HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES
INSTITUTE OF GENETICS AND BIOTECHNOLOGY

Address: 2100 Gödöllő, Szent-Györgyi A. str. 4.

COURSE CATALOGUE for Exchange students

2026/27 Academic year

The **Institute of Genetics and Biotechnology of MATE at Gödöllő Campus** is currently offering the following core courses for the 2026/27 academic year. **Additional courses will be announced before the start of the semester, providing a wider range of courses to choose from.**

Exchange students are integrated with full degree international students during the semesters' workflow in the following study programmes:

- **MSc in Agricultural Biotechnology**
- MSc in Crop Production
- BSc in Agricultural Engineering
- BSc in Environmental Engineering

Exchange students can take both bachelor's and master's subjects regardless of their study level or semester; however, timetable conflicts may occur.

Available subjects (based on MATE curricula) are mostly part of full degree study programmes, as exchange students are integrated with full degree international students during the semesters' workflow. **Additional courses will be announced before the start of the semester**, providing a wider range of courses to choose from.

2026/27 Autumn semester

Lectures: from early September to mid December.
Exams: mid December to late January

2026/27 Spring semester

Lectures: from early February to mid May.

Exams: mid May to late June

2026/27 Autumn semester

STUDY PROGRAMMES	SUBJECT CODE	SUBJECT NAME	ECTS Credits	*relevant semester of the study program at MATE*
BSc in Agricultural Engineering	GENBT041N	Plant Breeding and Biotechnology	3	3
emPLANT	GENBT017N – BUDA!	Functional and Structural Plant Genomics	4	2
MSc in Agricultural Biotechnology	GENBT016N – BUDA!	Aims and Results in Plant Breeding	3	4
	GENBT021N	Animal Gene Mapping	4	3
	GENBT010N	Bioinformatics	5	3
	GENBT058N	Cell and Tissue Culture Methodology	5	2
	GENBT024N	Classical, Population and Evolution Genetics	4	1
	GENBT033N	Microbiology and Microbial Biotechnology	4	1
	GENBT036N – BUDA!	Molecular Genetics	4	1
	GENBT040N	Molecular Plant Breeding	3	3
	GENBT061N	Transgenesis and Genomic Editing in Plants	4	3
	GENBT062N	Transgenic Animal Technologies in Animal Husbandry	4	3
MSc in Crop Production Engineering	GENBT031N	Microbiology	3	1
	GENBT043N	Plant Biotechnology	3	1

2026/27 Spring semester

STUDY PROGRAMMES	SUBJECT CODE	SUBJECT NAME	ECTS Credits	*relevant semester of the study program at MATE*
BSc in Agricultural Engineering	**GENBT019N**	**Genetics**	**3**	***2***
BSc in Environmental Engineering	**GENBT034N**	**Principles of Microbiology**	**3**	***2***
MSc in Agricultural Biotechnology	**GENBT023N**	**Experimental Embryology**	**4**	***4***
	GENBT009N	**Introduction to Plant and Animal Biotechnology**	**5**	***2***
	GENBT001N	**Molecular Biology and Gene Technology Methodology**	**4**	***2***
	GENBT037N	**Molecular Markers in Plant Breeding**	**3**	***2***
	GENBT048N – BUDA!	**Plant Reproduction and Reproduction Biotechnology**	**3**	***2***
MSc in Crop Production	**GENBT054N**	**Detailed Plant Breeding**	**3**	***2***

Plant Breeding and Biotechnology

Study Programme: BSc in Agricultural Engineering

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 3

SUBJECT CODE: GENBT041N

ECTS Credits: 3

AIM OF SUBJECT:
The aim of the course is to acquaint students with the origin, biological foundations, breeding goals and results of our most important cultivated plants. Acquire the theoretical and practical knowledge of the applicable traditional breeding methods - cross-breeding, mutation, polyploidization - and new - tissue culture and genetic engineering. Gain the most important theoretical and practical knowledge about genetically modified plants.

CONTENT:
Lecture Topics

1. Objectives and steps of plant breeding. Origin and domestication of cultivated plant species. Role and tasks of gene banks.

2. Genetic variability in plant breeding. Mutation breeding and polyploidy.

3. Tasks of plant breeding. Definition of a variety (cultivar) and the steps of its development. Concept, theory, and types of selection.

4. Fertilization systems. Principles and methods of breeding self-pollinated and cross-pollinated plants.

5. Concept and types of heterosis and its application. Production of hybrid varieties. Concept, types, and utilization of male sterility.

6. Breeding for increased yield. Quality (nutritional and compositional) breeding. Breeding for resistance to biotic and abiotic stresses.

7. Molecular genetic markers: definition and application in plant breeding. Midterm test 1.

8. Biotechnological techniques of sexual reproduction: flower culture; ovary, ovule, endosperm, embryo, anther, and pollen culture.

9. Biotechnological techniques of asexual reproduction: in vitro micropropagation, pathogen elimination, artificial seeds, in vitro gene banks, cryopreservation, protoplast fusion.

10. Definition and global status of transgenic plants; their importance in the development of new varieties. Steps in the production of genetically modified plants and the history of their cultivation.

11. First-generation transgenic plants: development and cultivation of genetically modified plants resistant to herbicides, insects, viruses, fungi, and bacteria.

12. Second-generation transgenic plants: possibilities for modifying metabolic processes—carbohydrates, fatty acids, proteins, flower color, and fruit ripening.

13. Risk factors of transgenic plants. Midterm test 2.

Practical Sessions

Fundamentals of plant cell and tissue culture and their applications.

Preparation of plant culture media.

In vitro micropropagation of plants.

Heterosis breeding of field and horticultural crop species.

Isolation of plant DNA.

Application of PCR techniques in plant breeding.

Plant transformation using Agrobacterium and the gene gun.

GRADING SYSTEM:

Attendance Requirements

Attendance at lectures is not mandatory but is strongly recommended, as some of the most recent information presented may not be included in the required or recommended literature.

Attendance at practical classes is mandatory.

Submission of Assignments During the Semester

Requirements for submitting coursework during the semester, deadlines, and methods of assessment.

Midterm Assessments and Their Evaluation, Possibility of Retakes

There are two written midterm tests for lectures and one written midterm test for practical classes. Each test may be retaken or improved once.

Requirements for Obtaining the Course Signature

At least 51% of the total points must be achieved in each midterm test.

Type and Evaluation of Assessment

Based on the results of the midterm tests during the semester, students may obtain a recommended grade of satisfactory, good, or excellent.

The final exam grade is obtained through a written examination.

LITERATURE:

Learning materials:

Presentation slides of lectures – available in E-learning

Functional and Structural Plant Genomics

Study Programme: emPLANT

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 2

SUBJECT CODE: GENBT017N

ECTS Credits: 4

AIM OF SUBJECT:
The subject gives a detailed description on the composition of prokaryotic and eukaryotic genome, provides an introduction to Omics, Systems Biology, Next generation sequencing techniques and other methodologies including reverse genetics. It presents the basic characters of viral and bacterial genomes, the Arabidopsis genome, the poplar genome, the genome structure of crop plants and Proteomics and Metabolomics.

CONTENT:
Module 1: The composition of prokaryotic and eukaryotic genome – J. Halász

Module 2: Introduction to Omics – A. Hegedűs

Module 3: Systems Biology – A. Hegedűs

Module 4: Methodology, reverse genetics – A. Hegedűs

Module 5: Next generation sequencing techniques – Zs. György

Module 7: Viral and bacterial genomes – Zs. György

Module 8: The Arabidopsis genome – Zs. György

Module 9: Poplar genome – J. Halász

Module 10: The genome structure of crop plants – A. Hegedűs

Module 11: Proteomics and Metabolomics Practice – M. Dernovics

Module 12: Student presentation 1

GRADING SYSTEM:
Requirements: The course includes lectures and practices. Lectures will provide the theoretical knowledge required to understand and solve practical problems and hence the participation in lectures is strongly recommended although it is not

obligatory. It is also recommended to continuously follow the topics touched in lectures week after week. In contrast, the participation in practice is obligatory according to the university regulations (TVSz III. 29.§).

Certification needed to submit when a practical module was missed: If a practical module is missed, students will need to submit a medical certificate for the specific date of the missed module. The official document on paper base must be left at the department secretary or posted as a registered letter in an envelope addressed for Dr. Attila Hegedűs. Students must inform the academic in an e-mail that the letter has been posted. After sending the medical certificate, students must consult with the instructor how to make up the missing information. Students absent from more than one practical modules without medical certificate or not contacting the instructor will be rejected from receiving signature for the course.

The eligibility requirements for obtaining a signature: Students need to get a signature indicating the fulfilment of course requirements. The signature will only be provided for students who have accomplished the student presentation task successfully and were no absent from practical modules without certification.

Final evaluation: In the end of the semester, students who have signature can register for written exams. The exam is carried out with personal presence.

Evaluation of exams: The result is expressed in marks as follows: excellent (5), good (4), average (3), pass (2) and fail (1). If students receive the mark 1 (fail), the exam is considered failed / unsuccessful.

LITERATURE:

Learning materials will be supplied in the E-learning system (password: Omics).

Aims and Results in Plant Breeding

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 4

SUBJECT CODE: GENBT016N

ECTS Credits: 3

AIM OF SUBJECT:
Students will synthesize their knowledge of both traditional and molecular plant breeding, and will be able to creat a breeding plan for any cultivated plant species to produce a new variety that meets the current challenges.

CONTENT:
Topics

1. The terminology of plant breeding. Classical and molecular approaches to plant breeding. Principles and types of heredity.

2. Reproductive systems, classification of plants according to their reproduction.

3. Plant breeding approaches for asexually and sexually propagated plants. Methods of plant breeding for sexual reproduction, methods of promoting and preventing self-fertilization.

4. Incompatibility systems in plants and methods developed to prevent them. Factors inhibiting crossing and methods of plant breeding to overcome them.

5. Ways to increase variability. Mutation, mutation breeding methods.

6. Importance of polyploidy, breeding methods

7. Importance of dihaploids. Conventional and biotechnological methods of producing haploids.

8. Challenges of plant breeding in the 21st century. Breeding aims.

9.-10.Breeding aims for specific plant species and their realisation.

11-13 Project work preparation and discussion on the breeding of a selected plant species

During the practice we will visit plant breeding companies where they will explain and demonstrate the breeding methods and steps for different plant species.

GRADING SYSTEM:

By the end of the semester, students will have to prepare their own breeding plan for a plant species of their choice.

LITERATURE:

Lecture materials will be uploaded to the e-learning system

Animal Gene Mapping

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 3

SUBJECT CODE: GENBT021N

ECTS Credits: 4

AIM OF SUBJECT:

CONTENT:

GRADING SYSTEM:

LITERATURE:

Bioinformatics

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 3

SUBJECT CODE: GENBT010N

ECTS Credits: 5

AIM OF SUBJECT:

CONTENT:

GRADING SYSTEM:

LITERATURE:

Cell and Tissue Culture Methodology

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 2

SUBJECT CODE: GENBT058N

ECTS Credits: 5

AIM OF SUBJECT:
Competence aquired by students

a) knowledge

Cell and tissue culture methodology course focuses on the latest available scientific knowledge on: the principle of plant biotechnology; nutrition medium and surface sterilization; types of in vitro cultures; somaclonal variations; haploid and doubled haploid techniques; protoplast isolation and fusion; in vitro mutant isolation; secondary products from cultured cells and organs.

b) attainments

After completing the course, students are able to perform sterile in vitro work. And able to apply the different methods of biotechnology apply in practice.

CONTENT:
Lecture Topics

1. The principle of in vitro cell and tissue culturing: origin, definitions, first attempts, most importan techniques: plant regeneration, micropropagation, somatic embryogenesis, protoplasts techniques, haploid-doubled haploid approach, somaclonal variation 2. Sterilization techniques: Dry heat treatment, Flame sterilization, Steam sterilization, Filter sterilization, Ultra violet sterilization,

3. Nutrition medium :Component of the plant medium, inorganic nutrients, organic supplements, vitamins

4. Nutrition medium: carbon and energy source, gelling agent, ph, general methodology for medium preparation, calculations M, normality, stock solution

5. Plant hormones and growth regulators: definition, categorisation, differentiation-dedifferentiation, synthesis, catabolism, conjugated forms,

transportation, their functions in vivo and in vitro, morphogenetic respones, modes of actions

6. Most important environmental conditions in a tissue culture: Light, Temperature, Humidity, Oxygen

7. Micropropagation: definition, practical value, advantages and disadvantages over traditional plant propagation techniques, laboratory- and industrial-level micropropagation, micropropagation in bioreactors

8. Types of plant tissue cultures: Seed Culture, Bud culture, Meristem culture, organ culture, Embryo culture, Cell culture

9. Embryo rescue technique, artificial seed: definition, practical value, laboratory- and industrial-level artificial seed production, somatic embryogenesis in bioreactors

10. Haploid-doubled haploid techniques: definition, practical value, overviews of cell divison mechanisms, evaluating the morphogenetic potential of different starting explants, known breeding programs involving haploid-doubled haploid technique

11. Cell culture: callus culture, cell suspension, protoplast culture, Plant-protoplast-plant system: definition, practical value, overviews of protoplast isolation techniques, modes of culturing plant regeneration from protoplasts

12. Mutant isolation: in vitro selection systems for an increased tolerance to abiotic and biotic stressors, herbicides and pests, secondary products from cultured cells and organs, Somaclonal variations: definition, practical value, advantages and disadvantages, induction and supression, case studies for proving its agronomic potential

13. Protoplast fusion, protplast transformation,: definition, practical value, assimetric fusions, selection of hybrid protoplasts, cybrids, overviews of corresponding techniques, modes of specific treatments, physiological studies on membrane functions

Practice Topics 1. Preparation of sterile containers and small instruments: e.g. flasks, tubes, pipette tips, glasses, papers etc.

2. Preparation of macro- and micronutrient stock solution, vitamin and growth regulator stock solutions.

3. Preparation of solid MS media

4. Seed culture: Preparation of sterilized seeds culture (tobacco, tomato, wheat, cauliflower, oregano, water melon, chili)

5. Organ culture: Preparation of sterilized buds culture (apple, pear, black locust, lilac, oregano etc)

6. The effect of plant hormons: Preparation of solid MS media with different growth regulators (auxin and cytokinin).

7. Shoot regeneration from leaves (tobacco) on medium containing various hormones

8. Callus culture: Callus induction from Nicotiana tabacum

9. Production of haploids: Preparation of steril haploid tissue culture from anther.

10. Organ culture: Preparation of sterilized flower culture from cauliflower.

11. Micropropagate the seeds, buds, flower cultures. Protoplast isolation

12. Acclimatization the tissue cultures

13. Evaluation of shoot regeneration experiment. Compare the callus induction growth from various explants.

GRADING SYSTEM:

During the semester 2 Test would be written.

The results obtained during the semester and the average of the results achieved in the written exam give the final score.

LITERATURE:

Lecture materials will be uploaded to the e-learning system

Classical, Population and Evolution Genetics

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 1

SUBJECT CODE: GENBT024N

ECTS Credits: 4

AIM OF SUBJECT:
Classical, Population and Evolution Genetics is a subject of the first semester. This subject focuses on the Mendelian classical genetic modes of inheritance and gives examples. The population genetics part reviews the theories which are important in the agricultural genetics: the Hardy - Weinberg principle / equilibrium, heritability, inbreeding, heterozygosity, Fis, Fst, genetic distance, the agents of evolutionary change: mutation, gene flow, nonrandom mating, genetic drift and natural/artificial selection. Evolutionary genetics focuses mainly on molecular phylogenetics and on phylogenetic tree building.

CONTENT:
1. Basics of mendelian genetics

2. Interallelic gene interactions

3. Intrallelic gene interactions

4. Linkage, sex linked inheritance

5. Allele- and genotype frequencies

6. Hardy - Weinberg principle

7.Hardy - Weinberg equilibrium

8. Heritability – h2

9. Inbreeding and heterozyosity

10. F-statistics

11. Mutation, gene flow

12. Drift, nonrandom mating

13. Selection

GRADING SYSTEM:

Prerequisites of getting signiture at the end of the semester and

attendance of the practical classes.

Exam: oral / written. Five topics. Grades are 1-5.

LITERATURE:

Compulsory literature: Handout of ppt-s and lecture notes of their own

Recommended literature: recent reviews actually selected by the teachers of the course

Microbiology and Microbial Biotechnology

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 1

SUBJECT CODE: GENBT033N

ECTS Credits: 4

AIM OF SUBJECT:
During the completion of the subject, the students can expand their previous knowledge of microbiology with practice-oriented microbiological and biotechnological application opportunities. During the semester, in addition to the general knowledge related to individual groups of microbes (viruses, bacteria and fungi), they will learn about the most important groups of bacteria and fungi used in various industrial areas. They will receive information about the agricultural and industrial application of microbes and the basics of fermentation technologies. The student will study about classical and modern methods of genetic modification of microbes, and will be able to expand their knowledge of the molecular biology. During the practises, the student will learn the basics of laboratory techniques with microbes (culture media preparation, sterile work, determination of the amount of microbes, dyeing procedures, biochemical tests, examination of antimicrobial agents).

CONTENT:
Topics of the lectures/week:

1. Introduction, history
2. Viruses
3. Procaryotic cells
4. Eukaryotic cell structure and function
5. Gut microbiota
6. Mass production, fermentation technology
7. TEST I.
8. Antibiotics resistance
9. Mycotoxin, secondary metabolites
10. Genetic dissections of symbiotic interactions
11. Food microbiology
12. TEST II.3.
13. Consultation

Practices:
Timeframe: every second week – Thursday 8:15-11:30
Form: online classroom practice traditional practice (personal attendance is essential)
Distance learning platform:

Practices
Traditional education (with attendance in person)
Laboratory safety, Isolation technics
classroom practices, calculations,
laboratory practice
Micromorphology of bacteria
Detection of endospores
FDA hidrolysis activity test
Determination of Colony Forming Unit
Test
Probiotics
The effect of antibiotics effect on microbes
Biochemical tests for identification
Plant extracts with antimicrobial properties
Test

Student Workload:
Staff/Student Contact Time:
1) Lectures
39 hours

2) Practice
26 hours
Directed Learning Time
Home Works
26 hours
Individual Learning Time:
Individual study
30 hours
Test and Exam Time

4 hours
Total Work Time

125 hours

Detailed description:
Topic

Traditional education
Distance learning
Lectures
attendance is recommended
classroom lectures
ppt-s are available at the lecturers and printed/electronic study material is available

attendance is recommended
in forms mentioned above
online invitation/link is to be sent by Neptun or e-mail to the students
PPt-s are available at e-learning/ SZIE Internal storage /Microsoft teams platform
Practices
attendance is compulsory
in form mentioned above

attendance is compulsory
in form mentioned above
some of the practices are to be organised only after lift of restricted measures.
Assessment during the semester
Homeworks- formula has to be handed in
Practical test
Evaluation: minimum 51% of points

Homeworks- formula evaluation has to be handed in
Practical test – Evaluation of sent reports
Evaluation: Evaluation of sent reports

Exam
written
personal attendance is required
5-10 questions in test
written
e-learning and/or test

GRADING SYSTEM:
Assessment during the semester
Homeworks- formula has to be handed in
Practical test
Evaluation: minimum 51% of points

Homeworks- formula evaluation has to be handed in

Practical test – Evaluation of sent reports
Evaluation: Evaluation of sent reports

Exam
written
personal attendance is required
5-10 questions in test
written
e-learning and/or test

Assessment:
The assessment has two steps.
The two steps are:
·1st getting the sign of the teacher, which means the students fulfilled the obligations of the practice, got the minimum points at written practise tests (51%) and filled the practise reports
·2nd taking a written exam at the end of the semester.

Without the fulfilment of the 1st step the student cannot pass to the 2nd step, which is a written exam

LITERATURE:
Required literature:
ppt presetations of lecture and practice will be handed out via e-mail or Microsoft teams

Molecular Genetics

Study Programme: MSc in Agricultural Biotechnology
SEMESTER: 2026/27/1
Relevant semester of the Study Programme at MATE: 1
SUBJECT CODE: GENBT036N
ECTS Credits: 4
AIM OF SUBJECT:
COURSE REQUIREMENTS

MOLECULAR GENETICS
(3GN18NAK09M and GENBT036N)

MSc in Agricultural Biotechnology
Year 2024/2025, fall semester

Neptun code: GENBT036N
Subject: Molecular genetics
Language: English
Institute / department: Group of Horticultural Plant Genetics, Department of Plant Biotechnology, Institute of Genetics and Biotechnology
Responsible educator: Dr. Júlia Halász
E-mail address: Halasz.Julia@uni-mate.hu
Official hours for questions: Monday morning between 11 and 12 after October 5. Students must register for consultation at least 3 days before by sending an e-mail with the student's Skype address. The Skype call will be initiated by the teacher during the following official hour.
Participating academics: Benyóné Dr. György Zsuzsanna, Dr. Halász Júlia, Dr. Hegedűs Attila
Credit number: 5
Number of hours (lecture + practical module) a week and in the semester: 2 + 3, 28 + 42

CONTENT:
Topics over the semester:

Modules contain lectures and seminar practices, starting at 9:00 a.m.

Module 1: The discovery of DNA structure and birth of molecular genetics – A. Hegedűs

Module 2: DNA structure, replication and the eukaryotic genome – A. Hegedűs

Module 3: Transcription – A. Hegedűs

Module 4: Translation – A. Hegedűs

Module 5: The levels of genetic regulation – A. Hegedűs

Module 6: Mutations – A. Hegedűs

Module 7: Test-paper 1

Module 8: Safety protocols, pipetting – J. Halász, Zs. György

Module 9: CTAB method – J. Halász, Zs. György

Module 10: DNA extraction with commercial kits – J. Halász, Zs. György

Module 11: Nanodrop, PCR – J. Halász, Zs. György

Module 12: Gel electrophoresis – J. Halász, Zs. György

Module 13: Test-paper 2

GRADING SYSTEM:

Final requirements: signature and oral exam

Preliminary requirements to take up the subject: no

Contribution of the subject to the educational program: Agricultural biotechnologists need to have a detailed knowledge of the structural composition of living organisms and the most important biological processes including the storage and expression of genetic information, the molecular basis of genetic variations and molecular genetics background of phenotypic traits. This knowledge is inevitable to understand and apply biotechnological methods and techniques.

Requirements: The course includes lectures and practices. Lectures will provide the theoretical knowledge required to understand and solve practical problems and hence participation in lectures is strongly recommended although it is not obligatory. It is also recommended to continuously follow the topics touched on in lectures week after week. In contrast, participation in practice is obligatory according to university regulations (TVSz III. 45§).

Certification needed to submit when a practical module was missed: If a practical module is missed, students will need to submit a medical certificate for the specific date of the missed module. The official document on a paper base must be left at the department secretary or posted as a registered letter in an envelope addressed to Dr. Júlia Halász. Students must inform the academic in an e-mail that the letter has been posted. After sending the medical certificate, students must consult with the instructor on how to make up the missing information.

Students absent from more than one practical module without a medical certificate or not contacting the instructor will be rejected from receiving a signature for the course.

Test-papers:

Two test papers will be written with the personal presence by students during the semester:

1st paper on topics: modules 1-6.

2nd paper on topics: modules 8-12.

The result is expressed in marks as follows: excellent (5), good (4), satisfactory (3), pass (2) and fail (1). If students do not reach at least the mark 2 (pass) result, the failed test paper (mark 1) could be rewritten on a later announced date in the first week of the exam period. If required, it is also possible to write both test papers on this occasion. However, there is only a single occasion to improve the failed tests!

The eligibility requirements for obtaining a signature: Students need to get a signature indicating the fulfillment of course requirements. The signature will only be provided for students who reached at least the mark 2 (pass) for each of the test papers (the marks are not averaged).

Final evaluation: In the end of the semester, students who have signature can register for the personal or online oral exam. The exam can be carried out with personal presence or using the E-learning BBB virtual classroom or Skype. The course leader will give the information how the exam will be organized. If online platform is used, the video and audio connection are required for the exam and students must ensure the appropriate technical background on their side. Oral exams include questions and prompt answers. All online exams are recorded to be used for clarification in debated cases. After the deadline of legal remedy, exam video files will be deleted.

Evaluation of exams: The result is expressed in marks as follows: excellent (5), good (4), average (3), pass (2) and fail (1). If students receive the mark 1 (fail), the exam is considered failed / unsuccessful.

LITERATURE:

Learning materials:

Presentation slides of lectures – available in E-learning (password: Watson)

Others:

Exams will be organized on several days from December 2024 to January 2025, and students can choose among those exam dates according to their preferen

Molecular Plant Breeding

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 3

SUBJECT CODE: GENBT040N

ECTS Credits: 3

AIM OF SUBJECT:
Competences to be acquired during the teaching of the subject

a) knowledge

The main areas covered by the subject: concept of molecular plant breeding, its correlation with the classical plant breeding; bases of MAS (marker assisted selection): markers, molecular markers (RFLP, RAPD, SSR, ISSR, AFLP, EST, SNP etc.); molecular mapping, mapping populations; linkage analysis, identification of QTL and anonymous loci with molecular markers; allele association, linkage disequilibrium, haplotypes, map-based cloning (positional cloning); gene pyramiding, genotype-building with the aid of molecular markers, molecular back-crosses. The practices will introduce students to the most important PCR-based molecular techniques that can be applied in MAS.

b) attainments

Understanding the scientific questions of plant molecular breeding, capability to comprehend and word appropriate answers to the new problems; reading and writing publications about plant molecular genetics-related papers.

CONTENT:
Lecture topics:

1, The concept, methods of molecular plant breeding; its conditions. The use of molecular markers in plant breeding and the characteristics of ideal molecular markers.

2-5, The essence and methodology of molecular markers (RFLP, MSAP, iPBS, RAPD, SSR, CAPS) used during the practice of the course and their comparison.

6, Overview of the main mapping populations. Linkage analysis; determination of linkage between two markers.

7, Application fields of molecular markers based upon DNA fingerprints.

8, Marker-assisted/aided selection (MAS): application and advantages of molecular markers linked to “agronomically important” loci. Discussion of marker-assisted selection with examples from hypothetical and real breeding.

9, Demonstration of introgression breeding and gene pyramiding using marker-assisted selection (MAS) with real breeding examples.

10, Genetic mapping, mapping with molecular markers. Determination of chromosomal localization of a structural gene with molecular markers based on cosegregation. Linkage disequilibrium, allele-specific variations/allele associations, haplotypes, linkage disequilibrium and their role in positional cloning, case studies.

11-12, QTL (Quantitative Trait Loci) analysis: searching and identifying loci responsible for determining polygenic traits with molecular markers, case studies. Introduction to DArt marker. Natural populations as mapping populations and the basis of GWAS.

13, Guest speakers: presentations by Syngenta vegetable breeders

Practice topics:

1. To describe the essence and methodology of the molecular markers used in the course (RFLP, MSAP/AFLP, iPBS, RAPD, SSR, CAPS) (oral report).

2-5, Basis of MAS: Application of SSR method for markering resistance genes in case of the parents and the segregating population (SSR marker-based genotyping on polyacrylamide gel (PCR), separation of PCR products amplified with microsatellite primers on polyacrylamide gel, allele size determination with DNA fragment analyzer (ALFExpress Maschine), evaluation of the results, linkage analysis.

6-9, Basis of MAS: Application of PCR- RFLP- (CAPS) methods for mapping resistance gene in the parents and the segregating population,

(PCR, product digestion with restriction endonuclease, gel electrophoresis), evaluation of the results, linkage analysis.

10-13, Genotyping with AFLP methods for clones (digestion, ligation of adaptor molecules, PCR, polyacrylamide gel electrophoresis), evaluation of the results, sequencing polymorphic bands, designing SCAR primer pairs (Primer3) based on the sequence, testing SCAR primer pairs (PCR, gel electrophoresis) evaluating the results, analysis of the results on additional clones.

GRADING SYSTEM:

Evaluation:

To obtain a signature for the semester, a report must be given in the first practical class. After the signed course, you may take a written exam. The written exam consists of two sets of questions: exercises and questions. Out of 16 problems, you will have to answer 6 random questions and you can only fail one. For the questions, the answers to the questions will be graded according to the usual grading system: 0-50% unsatisfactory, 51-60% satisfactory, 61-75% average, 76-85% good and 86-100% excellent.

LITERATURE:

.The material for the lectures and practicals.

Transgenesis and Genomic Editing in Plants

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 3

SUBJECT CODE: GENBT061N

ECTS Credits: 4

AIM OF SUBJECT:
The aim of the course is to acquaint students with the most important theoretical and practical knowledge about genetically modified plants, the genetic engineering strategies of cultivated plants, and the use of genome editing as a new precision breeding method. The prospect of the technology and the potential risk factors are also presented.

CONTENT:
Lecture contents:

1. Basic concepts of plant biotechnology. Key discoveries establishing genetic engineering. The relationship between genetic engineering and traditional plant breeding.

2. The process of producing transgenic plants and transgenic plant breeding.

3. Structure of plant expression vectors and functions of individual components. Gene transformation methods. Chloroplast transformation.

4. Genetic engineering strategies for cultivated crops. History of genetic engineering research and the cultivation of GM varieties. Global status of genetically modified plants.

5. Transgenic plant protection I: Production and cultivation of herbicide, virus, bacteria, and fungus-resistant transgenic plants.

6. Transgenic plant protection II: Production and cultivation of insect-resistant transgenic plants. Improving abiotic stress tolerance in plants using genetic engineering methods.

7. Genetic modification of primary metabolism in plants: Theories and results concerning plants with modified carbohydrate, fatty acid, and protein metabolism.

8. Genetic modification of secondary metabolism in plants: Biotechnological possibilities and achievements in modifying flower and fruit color, and ripening.

9. The role of genetic engineering in improving quality of life: Increasing the vitamin, antioxidant, and mineral content of crops using genetic engineering tools.

10. Possibilities for developing transgenic male sterility and its application in hybrid breeding. Genetic Use Restriction Technologies (GURTs) for GM varieties.

11. Transgenic plants as bioreactors.

12. Risk factors in the cultivation and consumption of genetically modified plant varieties.

13. Genome editing as a new opportunity for altering the hereditary traits of plants: theory and practice.

Lab exercises:

1. Preparation of a cloning plan, gene cloning, insertion into an expression vector.

2. Transformation of competent Escherichia coli cells.

3. Identification of recombinant Escherichia coli colonies using colony PCR.

4. Plasmid isolation and transformation of Agrobacterium.

5. Identification of recombinant Agrobacterium colonies using colony PCR. Preparation of glycerol stocks.

6. Agrobacterium-mediated transformation of tobacco leaves.

7. Washing off Agrobacterium, placing leaf explants onto selection and regeneration media.

8. Biolistic (gene gun) transformation of tobacco leaves.

9. DNA isolation from transgenic plants.

10. Detection of the transgene using polymerase chain reaction (PCR).

11. RNA isolation, investigation of transgene expression using RT-PCR.

12. Detection of the transgene using Southern hybridization.

13. Detection of GUS reporter gene expression using histochemical staining.

GRADING SYSTEM:

• Attendance requirements

Attendance at lectures is not compulsory but recommended, as some of the newest information presented is not included in the compulsory and recommended literature.

Attendance at practical sessions is compulsory.

• Submission of mid-semester assignments, deadlines, and their evaluation

Submission of practical session protocols/reports.

• Mid-semester assessments, their evaluation, and resit opportunities

• Conditions for obtaining the semester signature (credit)

Completion and appropriate documentation of the tasks assigned during the practical sessions.

• Nature and evaluation of the assessment

Written exam.

LITERATURE:

Learning materials:

Presentation slides of lectures – available in E-learning

Transgenic Animal Technologies in Animal Husbandry

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 3

SUBJECT CODE: GENBT062N

ECTS Credits: 4

AIM OF SUBJECT:

CONTENT:

GRADING SYSTEM:

LITERATURE:

Microbiology

Study Programme: MSc in Crop Production Engineering

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 1

SUBJECT CODE: GENBT031N

ECTS Credits: 3

AIM OF SUBJECT:
The aim of the course is to expand the student's previous knowledge of microbiology with microbiological and biotechnological tools. During the semester, in addition to the general knowledge related to microbial groups (viruses, bacteria and fungi) that play an important role in crop production, the student will learn about the most important groups of bacteria and fungi occurring to animal nutrition and food safety. The students receive detailed information about the molecular microbiological methods. The student can learn the basics of laboratory techniques with microbes (biochemical tests, investigation of antimicrobial agents, molecular techniques).

CONTENT:
Lectures:

Timeframe: Wednesday 12:00-13:30, (Tudástranszfer Központ 220, Gödöllő (GOD-TK.2-220))

Form: Contact Gödöllő, Hibrid (online) Kaposvár

Topics of the lectures:

Lectures

Teacher

Form of education

1.2024.09.11.

Introduction of microbiology

Classroom classes in Gödöllő.

HIBRID form in Kaposvár

2.2024.09.18.

Viruses of agricultural technologies

3.2024.09.25.

Function of prokaryotic cells in crop production

4.2024.10.02.

Eukaryotic cell structure and function in crop production

5.2024.10.09.

Factors influencing microbial growth

6.2024.10.16.

TEST

7.2024.10.23.

National holiday

8.2024.10.30.

Mycotoxins

9.2024.11.06.

Environmental microbiology, biogas, bioethanol

10.2024.11.13.

Antibiotic resistance

11.2024.11.20.

Fermentation technologies

12.2024.11.27.

GUT microbiota, rumen microbiology

13.2024.12.04.

TEST

Contact form in Gödöllő

Contact form in Kaposvár

Practices (week)

Topic

1.

Preparation, Isolation

3.

Schaeffer-Fulton spore staining

5.

Biochemical tests

7

Plant antimicrobial effects

9.

Food microbiology measurements, mycotoxin

11.

TEST

GRADING SYSTEM:

Detailed description:

Topic

Lectures

attendance is recommended

classroom lectures

ppt-s are available at the Microsoft teams platform

Practices

attendance is compulsory

in form mentioned above

Exam

written

personal attendance is required

5-10 questions in test

Assessment:

The assessment has two steps.

The two steps are:

·1st getting the sign of the teacher, which means the students fulfilled the obligations of the practice, got the minimum points at written practise tests and filled the practise reports

·2nd taking a written exam at the end of the semester.

Without the fulfilment of the 1st step the student cannot pass to the 2nd step, which is a written exam

LITERATURE:

ppt presetations of lecture and practice will be handed out via e-mail or Microsoft teams

Plant Biotechnology

Study Programme: MSc in Crop Production Engineering

SEMESTER: 2026/27/1

Relevant semester of the Study Programme at MATE: 1

SUBJECT CODE: GENBT043N

ECTS Credits: 3

AIM OF SUBJECT:
Competencies to be acquired during the course

a) Knowledge:

After completing the course material, the student will be familiar with the three main areas of plant biotechnology (cell and tissue culture, transgenic plants, and molecular plant breeding), including their techniques and practical applications.

b) Skills:

The student will be able to find solutions to the 21st-century challenges of crop production and plant breeding. After completing the course, the student will be capable of performing sterile laboratory work and carrying out in vitro techniques.

CONTENT:
Lecture topics:

Hour 1

Application of plant biotechnology to the challenges of crop production and plant breeding in the 21st century.

Classification of technologies.

Cell and tissue culture technology: history and current fields of application.

Hour 2

Environmental factors influencing the success of cell and tissue culture: culture media, temperature, light, sterility.

Application of plant hormones in cell and tissue cultures.

Hour 3

Biotechnologies of sexual reproduction: possibilities for the production of haploids and triploids, methods supporting hybridization, production of hybrids

(ovary culture, endosperm culture, in vitro pollination and fertilization, anther and pollen culture, pre-germinal and post-germinal embryo cultures).

Hour 4

Biotechnologies of asexual reproduction: applications and results.

In vitro micropropagation, pathogen elimination, in vitro gene bank.

Applications of somatic embryogenesis, production and use of artificial seeds.

Hour 5

Cell cultures: callus culture, cell suspension culture, protoplast culture.

Hour 6

Somatic hybridization. Protoplast fusion.

Somaclonal variability and in vitro mutant isolation in cell and tissue cultures.

Hour 7

Transgenic and cisgenic plants.

History of transgenic plant cultivation and the steps of transgenic plant production.

Hour 8

First-generation transgenic plants: applied gene constructs and the origin of genes.

Strategies for developing herbicide resistance, their implementation and application.

Hours 6–10

Transgenic plants: GMOs, the process of producing transgenic plants.

First-generation transgenic plants (herbicide, insect, bacterial and fungal resistance).

Second- and third-generation transgenic plants

(modification of protein metabolism, lipid metabolism and carbohydrate metabolism, terminator technology, golden rice).

Major cultivation and biosafety risks of transgenic plants and varieties, experiences with the cultivation of (GM) varieties.

Molecular plant breeding: molecular markers, DNA-based techniques, marker-assisted selection (MAS), DNA fingerprinting.

Practical course topics:

Hours 1–5

Cell and tissue culture: preparation of culture media, introduction to the plant growth room, micropropagation of in vitro plants.

Production of transgenic plants by direct (gene gun/particle bombardment) and indirect (Agrobacterium tumefaciens-mediated) methods.

Molecular techniques: DNA isolation, PCR, gel electrophoresis.

GRADING SYSTEM:

Class attendance requirements

Attendance at practical classes is compulsory.

Submission of assignments during the semester, deadlines and assessment

During the practical classes, students are required to keep a laboratory notebook/logbook, which is continuously checked by the instructor.

Mid-semester assessments, evaluation and opportunities for make-up

LITERATURE:

Compulsory literature: Handout of ppt-s and lecture notes of their own

Recommended literature: recent reviews actually selected by the teachers of the course

Genetics

Study Programme: BSc in Agricultural Engineering

SEMESTER: 2026/27/2

Relevant semester of the Study Programme at MATE: 2

SUBJECT CODE: GENBT019N

ECTS Credits: 3

AIM OF SUBJECT:
On the course, students will learn about the biochemical and biological functions of the DNA and the RNA, the heredity, the genetic basic of the reproduction, cell division (meiosis and mitosis), genetic stability and variability. Learn about the process of DNA replication, Proof-Reading and Repair. Acquiring knowledge the structure of eukaryotic chromosomes, and the packaging. Students will acquire the basic laws of classical genetics. Interpret the molecular genetic background of the dominance in case of the round and wrinkled peas phenotype inheritance. Students learn the basics of the population genetics and interpretation of the Mendelian rules of population genetics. Acquiring knowledge of molecular genetics from the scope: components genome in eukaryotic cells, the concept of the gene structure of eukaryotic genes, promoters types, transcription, translation,gebne expression and regulation. Learn the basics of in vitro recombination, PCR (polymerase chain reaction) and the use of molecular markers. They get an insight into the basic of the developmental genetics, behavior genetics, evolutionary genetic.

CONTENT:
1-2 The definition and subject of genetics. The definition of living. Programme of life and death. Reverse and reverse genetics, phenotype, genotype DNA (RNA) is the hereditary material. Biochemical characterization, structure, biological functions of DNA, RNA. What information does DNA carry? The genetic code

3-4 Inheritance, reproduction, reproductive systems, genetic role of cell division, stability and variability.

5-6 Basic laws of genetics: Mendelian genetics. Molecular interpretation of dominance and recessivity based on the phenotype of peas with rounded and wrinkled phenotypes. Deviations from Mendelian cleavage rates I (gene interactions)

7-8 Deviations from mendelian cleavage rates II. linkage, recombination analysis. Extrachromosomal inheritance, genetic cooperation of nucleus and organelles.

9-10 Basics of population genetics. Genetic balance of populations, changes in the genetic structure of populations.

11-12 Basics of quantitative genetics Investigation of the genetic background of a quantitative trait,

13-14 Basics of evolutionary genetics. the process of speciation, coevolution

15-16 DNA replication. Recombination. Mutation: gene, chromosome and genome mutation. Eupoloidia, aneuploidy, polyploidy

17-18 The eukaryotic genetic system. The concept of gene, structure of eukaryotic genes.

19-20 Transcription, translation, basics of eukaryotic gene regulation.

21-22 Genomics, genome analysis, gene mapping

23-24 Basics of in vitro recombination, gene isolation, gene identification, PCR (polymerase chain reaction), molecular markers

25-26 Genetic engineering, transgenic animals, transgenic plants

GRADING SYSTEM:

the obligations to attend classes

Attendance at the exercises is compulsory

submission of mid-semester assignments, deadlines and assessment

Practical exercises are given to students to help them prepare for Test

mid-term examinations and their assessment, possibility of making up

In order to achieve continuous learning, 2 lectures and 2 practical Examination TEST will be written during the semester. Each TEST will be marked (lecture 2X35 points, practical 2X15 points). Each test will be marked at least three times, with an additional opportunity to mark each paper in the first week of the exam period.

Conditions for signing the mid-term examination

A minimum of 10 points must be achieved in each of the lecture and practical Test

nature of the examination and assessment

The examination will be a written examination. During the semester, it is possible to obtain a mark of 3, 4 and 5 for the Tests. 61-75 marks are staisfactory, 76-85

marks are good and 86 marks and above are very good. Those who have obtained the signature but have not reached 61 points may take the exam by writing a pre Test. During the examination, they will be given 10 genetic definition (from the Terminology chapter of the compulsory textbook), of which if they answer 6 correctly, they will be allowed to sit the exam.

LITERATURE:

ppt slides of the presentations handed out to students

Principles of Microbiology

Study Programme: BSc in Environmental Engineering

SEMESTER: 2026/27/2

Relevant semester of the Study Programme at MATE: 2

SUBJECT CODE: GENBT034N

ECTS Credits: 3

AIM OF SUBJECT:
The aim of the course is to describe the microorganisms that play a role in agricultural production, as well as in the related environmental, feeding, animal husbandry and crop production processes.

CONTENT:
Form of course material for individual learning:

Week

Thematics

Oktató

1.

2023.02.12.

Introduction, history, Sterilisation methods

2.

2023.02.19.

Viruses

3.

2023.02.26.

Procariotyc cell structure and function

4.

2023.03.04.

Eukariotic cell structure and function

5.

2023.03.11.

Microbial Growth

6.

2023.03.18.

TEST I

7.

2023.03.25.

Soil microbiology

8.

2023.04.08.

Water microbiology

9.

2023.04.15.

Environmental microbiology

10.

2023.04.22.

Biological nitrogen fixation and its agricultural aspects

11.

2023.04.29.

Food microbiology

12.

2023.05.06.

TEST II.

13.

2023.05.13.

Consultation

Practices:

Form: traditional practice (personal attendance is essential)

Thematics

Traditional education (with attendance in person)

Isolation of microorganisms

Laboratory practise

Bacterial morphology and Gram-staining method

Laboratory practise

Bacterial and fungal abundance in soil samples: Colony Forming Unit -CFU

Laboratory practise

Effect of antibiotics on microorganisms

Laboratory practise

Mycorrhizal fungi isolation

Laboratory practise

TEST

Detailed description:

Topic

Traditional education

Lectures

attendance is recommended

classroom lectures

ppt-s are available at the lecturers and printed/electronic study material is available

Practices

attendance is obligatory

Assessment during the semester

Homeworks- sylabuses have to be handed in

Practical test – 1 during the semester

Evaluation: A minimum points have to acquired from the total of the points available during the semester, and both tests have to be passing grade

Exam

written

personal attendance is required

5-10 questions in test

GRADING SYSTEM:
Assessment during the semester

Homeworks- sylabuses have to be handed in

Practical test – 1 during the semester

Evaluation: A minimum points have to acquired from the total of the points available during the semester, and both tests have to be passing grade

Exam

written

personal attendance is required

5-10 questions in test

Assessment:

The assessment has two steps.

The two steps are:

·1st getting the signature of the teacher, which means the students fulfilled the obligations of the practice, got the minimum points at written practise tests and filled the practise reports

·2nd taking a written exam at the end of the semester.

Without the fulfilment of the 1st step the student cannot pass to the 2nd step, which is a written exam

LITERATURE:

ppt presetations of lecture and practice will be handed out via e-mail or Microsoft teams

Experimental Embryology

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/2

Relevant semester of the Study Programme at MATE: 4

SUBJECT CODE: GENBT023N

ECTS Credits: 4

AIM OF SUBJECT:
During the MSc course, after a brief historical overview of embryological research, we will introduce the basic embryological concepts by comparing the development of mouse, rabbit and chicken embryos. We will present the significance of chimeras in developmental biology research through practical applications, and we will discuss the importance of creating germline-based gene banks. Our goal is for students to learn the basic embryological concepts, the preimplantation development of mouse, rabbit, bird and farm animal embryos, and to provide an overview of the application possibilities of stem cell lines derived from mouse, rabbit and bird farm animal embryos. We also consider it important to explore the ethical issues related to embryological research.

CONTENT:
The subject's subject is based primarily on personal presence.

1.2 The subject's knowledge content

1. Presentation of animal biotechnology research in the GBI ÁBT AES group.

2. Overview of basic embryological concepts.

3. Oocyte maturation, fertilization and preimplantation embryo development.

4. Parthenogenetic, gynogenetic, androgenetic embryos.

5. Genome imprinting, tetraploid embryos.

6. Application of chimeras in the animal world.

7. Examination of sex determination in chimeric mice.

8. Application possibilities of human-animal chimeras.

9. Types of embryonic stem cells.

10. Mouse embryonic stem cell lines (mES cells).

11. Brief overview of transgenic mouse production methods.

12. ES cell lines derived from embryos of farm animals.

13. Ethical issues related to embryological research.

Our goal is for students to be able to express themselves in the field of agricultural biotechnology in English, both in writing and orally. They should also be able to read, interpret, present, write publications, and participate in discussions. They should also be able to analyze different areas of the given field in detail and explore comprehensive and special relationships. Finally, they should be able to independently apply the techniques learned during the exercises (embryo manipulation techniques, basic knowledge of stem cell culture, DNA, RNA isolation methods, qPCR technique) in their later research.

GRADING SYSTEM:

Credit value of the course: 4, 26 hours/lecture, 26 hours/practice

Personal requirements for teaching the subject:

Subject responsible/lecturer:

Dr. Elen Gócza, scientific advisor, DSc., corresponding member of the Hungarian Academy of Sciences (70%)

Participating colleagues in the lecture:

Dr. Bence Lázár scientific associate (20%)

Arnold Tóth scientific assistant (10%)

Subject practice supervisor:

Dr. Elen Gócza, scientific advisor, DSc., corresponding member of the Hungarian Academy of Sciences (40%)

Assisting colleagues in the practice:

Dr. Bence Lázár scientific associate (25%)

Arnold Tóth scientific assistant (25%)

Jehan Nayga, PhD student (10%)

Quality assurance of the subject teaching

Method of monitoring the quality of the teaching (underline the appropriate one):

• Regular evaluation by the lecturer of the subject being taught

• Student feedback on the teaching work

• Survey among graduate students

• Career monitoring studies

Subject requirements:

class attendance obligations:

·attendance at lectures is recommended

·participation in the practical is mandatory

·for each subtopic (8 subtopics) an essay must be prepared, which the subject teacher evaluates by giving a satisfactory or unsatisfactory grade to the essays,

·personal or online consultation helps to understand the material

·each student must give a lecture on a chosen topic related to the curriculum

semester signature conditions:

each submitted essay must receive a satisfactory grade

holding the lecture

Evaluation of the Assessment

The subject ends with an oral colloquium, only those who have received the semester signature can take the colloquium

6.4 The grade for the colloquium will be established in a 30-point system as follows:

·5 concepts from the published embryological glossary (5x2 points)

·In connection with the submitted essays, candidates will receive one quick question from each topic (8x1 point)

·oral exam, selecting one from the four main topics (12 points)

Evaluation:

30 - 26 points excellent (5)

25 - 21 points good (4)

20 - 16 points average (3)

15 - 11 points sufficient (2)

10 - 0 points insufficient (1)

In the case of a supplementary exam, the assessment is done orally, with one item selected from the four main topics.

LITERATURE:

Gócza Elen, Bősze Zsuzsanna (2009): Derivation and Characterization of Rabbit Embryonic Stem Cells in “Houdebine L.-M. and J. Fan (eds.), Rabbit Biotechnology: Rabbit Genomics, Transgenesis, Cloning and Models”, © Springer Science + Business Media B.V. pp

Introduction to Plant and Animal Biotechnology

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/2

Relevant semester of the Study Programme at MATE: 2

SUBJECT CODE: GENBT009N

ECTS Credits: 5

AIM OF SUBJECT:
Students will become familiar with the fundamentals of plant and animal biotechnology and gain a comprehensive overview of the latest molecular genetic and genetic engineering methods, results, and their applications in agriculture. They will acquire knowledge about biotechnological modifications of plant and animal reproduction, as well as the most recent biotechnological techniques used in plant breeding and animal husbandry.

CONTENT:
Plant biotechnology part

Application of plant biotechnology to the challenges of plant breeding in the 21st century. Categorisation of technologies, Cell and tissue culture technologies: Biotechnologies for sexual reproduction: applications, results, Biotechnologies for asexual reproduction: applications, results.,

In vitro micropropagation, virus free technology, in vitro gene bank, Zygotic and somatic embryogenesis, Cell culture: callus culture, cell suspension, protoplast culture, applications, results.

Somatic hybridization. Protoplast fusion, Somaclonal variability and in vitro mutant isolation

Transgenic plants: GMO, steps of transgenic plant production,

First generation transgenic plants (herbicide, insect, bacterial, fungal resistance), Second and third generation transgenic plants, (modification of protein metabolism, fatty acid metabolism, carbohydrate metabolism, terminator technology, golden rice)

Major crop safety risks of transgenic plants and varieties, experiences with the cultivation of (GM) varieties

Molecular plant breeding: molecular markers, DNA-based techniques, MAS, DNA fingerprinting

Animal biotechnology part:

Embryology basics Pre-embryonic development of mouse embryos, the process of embryo implantation and gastrulation. Mammalian stem cells, genome imprinting.

The changing concept of chimera, a historical overview. Mouse chimeras, concept of tetraploid complementation, interspecific chimeras.

Stem cell types, embryonic stem cells, naive and primed embryonic stem cells.

Comparison of mouse and rabbit embryonic stem cells. Targeted gene edition in mouse stem cells. Ethical issues in experimental embryology.

Production of transgenic and genome-edited animals, with a focus on mammals, particularly livestock. Historical overview, clarification of definitions, required materials, tools, and methods.

Overview of methods (microinjection, ES cell-based targeting, lentivirus-based transgenesis, "cloning," genome editing), with emphasis on DNA microinjection, gene constructs, and genome editing (CRISPR/Cas9 KO, base editing, prime editing). Description of gene knockout rabbit as a model organism, application of genome editing in practice through the explanation of a research project.

The aim of gene mapping in domestic animals. Genetic markers, Linkage mapping, Detection of recombination: Single sperm typing, Intercross, Backcross, Meiosis - Recombination, Linkage - Sytheny - Independent assortment. Genetic distance - Rekombination % - map distance cM

Example:Mapping the genetic background of a hypermuscular phenotype - the Compact mouse mutant – myostatin, SNP markers - Genomic selection

Application of genetic and genomic methods to the challenges of aquaculture and fish breeding in the 21st century (The evolution of fish genomes, genome duplications, genome manipulation methods, sex determination, sex manipulation, molecular genetic markers). Methods and experiences applied in the production of transgenic and genome-edited fish.

Practical part

Cell and tissue culture: preparing culture medium, micropropagation of in vitro plants

Transgenic plant production by direct (particle bombardment) and indirect (Agrobacterium tumefaciens-mediated) methods

Molecular techniques: DNA isolation, PCR, gel electrophoresis

GRADING SYSTEM:

During the semester 2 Test would be written.

The results obtained during the semester and the average of the results achieved in the written exam give the final score.

LITERATURE:

Gyulai G (Ed.) (2017) Plant Genetics, Biotechnology, and Forestry. 3rd Edition. University Textbook. St István University Press, Gödöllő, Hungary. ISBN: 978-963-269-580-8.

ppt slides of the presentations handed out to students

Molecular Biology and Gene Technology Methodology

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/2

Relevant semester of the Study Programme at MATE: 2

SUBJECT CODE: GENBT001N

ECTS Credits: 4

AIM OF SUBJECT:
The course provides theoretical and practical foundations of the most important methods in molecular biology and genetic engineering. During the semester, students are introduced to:

• Gene cloning, gene isolation, and genetic engineering techniques

• Construction and application of gene libraries

• Assembly of transformation vectors

• Major transformation methods (Agrobacterium-mediated transformation, gene gun)

• Selection of transformed cells

• Methods for verifying transgene integration, expression, and inheritance

• Key PCR-based and hybridization techniques

The course also offers opportunities for hands-on demonstration and practical application of most methods.

CONTENT:
Lecture Topics

• Types of reporter genes and their genetic and biotechnological applications

• Definition and history of genetic engineering; objectives of GMO production

• Steps of GMO production:

o Methods of gene isolation

o Cloning of genes (DNA fragments) into vectors

o Structure of expression vectors and expression cassettes

• Construction of genomic and cDNA libraries

• Transformation techniques:

o Direct and indirect methods

o Verification of transgene integration, expression, and inheritance

• Plant transformation: Agrobacterium tumefaciens (A. rhizogenes) as a natural gene transfer system

• Genetic modification by genome editing (application of the CRISPR–Cas system)

• PCR techniques in molecular genetics and genetic engineering:

o Principles of primer design and primer design software

o Identification of recombinant plasmid-carrying bacteria (colony PCR)

o Genotyping methods (RAPD, SSR)

o Touch-down, nested, and multiplex PCR

• PCR applications for gene isolation:

o RT-PCR, RACE-PCR, inverse PCR, TAIL-PCR

• Methods of directional cloning: TA cloning, etc.

• PCR applications in gene expression analysis:

o Semi-quantitative PCR

o Real-time PCR

GRADING SYSTEM:

• Written examination

• Graded on a 1–5 scale

LITERATURE:

• Sambrook J., RussellD.W. 2001. Molecular cloning. Cold Sprin Harbor Laboratory Press, New York.

Molecular Markers in Plant Breeding

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/2

Relevant semester of the Study Programme at MATE: 2

SUBJECT CODE: GENBT037N

ECTS Credits: 3

AIM OF SUBJECT:
The aim of the course is to provide an opportunity to the students to get know the up-to-date molecular marker technologies. The 'traditional' techniques like RAPD, AFLP, SSR, ISSR, CAPS, SCAR, ILP, SSCP, IRAP, REMAP, RBIP are also discussed and the advantages and disadvantages are listed. Marker development procedures are expounded. The students learn the principles of the Sanger sequencing and also the next generation sequencing techniques and also the available marker systems based on NGS are presented. The course gives an insight to the genetic mapping with the aid of molecular markers. Marker assisted breeding and some examples are shown and also the use of molecular markers in population genetic studies is covered.

CONTENT:
Topics over the semester:

week

Topic

Teacher

1

Introduction, morphological markers,

György Zs.

2.

Basic molecular techniques, primer design

György Zs.

3.

Random molecular markers

György Zs.

4.

Sequence-specific markers 1

György Zs.

5.

Sequence-specific markers 2

György Zs

6.

Special sequence specific markers, barcodes

György Zs.

7.

Single nucleotide polymorphism and detection

György Zs.

8.

Single nucleotide polymorphism and detection

György Zs.

9.

Linkage mapping

Halász J.

10.

History of molecular markers and marker development

György Zs.

11.

Use of molecular markers in plant breeding

György Zs

12.

Marker assisted selection

György Zs

13.

Essay presentation

Practices:.

Schedule: Fridays, according to Neptun

Form: contact hours (or in case of online teaching home works to be submitted)

Practice

Topic

practical form

1.

Use of restriction endonucleases

lab practice

György Zs.

2.

PCR for RAPD/ISSR/SSR markers

lab practice

György Zs., Halász J.

3.

Electrophoresis of the samples

lab practice

György Zs., Halász J.

4.

Evaluation of RAPD/ISSR molecular markers

classroom activity

György Zs.

5.

Evaluation of SSR molecular markers

classroom activity

György Zs.

6-7.

Sequence analysis, evaluation of SNPs

classroom activity

György Zs.

8-9.

Use of Databases, statistical softwares

classroom activity

György Zs.

GRADING SYSTEM:
Participation on the practicals is compulsory (80%).

The exam can only be taken, if the practical home works are done and accepted. A signature must be obtained indicating the fulfilment of course requirements.

In the end of the semester, students who have signature can register for the oral exam. Exams will be organized on several days in the exam period, and students can choose among those exam dates according to their preferences. Each studnet will get 5 questions at the exam. The result of the oral exam is expressed in marks as follows: excellent (5), good (4), satisfactory (3), pass (2) and fail (1). If students do not reach at least the mark 2 (pass) result, the failed exam must be taken again. In case oral exam will not be possible an online test will be the exam.

LITERATURE:

György Zsuzsanna: Molecular marker technologies in Molecular Plant Breeding available on the e-learning interface of the course

Plant Reproduction and Reproduction Biotechnology

Study Programme: MSc in Agricultural Biotechnology

SEMESTER: 2026/27/2

Relevant semester of the Study Programme at MATE: 2

SUBJECT CODE: GENBT048N

ECTS Credits: 3

AIM OF SUBJECT:
The course reviews plant reproductive strategies and different life cycles. After a detailed presentation of microsporogenesis and macrosporogenesis, we review the double fertilization of angiosperms. Physiological and genetic background of the flower development is discussed. A comprehensive evaluation of the horticultural and agricultural importance of incompatibility systems is shown. Biotechnological methods related to reproductive biology are presented in practice.

The course is held in 3 locations in block form by 3 teachers: Martonvásár, Budapest and Gödöllő. Timetable is available in Neptun system.

CONTENT:
1) History of plant reproductive biology. Discovery and evolution of plant sex processes. Various reproductive strategies, sexual and asexual reproduction.

2) Evolution of sexual plant reproduction. Comparing diploid/haploid life cycles. Reproduction of lower plant species.

3) Sexual reproduction of flowering plants; mechanism of pollination.

4) Macrosporogenesis of flowering plants, development of embryo sac, structure of female gametophyte.

5) Microsporogenesis of flowering plants, development of anthers, structure of male gametophyte.

6) Dimorphism of sperms, double fertilization; pollen tube growth through the style; hybridization between species and genus.

7) Development of zygote, apomixis; structure of the seed; germination.

8) Physiological and genetical background of flower development.

9) Phenology of flower; differentiation of buds, morphology of flowers; terminology of flower types.

10) Incompatibility: hetero- and homomorphic, gametophytic and sporophytic.

11) In vitro gynogenesis.

12) Methods of embryo rescue.

13) Isolation and micromanipulation of generative cells.

GRADING SYSTEM:

The course includes lectures and practices. Lectures will provide the theoretical knowledge required to understand and solve practical problems and hence the participation in lectures is strongly recommended although it is not obligatory. It is also recommended to continuously follow the topics touched in lectures week after week. In contrast, the participation in practice is obligatory according to the university regulations (TVSz III. 29.§).

In case of emergency, lectures and exams will be delivered in the E-learning system BBB or MS Teams virtual classroom or other online platforms, if needed. Practical modules are organized with personal presence.

The eligibility requirements for obtaining a signature:

Students need to get a signature indicating the fulfilment of course requirements. The signature will only be provided for students who participate in practices.

Final evaluation:

In the end of the semester, students who have signature can register for the personal or online written exam. The exam can be carried out with personal presence or using the E-learning BBB virtual classroom The course leader will give the information how the exam will be organized.

Evaluation of exams:

The result is expressed in marks as follows: excellent (5), good (4), average (3), pass (2) and fail (1). If students receive the mark 1 (fail), the exam is considered failed / unsuccessful.

LITERATURE:

Learning materials: Presentation slides of lectures – available in E-learning.

Detailed Plant Breeding

Study Programme: MSc in Crop Production

SEMESTER: 2026/27/2

Relevant semester of the Study Programme at MATE: 2

SUBJECT CODE: GENBT054N

ECTS Credits: 3

AIM OF SUBJECT:
There is a multifaceted interaction between the science of plant breeding and crop production; therefore, close cooperation between plant breeders and crop producers is essential for successful work. The different responses of varieties to prevailing weather conditions and agrotechnical practices, as well as their adaptation to various environmental conditions, are determined by the genotype of the variety. For each new variety, the most suitable sowing date, sowing density, plant spacing, fertilization method and timing, and overall adaptability must be determined through multi-year trials. The task of the crop producer is to provide the breeder with specific considerations and to define breeding objectives.

The course addresses the breeding of the most important cereals, industrial crops, legumes, fruit crops, vegetable crops, and certain forest tree species. For each plant species, its cultivation, botanical, genetic, and breeding characteristics are discussed. Special emphasis is placed on breeding objectives and on both traditional and modern methods for achieving them. Variety types and variety availability are also examined on a species-by-species basis. The course presents the possibilities and directions of molecular research, as well as the results of transgenic breeding (GMO). In the context of plant breeding and seed production, practical sessions include virtual visits to gene banks of the given plant species using the Internet, and students become familiar with the most commonly applied field and laboratory methods and instruments used in plant breeding.

Upon successful completion of the course, students gain insight into the workflows of plant breeding. They acquire fundamental plant breeding techniques, procedures and administrative steps required for variety evaluation and variety protection, as well as methods used to preserve plant genetic variability. In addition to domestication, plant gene centers, and the basic materials of plant breeding, students become familiar—within the framework of plant breeding—with selection breeding, combination (hybridization) breeding, heterosis breeding, mutation breeding, molecular breeding, and resistance breeding methods. They receive detailed information on the current status and future prospects of plant

breeding and biotechnology, and gain up-to-date knowledge of the methods applied to major crop species and the results achieved.

CONTENT:

LECTURE TITLES AND TOPICS

Objectives, tasks, and new directions of plant breeding; national and international status.

Related sciences of plant breeding.

Workflows of plant breeding.

The relationship between crop production and plant breeding.

Origin and domestication of cultivated plant species.

Basic materials of plant breeding.

Gene banks: their roles and activities.

Traditional and new methods of genetic conservation.

Importance of genetic variability and methods to increase it.

Use of mutations and polyploidy to enhance genetic variability.

Methods of plant breeding.

Selection breeding: methods and techniques.

Methods for selection of self-pollinating plants (e.g., wheat, barley).

Methods for selection of cross-pollinating plants (e.g., maize, pepper, alfalfa, triticale).

Heterosis breeding.

Types of heterosis.

Steps of heterosis breeding.

Types of hybrid varieties.

Synthetic varieties.

Male sterility in hybrid production (concepts, types).

Production of hybrids using traditional and molecular methods.

Haploidy.

Production of haploids using traditional and modern methods.

Haploids and doubled haploids.

Applications in breeding different plant species.

Breeding of vegetatively propagated plants.

Potato breeding: objectives, methods, and results.

The relationship between plant breeding and seed production.

Variety recognition and approval processes.

PRACTICAL COURSE TOPICS

Methods of storage in gene banks.

Methods and conditions of mutation treatments.

Production and selection of mutants.

Methods for hybrid production.

Testing disease resistance through artificial infection.

Virtual visits to research institutes.

GRADING SYSTEM:

During the semester, students are required to submit two assignments—summaries on two specified topics—by the given deadlines. These will be evaluated by the course instructor.

Requirements for completing the course:

Submission of the assignment sheets

Submission of summaries on the two topics

If a student fails to complete the assignments, the course coordinator will withhold the semester signature, preventing course completion.

The course concludes with a written/oral colloquium, which can only be taken by students who have received the semester signature.

The grade for the colloquium is determined on a 100-point scale

LITERATURE:

leper, D.A., Poehlman, J.M. 2006: Breeding Field Crops, Fifth Edition, Blackwell Publishing.

George Acquaah 2006. Principles of Plant Genetics and Breeding

ISBN: 978-1-4051-3646-4, 584 pages, , Wiley-Blackwell

http://eu.wiley.com/WileyCDA/WileyTitle

Study Programme:

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SUBJECT CODE:

ECTS Credits:

AIM OF SUBJECT:

CONTENT:

GRADING SYSTEM:

LITERATURE:

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