kovács PhD</td>
<td>30 + 90</td>
<td>4</td>
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<tr>
<td>Special aspects of crop production technologies</td>
<td>Rezső Schmidt CSc</td>
<td>30 + 90</td>
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<tr>
<td>Soil biology, rhizobiology, biofertilizer applications</td>
<td>Borbála Bíró DSc</td>
<td>30 + 90</td>
<td>4</td>
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<tr>
<td>Basic concepts of macro- and microeconomics for plant production</td>
<td>Imre Tell CSc</td>
<td>30 + 90</td>
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<td>* Compulsory for all students of the doctoral program</td>
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<td><strong>30 contact hours = 1 Credit, 120 hours = 4 Credit</strong></td>
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<td>*** For the “Plant Protection” course students can choose from one of the following topics:</td>
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<tr>
<td>a) Plant pathology</td>
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<tr>
<td>b) Plant protection zoology</td>
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<td>c) Herbolody</td>
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</table>
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?
3. The preconditioning, location-specific crop production technologies for geospatial conditions.
4. The technical conditions of precision, site-specific crop production technologies (tilleage, 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.).
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:


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:
Bujdosó E. (1986): Bibliometria és tudománymetria, Budapest, MTA Könyvtára
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.

2. Occurrence, reproduction, nitrogen fixation and photosynthesis of cyanobacteria.
4. Eukaryotic algae divisions: cryptophyta, dinophyta and euglenophyta.
5. Eukaryotic algae division: chlorophyta and its 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:
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.
5. Parasite type: bacteria.
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:
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 autecological and synecological 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.
11. Pests of fruit orchards (apple, pome or grape).

Required and recommended readings:
Szentesi Á., Török J. (1997): Állatokológia, 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.
5. Weed-collection methods.
6. The principle and practice of integrated weed control.
7. Non-chemical weed control methods.
8. Chemical weed control.
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:
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.
3. Biotechnology of sexual reproduction (embryo cultures, haploid and triploid cultures, in vitro fertilization, biotechnology of apomixis).
5. The theory and practice of in vitro vegetative micro propagation.
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:
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.
10. RS systems, satellite, airborne and UAVs.
11. Sensors in RS.

Required and recommended readings:

Digitally available literature:
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 enzymes and metaloenzymes.

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
11. Macro- and micronutrients deficiency symptoms.

Required and recommended readings:
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:**
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:
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).

Required and Recommended Readings:
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:
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.
10. Maintenance of vine varieties.
11. Health problems of plants and disinfection in horticulture.

Required and recommended readings:
J., Papp (2003): Basic knowledge of fruit production 1. Mezőgazda Kiadó, 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:
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).
14. Soil moisture control as important element of rational, sustainable and efficient land-use, environment control and harmonized rural development.

Required and recommended readings:
**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.
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):
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.
12. Alternative energy systems and their applications in agriculture.

**Required and recommended readings:**

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.
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
Radics László (2010): Fenntartható szemléletű szántóföldi növénytermesztés I., II., III. Budapest Agroinform 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-phyro-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. Interalrelations 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.
8. Microbial strain selection and characterization, strain collection, and maintenance, in vitro stress tolerance tests.
10. Soil-biota and soil-physical, -chemical, biological properties.

Required and recommended readings:
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.
8. Comparative analysis of different plant production technologies.
10. Innovation, product and technology development in plant production.

Required and recommended readings:
Emery N. Castle, Manning H. Becker, A. Gene Nelson (1992): Farmgazdálkodás (Farm Business Management), Budapest, Mezőgazda Kiadó
### “Ujhelyi Imre Doctoral Program” for Animal Science
#### Program Leader: Prof. Dr. Ferenc Szabó, DSc

<table>
<thead>
<tr>
<th>Course</th>
<th>Course leader</th>
<th>Hours**</th>
<th>Credit</th>
<th>Semester</th>
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<tbody>
<tr>
<td><strong>Compulsory</strong></td>
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<tr>
<td>Genetic Basics of Animal Husbandry</td>
<td>Ágnes Bali Papp PhD Károly Tempfli PhD</td>
<td>30 + 120</td>
<td>5</td>
<td>1.</td>
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<tr>
<td>Physiology of Animal Production</td>
<td>Borisz Egri, DSc, MRANH Erika Lencsés-Varga PhD</td>
<td>30 + 120</td>
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<tr>
<td>Theoretical foundation of livestock nutrition</td>
<td>János Schmidt MHAS Eszter Zsédely PhD</td>
<td>30 + 120</td>
<td>5</td>
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<tr>
<td>Breeding and selection of farm animals</td>
<td>Ferenc Szabó DSc László Gulyás PhD</td>
<td>30 + 120</td>
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<tr>
<td>Methodology of research *</td>
<td>Zoltán Varga PhD László Varga PhD</td>
<td>30 + 120</td>
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<tr>
<td>Special research methodology in animal breeding *</td>
<td>Tamás Tóth PhD Károly Tempfli PhD</td>
<td>30 + 120</td>
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<tr>
<td><strong>Facultative</strong></td>
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<tr>
<td>Biotechnology in animal husbandry</td>
<td>Ágnes Bali Papp PhD Erika Lencsés-Varga PhD</td>
<td>30 + 90</td>
<td>4</td>
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<tr>
<td>Molecular genetics</td>
<td>Ágnes Bali Papp PhD Károly Tempfli PhD</td>
<td>30 + 90</td>
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<tr>
<td>Epidemiological relations of food production of animal origin</td>
<td>Borisz Egri, DSc, MRANH</td>
<td>30 + 90</td>
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<tr>
<td>Diseases of game animals</td>
<td>Borisz Egri, DSc, MRANH</td>
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<tr>
<td>New trends in animal nutrition</td>
<td>Tamás Tóth PhD Eszter Zsédely PhD</td>
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<tr>
<td>New theories and modern methods in horse breeding</td>
<td>László Pongrácz PhD</td>
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<tr>
<td>Sustainable cattle production</td>
<td>Ferenc Szabó DSc László Pongrácz PhD</td>
<td>30 + 60</td>
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<tr>
<td>Modern sheep and goat production</td>
<td>Kukovics Sándor PhD</td>
<td>30 + 60</td>
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<tr>
<td>Novel methods in pig breeding</td>
<td>Tamás Tóth PhD Károly Tempfli PhD</td>
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<tr>
<td>Traditional and new methods of poultry breeding and farming</td>
<td>Eszter Zsédely</td>
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<tr>
<td>Modern fish production systems</td>
<td>László Szathmári PhD</td>
<td>30 + 60</td>
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<td>3-4.</td>
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<tr>
<td>Basic concepts of macro- and microeconomics for animal husbandry</td>
<td>Imre Tell CSc Nóra Gombkötő PhD</td>
<td>30 + 90</td>
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* 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 breeding, 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.
8. Definition of fitness. Absolute and relative fitness.
9. The role and significance of the h² rate, and usefulness in animal breeding. Correlation and regression

Required and recommended readings:
Török P., Maróy P. (2011) Genetika BS.(Genetics) JATE Press, Szeged
R.F. Weaver, P.W. Hedrick (2000): Genetika(Genetics), Panem Kiadó, Budapest,
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.

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.
8. Biochemical relations of muscular contractions.
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:
Course title: Theoretical foundation of livestock nutrition
Course type: Compulsory
Lecturers: János Schmidt professor emeritus, MHAS
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
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:
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.
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., Bokor Á., Bene Sz., Polgár P. (2012): Animal breeding, TÁMOP tanagyag, Kaposvár, Keszthely
Course title: Methodology 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:
Bujdosó E. (1986): Bibliometria és tudománymetria, Budapest, MTA Könyvtára
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).
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
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.
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.
9. Microbiome research.
11. Comparing different genetic engineering methods, specifically on domesticated animals.

Required and recommended readings:
J. Watson (2002): DNS, az élet titka, (DNA, the secret of life) HVG könyvek, Budapest,

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.

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.
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 CRISPR method and the possibilities of genome manipulation.
11. Up-to-date results of genetic mapping.
12. Functional genomics.

Required and recommended readings:
Balázs Ervin-Dudits Dénes (2017) Precizős nemesítés Kulcs az agrárinnovációhoz (Precision breeding. Key to agroinnovation) Agroinform, Budapest

Relevance foreign and Hungarian papers
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).
5. Interpretation of statistical values (morbidity, mortality, cohorts, case control).
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 sp.*
13. Epidemiology in food hygiene III: Shigella sp., *colibacteriosis*.

Required and recommended readings:
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.
3. Frequent infectious and parasitic diseases of ducks in the wild.
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:
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:
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.
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
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
evolution, 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.

Required and recommended readings:
Szabó F. (szerk.) (2005): Húsmarhatenyésztés, Mezőgazda Kiadó, Budapest
Education, Prentice Hall, seventh edition
Fries R., Ruvinsky A. (1999): The genetics of cattle. CAB International, New York, USA
Prentice Hall
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.
10. Methods to estimate breeding value.
12. Organic sheep and goat breeding.

Required and recommended readings:
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.
12. Changes in the field of animal protection and developments in husbandry technologies.

Required and recommended readings:
Rothschild, M.F., Ruvinsky, A. (2011): The genetics of the pig. 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.
5. Methods and regulations of producing commercial eggs.
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:
Aliczki K. (2014): A magyarországi pulykavertikum egy évtizedes fejlődési pályájának értékelése, AKI
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.
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:
Molnár K., Szakolczai J. (1980): Halbetegségek Mezőgazdasági Kiadó Budapest
L. Horváth, G. Tamás (2002): Carp and Pond Fish Culture Backwell Science London UK
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
<table>
<thead>
<tr>
<th>Course</th>
<th>Course leader</th>
<th>Hours**</th>
<th>Credit</th>
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<tbody>
<tr>
<td><strong>Compulsory</strong></td>
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<tr>
<td>The methodology of research *</td>
<td>Zoltán Varga PhD</td>
<td>30+120</td>
<td>5</td>
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<tr>
<td>Technologies and machines in plant based food production</td>
<td>Attila József Kovács PhD</td>
<td>30+120</td>
<td>5</td>
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<tr>
<td>Animal product processing and preservation</td>
<td>Péter Kovács PhD</td>
<td>30+120</td>
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<tr>
<td>Special Aspects of Quality Assurance in Food Production</td>
<td>Balázs Ásványi PhD</td>
<td>30+120</td>
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<tr>
<td>Food Hygiene and Quality Control</td>
<td>László Varga DSc</td>
<td>30+120</td>
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<tr>
<td>Follow-up in the foodchain</td>
<td>Zsolt Ajtony PhD</td>
<td>30+120</td>
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<td><strong>Facultative</strong></td>
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<tr>
<td>Quality management for animal product processing</td>
<td>Zsolt Ajtony PhD</td>
<td>30+90</td>
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<tr>
<td>Applied Microbiology</td>
<td>Jenő Szigeti CSc</td>
<td>30+90</td>
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<td>Food Microbiology</td>
<td>László Varga DSc</td>
<td>30+90</td>
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<tr>
<td>Dairy machinery, operations and technologies</td>
<td>László Varga DSc</td>
<td>30+90</td>
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<td>Meat industry operations and machinery</td>
<td>Péter Kovács PhD</td>
<td>30+90</td>
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<td>Food Biotechnology</td>
<td>Jenő Szigeti CSc</td>
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<tr>
<td>Effects of animal infections on food safety and human health</td>
<td>Borisz Egri DSc MRANH</td>
<td>30+60</td>
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<td>Slaughtering and meat processing technology</td>
<td>Péter Kovács PhD</td>
<td>30+60</td>
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<td>Food physics</td>
<td>Ottó Dóka CSc</td>
<td>30+60</td>
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<td>Role of micronutrients in producing functional food and/or dietary additives</td>
<td>Pál Szakál PhD</td>
<td>30+60</td>
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<td>Characteristics of plant based food raw materials</td>
<td>Ferenc Petróczki PhD</td>
<td>30+60</td>
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<tr>
<td>Food raw materials of animal origin</td>
<td>Borisz Egri DSc MRANH</td>
<td>30+60</td>
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<tr>
<td>Fermentation industries</td>
<td>Balázs Ásványi PhD</td>
<td>30+90</td>
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</table>

* 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 Varga 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:**  
Bujdosó E. (1986): Bibliometria és tudománymetria, Budapest, MTA Könyvtára  
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:
Albert Ibarz, G.V. Barbosa Cánovas (2003): Unit operation in food engineering. 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.

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.
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
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.
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.
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:**


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.
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.
11. IT tools for product follow-up.
12. Evaluation of follow-up system.

Required and recommended readings:
Kovács F., Biró G. (2003): Food safety EU regulation. Agroinform Publisher, Budapest
Katona L., Rácz E. (2000): Standardization and the Hungarian Food Book; Agriculture Publisher, Budapest
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.
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.
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

Required and recommended readings:
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:**

**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:**
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.
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.

Required and recommended readings:
Hoffer E. (2006): Dairy machinery and equipment. FVM Training and Consultancy Institute
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.
7. Packaging of meat products.
8. Separation systems.
9. Heat transfer systems.
11. Pickling techniques and machines.
12. Technical developments.

Required and recommended readings:
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.
11. Major food fermentation methods and separation techniques.
12. Genetic modification (engineering) in food production.

**Required and recommended readings:**


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.
12. Production of healthy animal products from the point of view of human health.

Required and recommended readings:
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.
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
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.
11. Rheology and rheological models.
12. Rheological properties of foods.

Required and recommended readings:
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.
9. Role of vitamins in the production of functional food.
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 antioxidánkok szerepe az egészségmegőrzésben http://chemonet.hu/osztaly/eloadas/birgyorgy.html
Körös E. (1980): Bio-szervetlen kémia, Gondolat Kiadó, Budapest http://www.oeti.hu/?m1id=1&m2id=45
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.
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:
Albert Ibarz, G.V. Barbosa Cánovas (2003): Unit operation in food engineering. 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.
7. Condensed and powdered dairy products.
8. Eggs and egg products.
11. Fish and fish products.

Required and recommended readings:
Krász Á., Unger A. (1994): A termelői nyerstej mintavétele, minősítése; Tanfolyami jegyzet, Mosonmagyaróvár
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.
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.
12. Legal regulatory background and description of excise regulation.

**Required and recommended readings:**