**UNIVERSITA' DEGLI STUDI DI PERUGIA**
**TEACHING REGULATIONS 2024/2025 FOR THE INTERNATIONAL MASTER'S DEGREE COURSE** in
# AGRICULTURAL AND ENVIRONMENTAL BIOTECHNOLOGY
(Class LM-7, Agricultural Biotechnology)

## Art. 1 - Objectives

1. This Didactic Regulation (DR) define the didactic contents and organizational aspects of the Master's Degree Course (CdLM) in AGRICULTURAL AND ENVIRONMENTAL BIOTECHNOLOGY (AEB), pursuant to the provisions of art. 12 of the Ministerial Decree n. 270/2004 and subsequent amendments, and by the current Didactic Regulation of the University of Perugia (DR_UNIPG).
2. The CdLM in AEB was activated on 01/01/2009 in Italian as "Biotecnologie Agrarie e Ambientali"; from 01/04/2020 it is offered in English under the name of Agricultural and Environmental Biotechnology. The CdLM in AEB is offered at the Department of Agricultural, Food and Environmental Sciences (DS3A), it issues the academic title of Master of Science Degree and, from 2023-24, also a double degree with the MATE University (Magyar Agrár- és Élettudományi Egyetem) of Godollo, Hungary.
3. Pursuant to current legislation and the provisions of the University of Perugia Statute and the University Didactic Regulation, the functions envisaged in the present teaching regulation are carried out by the Master's Degree Course Council (CCdLM).
4. The CCdLM has the functions provided for by art. 45 of the University of Perugia Statute.

## Art. 2 - Contents of the Didactic Regulations of the CdLM

1. The DR determines:
   a) all training activities, including the list of study units, with the indication of the scientific- disciplinary sectors of reference;
   b) the specific educational objectives, the University Educational Credits (CFU) and any preparatory aspects of each course and any other educational activity;
   c) the typologies of didactic activities, including those at distance, the evaluation of the achievement and other verifications of students' achievement;
   d) the criteria for planning and managing didactic activities;
   e) the provisions on any attendance obligations;
   f) the criteria for the distribution of material and financial resources among the individual study units;
   g) the modalities for the evaluation of the didactic activity;
   h) the modalities of the final exam and graduation of the CdLM;
   i) the criteria for the recognition of the credits acquired in other study programs, both at the University of Perugia and at other Universities;
   l) the types and methods of tutoring.
2. The DR, according to the provisions of art. 11, paragraph 2, of Law 341/1990, and by art. 12, paragraph 1 of the Ministerial Decree no. 270/2004 is resolved and approved with the procedures envisaged by the University of Perugia DR.

## Art. 3 - Structure and organization of the course

1. The CdLM has a sustainable enrolment of 60 students.
2. The CdLM is organized and managed according to the following articles on the basis of the following acts:
   a) Didactic organization (annex A) which defines the structure and organization of the CdLM.
   b) Framework of teaching and training activities (Annex B) which defines the specific objectives, the prerequisites, the types of tests for the assessment of student progress and the credits.
   c) List of the teaching activities (Annex C) which determines the organizational methods of the AEB study program, with particular regard to the distribution of study units over the two-year period.
   d) Criteria and procedures to be followed by the students in carrying out their training activities (Annex D) for a correct functioning of the CdLM and a profitable level of their learning.
3. Annexes A-D are an integral part of this Regulation.

**Art. 4 - Attainment of the qualification**

1. To achieve the Master's Degree the student must acquire 120 ECTS credits.
2. Considering that 60 credits correspond to one year, the duration of the degree course is two years.
3. According to the Agreement signed with the MATE University (Magyar Agrár-és Élettudományi Egyetem) of Godollo, Hungary, the Master's Degree in AEB is a double degree course. Regularly enrolled students applying to join the program could also obtain the Hungarian Master of Science title in "Agricultural Biotechnology". To acquire the double title, the student must have obtained 40 of the 120 credits envisaged by the study plan at MATE. The details are given in the Agreement and in Annex D, par. 6.8.

**Art. 5 - Enrolment in the Master's Degree Course**

1. Enrollment in the CdLM is subject to the possession of a three-year degree or a three-year university diploma, or other qualification, also obtained abroad and recognized as suitable. Furthermore, enrolment can be completed only after a positive verification of the curricular requirements and an adequate personal preparation of the applicant, as defined in the following paragraphs.
2. The possession of the curricular requirements of those who request to enrol in the CdLM are considered as ascertained in the event that the applicant:
   - has the Bachelor's Degree in Biotechnology, both that relating to the order of class 1 of the Ministerial Decree 04/08/2000, and that relating to the classification of class L-02, of the Ministerial Decree 16/03/2007
   - has the Bachelor's Degree in Agricultural and Environmental Sciences, curriculum in Biotechnology, obtained at the University of Perugia.

   In all other cases and in relation to the curricular requirements, for enrolment it is necessary that the applicant possesses at least 80 ECTS credits in basic and characterizing scientific-disciplinary sectors, as specified in Annex D, point 6.
   For admission, a knowledge of the English language equal to level B2 of the Common European Framework of Reference is also required.
   The verification of the possession of the curricular requirements is carried out by a specific Commission appointed by the CCdLM with the purpose of verifying the competencies and motivations of the candidate.
3. The personal preparation of the applicant is given as proven for a final Bachelor score equal to or greater than 90% (99/110 in the Italian graduation marks). In the event that the applicant has not demonstrated an adequate personal preparation, before completing the enrolment, he/she must complete it according to the procedures set out in Annex D, point 7.
4. Initial and the second year enrolment are carried out in compliance with the provisions of the DR_UNIPG.

**Art. 6 - Access by transfer from other CdLMs**

1. Enrolment in the CdLM can be requested by students coming from other CdLs of the University of Perugia or other universities.
2. The total or partial recognition of the credits acquired by the applicant is assessed by the CCdLM, also making use of a specific Commission.
3. Based on the application and documents produced by the student, the CCdLM evaluates the transcript of records and verifies the consistency between the didactic activities for which the student requests the recognition of the relative credits and the didactic activities foreseen by the CdLM in AEB. To this end, the CCdLM can make use of the opinions of the Professors of the CdLM directly involved in the recognition of credits. The CCdLM, if it deems it necessary, makes use of specific interviews to verify the knowledge actually possessed by the applicant.
4. In the event that the transfer of the student is carried out between master's degree courses belonging to the same class, the share of credits relating to a scientific-disciplinary sector recognized to the student cannot be less than 50% of those in the same sector already accrued. In such cases, the criteria adopted in the recognition must be specified.
5. The CCdLM provides for the total or partial recognition of the credits acquired by the applicant, giving reasons for those not-recognized. However, unrecognized credits are shown in the complementary certificate to the degree diploma (art. 26 DR_UNIPG).

**Art. 7 - Structure of the CdLM**

1. The Degree Course in AEB is delivered in English. Based on the DD n. 2711, implementing the DM 1154/2021, and in particular Tab. A of Annex 1 type C (study courses delivered entirely in a foreign language), all the reference teachers of

the International MSc course in AEB have the C1 level of English.

2. Upon request, the student can follow some courses in Italian present in the didactic offer of the DSA3. It includes the following types of training activities:
   a) characterizing training activities equal to a total of 78 ECTS, organized according to annexes A, B and C;
   b) training activities similar or supplementary to the basic and characterizing ones equal to a total of 12 credits, organized according to annexes A, B and C;
   c) electives for 8 ECTS, organized according to annexes A, B, C and D;
   d) activities for the thesis preparation and discussion for 16 ECTS organized according to annexes A, B, C and D;
   e) practicals, internship activity for 6 ECTS, as reported in annexes A, B, C and D.

**Art. 8 - Attendance obligations**

1. The CdLM does not normally provide for an obligation to attend.
2. The credits relative to the practical-internship activities are accrued following the frequency of the relative activities.

**Art. 9 - Joint Professor-student Commission (CPD)**

The CPD carries out the tasks envisaged by art. 43 of the Statute of the DR_UNIPG and art. 11 of the DSA3 Regulation.

**Art. 10 - Programming of training activities**

1. Within the date set by current legislation and as established by the DR_UNIPG, the CCdLM proposes for approval to the Department Council (CdD):
   a. the annual plan of all training activities and the responsible lecturers,
   b. the program for each training activity, drawn up by the lecturer in charge,
   c. any attendance obligations for specific training activities,
   d. the training activities other than study units planned by the CdD,
   e. the periods of delivering the lessons, of the exam sessions and of the graduation exams,
   f. teaching support activities to be submitted to the CdD.

**Art. 11 - Forms of teaching**

1. The teaching activities are carried out by the lecturers in the form of theoretical and/or practical lectures (official teaching) in the classroom or in the laboratory.
2. Lectures are measured in hours carried out by the lecturer, hours that are used for the obtainment of credits for each activity. As required by art. 5 of Ministerial Decree 270/2004, 1 credit corresponds to 25 hours of overall activity (assisted and individual) carried out by the student. The following table indicates the number of hours of commitment, for different training activities and for 1 credit:

| ***Type of didactic activity*** | ***Individual*** *(hours)* | ***Assisted*** *(hours)* |
|---|---|---|
| Official teaching | 9 | 16 |
| Thesis | 5 | 20 |

3. On the basis of the indications of the previous paragraph, a course of 6 credits includes 54 hours of official teaching, part of which can also be delivered in several rounds.
4. In the annual planning phase the CCdLM identifies the lecturer in charge of each training activity.
5. The teachings of the CdLM are carried out by the lecturers in a way that they are not in common with other CdL or CdLM, except as provided for in the annual didactic planning.

**Art. 12 - Programs of training activities**

1. The training activity programs must be defined and implemented in such a way as to ensure compliance with the objectives set and the credit assigned to them, as indicated in Annex B.
2. The program of each training activity is prepared annually by the lecturer in charge and approved by the CCdLM and

transmitted to the CdD.

3. According to the provisions of art. 16 - paragraph 4 - of the DR_UNIPG, the CCdLM may request, with a motivated resolution, modifications to the proposed program on the exclusive basis of the purposes referred to in art. 12 - paragraph 1 - of the DR_UNIPG. In the event that the CCdLM does not approve the program, the matter is brought to the examination of the CdD and, where necessary, of the Academic Senate.
4. For documented reasons, the lecturer in charge of each training activity can ask to be relieved of the scheduled assignment by the CdD.
5. According to the regulations in force the programs of the training activities assigned to professors and researchers of other Departments or of other Universities or to external experts are defined by the CCdLM which proposes them for approval by the CdD.

**Art. 13 - Tutoring**

1. The CdLM makes use of the service of the Didactic Secretariat for guidance tutoring organized by the DSA3, aimed at directing and assisting students before, during and after the course of studies, to make them participate in educational progress, to remove obstacles for a profitable attendance of courses, to facilitate their entrance in the world of work, also through initiatives related to the needs, attitudes and desires of individuals.
2. The CdLM avails itself of the collaboration of the Orientation service of the University of Perugia and of the DSA3.

**Art. 14 - Training activities carried out abroad**

1. For the development and recognition of training activities carried out at foreign universities, are valid the rules established by the DR_UNIPG and by the University regulations for Erasmus mobility.

**Art. 15 - Educational activities and services for part-time and off-course students**

1. Following any requests from students and within the deadline set by Article 10, the CCdLM assesses annually the opportunity to organize extraordinary educational services and activities for the recovery of students who are out of course and for those unable to use ordinary educational services.

**Art. 16 - Proof of profit**

1. In accord to the provisions of art. 28 and 29 of the DR_UNIPG and in compliance with the criteria set out in point 5 of annex D, the assessment of students' learning is carried out through exams by a specific Commission.
2. Exams are carried out in sessions distributed in specific periods of the academic year, as indicated in Annex D, point 5. The calendar of exams is proposed by the lecturers to the CCdLM and approved by the CdD by September of each year.
3. For didactic activities with pass / fail assessment the verification of students' level of learning is carried out by the lecturers involved in the training activity, according to methods established by them, approved annually by the CCdLM and made known to the students at the beginning of the activities.
4. As indicated in point 5 of annex D, students regularly attending lectures and practicals can take advantage of ongoing tests eventually proposed by the lecturers, in compliance with the regular performance of other scheduled training activities.

**Art. 17 - Evaluation of the didactic activity**

1. Pursuant to Legislative Decree 49/2012 and Ministerial Decree 47/2013, as well as in close collaboration with the CPD, the CCdLM carries out all the assessments related to the periodic accreditation of the Course and the quality of teaching provided annually by the University,

**Art. 18 – Graduation Commission**

1. The Graduation Commission is appointed by a Rector decree after recommendations of the President of the study program.
2. The members of the Commission range between seven and eleven, with at least five effective members be lecturers and / or researchers teaching in the CdLM, and by 2 alternate members. The members of the Commission are identified mainly among the supervisors and co-supervisors of the thesis and among those who carry out teaching activities within the CdLM.

3. Only for non-postponed commitments and, in any case, at least 5 days before the date of the graduation session, a member of the Commission can ask the President of the CdLM to be replaced by an alternate member.
4. The final exam Commission is chaired by the President of the CdLM or by the dean of the Commission, or by any other lecturer indicated by the President. The alternative members must be available until the closing of the proceedings.

**Art. 19 - Criteria for allocating material and financial resources for training activities**

1. The material, financial and human resources available for the training activities of the CdLM are identified annually by the CdD which allocates them in order to get the maximum effectiveness, taking into account the activities of all the CdLM.
2. The financial resources available for each training activity are assigned annually by the CdLM according to the didactic commitment related to the same activity.

**Art. 20 - Modification of the Regulations**

1. Amendments to these Regulations are approved by the CCdLM, subject to the indication of the CPD, and approved by the CdD, in accordance with the provisions of the DR_UNIPG.

**Art. 21 - Entry into force of these Regulations**

1. In relation to the didactic system referred to in this regulation, the CdLM is activated starting from the Academic Year 2020-2021.
2. This regulation enters into force on the following day issued by Rector's Decree.

**Art. 22 - Postponement**

1. For anything not provided for in the previous articles, the rules and principles of Ministerial Decree no. 270/2004 and subsequent DM relating to it and the DR_UNIPG.

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DIPARTIMENTO
DI SCIENZE AGRARIE,
ALIMENTARI E AMBIENTALI



# INTERNATIONAL MASTER DEGREE COURSE in AGRICULTURAL AND ENVIRONMENTAL BIOTECHNOLOGY

(Class LM-7 Agricultural Biotechnology of DM 270/2004)

## 1. The Degree Course in brief

The Master's Degree Course in Agricultural and Environmental Biotechnology (AEB) is dedicated to the training of a specialist able to use all biotechnological techniques, both conventional and advanced, in order to collaborate in the development of research and technological application projects on agricultural and environmental sectors.

## 2. Professional profile and career opportunities

**Functions in a work context**

The graduate in AEB acquires high levels of knowledge in the scientific, technical and productive development of biotechnological tools to be applied in the agricultural and environmental sector; he/she will be able to operate alone or in collaboration with other professionals at high responsibility levels in the following functions:

- management of agroecosystems, including the reintroduction of genetically characterized microorganisms, plants and animals;
- conservation and use of plant, animal and microbial genetic resources of agricultural importance;
- molecular characterization of food products for quality control;
- selection of plants, animals and microorganisms, to improve the quality and/or quantity of agricultural and agro-industrial products, and to obtain pharmaceutical, industrial, environmental, medical and veterinary products;
- use of techniques aimed at the genetic transformation of plants, microbes and animals, in particular in advanced biotechnological applications characterized by low environmental risk;
- foodstuff control for presence of GMOs and assessment of the environmental risk associated with the introduction of GMOs, also for a correct application of the precautionary principle;
- quality control of seed and nursery products.

**Skills associated with the function**

Graduates in Agricultural and Environmental Biotechnology develop the following skills:

- ability to find information, analyze and interpret the data necessary to conduct research and to plan actions in the agricultural and environmental biotechnology sector;
- ability to identify appropriate methods and techniques for problem solving;
- ability to draw up technical reports and projects and communicate correctly in Italian and English;
- ability to use IT tools in the field of biotechnology;
- ability to plan and develop conventional and biotechnological breeding methods;
- ability to plan interventions in the fields of crop protection and agro-industrial products, the study of the impact of GMOs, pollution control and environmental remediation, risk control in the agricultural biotechnological industry.

**Employment opportunities**

The graduate's career opportunities are foreseen in the context of business service activities through consultancy and planning of interventions concerning advanced biotechnologies in the agricultural sector, in public administration and in public and private research institutions. The profile of the graduate falls within that envisaged for the professions of agronomist and biotechnologist. Graduates will therefore be able to operate:

- at organizations, companies or professional studios / laboratories that deal with environmental enhancement and protection;
- in seed and nursery industries;
- in public and private scientific research institutions;
- in public and private bodies that carry out experimentation activities in conventional, assisted and advanced genetic improvement and control of the spread of GMOs in the environment and the assessment of the related environmental risk;
- in product certification bodies in the plant, animal and industrial processing sectors;
- at public and private certification bodies and analysis laboratories;
- in the educational sector, at training centres, schools, universities.

**The course prepares for the profession of (ISTAT codes):**
Biotechnologists - (2.3.1.1.4)
Agronomist and foresters - (2.3.1.3.0)

## 3. Admission procedures

Enrolment in the CdLM in AEB is subject to the possession of a three-year degree or a three- year university degree, or other recognized, suitable qualification obtained abroad.
Undergraduates in Agricultural and Environmental Sciences (Biotechnology curriculum), or in Biotechnology obtained at the University of Perugia are considered as ascertained. In all other cases, the enrolment it is possible if:

a) the applicant possesses at least 80 CREDITS in basic and characterizing scientific-disciplinary sectors, as specified below:

| SSD | Minimum credit | Maximum credit |
|---|---|---|
| AGR/07, AGR/16 | 0 | 12 |
| AGR/01 | 0 | 6 |
| AGR/02, AGR/03, AGR/04, AGR/11, AGR/12, AGR/13, AGR/15, AGR/17, AGR/18, AGR/19 | 0 | 20 |
| BIO/01, BIO/02, BIO/03, BIO/04, BIO/05, BIO/06, BIO/09 BIO/10, BIO/11, BIO/12, BIO/13, BIO/14, BIO/15, BIO/16, BIO/17, BIO/18, BIO/19 | 20 | 70 |
| CHIM/01, CHIM/02, CHIM/03, CHIM/06, CHIM/08, CHIM/09, CHIM/10 | 9 | 20 |
| MAT/01, MAT/02, MAT/03, MAT/05, MAT/06, MAT/07, MAT/09, FIS/01, FIS/03, FIS/07, FIS/08, INF/01 | 6 | 12 |

b) the applicant has a good knowledge of the English language, equal to the B2 level of the Common European Framework of Reference (CEFR).

Verification of the personal preparation of candidates for admission is carried out by a specific Commission appointed by the Degree Course Council.

## 4. Specific training objectives of the course and description of the training path

The master's degree program in Agricultural and Environmental Biotechnology aims to train graduates with a solid multidisciplinary scientific background and with the professional skills necessary to carry out the following activities:

- carry out biotechnological interventions, also by means of genetic engineering, aimed at optimizing the productive and reproductive efficiency of organisms of agricultural interest;

- conceive, design and manage technical-scientific projects related to biotechnological disciplines of the agricultural sector;

- operate autonomously, assuming structure and project responsibilities;

- evaluate the effects on agroecosystems of pesticides and the presence of their residues in different matrices;

- develop and fine-tune survey methods for the characterization of organisms of agricultural interest;

- select plants, animals and microorganisms in order to improve the quality and/or quantity of agricultural products, and to obtain useful products in other sectors (pharmaceutical, industrial, environmental, medical and veterinary);

- produce microorganisms of agricultural and agro-industrial interest;

- produce plants of agricultural interest by means of micropropagation techniques;

- carry out the genetic transformation of plants and microorganisms;

- identify genetically modified organisms (GMOs) and products derived from GMOs in foodstuffs;

- characterize and control food products using molecular techniques;

- check the varietal characteristics of crops;

- control agroecosystems through advanced biotechnology approaches;

- study biodiversity using molecular techniques, with particular attention to plant, animal and microbial agricultural genetic resources.

These knowledges and understanding skills are acquired during the 2 years of the CdLM, during which the student obtains 120 credits. During the first year, students will concentrate on plant development and will acquire the basics for the correct conduct of biological-agricultural experimentation and the interpretation of its results. They will learn the theoretical basis of genetic improvement through the study of biometrical genetics and genomics, the study of bioinformatics will broaden bioinformatic skills in the field of genomic analysis; in the second semester they will acquire knowledge on biodiversity and its evolution. All these will allow to deepen the techniques and methods of genetic improvement, both conventional and biotechnological, of plants and farm animals. Students will also learn the use of microorganisms for industrial, biotechnological productions and their importance in environmental monitoring and remediation.

During the second year, the preparation will be devoted more to agricultural production: agricultural chemistry, agronomy and sustainable crops, plant protection, the seed industry and technologies for the propagation of tree species. The preparation will finally be completed by the study of the basic concepts of economics applied to biotechnology. The internship and the experimental activities related to the preparation of the master's degree thesis will occupy a large part of the activities of the second semester.

The total number of exams including the final dissertation is 12. Lectures, practicals, seminars and educational visits are organized in four semesters. In particular, each study unit can be monodisciplinary or based on two modules. The student can choose elective courses (8 credits), including the Italian Language at the Linguistic Center of the University of Perugia.

Each student can ask for assistance and be oriented on his/her entry and in progress by the staff of the Student didactic service of the Department. On leaving, the career orientation is carried out by the Job placement service of the DSA3. All aspects relating to the organization and management of the master's degree program in Agricultural and Environmental Biotechnology are described in the specific Didactic Regulations, available on the DSA3 website.

## 5. Ability and understanding and Ability to apply finowledge and understanding: Summary

Knowledge and capacity from understanding

Graduates in Agricultural and Environmental Biotechnology acquire and know how to use the specific skills of knowledge (knowledge) listed below: knowledge of biology applied to biotechnology, knowledge of experimental methodology and bioinformatic, knowledge of microbial biotechnology for agro-industry and the environment, knowledge concerning the evolution and conservation of biodiversity, biometric genetics and molecular biology techniques, knowledge concerning plant and animal genetic biotechnologies, knowledge of agricultural chemistry and biotechnologies applied to tree and herbaceous crops, advanced knowledge of entomopathological biotechnology, knowledge of economics and management of biotechnologies.

These ability are acquired with classroom lessons and individual study, verified with ongoing tests, discussion sessions and final exams.

Ability to apply knowledge and understanding

Graduates in Agricultural and Environmental Biotechnology acquire the skills to identify, locate, obtain and analyze the data necessary to conduct research and to plan actions related to the profession of biotechnologist. In particular, through the use of appropriate methods and techniques learned during the training course, he/she will be able to apply them in the following applications and skills:

express themselves with a correct written and oral technical vocabulary in English (the language in which the course is held); use IT tools in the field of biotechnology, plan and develop biotechnological projects, use analysis methods in the biotechnology sector and interpret the results, plan and develop methods of genetic improvement; apply advanced biotechnologies in the defense of crops and agro-industrial products; develop techniques for the identification and study of the impact of genetically modified organisms; intervene in the field of coexistence between biotechnological, conventional and organic agriculture; use microbial techniques in pollution control and environmental remediation; manage research projects, quality systems; carry out risk control in the agricultural biotechnology industry; develop, manage and evaluate basic, pre-competitive and industrial development research projects in the sector of the agricultural technology.

The ability to apply the acquired knowledge is developed with the participation in exercises in the classroom, in the laboratory and in the open field; participation in seminars will also contribute to the students' ability to re-elaborate theoretical information in an applicative sense. These skills are verified through specific written reports, mainly relating to the internship and the thesis, according to the methods specified, for each activity, in the didactic regulations of the degree course.

## 6. Ability and understanding and Ability to apply knowledge and understanding: details

Knowledge and understanding

Graduates in Agricultural and Environmental Biotechnology will acquire how to use the specific skills of knowledge listed below and grouped into functional classes with respect to the main specific objectives of the course:

KNOWLEDGE OF BIOLOGY APPLIED TO BIOTECHNOLOGY

Knowledge of vegetative growth and the reproductive system of plants, with particular attention to plant species of agricultural interest. Knowledge of cellular communication systems and how the flexibility of plant metabolism allows them to face, through acclimatization and adaptation mechanisms, environments that change their characteristics over time.

KNOWLEDGE OF MICROBIAL BIOTECHNOLOGY FOR AGROINDUSTRY AND THE ENVIRONMENT

Knowledge necessary to use biotechnological approaches in the microbial world for the purposes of environmental conservation and recovery and in the field of industrial microbiology.

KNOWLEDGE ABOUT THE EVOLUTION AND CONSERVATION OF BIODIVERSITY, BIOMETRICAL GENETICS AND MOLECULAR BIOLOGY TECHNIQUES

Knowledge on the plasticity of the eukaryotic genome, on the changes of genomes and chromosomes, on polyploidy and the evolution of plants, on molecular cytogenetics. In-depth knowledge on the disturbing factors of Hardy Weinberg's law, on inbreeding and its effect on quantitative traits and on heterosis.

Knowledge on the genetic constitution of diploid and polyploid populations, on continuous variation, heritability of characters and response to selection. In-depth knowledge on the use of biochemical and molecular markers, on gene mapping, on gene expression analysis, on DNA sequencing and bioinformatics analysis, on genetic improvement assisted by molecular markers. Knowledge of agricultural biodiversity and genetic resources, gene pools, evolution of the genetic diversity of the main cultivated species, use of genetic resources in the varietal constitution, in situ and ex situ conservation.

KNOWLEDGE OF BIOINFORMATIC ANALYSIS

Gaining and deepening expertise in bioinformatic analysis of DNA sequences, which are essential in plant, animal, and microbial breeding programs, in biodiversity studies, and in the genomic analysis of plant pathogens and parasites.

KNOWLEDGE REGARDING VEGETABLE AND ANIMAL GENETIC BIOTECHNOLOGIES

In-depth knowledge of selection theory, its applications and methods of genetic improvement of predominantly self-pollinating, mainly allogamous and vegetative propagation plants. In-depth knowledge of advanced genetic biotechnologies for the isolation of genes from plants, the optimal expression of introduced genes, gene silencing, clean genetic engineering techniques.

Knowledge of animal genetic improvement and the importance of biotechnologies in the livestock sector. Applications of molecular biotechnologies to animals in livestock production. Reproductive biotechnologies and their applications in animal husbandry. Knowledge of the main regulatory aspects relating to the production and dissemination in the environment of genetically modified organisms.

KNOWLEDGE OF AGRICULTURAL CHEMISTRY AND BIOTECHNOLOGIES APPLIED TO TREE AND HERBACEOUS CROPS

Knowledge of herbicides, fungicides, insecticides, formulas and chemical-physical properties of the compounds most used in agricultural practices. Biological activity of the compounds described. Notes on the determination of residues on different matrices. Primary and secondary metabolites. Role of secondary metabolism in living things. Knowledge necessary for understanding the functions of arboreal and shrubby plants and types of greenery. Skills to be able to work in the field of plant genetic biotechnology using in vitro culture approaches. Also for the purpose of conserving agricultural genetic resources. Basic knowledge of herbaceous crops and seed production as sectors of application of advanced biotechnologies. Specific knowledge of the production chains of the main herbaceous and horticultural crops and of the seed production sector with reference to the problems and perspectives related to the application of biotechnologies.

ADVANCED KNOWLEDGE OF ENTOMOPATHOLOGICAL BIOTECHNOLOGY

Knowledge on insect-other organisms interactions and on ecological, ethological and physiological manipulation of

arthropods also as regards the evaluation of the related eco- toxicological aspects. Knowledge of genetic manipulation and transformation for defense against arthropods. Expertise in mass production of natural arthropod antagonists, in quality control and risk assessment. Knowledge of the aggression factors of pathogens, of the molecular aspects of pathogenicity and virulence, of avirulence, resistance and defense genes of plants. Knowledge of molecular signals in plant-pathogen interaction. Expertise in strategies for obtaining transgenic plants resistant to biotic diseases and in molecular characterization and diagnosis.

KNOWLEDGE OF ECONOMICS OF BIOTECHNOLOGIES

Knowledge of the dynamics of innovative processes, with particular reference to economic and managerial issues. Knowledge of the biotechnological industrial world and the management of research projects such as organizational processes, quality systems, risk control, reality and perspectives of the biotechnology industry in Italy. Knowledge of the relationships between business economics and biotechnological disciplines. Classification of companies according to the criterion of value for the stakeholders. The business-economic system. Management and project management. The structure of the economic accounts and the capital formation process in biotech companies. Financial management. Notes on company evaluation. Corporate strategy concept. Management control in research activities. The organizational system and organizational processes.

Ability to apply knowledge and understanding

Graduates in Agricultural and Environmental Biotechnology, in general, acquire the skills to identify, locate and obtain the data necessary to conduct analytical investigations and to plan actions inherent to the performance of the biotechnologist profession. In particular, through the use of appropriate methods and techniques that are part of the training course, he is able to apply the knowledge of knowledge acquired, thus obtaining the following skills of knowing how to do (skills):

- be able to express themselves with a correct written and oral technical vocabulary in the mother tongue and in English;
- know how to use IT tools at the level of research and agro-industrial production in the biotechnology field;
- knowing how to plan and develop biotechnological projects applied to the environment, plant and animal production and agro-industry;
- use analysis methods in the biotechnology sector and know how to interpret the analytical results,
- know how to plan and develop genetic improvement methods in plants, animals and microbes using conventional and advanced biotechnology approaches;
- know how to apply advanced biotechnologies in the defense of crops and agro-industrial products from entomo-pathological attacks;
- know how to develop techniques for identifying genetically modified organisms at the environmental level and components derived from genetically modified organisms in agri-food products;
- being able to evaluate the effect of the introduction of genetically modified organisms at the level of the environment, crops and agri-food products and knowing how to intervene, in collaboration with other professionals, in the sector of coexistence between biotechnological, conventional and organic agriculture;
- know how to use microbial techniques in pollution control and environmental remediation;
- know how to evaluate the technical and economic results of a biotechnology company and prepare general projects for its development;
- knowing how to solve the problems of a technical nature that may arise during the carrying out of basic, pre-competitive research and industrial development projects in the vegetated, animal and microbial biotechnology sector.

The ability to understand knowledge and to know how to use it is acquired through participation in exercises, in the classroom in the laboratory and in the open field, and in seminars and is verified during the oral tests and/or specific written reports according to the specified methods, for each activity, in the didactic regulations of the degree course.

## 7. Autonomy of judgment; Communication skills; Learning ability

Autonomy of judgment

Graduates in Agricultural and Environmental Biotechnology will have the ability to integrate knowledge to manage the complexity implicit in sustainable development processes. He/she acquires the autonomy to judge the reliability of the information necessary for the activities that characterize his work and to make decisions in a critical and synthetic way to solve problems. For the purposes of the course, graduates will also be sensitized to focus their attention on the skills of knowing how to be (social responsibility of organizations, technology risks, technology sustainability). These skills will be favored by the coordinated carrying out of all didactic activities and by specific seminars. The monitoring of the achievement of learning outcomes in terms of independent judgment takes place during the course of the assessment of

the individual courses and, in particular, of the final exam.

Communication skills

Graduates in Agricultural and Environmental Biotechnology have the ability to clearly communicate information, ideas and problem solving to specialist and non-specialist interlocutors, both nationally and internationally, through written and oral forms. He/she knows how to use the main tools of Information and Communication Technology to carry out his business. They will have acquired the communication and interpersonal skills to be able to work in a group, be able to manage or coordinate other people in the context of decision-making and negotiation processes. These skills will be fostered through the carrying out of specific seminars and supported with the creation of specific reports during the development of the more professionalizing courses. The monitoring of the achievement of learning outcomes in terms of communication skills takes place during the course of the assessment of the individual courses and, in particular, of the final exam.

Learning ability

Graduates in Agricultural and Environmental Biotechnology have the skills and the level of autonomy essential to attend the third level of university education and to face the continuous updating of the knowledge and skills necessary for the profession. The verification of the acquisition of this skill takes place during the period of realization of the thesis related to the final exam.

## 8. Characteristics of the final exam

In order to be admitted to the discussion of the final exam, it is necessary to have acquired 104 out of 120 credits foreseen in the study plan of the course.

The training activities related to the preparation of the final exam for the attainment of the title provide for an educational load equal to 16 credits, which can be increased to 20 by linking part of the credits assigned to the internship activities to those of the final test. The final exam consists in the elaboration of a theoretical-practical study on a topic of significant interest for the agricultural and environmental biotechnology sector.

The choice of the topic relating to the paper and/or report is made by the graduate student, according to his or her scientific and professional interests and the type of research and experimentation activities carried out by the teachers of the DSA3. For this purpose, the graduate student identifies the availability of a teacher of the DSA3 who can play the role of guide/supervisor for the preparation of the paper and/or of the report and of supervisor during the discussion of the final exam. Furthermore, the supervisor is responsible for verifying the operational commitment of the graduate student during the preparation and for assessing the completeness of the paper and/or report before the discussion. The final exam consists in the presentation and discussion of the paper and/or report in front of a specific commission. The evaluation will follow the criteria established in the Didactic Regulations of the CdLM and DSA3. The evaluation is expressed in one hundred and ten, with honors.

## 9. Characterizing training activities

| **Disciplinary area** | **Sector** | **CREDITS** |
|---|---|---|
| General, biotechnological disciplines | AGR/07 Agricultural genetics<br>AGR/16 Agricultural microbiology<br>AGR/17 General animal husbandry and genetic improvement<br>BIO/11 Molecular biology | 40-42 |
| Agricultural, biotechnological disciplines | AGR/02 Agronomy and herbaceous crops<br>AGR/03 General arboriculture and tree crops<br>AGR/11 General and applied entomology<br>AGR/12 Plant pathology<br>AGR/15 Food science and technology<br>BIO/04 Plant physiology | 26-28 |
| Management and ethical disciplines | AGR/01 Economy and rural appraisal<br>IUS/14 European Union law | 5-5 |
| **Range of credits reserved for characterizing activities** (from DM min 45**)** | | **71-75** |

**Related activities**

| **Disciplinary area** | **Sector** | **CREDITS** |
|---|---|---|
| Related or supplementary training activities | AGR/13 - Agricultural chemistry<br>BIO/03 - Environmental and applied botany<br>BIO/11 Molecular biology | 12-18 |

| **Other didactic activities (D.M. 270 art.10 §5)** | | **CFU** |
|---|---|---|
| Electives (Article10, paragraph 5, letter a) | | 8 |
| Final exam, thesis discussion (Article 10, paragraph 5, letter c) | | 16 |
| Additional training activities (Article 10, paragraph 5, letter d) | Additional linguistic knowledges | 0 |
| | IT and telematic skills | |
| | Training and orientation internships | 6 |
| | Other useful knowledge for the world of work | |
| **Ranged of credits reserved for other activities** | | **30-34** |
| **Total credits for the attainment of the MSc degree title** | | **120** |

For the coverage of similar or supplementary training activities, scientific-disciplinary sectors (SSDs) were chosen, included in the characterizing disciplinary areas (BIO/03 and AGR/13).
On the merits, the skills provided by these SSDs are complementary to the achievement of the knowledge transferred from the disciplines of the SSDs AGR/02, AGR/03, AGR/07 and AGR/16. In fact, the development of plants, treated in the teaching "Biology of the development of higher plants" (BIO/03), is not generally dealt with in the Biotechnology Degrees, but is required to complete and broaden the knowledge relating to the disciplines of Advanced genetic improvement of plants (AGR/07), Herbaceous crops, seed activities and biotechnologies (AGR/02) and Biotechnologies applied to nursery activities (AGR/03).
The Agricultural Chemistry course (AGR/13) gives students, particularly those coming from the BSc in Biotechnology, complementary knowledge and those acquired in the courses of Field crops, seed production and biotechnology (AGR/02) and Microbiology applied to the environment (AGR/16), in particular those relating to the behavior and fate of pesticides in the plant-soil system, which could not be acquired otherwise.
The Bioinformatics course (BIO/11) provides students with knowledge that complements what is acquired in the course 'Experimental Methodology in Agriculture' (AGR/02), by enhancing their bioinformatic skills in the analysis of data derived from DNA sequences relevant to plant (AGR/07), animal (AGR/17), and microbial (AGR/16) genetic breeding programs; in the course 'Evolution of Biodiversity'; and in the genomic analysis of plant pathogens and parasites (AGR/11 and AGR/12).
The SSD BIO/03 and AGR/13 are therefore effective in pursuing the training objectives set out in the study plan.
The Didactic Regulations of the study course and the programmed Educational Offer will allow students who wish to follow training courses in which there is an adequate amount of credits in similar and supplementary sectors that are not already characteristic

**INTERNATIONAL MASTER DEGREE COURSE in**
**AGRICULTURAL AND ENVIRONMENTAL BIOTECHNOLOGY**
(Class LM-7 Agricultural Biotechnology of DM 270/2004)

**Teaching and Training activities**

**YEAR 1 – SEMESTER 1**

**PLANT DEVELOPMENTAL BIOLOGY**
**Educational objectives:** The aim of this subject is to provide students with knowledge about the development and structure of plants useful for the definition and organization of complex experiments of plant biotechnology. The students will acquire knowledge concerning the mechanisms of development (embryonic, cauline, radical and floral) and of differentiation in Angiosperms, as well as knowledge of the mechanisms of plant-environment interactions. Students' skills will be deepened in evaluating the most useful methodologies in studying the biology of plants, in understanding the genes involved in plant development, in evaluating the results of experimental data and in critically assess recent scientific literature related to the plant biology.
**Teaching methods:** conventional
**Credits:** 6
**Types of teaching:** theoretical and practical lectures
**Hours:** 54
**Prerequisites:** none
**Learning assessment:** oral exam.

**STATISTIC AND BIOINFORMATICS**
**Educational objectives:** The course aims to provide the students with theoretical background and practical tools to design scientifically sound experiments and to carry out the statistical analysis of data and presentation of the results. Basic aspects on experimental design include: main experimental designs, the use of ANOVA, application of the linear regression, multiple comparison procedures, non-linear regression. It aims to provide students with the theoretical and practical foundations for the bioinformatic analysis of DNA sequences that are relevant to plant, animal, and microbial genetic breeding programs; to study biodiversity and to analyse genomes of plant pathogens and parasites.
**Module: Experimental methods in agriculture**
**Teaching methods:** conventional
**Credits:** 5
**Types of teaching:** theoretical and practical lectures
**Hours:** 45
**Prerequisites:** none
**Learning assessment:** oral exam.

**Module: Bioinformatics**
**Teaching methods:** conventional
**Credits:** 5
**Types of teaching:** theoretical and practical lectures
**Hours:** 45
**Prerequisites:** none
**Learning assessment:** oral exam

**BIOMETRICAL GENETICS**
**Educational objectives:** To provide the students with the necessary information to understand the phenomena and evolutive forces acting in natural and improved populations, in qualitative and quantitative traits, as well as the knowledge to manage conventional and advanced breeding programs. The course also provides the student with detailed knowledge of techniques based on molecular markers, gene expression and cloning in order to use them in the context of assisted genetic improvement. Finally, some aspects of bioinformatics will be developed such as the use of basic commands applied both to genomic analysis based on SNPs (GWAS) and to DNA methylation in plants of agricultural interest.
**Module: Quantitative genetics**
**Teaching methods:** conventional
**Credits:** 6

**Types of teaching:** theoretical and practical lectures
**Hours:** 54
**Prerequisites:** none
**Learning assessment:** final written and oral exam.

**Module: Genomic analysis**
**Teaching methods:** conventional
**Credits:** 6
**Types of teaching:** theoretical and practical lectures
**Hours:** 54
**Prerequisites:** none
**Learning assessment:** oral exam.

## YEAR 1 – SEMESTER 2

### APPLIED MICROBIOLOGY

**Educational objectives:** Provide students with knowledge relating to innovative biotechnological processes in the field of microbial biotechnologies applied to food, nutraceutical, pharmaceutical and food additive industries; deepen the aspects related to the use of selected microorganisms for innovative biotechnological processes. Provide students with knowledge related to the concept of diversity and microbial presence in natural environments and environmental technologies, in relation to their metabolic capacity and by observing the main factors affecting their survival
**Module: Industrial Microbiology**
**Teaching methods:** conventional
**Credits:** 6
**Types of teaching:** theoretical and practical lectures
**Hours:** 54
**Prerequisites:** none
**Learning assessment:** oral exam.

**Module: Environmental Microbiology**
**Teaching methods:** conventional
**Credits:** 6
**Types of teaching:** theoretical and practical lectures
**Hours:** 54
**Prerequisites:** none
**Learning assessment:** oral exam.

### EVOLUTION OF PLANT BIODIVERSITY

**Educational objectives:** Provide essential information and concepts for understanding the origin of biodiversity. To explore the evolutionary pathways of the living organisms by studying the genome and chromosome modifications and the identification of chromosome variants. To understand the importance of wild flora for the study of evolutionary processes and the maintenance of biodiversity. Provide the students with knowledge of the main events connected to the processes of domestication of plants and animals.
**Teaching methods:** conventional
**Credits:** 6
**Types of teaching:** theoretical and practical lectures
**Hours:** 54
**Prerequisites:** none
**Learning assessment:** oral exam.

### ADVANCED BREEDING

**Educational objectives:** The aim of the course is to provide knowledge on techniques and strategies to improve plants and animals of agricultural interest through traditional methods and advanced genetic biotechnologies. The goal will be achieved through lectures, practices and educational visits.
**Module: Advanced plant breeding**
**Teaching methods:** conventional

**Credits:** 6
**Types of teaching:** theoretical and practical lectures
**Hours:** 54
**Prerequisites:** none
**Learning assessment:** oral exam.

**Module: Advanced animal breeding**
**Teaching methods:** conventional
**Credits:** 5
**Types of teaching:** theoretical and practical lectures
**Hours:** 45
**Prerequisites:** none
**Learning assessment:** oral exam.

## YEAR 2 – SEMESTER 1

### AGRICULTURAL CHEMISTRY

**Educational objectives:** Students will study the impact of pesticides on the soil/plant system and on the human health; the impact of pesticides on the cycle system of the water; the rules for pesticides utilization. The student will be able to estimate the environmental concentrations of pesticides in soil and water, the sustainable pest control strategies as alternative of the chemical pesticides and the biotechnological methods to manage the organic wastes and byproducts to produce organic fertilizers promoting circular economy.
**Teaching methods:** conventional
**Credits:** 6
**Types of teaching:** theoretical and practical lectures
**Hours:** 54
**Prerequisites:** none
**Learning assessment:** oral exam.

### ECONOMIC ASPECTS OF BIOTECHNOLOGY

**Educational objectives:** The aim of the course is to provide students with the knowledge and tools to understand the dynamics of the innovative processes of biotechnology companies, with particular reference to economic and managerial issues. Applications in the agricultural field will be carried-out by examining the economic aspects concerning the supply and demand of genetically modified foods, insect-resistant fibers, food processing. The economics of the biotechnological industry in will be treated, including the economic tools to examine the strategies used by the most important biotechnology companies.
**Teaching methods:** conventional
**Credits:** 5
**Types of teaching:** theoretical and practical lectures
**Hours:** 45
**Prerequisites:** none
**Learning assessment:** oral exam, for the practical activities, the final discussion will take place in the classroom with all the students and the teacher.

### BIOTECHNOLOGIES FOR PLANT HEALTH

**Educational objectives:** Main knowledge and skills that the students are expected to acquire are: the most important and economically relevant insects and other arthropods; molecular and conventional systematics and diagnostics in entomology; ecological and physiological interactions of arthropods with other organisms; exploitation of entomological resources; pest management. Ability to apply the acquired knowledge in entomology. Students are also expected to acquire the molecular aspects of the infectious process of pathogenic fungi and bacteria, of the race-specific resistance and of induced plant defence responses. They will learn the principles of molecular diagnosis of plant disease and will be able to plan experiments, extract DNA from phytopathogenic bacteria and fungi, apply the basic analytical methods for the study of plant-pathogen interactions.
**Module: Insect Biotechnology**
**Teaching methods:** conventional
**Credits:** 6

**Types of teaching:** theoretical and practical lectures
**Hours:** 54
**Prerequisites:** none
**Learning assessment:** oral and presentation of one of the treated topics.

**Module: Molecular plant pathology**
**Teaching methods:** conventional
**Credits:** 6
**Types of teaching:** theoretical and practical lectures
**Hours:** 54
**Prerequisites:** none
**Learning assessment:** oral exam.

## YEAR 2 – SEMESTER 2

**FIELD CROPS, SEED PRODUCTION AND BIOTECHNOLOGY**
**Educational objectives:** The aim of the course is to provide students with elements of crop science related to the most important agricultural crops, particularly in biotechnological aspects of seed biology and seed production. The educational goal is achieved through lectures and practices, analysis of scientific articles and educational visits.
**Teaching methods:** conventional
**Credits:** 5
**Types of teaching:** theoretical and practical lectures
**Hours:** 45
**Prerequisites:** none
**Learning assessment:** oral exam.

**BIOTECHNOLOGY APPLIED TO PLANT NURSERY PRODUCTION**
**Educational objectives:** The subject will provide the students with the theoretical and practical background of plant propagation through biotechnological applications such as the basics of in vitro cultures (totipotency, regenerative processes and growing conditions) and plant micropropagation, with particular focus on their nursery applications. Innovative techniques and technologies to improve the management of vitro-derived plant material will be described.
**Teaching methods:** conventional
**Credits:** 5
**Types of teaching:** theoretical and practical lectures
**Hours:** 45
**Prerequisites:** none
**Learning assessment:** oral exam.

**INTERNSHIP**
**Educational objectives:** it includes stages in university laboratories and/or in private companies aiming at acquiring the professional skills required in the working sector. (see Annex D).
**Credits:** 6 (possibility to extend them up to 2 additional credits from Electives)
**Types of teaching:** supervised and individual work.
**Hours:** 150-200
**Learning assessment:** final report (see Annex D).

**FINAL DISSERTATION**
**Educational objectives:** Writing and discussing a thesis based on a research study covering any topic related to agricultural and environmental biotechnology. The activity is carried out with the guidance of a supervisor (see Annex D).
**Credits:** 16
**Types of teaching:** assisted and individual work
**Hours:** 400 including tutoring and individual work
**Learning assessment:** presentation and discussion of the paper.

**Annex C- 2025-2026**

| | |
|---|---|
| International Master of Science degree course in: | **Agricultural and Environmental Biotechnology** |
| Academic year | 2025/2026 |
| Didactic venue | Perugia |
| President | Prof.ssa Chiaraluce Moretti |
| Web site | http://dsa3.unipg.it/en/aeb |
| Access to further studies: | 2nd level Master degree, Research Doctorate |
| Maximum number of enrollments: | 65 |

| Exam n. | Year | Sem. | Study units | Module | Scientific area | Credis | Disciplnary area |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | Plant developmental biology | | BIO/03 | 6 | Plant biotechnology |
| 2 | 1 | 1 | Statistics and bioinformatics | Experimental methods in agriculture | AGR/02 | 5 | Agricultural biotechnologies |
| 2 | 1 | 1 | Statistics and bioinformatics | Bioinformatics | BIO/11 | 5 | General biotechnologies |
| 3 | 1 | 1 | Biometrical genetics | Quantitative genetics | AGR/07 | 6 | General biotechnologies |
| 3 | 1 | 1 | Biometrical genetics | Genomic analysis | AGR/07 | 6 | General biotechnologies |
| 4 | 1 | 2 | Evolution of plant biodiversity | | AGR/07 | 6 | General biotechnologies |
| 5 | 1 | 2 | Applied microbiology | Industrial microbiology | AGR/16 | 6 | General biotechnologies |
| 5 | 1 | 2 | Applied microbiology | Environmental microbiology | AGR/16 | 6 | General biotechnologies |
| 6 | 1 | 2 | Advanced breeding | Advanced plant breeding | AGR/07 | 6 | General biotechnologies |
| 6 | 1 | 2 | Advanced breeding | Advanced animal breeding | AGR/17 | 5 | General biotechnologies |
| | 1 | 2 | Electives | | | 3 | |
| 7 | 2 | 1 | Agricultural chemistry | | AGR/13 | 6 | Agricultural biotechnologies |
| 8 | 2 | 1 | Economic aspects of biotechnology | | AGR/01 | 5 | Management and ethical disciplines |
| 9 | 2 | 1 | Biotechnologies for plant health | Insect biotechnology | AGR/11 | 6 | Agricultural biotechnologies |
| 9 | 2 | 1 | Biotechnologies for plant health | Molecular plant pathology | AGR/12 | 6 | Agricultural biotechnologies |
| | 2 | 1 | Electives | | | 5 | |
| 10 | 2 | 2 | Field crops, seed production and biotechnology | | AGR/02 | 5 | Agricultural biotechnologies |
| 11 | 2 | 2 | Biotechnology applied to plant nursery production | | AGR/03 | 5 | Agricultural biotechnologies |
| | 2 | 2 | Internship | | | 6 | |
| | 2 | 2 | Final dissertation | | | 16 | |
| | | | | | | **120** | |

**International Master's Degree Course in**
**AGRICULTURAL AND ENVIRONMENTAL BIOTECHNOLOGY (AEB)**
(Class LM-7, Agricultural Biotechnology, DM 270/2004)

**Abbreviation**
CCdLM..... Council of the Master's Degree Course in Agricultural and Environmental Biotechnology
CdD..... Council of the Department of Agricultural, Food and Environmental Sciences
CdLM ..... Master's Degree Course
CFU ..... University Training Credits
DSA3 ..... Department of Agricultural, Food and Environmental Sciences
SD..... Didactic secretariat
SS..... Student's secretariat
TPA..... Practicals (internship)

Annex D reports the criteria and rules to be referred to for the enrolment and all didactic activities of the Master's Degree Course (CdLM):

1. Enrolment requirements;
2. Admission procedures.
3. Student exams and progression of studies;
4. Electives;
5. Internship;
6. International activities and double degree;
7. Final examination;
8. Detailed basic knowledge for enrolment in the CdLM in AEB.

**1. ENROLLMENT REQUIREMENTS**
Enrollment in the CdLM in Agricultural and Environmental Biotechnology is subject to a three-year university degree, or other qualification obtained abroad, recognized as suitable. In particular, the curricular requirements are ascertained according to class 1 of the Ministerial Decree 04/09/2000 or to the didactic system referred to class L-02 , of the DM 16/03/2007, Bachelor's Degree in Agricultural and Environmental Sciences, Biotechnology curriculum, obtained at the University of Perugia.
In all other cases and in relation to the curricular requirements, for enrollment it is necessary that the applicant gained at least 80 credits in basic and characterizing scientific disciplinary sectors (SSD, see annex A point 6), as specified below:

| **Scientific Disciplinary Sectors (SSD)** | **Minimum number of credits** | **Maximum number of credits** |
|---|---|---|
| MAT/01, MAT/02, MAT/03, MAT/05, MAT/06, MAT/07, MAT/09, FIS/01, FIS/03, FIS/07, FIS/08, INF/01 | 6 | 12 |
| CHIM/01, CHIM/02, CHIM/03, CHIM/06, CHIM/08, CHIM/09, CHIM/10 | 9 | 20 |
| BIO/01, BIO/02, BIO/03, BIO/04, BIO/05, BIO/06, BIO/09 BIO/10, BIO/11, BIO/12, BIO/13, BIO/14, BIO/15, BIO/16, BIO/17, BIO/18, BIO/19 | 20 | 70 |
| AGR/02, AGR/03, AGR/04, AGR/11, AGR/12, AGR/13, AGR/15, AGR/17, AGR/18, AGR/19 | 0 | 20 |
| AGR/07, AGR/16 | 0 | 12 |
| AGR/01 | 0 | 6 |

A knowledge of the English language of B2 level (CEFR, Common European Framework of Reference) is required for admission. On a transitional basis, the admission to the Academic Year 2024-25 of students with a B1 certification level is possible after a quick test verifying the linguistic competence; nevertheless, soon after the enrollment the students must acquire the B2 level certification at the University Language Center (CLA) within the first semester of attendance.

**2. ADMISSION**

The adequate applicant's preparation, following the ascertainment of the curricular requirements, is verified by a Commission appointed by the Degree Course Council, through an interview that takes place according to the procedures defined in the Didactic Regulation. In any case, the preparation of the applicant is considered as proven for three-year graduates who have obtained a degree mark higher than 99/110 (90%) or an average career mark of at least 27/30.

With a positive outcome of the verification, the applicant can complete enrolment in the master's degree within the deadlines indicated in the University Academic Regulations. In the event that the verification highlights shortcomings to the requirements, the applicant must provide evidence that the shortcomings have been overcome before completing the enrolment.

**3. PROGRESSION OF THE STUDIES AND STUDENTS EXAMS**

3.1. The calendar of the academic year (lectures timetable and exams calendar for each study unit) is published on the DSA3 website.

3.2. Exam dates for each study unit are distributed throughout the academic year as follows:
- winter session (Dec-Feb): 3 dates for the first semester study units;
- summer session (Jun-Jul): 3 dates for all study units;
- autumn session (September): 2 dates for all study units;

Off-course students are admitted to additional dates planned with the lecturer.

3.3. The lecturer of each study unit indicates the place and time of the test using the University On- Line Secretariat platform area (SOL-ESSE3).

3.4. The student signs up for the examination tests in the On-Line Secretariat area (SOL-ESSE3).

3.5. The lecturer of each study unit can postpone the exam date and / or time only in the event of a sudden and mandatory commitment; in such a case the lecturer must notify it in the SOL-ESSE3 platform sending an e-mail to all enrolled students.

3.6. Only for motivated didactic needs of the students the Director of the DSA3 can authorize the anticipation of the exam date. In such a case the lecturer must also guarantee the original date to students who are not interested in sustaining the exam earlier.

3.7. The President of the Examination Commission, for serious and proven reasons, may ask the Director of the DSA3 to be replaced; in this case, the substitute must be identified among the lecturers indicated in the Examination Commission.

3.8. To sit for a test/exam, the student must be in line with the payment of university fees and have taken the preparatory courses as indicated in Annex B of the Regulation, and completed the evaluation questionnaire dedicated to the students' opinions on teaching activities.

3.9. The assessment procedures of each study unit are indicated in the syllabus.

3.10. If during the test the student does not want to continue the examination, the Commission will record "Renounced" in the notes.

3.11. The Examination Commission records the results of the test by filling the exam report in the SOL-ESSE3 platform.

**4. ELECTIVES**

4.1. Electives up to 8 credits should be chosen by the student starting from the second semester of the first year amongst the didactic activities scheduled by the University of Perugia. The President of the CdLM validates their consistency with the training objectives of the AEB CdLM.

4.2. The student must submit to the SD the elective credits chosen at least 30 days before their onset, by filling a specific form available on the DSA3 website. The President of the CdLM evaluates the request and, if approved, transmits it to the SD. The student can carry out training activities at other Italian or foreign universities, in whole or in part, if authorized by the CdLM or the Erasmus Commission.

4.3. In the event a student is transferred from another CdLM, he/she can request as electives some credits acquired in the CdLM of origin; the CCdLM evaluates whether the request is consistent with the educational objectives of the AEB CdLM and eventually approves them.

4.4. If the electives are chosen for a second foreign language or for a more advanced level of English (C1 or C2), the student must refer to the procedures defined in paragraph 4.9.

4.5. If electives will be carried out in an international context, the student must refer to the procedures defined in paragraph 5 of this annex.

4.6. If the electives are chosen to integrate the practicals, the student can use a maximum of 3 credits to carry out activities in one or more DSA3 laboratories; in each laboratory the student must complete a minimum of 25 hours (1 credit). The request must be validated by the lab supervisor. The student will keep records of the hours of activities in an appropriate register. At the end, a written report on the activities carried out must be submitted to the supervisor, who will register the credits in the student's curriculum. Activities carried out in more than one lab should be registered by the President of the CdLM.

4.7. The student can use up to a maximum of 4 credits of the Electives in activities scheduled annually by the CdD and defined as "Other Educational Activities" (Altre Attività Formative).

4.8. Students willing to acquire another foreign language (French, Spanish, German or Portuguese, all level B1), they must contact the Linguistic Centre (CLA) for lectures and tests. Foreign students whose mother tongue is not Italian can choose Italian Language - level B1. CLA will send the result directly to the Student Secretariat for registration in the student's career as "Electives" for 3 CFU.4.1 Lo studente deve scegliere, tra le attività formative programmate dall'Università di Perugia, un numero di CFU pari a 8. Il Presidente del CdLM verifica che la scelta di tali attività sia coerente con il progetto formativo del CdLM.

**5. INTERNSHIP (TPA)**

5.1. Agreements with the institutions of the TPA

a. The TPA credits are 6 (see point 5.3 for the possibility of extensions) and can be carried out in university research laboratories and/or in other Italian or foreign public and private bodies (research institutes, companies, industries, professional firms).

b. The TPA institutions are those that signed a specific agreement with the DSA3 or that host students in international mobility.

c. The student who intends to promote a new agreement with an institution not yet affiliated with the DSA3 must submit a detailed description of it to the lecturer chosen as TPA tutor. The Tutor submits the proposal to the CCdLM that verifies its suitability with the objectives of the AEB CdLM. If approved the Director of the DSA3 will sign the new Agreement.

d. The institution that intends to sign an agreement with the DSA3 in order host students willing to carry out the TPA must provide detailed indications on their activity, indicating the operations in which students are to be involved during the TPA period. Information is needed before signing a new agreement, or in case of renewal of an existing one.

e. The affiliated institutions are included in a list available on the DSA3 website.

5.2. Application for the TPA

a. To apply for the TPA the student must have acquired 30 credits. The CCdLM may derogate from this requirement if adequately motivated.

b. In the application form, available on the DSA3 website, the student must detail the training objectives and the program of activities, both necessary in order to be covered by the University insurance. A copy of the application is kept by the university tutor.

c. The application must be submitted at least 30 days before the starting date of the TPA.

d. The DSA3 responsible for the TPA verifies that all the required data are present and that the program is consistent with the declarations produced by the affiliated institution about the activities that the trainees will carry out and transmit it to the CCdLM for approval.

5.3. Prolongation of the TPA activity.

The internship can be extended up to a total of 8 credits, drawing a maximum of 2 credits from the Electives. The student who intends to make use of this possibility must declare it when submitting the TPA application.

5.4. Conduct of the TPA

The student must carry out the activities declared in the approved program.

The student keeps daily records of the activities (hours and type) in a diary available on the DSA3 website, validated by the tutor.

5.5. Recognition of credits for the TPA Credits for the TPA are recognized only from:

a. activities carried out by the student in the Erasmus mobility or in any other international mobility program, approved before the student's departure and recognized, upon his/her return, according to the procedures listed in paragraph 6.4 of this annex.

b. The activities carried out within the National Voluntary Civil Service, up to a maximum of 4 credits. The CdD decides on the admissibility of the Civil Service projects proposed to the DSA3, evaluating the relevance of the activities foreseen in the projects with the training objectives of the Degree Course. The student who has carried out the TPA as part of the Civil Service projects approved by the DSA3 submits a request for recognition to the CCdLM, compulsorily documenting the nature and time commitment of the activities carried out. The CCdLM, on the basis of the documentation produced by the student, establishes the number of recognized credits.

5.6. Term and evaluation of the TPA

At the end of the TPA, the student must deliver the following documents to the university tutor:

- the TPA diary,

- the final report of the TPA,

- the evaluation questionnaire on internship activities by the student,

- the evaluation questionnaire of the company tutor. The forms are available on the DSA3 website. The above documents are evaluated by the university tutor who will record the credits. The comments box of the Internship report must clearly indicate whether it was carried out in an INTERNAL / EXTERNAL / FOREIGN structure.

The tutor keeps the written report and transmits all other documents to the SD.

For students carrying out the TPA abroad is valid what reported in 5.5a on the base of a certificate of end of mobility with the assessment by the supervisor on the activity carried out and on the final report written by the student..

## 6. INTERNATIONAL ACTIVITIES AND ATTAINMENT OF A DOUBLE DEGREE

6.1. Every year the University publishes a call for student applications with a number of international mobility grants (ERASMUS for Studies or ERASMUS Traineeship, Cooperation Agreements, etc.). Destinations, monthly grants, deadlines and participation procedures are announced on the DSA3 website.

6.2. Before departure, the student who awards a mobility grant is asked to develop a program of didactic activities (lectures, internship, laboratory) to be carried out at the host university (*learning agreement*). The Erasmus Commission of the Department validates the proposal.

6.3. At the end of the stage the activities actually carried out by the student, duly certified by the host University, are recognized in the student's curriculum with a resolution of the Erasmus Commission of the Department, ratified by the CdLM or CdD.

6.4. The same rules apply for internship carried out abroad. The recognition of the internship activity is carried out by the Erasmus Commission of the Department and ratified by the CdLM or CdD.

6.5. The recognition of the activities carried out abroad and aimed at the preparation, drafting and discussion of the thesis / final exam takes place at the time of discussion / graduation. The Erasmus Commission proposes to the Graduating Commission up to 2 additional marks to students who have successfully completed a study program abroad according to credits and marks obtained, in line with the Erasmus Regulation of the University of Perugia.

6.6. The minutes of the recognition resolution are sent to the SS and to the Erasmus Office of the University.

6.7. Students who join a mobility program for the achievement of the double degree with the MATE University of Godollo, Hungary, participate in an ad hoc call published by the University of Perugia. If at the end of the mobility they achieve 40 credits, as reported in the agreement between the two universities, in addition to the recognition of the same subjects in their university career, they will obtain the double degree.

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| PERUGIA | | | MATE | | |
|---|---|---|---|---|---|
| **Sem.** | **Study unit** | **Credits** | **Sem.** | **Study unit** | **Credits** |
| 2 | Applied microbiology | 12 | 2 | Microbiology and microbial biotechnology | 5 |
| | | | 2 | Industrial microbiology | 3 |
| | | | 2 | Environmental microbiology | 3 |
| 2 | Advanced plant breeding | 6 | 2 | Transgenesis and genome editing in plants | 4 |
| | | | 4 | Aims and results in plant breeding | 3 |
| 2 | Advanced animal breeding | 5 | 2 | Introduction to plant- and animal biotechnology | 5 |
| 4 | Biotechnologies appl. to nursery products | 5 | 2 | Cell and tissue culture methodology | 5 |
| 2 | Master Thesis1 | 3 | 2 | Master Thesis1 | 3 |
| 2 | Internship | 9 | 2 | Internship | 10 |
| | Total credits | **40** | | Total credits | **41** |

## 7. FINAL TEST

7.1. The activities related to the preparation of the final exam for the attainment of the qualification of the MSc degree foresee a credit load of 16.

7.2. These activities consist in a study on a topic of significant interest in the sector of biotechnologies applied to agricultural and environmental sciences; in particular, the thesis will be developed after a research study concerning aspects of conventional and advanced biotechnologies.

7.3. At the request of the candidates the CCdLM evaluates the possibility of admitting works produced collectively by several students and the methods of their preparation and discussion; in such situations, the CCdLM must in any case be provided with the essential elements to evaluate the individual contribution of the candidates. The same procedure applies to requests to take the final exam at other Italian or foreign universities or research institutions.

7.4. The choice of the thesis topic is made by the student according to his/her scientific and professional interests and the type of research and experimentation activities carried out by the supervisor of the DSA3. For this purpose, the graduate student identifies the availability of a tutor of the CdLM or DSA3 with whom he/she wishes to develop the topic of the thesis.

7.5. The tutor/supervisor plays the role of guide for the preparation of the thesis, is responsible for verifying the operational commitment of the graduate during its preparation and for assessing the completeness of the thesis before the discussion, and exercises the function of supervisor during the discussion of the final test.

7.6. The costs for the preparation of the thesis are borne by the candidate.

7.7. The final exam consists in the presentation and discussion of the research thesis in front of a specific Commission.

7.8. The Commission for the final exam is composed of the Professors of the CdLM, the DSA3, the three-year Degree Course in Biotechnology and the Departments involved in the degree courses in Biotechnology. The Commission is appointed by a Rector decree on a proposal of the President of the CdLM and is chaired by him/her or by the Dean of the Commission. The President of the CdLM can rectify the composition of the Commission only for documented commitments of one of the components.

7.9. The Commission expresses the evaluation of the final exam in marks out of 110, verifying the student's ability to explain and discuss the topic of his/her research with clarity and mastery, completeness and congruity, and by taking into consideration the overall student's curriculum. The final score is assigned on the basis of criteria established by the CCdLM.

7.10. The results obtained with the activity related to the final exam can be disclosed with the consent of the candidate, the supervisor and any external partners possibly involved.

7.11. For admission to the discussion of the final exam, the student must:

- have achieved all the credits required by the Didactic Regulations for all didactic activities other than the final exam;
- fulfill the obligations within the times indicated in the table below:

| DOCUMENT | TERMS |
|---|---|
| Application for graduation | 45 days before the date annually defined by the CdD |
| Delivery of the Thesis | 20 days prior to the date annually defined by the CdD |
| Last exam | 10 days before the date annually defined by the CdD |

**8. Detailed basic knowledge for enrolment in the CdLM in AEB**

The basic knowledge required for admission to the CdLM are indicated below.

Mathematics, statistics and computer science - Main mathematical tools necessary for the understanding of a broad spectrum of elementary mathematical models (knowledge extended up to derivatives and integrals). Elements of combinatory. Probability of an event; probability of the logical sum of events; probability of the logical product of events. Total probability. Scientific procedure, measurement of natural phenomena, variability of experimental data. Absolute, relative and cumulative frequency distributions. Mean, fashion and median. Range of variation, deviance, variance, standard deviation, coefficient of variability. Confidence intervals of an average. Percentiles. Population and sample. Theoretical frequency distributions: normal distribution. Sampling from a normal distribution. Parameters and estimates. Estimation methods and criteria. Correlation and regression. Use of simple IT tools (functions and analysis tools of Microsoft Excel) for the statistical analysis of the data and for the visualization of the results.

Physics - Concepts of space-time and measurement. Systems of units of measure. Dimensions of a physical quantity. Outline of vector calculus. Fundamentals of kinematics, kinematics of the material point, trajectory, motion on a predetermined trajectory: displacement, speed, acceleration. Fundamentals of Dynamics: concept of force. Force, weight and static measurement of forces. First, second and third principles of dynamics. Work and Energy: definition of work. Power. Power. Energy of position. Conservation of mechanical energy. Gases and liquids in equilibrium and in motion: pressure. Fluid statics. Thrust of Archimedes. Fluid kinematics. Bernoulli equation for perfect and real fluids. Thermodynamics: temperature, thermal equilibrium, temperature measurement. Work done on an ideal gas. Heat. Thermal equivalent of calorie. Thermal capacity and specific heat: first law of thermodynamics. Heat transmission: conduction, convection, radiation. Second law of thermodynamics. Entropy.

General and Inorganic Chemistry - Basic notions of General Chemistry and Inorganic Chemistry useful for understanding the chemical and biochemical phenomena that will be taken into consideration in the study of the environmental impact due to organic xenobiotics, with particular reference to phytosanitary products and in the study of natural molecules which can be used as plant protection products. Knowledge for understanding the mechanisms underlying the biotechnological treatment of organic waste (composting and anaerobic digestion process). Knowledge of general chemistry related to: chemical bonds; balancing of chemical reactions; acid-base reactions and redox reactions; electrolytic dissociation; homogeneous and heterogeneous equilibria; equilibrium constant; water self-protolysis; strength of acids and bases; specific constant of speed, order of reaction; reaction mechanism.

Organic Chemistry - Organic reactions and reaction intermediates. Main classes of organic molecules. Functional groups. Structural formulas. Aliphatic hydrocarbons Alkyl halides. Aromatic hydrocarbons. Aromaticity. Alcohols and phenols. Organic sulfur compounds. Carboxylic acids and derivatives. Hydroxy acids, keto acids and amino acids. Nitro-derivatives.

Aliphatic and aromatic amines. Carbohydrates, lipids, phospholipids. Heterocyclic compounds. Peptides, polysaccharides and nucleic acids.

Biochemistry - Amino acids: structure and chemical-physical characteristics. General properties and biological functions of proteins. Levels of organization of the protein structure. Enzymes nomenclature and classification. Enzymatic catalysis. Enzyme kinetics. Regulation of enzymatic activity: pH, temperature, enzymatic inhibition. Regulatory enzymes. Isoenzymes. Constitutive and inducible enzymes. Coenzymes and water-soluble and fat-soluble vitamins. Glycides: monoses, disaccharides, oligosaccharides and polysaccharides. Lipids: fatty acids, triglycerides, phospholipids. Nucleosides, nucleotides and nucleic acids. Concepts of metabolism, anabolism and catabolism. Conservation of energy: ATP. Formation of glucose 6P. Glycolytic process and the pentose phosphate pathway. Gluconeogenesis, glycogenolysis and glycogenosynthesis. Biosynthesis of fatty acids, triglycerides, phospholipids and ketone bodies. Catabolism of fatty acids. Transamination. Urea cycle. Decarboxylation of amino acids. Synthesis of glutathione. Synthesis of creatine. Krebs cycle and respiratory chain.

Biology - The kingdoms of living organisms. Protists and origin of eukaryotes: endosymbiotic theory. Cell theory. Prokaryotic and eukaryotic cells. Virus. Eukaryotic cell. Plasma membrane: composition and ultrastructure; permeability and transport of ions and molecules. Intracellular compartments. Endoplasmic reticulum. Golgi apparatus. Lysosomes. Vesicular transport, exocytosis and endocytosis. Peroxisomes. Mitochondria. Nucleus: chromatin, chromosomes, nucleolus. Cytoskeleton: microtubules, microfilaments and intermediate filaments. Cellular communication. Chemical signals. Membrane and intracellular receptors. Signal transduction. Cell cycle in eukaryotes. Apoptosis. Asexual and sexual reproduction. Meiosis. Gametogenesis and fertilization. Energy metabolism. The cell and energy. The flow of energy. Role of ATP and cellular work. Heterotrophic, chemoautotrophic and photoautotrophic organisms. Energy metabolism. Photosynthesis. Cellular respiration. Plant cytology: typical structures of the plant cell. Cell wall and its secondary modifications. Plastids. Vacuole. Primary and secondary meristems. Plant tissues: origin, cytological characters and functions.

Microbiology - General microbiology: cellular and molecular organization of prokaryotes, asexual and sexual reproduction and stages of microbial development, physicochemical factors influencing microbial growth, disinfection and sterilization, in vitro cultivation of microorganisms (culture media, isolation, storage). Main organic molecules, types of energy metabolism in microorganisms (glycolysis, homo- and hetero-fermentations, aerobic and anaerobic respiration).

Genetics - Mendelian genetics: Mendel's laws, extensions and exceptions. Mutations. Mechanisms of recombination. Determination of the genetic basis of the characters. Linkage and genetic maps. Bacterial and phage genetics. The nature of the gene. The genetic code. Regulation of gene expression. Population genetics: gene and genotype frequencies and their determination; Hardy Weinberg's law of equilibrium; fitness and adaptation.

Molecular biology - Structure and properties of DNA and RNA. Organization of the genome and genes in prokaryotes and eukaryotes. Molecular maps of the genome. Restriction endonucleases. DNA replication. Reactions catalyzed by DNA polymerases. DNA polymerase chain reaction. DNA repair systems. Homologous and site-specific recombination. Transposons. Transcription in prokaryotes. Structure of prokaryotic promoters. Eukaryotic polymerase. Regulation of transcription in eukaryotes. Protein synthesis. Maturation of transcripts and alternative splicing. Recombinant DNA technologies: vectors for cloning, construction, cloning and selection of recombinant DNA.