

COURSE DESCRIPTION

Title:	Agricultural Applications of Medical Cross-Sectional Imaging Technologies
Neptun code:	
Lectures/Practices:	60
Credit:	6
Program:	PhD
Type:	
Requirements:	-
Semester:	tavaszi/ősz
Language:	English
Pre-requirements:	-
Institute/Department:	-
Course leader:	Dr. Tamás Donkó PhD
Description: the course aims to familiarize students with investigative methodologies based on the use of medical cross-sectional imaging technologies. It also covers the principles and methodologies of digital image processing. The curriculum addresses potential applications in animal breeding and animal sciences, with particular emphasis on their use in selection and breeding programs. Furthermore, it examines the application of these in vivo imaging techniques in studies of growth biology and animal nutrition. In addition, the course discusses the potential of these methods for the investigation of hidden lifestyle plant pests and explores their applications in veterinary medicine and animal health research.	
Aims: Upon successful completion of the course, students will acquire a comprehensive understanding of the potential applications of the aforementioned imaging technologies in the agricultural sciences, including their utilization in research, breeding, and production-related contexts.	
Syllabus: 1. Fundamentals of CT, MRI, and PET imaging. 2. Historical development of the agricultural applications of cross-sectional imaging technologies. 3–7. Applications of imaging modalities in different animal species: pig, poultry, rabbits, cattle and horses, exotic animal species, 8. Digital image post-processing techniques. 9. Manual image segmentation I. 10. Manual image segmentation II. 11. Advanced image processing methods and applications I. 12. Advanced image processing methods and applications II.	
Grading: Successful completion of the course requires regular attendance and active participation in the scheduled sessions, as well as satisfactory performance in the final examination.	
References: <ul style="list-style-type: none"> - Lecture notes and materials presented during the course sessions. - Scientific literature and supplementary references provided or recommended by the instructor during the lectures. 	

COURSE DESCRIPTION

Title:	<i>Application of sensors in animal husbandry</i>
Neptun code:	
Lectures/Practices:	2
Credit:	3
Program:	PhD
Type:	<i>elective</i>
Requirements:	<i>Manuscript + oral presentation</i>
Semester:	<i>autumn</i>
Language:	<i>Hungarian</i>
Pre-requirements:	<i>none</i>
Institute/Department:	<i>MATE, Institute of Animal Sciences</i>
Course leader:	<i>Dr. Levente Kovács DSc</i>
<p>Description: The course introduces the sensor technologies of precision livestock farming (PLF) and their practical use, with special emphasis on dairy cattle production. Students learn the operating principles, strengths and limitations of individual identification, behaviour and activity monitoring, rumen boluses, milking-system sensors, machine vision, infrared thermography and heart rate variability (HRV) measurement. The course follows sensor data from the point of measurement to alerts and on-farm decisions, covering data quality, validation (sensitivity, specificity, ROC analysis), the handling of false alerts and data security. Particular attention is given to health and welfare applications: detection of oestrus and calving, early detection of mastitis, lameness, metabolic disorders and heat stress, and the non-invasive, sensor-based assessment of stress. In the practical sessions students process real on-farm sensor datasets and evaluate the practical and economic applicability of a selected technology.</p>	
<p>Aims: Students will be able to understand how sensor systems used on dairy farms work, to interpret their outputs critically, to select technologies that fit the goals of a given farm, and to integrate sensor data into health, reproduction and animal welfare decisions.</p>	
<p>Syllabus:</p> <ol style="list-style-type: none"> 1. Concept, aims and systems approach of precision livestock farming; the sensor–data–decision chain 2. Individual identification: RFID technology, electronic ear tags, collar and leg sensors 3. Activity and behaviour monitoring: accelerometers, pedometers; measuring lying, rumination and feeding time 4. Reproduction: oestrus detection, calving prediction, in-line milk progesterone measurement 5. Rumen bolus systems: rumen pH, temperature and water intake; early detection of subacute ruminal acidosis and fever 6. Milking-system sensors and automatic milking: milk yield, electrical conductivity, somatic cell count, milk composition, mastitis alerts 7. Automated lameness detection: pressure plates, 2D/3D camera-based gait analysis, accelerometer-based locomotion patterns 8. Infrared thermography: hoof, udder and eye temperature; recording protocols and sources of error 	

<p>9. Heart rate and heart rate variability: measuring autonomic balance, assessment of stress and pain</p> <p>10. Automated measurement of body condition, body weight and feed intake: 3D camera BCS, walk-over scales, individual feeding systems</p> <p>11. Barn climate and heat stress: THI, air speed, ammonia; sensor-controlled cooling</p> <p>12. Sensors in calf rearing: automatic milk feeders, activity and temperature monitoring, early disease detection</p> <p>13. Data processing and decision support: alert algorithms, machine learning, validation (sensitivity, specificity, ROC), data security and data ownership</p> <p>14. Farm visit and student project presentations: evaluation of a selected sensor system</p>
<p>Grading: The course ends with a written exam; the final grade is based on the paper written (60%) and the oral presentation (40%).</p>
<p>References:</p> <ul style="list-style-type: none"> - Halachmi, I. (szerk.) (2015): Precision livestock farming applications: Making sense of sensors to support farm management. Wageningen Academic Publishers, Wageningen. - Rutten, C.J., Velthuis, A.G.J., Steeneveld, W., Hogeveen, H. (2013): Invited review: Sensors to support health management on dairy farms. Journal of Dairy Science 96(4): 1928–1952. - Berckmans, D. (2014): Precision livestock farming technologies for welfare management in intensive livestock systems. Revue Scientifique et Technique (OIE) 33(1): 189–196. - Van Nuffel, A., Zwervaegher, I., Pluym, L., Van Weyenberg, S., Thorup, V.M., Pastell, M., Sonck, B., Saeys, W. (2015): Lameness detection in dairy cows: Part 1. How to distinguish between non-lame and lame cows based on differences in locomotion or behavior. Animals 5(3): 838–860. - von Borell, E., Langbein, J., Després, G., Hansen, S., Leterrier, C., Marchant-Forde, J., Marchant-Forde, R., Minero, M., Mohr, E., Prunier, A., Valance, D., Veissier, I. (2007): Heart rate variability as a measure of autonomic regulation of cardiac activity for assessing stress and welfare in farm animals – A review. Physiology & Behavior 92(3): 293–316. - Kovács, L., Kézér, F.L., Jurkovich, V., Kulcsár-Huszenicza, M., Tőzsér, J. (2015): Heart rate variability as an indicator of chronic stress caused by lameness in dairy cows. PLoS ONE 10(8): e0134792. - Stewart, M., Webster, J.R., Schaefer, A.L., Cook, N.J., Scott, S.L. (2005): Infrared thermography as a non-invasive tool to study animal welfare. Animal Welfare 14(4): 319–325.

COURSE DESCRIPTION

Title:	<i>Cattle breeding</i>
Neptun code:	
Lectures/Practices:	2
Credit:	4
Program:	<i>PhD</i>
Type:	<i>full-time/correspondence</i>
Requirements:	<i>none</i>
Semester:	<i>spring/autumn</i>

Language:	<i>Hungarian</i>
Pre-requirements:	<i>none</i>
Institute/Department:	<i>MATE Institute of Animal Sciences</i>
Course leader:	<i>Dr. Gabriella Holló PhD</i>
Description: The course provide for students with comprehensive knowledge of modern selection objectives, breeding methods, and breeding programmes in cattle breeding. The course introduces the most recent developments in phenotypic and genomic breeding value estimation, as well as precision technologies applied in practical breeding work. Particular emphasis is placed on housing technology, reproductive management, feeding, and animal welfare.	
Aims: The main objective of the course is to familiarise students with the current and future status of cattle breeding, as well as new directions in breeding.	
Syllabus: <ol style="list-style-type: none"> 1. The role of cattle breeding and its current challenges. 2. The importance of functional traits, including productive lifespan, feed efficiency, and health status, in cattle breeding. 3. Selection objectives in dairy cattle breeding. 4. Selection objectives in beef cattle breeding. 5. Breeding programmes in dairy cattle breeding. 6. Breeding programmes in beef cattle breeding. 7. Breeding value estimation and the importance of genomic selection. 8. Phenomics: precision measurement and the integration of novel phenotypic traits into breeding work I. 9. Phenomics: precision measurement and the integration of novel phenotypic traits into breeding work II. 10. Emerging opportunities for climate-smart cattle breeding. 11. Emerging opportunities in selection aimed at methane reducing emissions. 12. Student presentations. 	
Grading: Attendance in the course and completion of the online examination.	
References: Materials presented available on the e-learning platform created for the course.	

COURSE DESCRIPTION

Title:	<i>Milking Technology and Dairy Hygiene</i>
Neptun code:	
Weekly contact hours (Lectures, practices):	<i>2 (Block-teaching)</i>
Credit:	<i>6</i>
Degree program:	<i>PhD</i>
Type:	<i>Full-time/Part-time</i>
Requirements:	<i>Non</i>
Semester:	<i>Spring/Fall</i>

Language:	<i>Hungarian</i>
Prerequisite course(s):	<i>Non</i>
Institute/Department:	<i>MATE Institute of Animal Breeding</i>
Course leader:	<i>Dr. Póti Péter PhD</i>
Course description: Students are introduced with the impact of different milking methods, technologies to the quality and quantity of sheep milk, in connection with the economically, environmentally and socially sustainable dairy farming. The neuro-hormonal regulation of milk let-down, the importance of udder morphology in milking, opportunities of precision technologies and utilisation possibilities of big data during milking are discussed. Laboratory methods and analysing ingredients of raw milk are demonstrated in practice during the course.	
Aims: Milk quality, udder health impacts of different milking methods, protocols are clarified to students, as well as possibilities of reduction in chemical and drug use, solutions given by precision technologies, and the influence of milking to the efficiency of milk and dairy production.	
Syllabus: <ol style="list-style-type: none"> 15. Importance of milk and dairy products in healthy diet. 16. History of milking, machine milking, clarification of the terms used. 17. The neuro-hormonal regulation of milk let-down and udder morphology in connection with machine milking. 18. Evaluations and improvement possibilities of production traits in connection with machine milking systems. 19. Introducing and evaluating of main milking protocols. 20. Evaluating farming technologies in connection with milking technologies. 21. Effect of milking to the assured and functional quality of the milk. 22. Animal welfare aspects of milking 23. Precision technology solutions and possibilities during milking I. 24. Precision technology solutions and possibilities during milking II. 25. Opportunities in studying the big data resulted from milking. 26. Laboratory analysis of raw milk I. 27. Laboratory analysis of raw milk II. 	
Grading: Class attendance and oral exam	
References: <ul style="list-style-type: none"> - Sources cited in classes - Materials uploaded to the e-learning site of the course 	

COURSE DESCRIPTION

Title:	<i>Molecular genetic methods applied in animal breeding</i>
Neptun code:	
Lectures/Practices:	<i>40/0</i>
Credit:	<i>6</i>
Program:	<i>PhD</i>
Type:	<i>full time</i>
Requirements:	<i>Animal breeding, Genetics</i>
Semester:	<i>spring</i>
Language:	<i>English</i>

Pre-requirements:	<i>MSc</i>
Institute/Department:	<i>Institute of Animal Sciences</i>
Course leader:	<i>Dr. ZsolnaiAttila, DSc</i>
Description: The practical application of molecular genetic methods is an integral part of animal biotechnology. The subject discusses the relevant basic knowledge, methods and practical applications, with particular attention to the presentation of the results achieved so far.	
Aims: Learning about the relevant basic knowledge, methods and practical applications in the topic.	
Syllabus: At present there is considerable interest in the application of molecular technologies for specific DNA markers associated with various QTL (Quantitative Trait Loci) to promote more efficient and relatively easy selection in farm animals. Recent advances in molecular genetics have enabled the application of MAS (Marker Assisted Selection) and GWAS (Genome-Wide Association Study) in achieving different breeding objectives. The course gives a summary of the main molecular markers and methods used in livestock improvement programmes.	
Grading: 1-5, colloquium	
References: Zsolnai Attila: Genetics <ol style="list-style-type: none"> 1. Anton I., Húth B., Füller I. et al.: Effect of single nucleotide polymorphisms on intramuscular fat content in Hungarian Simmental cattle. <i>AJAS</i>, 31, 9, 1415-1419. (2018). 2. Zsolnai A., Maróti-Agóts Á., Kovács A., Bálteanu AV., Kaltenecker E., Anton, I.: Genetic position of Hungarian Grey among European cattle and identification of breed-specific markers. <i>Animal</i>, 14, 9, 1786-1792, (2020). 3. Zsolnai A., Egerszegi I., Rózsa L., Anton I.: Genetic status of lowland-type Racka sheep colour variants. <i>Animal</i>, 15, 2 , Paper: 100080 , 6 p. (2021). 4. Zsolnai A., Egerszegi I., Rózsa L., Mezőszentgyörgyi D., Anton I.: Position of Hungarian Merino among other Merinos, within-breed genetic similarity network and markers associated with daily weight gain. <i>Animal Bioscience</i> 36, 1.,10-18. , 9 p. (2023). 5. Kis J., Rózsa L., Husvéth F., Mezőszentgyörgyi D., Kovács S., Bakos Z., Zsolnai A., Anton I.: Association of myostatin gene polymorphism with echocardiographic and muscular ultrasonogr. measurements in Hungarian thoroughbred horses. <i>Res.Vet.Sci.</i>,160, 45-49. (2023). 6. Márton J., Szabó F., Zsolnai A., Anton I.: Genetic diversity and phylogenetic relationship of Angus herds in Hungary and analyses of their production traits. <i>Anim. Biosci.</i> (2023). https://doi.org/10.5713/ab.23.0157 	

COURSE DESCRIPTION

Title:	<i>Pig Genetics</i>
Neptun code:	
Lectures/Practices:	<i>2</i>
Credit:	<i>6</i>
Program:	<i>Animal Sciences</i>
Type:	<i>Optional</i>
Requirements:	<i>-</i>
Semester:	<i>Spring/Autumn</i>
Language:	<i>Hungarian/English</i>

Pre-requirements:	-
Institute/Department:	<i>MATE, ÁTI, Department of Animal Breeding</i>
Course leader:	<i>Prof. Dr. Nagy István DSc.</i>
Description: Upon successful completion of the course, students will be able to: Explain advanced genetic and genomic principles relevant to pig breeding. Estimate and interpret genetic parameters and breeding values. Evaluate and apply genomic selection methodologies. Assess genetic diversity and develop strategies to control inbreeding. Critically analyze scientific literature in animal genetics and breeding. Design and evaluate breeding programs aimed at improving productivity, sustainability, and animal welfare. Conduct independent research in the field of pig genetics and breeding.	
Aims: The course provides an in-depth understanding of the genetic principles underlying pig breeding and the application of modern genomic technologies in breeding programs. Students will gain expertise in quantitative and molecular genetics, genomic selection, breeding value estimation, and the management of genetic diversity in pig populations. The course aims to develop the ability to critically evaluate scientific literature and design innovative breeding strategies for sustainable pork production.	
Syllabus:	
1. Genetic Resources of Pig Populations <ul style="list-style-type: none"> Genetic diversity of pig breeds Indigenous and commercial breeds Conservation of animal genetic resources Sustainable utilization of genetic variability 	
2. Principles of Mendelian and Quantitative Genetics <ul style="list-style-type: none"> Modes of inheritance in pigs Genetic and environmental sources of variation Heritability and repeatability Genetic correlations among economically important traits 	
3. Genetics of Economically Important Traits <ul style="list-style-type: none"> Reproductive performance traits Growth and carcass quality traits Feed efficiency and nutrient utilization Disease resistance and robustness traits Welfare-related genetic characteristics 	
4. Breeding Value Estimation <ul style="list-style-type: none"> Selection index theory BLUP methodology Animal models and mixed model equations Genetic trend analysis Accuracy and reliability of breeding values 	
5. Molecular Genetics in Pig Breeding <ul style="list-style-type: none"> DNA markers and marker-assisted selection 	

- Single nucleotide polymorphisms (SNPs)
- Candidate genes and quantitative trait loci (QTL)
- Functional genomics approaches

6. Genomic Selection

- Principles of genomic breeding value estimation
- Reference populations
- Genomic prediction models
- Integration of genomic information into breeding programs
- Economic impact of genomic selection

7. Reproductive and Genetic Biotechnologies

- Assisted reproductive technologies
- Artificial insemination and embryo transfer
- Gene editing technologies (e.g., CRISPR/Cas systems)
- Transgenic pigs and their applications

8. Inbreeding and Genetic Diversity Management

- Measurement of inbreeding
- Effective population size
- Population genetic parameters
- Strategies for maintaining long-term genetic progress

9. Current Research Trends in Pig Genetics

- Epigenetics and gene regulation
- Precision livestock farming and big data applications
- Systems biology approaches
- Genome-wide association studies (GWAS)
- Future perspectives in pig breeding and genetics

Grading: Attendance in class (10%), analysis and presentation of published articles or book chapters (40%), and a written exam (50%).

- **References:** Rothschild and Ruvinsky: The Genetics of the Pig. CABI, 2006.
Weller: Genomic Selection in Animals. Wiley, 2016.

COURSE DESCRIPTION

Title:	<i>Pig management</i>
Neptun code:	
Lectures/Practices:	2
Credit:	6
Program:	<i>PhD</i>
Type:	<i>full time/part time</i>

Requirements:	-
Semester:	<i>spring/autumn</i>
Language:	<i>English</i>
Pre-requirements:	-
Institute/Department:	<i>Institute of Animal Sciences</i>
Course leader:	<i>Dr. Henrietta Nagyné Kiszlinger, PhD</i>
Description: The course provides comprehensive knowledge of the theoretical and practical foundations of modern pork production. Students will learn the characteristics of the most important pig breeds and hybrids in light of market and user needs, and will learn the biological foundations of pork production, as well as the feeding and husbandry technology of pigs.	
Aims: The PhD student should learn and master the methods of breeding, keeping and feeding pigs, as well as the possibilities of producing quality products.	
Syllabus: Basic breeds and hybrids evaluated in terms of user needs. Biological basis of pork production. Guidelines for pig feeding. Reproduction technology. Breeding stock raising. Methods of sow and boar husbandry. Methods of pig fattening. Classification of slaughter pigs and factors affecting quality. Special pig husbandry practices. Challenges caused by heat stress in pig breeding and husbandry.	
Grading: Personal appearance at the course and passing the exam.	
References: <ul style="list-style-type: none"> – lecture notes – Ilias Kyriazakis és Colin T. Whittemore: Whittemore's Science and Practice of Pig Production. 2006. Blackwell Publishing Ltd – Pluske John R. Le Dividich Jean Hampson David J: Nursery pig management. Oxfordcop. Oxford Blackwell Science cop.2006 	

COURSE DESCRIPTION

Title:	<i>Biology of the rabbit</i>
Neptun code:	
Lectures/Practices:	2
Credit:	6
Program:	<i>PhD</i>
Type:	<i>full time/part time</i>
Requirements:	-
Semester:	<i>spring/autumn</i>
Language:	<i>English</i>
Pre-requirements:	-

Institute/Department:	<i>Institute of Animal Sciences</i>
Course leader:	<i>Dr. Zsolt Gerencsér</i>
Description: The biology of the domestic rabbit focuses on the anatomical and physiological characteristics of rabbits; therefore, it is recommended only for students whose doctoral research is relevant to this topic. Within the scope of this course, students will learn about the physiological characteristics of domestic rabbits (reproduction, digestive physiology, genetic foundations, and behavior).	
Aims: Students will learn about the specific biological functions of rabbits and will study and analyze the scientific literature on rabbit biology relevant to their doctoral research topics.	
Syllabus: <ol style="list-style-type: none"> 1. Domestication and Distribution of the Domestic Rabbit 2. Anatomy of the Rabbit 3. Genetic Foundations 4. Effects of Body Fur, Heat Dissipation, and Heat Stress 5. Reproductive organs and their characteristics 6. Characteristics of rabbit reproductive biology 7. The rabbit's digestive system and its characteristics 8. Characteristics of rabbit digestive physiology 9. The rabbit's immune system and health 10. The Ancestors of Rabbits and Their Lifestyle 11. Rabbit Behavior 12. Biological Aspects of Specific Topics Related to Rabbits 13. Animal Welfare Considerations in Rabbit Breeding 	
Grading: Presentation of the unique topic (literature summary and short presentation)	
References: <ul style="list-style-type: none"> - Maertens & Coudert (2006) RECENT ADVANCES IN RABBIT SCIENCES. http://world-rabbit-science.com/Documents/Cost848.pdf 	

COURSE DESCRIPTION

Title:	<i>Genetics of the rabbit</i>
Neptun code:	
Lectures/Practices:	2
Credit:	6
Program:	<i>PhD</i>
Type:	<i>full time/part time</i>
Requirements:	-
Semester:	<i>spring/autumn</i>
Language:	<i>English</i>
Pre-requirements:	-
Institute/Department:	<i>Institute of Animal Sciences</i>
Course leader:	<i>Dr. Zsolt Gerencsér</i>
Description: The genetics of domestic rabbits is a very narrow and specialized field of genetics; therefore, it is recommended only for students whose doctoral research is relevant to this topic. Within the framework of this course, students will learn about the genetic basis underlying the major performance traits of domestic rabbits.	
Aims: To expand students' knowledge of genetics and to review and master the literature on rabbit genetics relevant to their doctoral research topics.	

Syllabus: <ol style="list-style-type: none"> 1. Domestication and spread of the domestic rabbit 2. Rabbit breeds and hybrids 3. Cytogenetics in rabbit breeding 4. Immunogenetics in rabbit breeding 5. Inheritance of coat color 6. Inheritance of coat quality 7. Inherited diseases in rabbit breeding 8. Genetic background of resistance 9. Inheritance of growth and slaughter traits 10. Inheritance of fertility 11. Biotechnologies and technology in rabbit breeding 12. Rabbit genetic aspects of individual topics 13. The rabbit as a biomedical model
Grading: Presentation of the unique topic (literature summary and short presentation)
References: <ul style="list-style-type: none"> - Luca Fontanesi (2021) The genetics and genomics of the rabbit.

COURSE DESCRIPTION

Title:	<i>Technology of goat breeding</i>
Neptun code:	<i>SDIATD8 033</i>
Lectures/Practices:	2
Credit:	6
Program:	<i>Animal Breeding and Genetics Subprogram</i>
Type:	
Requirements:	-
Semester:	<i>spring/autumn</i>
Language:	<i>English</i>
Pre-requirements:	-
Institute/Department:	<i>Institute of Animal Sciences</i>
Course leader:	<i>Dr. Ferenc Pajor, PhD</i>
Description: The aim of the course is to familiarize PhD students involved in goat breeding and goat product research with the sectoral and research-specific characteristics of goat production. The course provides knowledge about the biological foundations of goat breeding, as well as the possibilities of applying breeding, selection, feeding, housing, and product production methods and technologies. Furthermore, the course presents the results of national and international research related to goat breeding, including current trends and future development directions.	
Aims: PhD students gain a comprehensive overview of the biological, technological, and research fundamentals of goat breeding, as well as national and international development trends.	
Syllabus: <ol style="list-style-type: none"> 1. Origin and domestication of goats. History of goat breeding. Global market situation of goat products (production, trade, consumption). 	

<ol style="list-style-type: none"> 2. The national and international role of goat breeds. Possibilities for the use of breeds in goat production. 3. Operation and responsibilities of breeding organizations, animal identification and registration system. Breeding methods used in goat production, with examples. 4. Economic traits of goats in different production types. 5. Importance of conformation evaluation and assessment of body structure and body parts in goats. 6. Evaluation of the current practice of goat performance testing systems and possibilities for their further development. 7. Feeding of goats of different age groups I. Importance of body condition scoring. 8. Feeding of goats of different age groups II. 9. Goat housing technologies (buildings, equipment, etc.). 10. Technologies of kid rearing and young stock raising: housing, feeding, watering, treatments, fattening, in breeding and commercial herds. 11. Kid fattening, introduction to slaughter line technology, requirements for slaughter kids. Quality characteristics of goat meat. 12. Reproduction of goats. 13. Basics of goat milk processing.
Grading: Personal attendance at the course and successful completion of the examination.
References: <ul style="list-style-type: none"> - lecture and practice materials - recommended scientific journal articles

COURSE DESCRIPTION

Title:	<i>Dog Breeding</i>
Neptun code:	
Lectures/Practices:	2
Credit:	6
Program:	<i>PhD</i>
Type:	<i>full time/part time</i>
Requirements:	<i>none</i>
Semester:	<i>spring/autumn</i>
Language:	<i>English</i>
Pre-requirements:	<i>none</i>
Institute/Department:	<i>MATE Institute of Physiology and Nutrition /Department of Farm Animal Nutrition</i>
Course leader:	<i>Dr. Virág Bánovics-Ács</i>
Description: This course provides an overview of the scientific foundations of modern dog breeding, highlighting preservation of genetic diversity, the prevention of hereditary diseases, the breeding-related aspects of canine behaviour and welfare, and the practical application of molecular genetic testing. During the course, students will gain an understanding of the genetic characteristics of dog breeds, population genetic processes, the consequences of inbreeding, the background of inherited disorders, and the importance of behavioural and welfare-related traits in breeding programs. The course also addresses the modern genetic interpretation of coat colour inheritance, with special focus on the merle gene, as well as the development of ethical and sustainable breeding strategies.	

Aims:

The aim of the course is to provide an advanced understanding of the genetic, welfare, behavioural, and health-related principles of modern dog breeding. Students will gain comprehensive knowledge of population genetics, hereditary diseases, molecular genetic testing, and breeding strategies aimed at maintaining genetic diversity and improving canine health and welfare. The course also seeks to develop students' ability to critically evaluate breeding programs, interpret genetic data, and apply current scientific findings to the design of ethical, sustainable, and evidence-based breeding practices. Furthermore, the course promotes a multidisciplinary approach integrating genetics, animal welfare science, behaviour, and veterinary aspects of dog breeding.

Syllabus:

1. Domestication and breed development of the domestic dog
2. Canine behaviour, welfare, and the human–dog relationship
3. Principles of canine genetics and genomics
4. Population genetics and the maintenance of genetic diversity
5. Inbreeding, linebreeding, and their genetic consequences
6. Molecular genetics and DNA-based testing in dog breeding
7. Monogenic and polygenic inheritance in dogs
8. Hereditary diseases: genetic background, diagnosis, and prevention
9. Breeding strategies for improving health and welfare
10. Coat colour genetics and the molecular basis of the merle gene
11. Behavioural traits and welfare indicators in breeding programs
12. Ethical, legal, and sustainability aspects of modern dog breeding
13. Current research trends and case studies in canine genetics and breeding

Grading:

- Active participation in class discussions and seminars – 10%
- Written assignment (literature review or critical analysis of a scientific paper) – 30%
- Final oral examination – 60%

References:

- Gazzano, A., & Mariti, C. (Eds.). (2020). *Dog Behaviour, Physiology and Welfare*. MDPI, Basel, Switzerland.
- Zöldág, L. (2020). *A kutya örökletes hátterű betegségei*. Budapest, Hungary.
- Langevin, M. (2018). *Merle – SINE Insertion from Mc to Mh: The Incredible Story of Merle*.

COURSE DESCRIPTION

Title:	<i>Population genetics</i>
Neptun code:	
Lectures/Practices:	2

Credit:	6
Program:	PhD
Type:	full time/part time
Requirements:	none
Semester:	spring/autumn
Language:	English
Pre-requirements:	none
Institute/Department:	MATE Institute of Animal Sciences
Course leader:	Prof. Dr. Nagy István
Description: During the course, students will learn about the genetic structure of populations, the maintenance of genetic diversity, and the genetic basis of evolutionary processes. Students will learn about the mechanisms that shape the genetic composition of populations. Due to its application in animal breeding, the heritability of quantitative traits, the maintenance of genetic diversity, inbreeding, and inbreeding depression are topics of particular importance.	
Aims: The primary goal of teaching population genetics is to help students understand the origin and maintenance of genetic diversity, the mechanisms of evolutionary processes, and how the genetic composition of populations changes over time and space. This ensures an understanding of the scientific foundations of evolution, animal breeding, and modern genetics.	
Topics: <ol style="list-style-type: none"> 1. Phenotypic variance 2. Heritability 3. Selection 4. Pedigree analysis 5. Inbreeding 6. Inbreeding depression 7. Genetic drift 8. Effective population size 9. Evaluation of possible population subdivision 10. Genomic methods in animal breeding 	
Grading: Critical analysis and presentation of a published article and/or book chapter (50%) End-of-semester oral exam/presentation of data analysis conducted within the framework of the students own PhD research topic (50%)	
References: <ul style="list-style-type: none"> • Szabó Ferenc, Általános Állattenyésztés Mezőgazda Kiadó, 2015. • Simm, Pollott, Mrode, Houston, Marshall, Genetic Improvement of Farmed Animals, CABI, 2021. • Khatib, Molecular and Quantitative Animal Genetics, Wiley, 2015. • Allendorf, Funk, Aitken, Byrne, Luikart, Conservation and the Genomics of Populations, 3rd Ed. Oxford, University Press, 2022. 	

Course Description

Course title / Neptun code: AI in animal breeding	Number of credits: 6
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Course coordinator (name, position, academic degree): György Kövér, associate professor, PhD
Instructor(s) involved in teaching the course, if applicable (name, position, academic degree):
Course type: compulsory/elective elective
Type of class: <u>lecture</u> /seminar / <u>practical</u> / consultation, and total number of contact hours in the semester: .18/18/36..... contact hours
Teaching methods and specific educational tools used for knowledge transfer (e.g. case presentations, case-study analyses, project-based learning, other methods): presentations, case-study analyses and project based homework
Requirements for successful completion: Students choose an AI method covered and apply it to a question connected to their own research area. The result must be presented.
Assessment methods applied for evaluating learning outcomes: exam
Recommended semester
Prerequisites (if any):
<p>Course Description</p> <p>Objectives of the course and a concise yet informative description of the knowledge and skills to be acquired.</p> <p>The use of artificial intelligence tools appears in nearly every area of animal husbandry research. Building on machine learning methods, we can analyse data measured during precision livestock farming and images generated through computer vision. The course is introductory in nature. We present individual application possibilities topic by topic.</p> <p>Students will be able to determine, for any given AI method, whether it is applicable to their own research.</p> <p>During computer lab exercises, we demonstrate the methods by analysing databases using freely available applications.</p> <p>AI tools form an essential part of the course material. Their use must comply with MATE's relevant guidelines.</p>
<p>Course Topics / Semester Schedule:</p> <ul style="list-style-type: none"> • Introduction. A survey map of where AI already touches the animal Research. • Supervised vs. unsupervised learning, neural networks, validation, overfitting, the 'trained model'. • Computer Vision — Detecting and Tracking Animals, pose estimation, behavior classification. • AI for Wildlife Monitoring and Conservation. Camera-trap image classification. • Precision Livestock Farming. Sensor and computer-vision systems. Welfare and health monitoring, behavior detection. • AI in Veterinary Diagnostics. • Genomic selection, GWAS combined with machine learning.

- AI and the 3Rs: Replacement Technologies (replacement, reduction, refinement)
- FAIR data principles, dataset bias, validation.
- Ethics, Welfare & Governance of AI in Animal Research
- LLMs in the Research Workflow. synthesis, hypothesis generation. Hallucination.

List of the 2–5 Most Important Required Literature

(textbooks, lecture notes, or other study materials)

Provide complete bibliographic information: author(s), title, publication details, page numbers (if applicable), and ISBN.

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(textbooks, lecture notes, or other study materials)

Provide complete bibliographic information: author(s), title, publication details, page numbers (if applicable), and ISBN.

1. Akbarein, H., Taaghi, M. H., Mohebbi, M., & Soufizadeh, P. (2025). Applications and considerations of artificial intelligence in veterinary sciences: A narrative review. *Veterinary Medicine and Science*, 11(3). <https://doi.org/10.1002/vms3.70315>
<https://pmc.ncbi.nlm.nih.gov/articles/PMC11964155/>
Publisher: Wiley · ISSN: 2053-1095 · DOI: 10.1002/vms3.70315 · Open-access copy: PMC11964155
2. Tuia, D., Kellenberger, B., Beery, S., Costelloe, B. R., Zuffi, S., Risse, B., Mathis, A., Mathis, M. W., van Langevelde, F., Burghardt, T., Kays, R., Klinck, H., Wikelski, M., Couzin, I. D., Van Horn, G., Crofoot, M. C., Stewart, C. V., & Berger-Wolf, T. (2021). Seeing biodiversity: Perspectives in machine learning for wildlife conservation (*arXiv:2110.12951*). arXiv.
<https://arxiv.org/abs/2110.12951> <https://arxiv.org/abs/2110.12951>
Format: arXiv preprint · No formal journal, publisher, or DOI attached to the preprint itself
3. Neethirajan, S., Scott, S., Mancini, C., Boivin, X., & Strand, E. (2024). Human-computer interactions with farm animals—enhancing welfare through precision livestock farming and artificial intelligence. *Frontiers in Veterinary Science*, 11, Article 1490851. <https://doi.org/10.3389/fvets.2024.1490851>
<https://pmc.ncbi.nlm.nih.gov/articles/PMC11604036/>
Publisher: Frontiers Media SA · Published: November 14, 2024 · DOI: 10.3389/fvets.2024.1490851 · PMID: 39611113 · PMCID: PMC11604036
4. Foris, B., Sheng, K., Dürnberger, C., Oczak, M., & Rault, J.-L. (2025). AI for one welfare: The role of animal welfare scientists in developing valid and ethical AI-based welfare assessment tools. *Frontiers in Veterinary Science*, 12, Article 1645901. <https://doi.org/10.3389/fvets.2025.1645901>
<https://www.frontiersin.org/journals/veterinary-science/articles/10.3389/fvets.2025.1645901/full>
Publisher: Frontiers Media SA · DOI: 10.3389/fvets.2025.1645901

Professional Competences Developed by the Course

Please specify the professional competences, competence elements and skills to which the course substantially contributes, including:

Knowledge, Skills, Attitudes, Autonomy and Responsibility

Knowledge

- Is familiar with the categories of AI methods usable in animal breeding research

- Knows several suitable computer tools for solving AI tasks

Skills

- Is able to select AI tools applicable to their own field
- Is able to independently evaluate computational results
- Is able to explain the results in an accessible way

Attitudes

- Is open to keeping up with developments in AI tools

Autonomy and Responsibility

- Uses AI tools responsibly, taking their drawbacks into account.
- Adheres to the principles of ethical research.

COURSE DESCRIPTION

Title:	<i>Technology of Sheep Milk and Mutton Production</i>
Neptun code:	
Weekly contact hours (Lectures, practices):	<i>2 (Block teaching)</i>
Credit:	<i>6</i>
Degree program:	<i>PhD</i>
Type:	<i>Full-time/Part-time</i>
Requirements:	<i>Non</i>
Semester:	<i>Spring/Fall</i>
Language:	<i>Hungarian</i>
Prerequisite course(s):	<i>Non</i>
Institute/Department:	<i>MATE Institute of Animal Breeding</i>
Course leader:	<i>Dr. Póti Péter PhD</i>
Course description: The course introduces the different technologies of sheep milk and mutton production – ewe farming and fattening - based on various breeds, genotypes, according to up-to-date research, including possibilities in precision sheep breeding and farming. That information may help in evaluating and studying a broader or a more specialised field within this topic. Laboratory methods of analysing raw milk and mutton according to their nutritional values are also presented during the course.	
Aims: Give students an insight about correlations of breed/genotype, technology and market, the opportunities of improvement and research in this field, for environmentally, economically and socially sustainable sheep farming, sheep milk and slaughter lamb production.	
Syllabus:	
28. Regional demand for sheep milk and mutton	
29. Requirements according slaughter lambs, mutton and sheep milk by regions (countries, group of countries), quantitative and qualitative expectations of the market, possible trends,	
30. Clarification of term in sheep farming, criteria for methods for designing technologies.	
31. Directions and possibilities of improving daily sheep farming based on grazing.	
32. Directions and possibilities of improving technologies of full sheep housing, barn based daily sheep population.	

33. Introducing and evaluating the milking process and protocol in sheep. The importance of milking and primary milk handling.
34. Requirements and demand of slaughter lambs and mutton, correlations of breed/genotype and environment and their consistency.
35. Improvement possibilities and trends in mutton dam farming technologies.
36. Introducing the technologies of slaughter seep production, fattening methods.
37. Possibilities and solutions according to precision technologies in sheep breeding I.
38. Possibilities and solutions according to precision technologies in sheep breeding II.
39. Laboratory evaluation of raw sheep milk.
40. S/EURP grading system, the laboratory evaluation of mutton.

Grading: Class attendance and oral exam

References:

- Sources cited in classes
- Materials uploaded to the e-learning site of the course