

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

MASTER TRAINING OFFER

Establishment	Faculty	Department
Djilali Bounaama University of Khemis Miliana	Natural and Life Sciences & Earth Sciences	Biological Sciences

Field	Branch	Speciality
Natural and Life Sciences	Biotechnology	Microbial Biotechnology

Identity sheet of the training

Location of the training

Faculty: Natural and Life Sciences & Earth Sciences

Department: Biological Sciences

External partners

Other academic institutions:

- ▶ Saad Dahlab University of Blida 1
- ▶ Hassiba Benbouali University of Chlef
- ▶ Biotechnology Research Center (CRBt)
- ▶ National Higher School of Biotechnology (ENSB)

Socio-economic partners:

- ▶ Hospital laboratories (Khemis Miliana, Miliana, Ain Defla)
- ▶ Medical analysis laboratory
- ▶ SAIDAL

International partners:

- ▶ National Institute of Agronomic Research (INRAE) France
- ▶ Institute of Research for Development (IRD) France

Objectives

In recent years, growing demands for basic research in the exploitation and development of microorganisms have come from many academic research laboratories and professionals working in this field. The objective of the “*Master in Microbial Biotechnology*” specialty is to train scientists and operational managers who master the basic techniques of Microbiology and its biotechnological applications. The lessons programmed, according to the progression of the semesters (M1 and M2), in particular the fundamental units (UEF), will allow the progressive acquisition of the various tools and basic knowledge of the microbial world in its aspects of biodiversity, evolution and adaptation in different ecosystems. The metabolic biochemistry and enzymology Unit will deal with the proteomic and enzymological aspects necessary for understanding the functioning of microbial metabolism, its interaction with the environment and its regulation. Microbial genomics is a tool for investigating microbial functions and intervenes directly in the production and valorization of biomass and microbial activities.

The study of microbial applications will allow the perception of the stakes and the impact of innovative biotechnological approaches, in terms of valorization and exploitation of microbial functionalities, in particular those relating to natural actions and activities. The UEM (Methodology) are focused on the techniques of chemical analysis and bioanalysis and the methods of characterization and identification of microorganisms, in addition to in silico tests and biostatistics analyses. Other subjects (UED and UET) deal with marketing, strategic management and communication as well as business creation, to give a better knowledge of the functioning of the company and to facilitate the professional integration of graduates and to be able to learn and undertake research activities.

Targeted skills

The technical and specialized education given to students in this training allows to train competent laureates in the fields of microbial biotechnology, such as the use of microorganisms in the food industry, the interest of microorganisms in the protection of the environment, the molecular diagnosis of infectious diseases, food microbiology (classical and molecular identification of microorganisms from food, preservation of food against contamination...etc). Our graduates will also have good skills in the field of hygiene and food safety and quality control. In addition, the trained students will have in-depth knowledge in the field of genetic engineering and its applications (genetic improvement of microorganisms producing substances of medical and agri-food interest). Thus, at the end

of this training, the student should be able not only to integrate the field of research and development but also to find scientific solutions to problems encountered in laboratories belonging to the public and private sectors.

Employability

- ✓ Food industries (microbiological analysis of food, monitoring and control of the production of food products synthesized by microorganisms, GMO diagnosis, implementation of quality standards, etc.).
- ✓ Medical laboratories (molecular diagnosis of infectious diseases such as hepatitis, tuberculosis...etc.).
- ✓ Pharmaceutical industry (monitoring the production of drugs developed by genetic engineering methods, improving the strains used...etc.).

Performance indicators

The pedagogical team relies on a coherent whole based on the synergy of scientific know-how, technical means, experiences in the field of research and teaching during the whole training. A continuous evaluation of the students, a permanent accompaniment during the realization of the training courses and the estimate of the number of graduates compared to the total of registered students constitute indicators, which will be informed regularly, testify to the effectiveness of the actions which contribute, themselves, to the achievement of the global strategic objectives.

Material resources

Pedagogical laboratories

Biochemistry and Molecular Biology Laboratory

Equipment	Number
Microscope	2
Hot plate	1
Precision scale	2
pH meter	5
Chromatography	3
Horizontal electrophoresis cells	1
Centrifugeuse	3
Water bath	2
Thermocycleur	1
Optical spectrophotometer	1
Oven	1
Refrigerator	1
Freezer (-20)	1
Hot plate	4
Heated magnetic stirrer	4
Vortex shaker	2
Generators 300 V	2

Microbiology Laboratory

Equipment	Number
Manual autoclave	2
Automatic autoclave	1
Incubator oven	2
Microscope	12
Bec bensen	20
Sterilizer oven	1
Colony counter	1
Refrigerator	1
Analytical balance	1
Water bath	1
Vertical laminar flow hood	1
Spectrophotometer	1
Stirrer	1

Biology Laboratory

Equipment	Number
Microscope	20
Analytical balance	6
Spectrophotometer	1
Thin layer chromatography	5
pH meter	1
Electric thermometer	8
Centrifuge	2
Water bath	3
Refrigerator	1
Hot plate	5
Magnetic stirrer	4
Precision scale	1
Oven	2

Semester organization of the courses

First semester

Teaching unit	Matter	Credit	Coefficient	C	TD	TP	HV
Fundamental unit (UEF)	Microbial biodiversity	6	3	3h00	1h30		67h30
	Microbial physiology and metabolism	8	4	3h00	1h30	1h30	90h00
	Enzymatic engineering	4	2	1h30	1h30		45h00
Methodological unit (UEM)	Valorization of substances of biotechnological interest	4	2	1h30	1h30		45h00
	Molecular biology techniques	5	3	3h00	1h00		60h00
Discovery unit (UED)	Scientific English	2	2	1h30	1h30		45h00
Transversale unit (UET)	Communication	1	1	1h30			22h30

Second semester

Teaching unit	Matter	Credit	Coefficient	C	TD	TP	HV
Fundamental unit (UEF)	Genomics and proteomics	6	3	3h00	1h30		67h30
	Microbial interactions	6	3	3h00		1h30	67h30
	Soil microbiology	6	3	3h00	1h30		67h30
Methodological unit (UEM)	Bioinformatics	5	3	1h30		2h30	60h00
	Techniques for the destruction and elimination of microorganisms	4	2	1h30	1h30		45h00
Discovery unit (UED)	Initiation to scientific research	2	2	1h30	1h30		45h00
Transversale unit (JET)	Legislation	1	1	1h30			22h30

Third semester

Teaching unit	Matter	Credit	Coefficient	C	TD	TP	Volume
Fundamental unit (UEF)	Toxicity and pathogenicity of microorganisms	6	3	3h00	1h30		67h30
	Bioengineering and industrial microbiology	6	3	3h00		1h30	67h30
	Microbial biotechnology applied to the environment	6	3	3h00	1h30		67h30
Methodological unit (UEM)	Experimentation and data analysis	5	3	3h00	1h00		60h00
	Molecule characterization techniques	4	2	1h30		1h30	45h00
Discovery unit (UED)	Research and valorization of results	2	2	1h30	1h30		45h00
Transversale unit (JET)	Entrepreneurship	1	1	1h30			22h30

Fourth semester

	VHS	Coeff	Credits
Personal Work	300h	10	20
Internship in a company	75h	5	10
Total Semester 4	375h	15	30

Program description

Module title: Microbial biodiversity

Credits: 6

Coefficient: 3

Prerequisites

This unit requires knowledge of general microbiology, but also knowledge of microbial ecology.

Objectives

The student must have a basic understanding of the biodiversity of microorganisms.

Contents

1. Reminder on Archaea and Proteobacteria
2. Gram-positive bacteria with low GC content
 - The class of Mollicutes (Mycoplasma)
 - Gram-positive bacteria poor in GC in the Bergey manual
 - Class Clostridia
 - The class Bacilli
3. Gram-positive bacteria rich in GC
 - General properties of actinomycetes
 - Gram-positive bacteria rich in GC in the Bergey manual
 - The suborder Actinomycineae
 - The sub-order Micrococcineae
 - The sub-order Corynebacterineae
 - The sub-order Micromonosporineae
 - The sub-order of Propionobacterineae
 - The suborder of Streptomycineae
 - The sub-order of Streptosporangineae
 - The sub-order of Frankineae
 - The order of Bifidibacteriales

4. Fungi

- The distribution
- The importance
- The structure
- Nutrition and metabolism
- Reproduction
- Characteristics of the phyla of fungi
- Slime molds and water molds

5. The algae

- The distribution
- The classification
- Cellular ultrastructure
- Nutrition
- Structure of the thallus (vegetative form)
- Reproduction
- Characteristics of the algal phyla

6. Protozoa

- The distribution
- The importance
- The morphology
- Nutrition
- Encystment and de-cystment
- Locomotor organelles
- The reproduction
- The classification
- Representative types

Evaluation methods

Continuous assessment and semester exam

Module title: Microbial physiology and metabolism

Credits: 8

Coefficient: 4

Prerequisites

This unit requires knowledge of microbiology, but also knowledge of microbial genetics and biochemistry.

Objectives

The student must have the basic concepts related to the physiology and metabolism of microorganisms.

Contents

1. Conditions for microbial development
 - ✓ Nutritive conditions
 - ✓ Physicochemical conditions
2. Microbial growth
 - ✓ Growth curve
 - ✓ Measurement of microbial growth
 - ✓ Continuous culture of microorganisms
 - ✓ Influence of the environment on growth
3. Exchange with the environment
 - ✓ Permeation mechanism (simple diffusion and specific transport)
 - ✓ Exit mechanism
4. Energy metabolism and consequences
 - ✓ Trophic types (phototrophy, chemotrophy)
 - ✓ Respiratory types (respiration, fermentations, oxidative fermentations)
5. Main pathways of catabolism
 - ✓ Reminders on the catabolism of carbohydrates, proteins, lipids and related compounds, alcohols and organic acids.

6. Anabolism

- ✓ Principles of biosynthesis
- ✓ Anaplerotic reactions and gluconeogenesis
- ✓ Synthesis of amino acids and proteins
- ✓ Synthesis of purines, pyrimidines and nucleotides

7. Regulation of metabolism

- ✓ Reminder of the gene-protein relationship
- ✓ Mechanism of regulation of metabolism
- ✓ Regulation of enzyme function
- ✓ Regulation of protein synthesis
- ✓ Importance of regulatory phenomena.

Evaluation methods

Continuous assessment and semester exam

Module title: Enzymatic engineering

Credits: 4

Coefficient: 2

Objectives

The objective of this course is to improve the ecological variability of the industry through biotechnology.

Contents

1. Generalities on enzymology
 - ✓ Enzymatic catalysis: transition state and activation energy
 - ✓ Enzyme specificity
 - ✓ Enzymatic cofactors
 - ✓ Classification of enzymes
2. Michaelis kinetics
 - ✓ Michaelis - Menten equation
 - ✓ The phases of the enzymatic reaction
 - ✓ Determination of the kinetic constants K_m and V_{max} .
 - ✓ Determination of kinetic parameters from graphical representations
3. Effectors of enzymatic reaction
 - ✓ The different types of effectors of the enzymatic reaction
 - ✓ Inhibitors and determination of kinetic parameters
 - ✓ Influence of temperature and pH
4. Industrial enzymes
 - ✓ Preparation of enzymes
 - ✓ Immobilized enzymes
 - ✓ Use of enzymes in the food industry

Evaluation methods

Continuous assessment and semester exam

Module title: Valorization of substances of biotechnological interest

Credits: 4

Coefficient: 2

Prerequisites

This unit requires knowledge of biochemistry, but also knowledge of biotechnology and plant physiology.

Objectives

The objective of this course is to study the biological properties of biomolecules and their valorisation in the agro-food field.

Contents

1. Natural products of plant origin (Terpenic compounds; polyphenolics and alkaloids)
2. Valorization and application of natural products in industry
3. The main compounds resulting from secondary metabolism and their derivatives used in industrial applications (food, cosmetics, pharmaceuticals).
 - ✓ Enzymatic activity
 - ✓ Antioxidant and anti-inflammatory activity
 - ✓ Antibacterial and antiviral activity
 - ✓ Anti-coagulant and anti-aggregating activity
 - ✓ Hormone activity
 - ✓ Anti-glycemic activity
 - ✓ Biological activities of antibodies and complement
4. Molecules of bacterial origin: biological activities, production and valuations.
5. Fungi: biomolecules of agri-food interest.

Evaluation methods

Continuous assessment and semester exam

Module title: Molecular biology techniques

Credits: 5

Coefficient: 3

Objectives

The student must know the techniques related to molecular biology and genetic engineering

Contents

1. Reminder on the properties of nucleic acids
2. Extraction, purification and revelation of nucleic acids
3. PCR and its applications
4. Molecular hybridization
5. DNA sequencing methods
6. Molecular markers
7. Recombinant DNA techniques

Evaluation methods

Continuous assessment and semester exam

Module title: Scientific English

Credits: 2

Coefficient: 2

Objectives

The student must have the basic notions of the English language in order to understand and write a scientific article.

Contents

1. Understanding communication
2. Reading and listening comprehension of scientific texts
3. Writing or speaking for specific audiences

Evaluation methods

Continuous assessment and semester exam

Module title: Communication

Credits: 1

Coefficient: 1

Objectives

As books and articles published abroad are more and more rarely translated into French, the future Master's graduate, and especially those who intend to do research, must be trained to understand them at first reading and to extract the essential points without misunderstanding.

Contents

1. English classes (written and spoken) with support from articles and publications written in English.
2. Scientific communication (overview of the different forms of scientific communication)
3. Oral communication of research results.
4. Scientific communication in the form of a poster.

Evaluation methods

Semester exam

Module title: Genomics and proteomics

Credits: 6

Coefficient: 3

Prerequisites

This unit requires knowledge of molecular biology, but also knowledge of molecular genetics.

Objectives

Know the main databases and modern methods of analysis of the evolution and functioning of genomes.

Contents

1. Introduction to genomics and proteomics
2. Post-genomic approach
 - ✓ The genome, its structure and its cellular environment
 - ✓ Functioning of the genome
 - ✓ Genome structure and roles of telomeres
 - ✓ Structural and functional analysis of centromeres
 - ✓ Transcriptomes: quantitative analysis methods
 - ✓ Multi-protein complexes and gene expression
 - ✓ Multi-protein chromatin modification complexes and cell cycle control
3. Different approaches to proteomics
 - ✓ Functional and structural proteomics
 - ✓ The challenges of proteomics
 - ✓ Expression proteomics (methods, performances and limits).

Evaluation methods

Continuous assessment and semester exam

Module title: Microbial interactions

Credits: 6

Coefficient: 3

Prerequisites

This unit requires knowledge of general microbiology, general biochemistry, secondary metabolites.

Objectives

The objective of this course is to study the role of microorganisms in natural or artificial ecosystems and the aspect of microbial activity in different fields.

Contents

1. Introduction
2. Interactions between microorganisms (signals and communization, dynamics).
3. Cyclic interactions of nutrients: life cycles.
4. Interactions between microorganisms-plant
 - Rhizobial symbiosis (rhizobia-legumes)
 - Symbiosis m mycorrhizae (fungus-plant)
5. Animal digestive flora and basis of pathogenicity.

Evaluation methods

Continuous assessment and semester exam

Module title: Soil microbiology

Credits: 6

Coefficient: 3

Prerequisites

This unit requires knowledge of general microbiology, general biochemistry, secondary metabolites.

Objectives

The objective of this course is to discover the role played by microorganisms, the consequences of their actions on the environment and their use in some practical examples. Particular attention is paid to the importance of microbiological principles in the fields of engineering.

Contents

1. General information on soil microflora.
2. Influence of the physico-chemical properties of the soil on the availability and activity of microorganisms
3. Influence of microorganisms on the physicochemical properties of soil
4. Microbial transformation of nitrogen, sulfur, manganese and phosphorus.
5. Microorganisms and organic matter
6. Exploitation of microbial activities in the biological treatment of soils.

Evaluation methods

Continuous assessment and semester exam

Module title: Bioinformatics

Credits: 5

Coefficient: 3

Prerequisites

This unit requires knowledge of molecular biology, but also knowledge of genetics and computer science.

Objectives

Identification of DNA sequences and exploitation of biological libraries.

Contents

1. Introduction to bioinformatics
 - ✓ What is the function of the genome? Of a gene ?
 - ✓ What is the biological function of a gene?
2. Prediction and structure of a gene - ORFs
3. Prediction of 2D and 3D structures of a protein
4. Similarity searches
 - ✓ Comparison with libraries
 - ✓ Multiple alignment
 - ✓ Motif search
5. Phylogeny
 - ✓ Sequence evolution by mutations
 - ✓ Phenetic methods (based on distances)
 - ✓ Cladistic methods (based on sequences)
 - ✓ Bootstrap (and other evaluation methods).

Evaluation methods

Continuous assessment and semester exam

Module title: Techniques for the destruction and elimination of microorganisms

Credits: 4

Coefficient: 2

Prerequisites

This unit requires knowledge of general microbiology and bacterial physiology.

Objectives

This course covers the study of the different types of antimicrobial agents (antibiotics, antivirals, antifungals, antiparasitics), their mechanisms of action and the resistance mechanisms developed by the microorganisms.

Contents

1. General Principles: Definitions, Kinetics of microbial lethality and conditions affecting the efficacy of antimicrobial activity.
2. Physical agents: heat, cold, filtration and electromagnetic radiation.
3. Chemical agents: mode of action and major types of chemical agents.
Disinfectants and antiseptics: definitions, chemical nature of antiseptics (alcohols, etc.) and disinfectants (aldehydes, detergents, heavy metals), use in therapeutics in cleaning operations for the conservation of bioproducts, spectrum of activity and mode of action.
4. Biological agents:
 - 4.1. Antibiotics: generalities, classification of antibiotic substances and mechanism of action
 - 4.2. Antifungals, antivirals, antiparasites: definition, classification and mode of action.
5. Resistance of microorganisms to antimicrobial agents: mechanisms of resistance, genetic supports and evolution of resistance.
6. Determination of antimicrobial activity
 - 6.1. Concept of test germ
 - 6.2. Determination of the active doses of an antimicrobial agent
 - Measurement of the phenol coefficient
 - Germ carrier method
 - Determination of minimum inhibitory and bactericidal doses

- Determination of the in vitro sensitivity to antibiotics

6.3. Control of disinfection

7. Use of antimicrobial agents in food, agriculture and animal production.

Evaluation methods

Continuous assessment and semester exam

Module title: Initiation to scientific research

Credits: 2

Coefficient: 2

Objectives

Present the basic rules of bibliographic research, write bibliographic references for the main types of documents and use a scientific article.

Contents

1. General
2. How to conduct a search?
3. Research questions
 - ✓ Sources of research ideas
 - ✓ Hypotheses: how to formulate them?
4. How to structure the essay?
5. Morphology of a research paper

Evaluation methods

Continuous assessment and semester exam

Module title: Legislation

Credits: 1

Coefficient: 1

Prerequisites

Introduce the learner to regulatory concepts, definitions and origins of legislation and knowledge of criminal consequences.

Objectives

The student must have a basic understanding of the regulatory aspects of the use of living organisms.

Contents

1. General legal concepts (introduction to law, criminal law)
2. Presentation of Algerian legislation
3. General regulations (law on consumer protection, hygiene, labeling and information, food additives, packaging, brand, safety, conservation)
4. Access to genetic resources and fair and equitable benefit sharing
5. Biopiracy
6. Patentability of life
7. Protection of traditional knowledge
8. Access to and transfer of technology
9. Management of biotechnology and distribution of its benefits
10. Control bodies (DCP, CACQUE, hygiene office, ONML)
11. Standardization and accreditation (IANOR, ALGERAC)
12. International standards (ISO, food codex, NA, AFNOR)

Evaluation methods

Semester exam

Module title: Toxicity and pathogenicity of microorganisms

Credits: 6

Coefficient: 3

Objectives

Students will be introduced to the concept of microbial toxins of bacterial and fungal origin.

Contents

1. Introduction

2. Infectivity

2.1. Stages of infection

- Contamination
- Penetration or entry of the pathogen
- Action

2.2 Microbial characteristics favoring virulence

- Adhesion, penetration and invasion power
- Pathogenicity itself,
- Attenuation and exaltation of virulence

3. Toxic power

3.1 Modalities: (Intoxications; intoxications; Toxi-infection and toxinogenesis linked to virulence)

3.2. Types of toxins

- Toxins of microbial eukaryotes
- Bacterial toxins

4. Defense of the organism

5. Demonstration of pathogenicity

Evaluation methods

Continuous assessment and semester exam

Module title: Bioengineering and industrial microbiology

Credits: 6

Coefficient: 3

Objectives

It will give students operational skills in bioengineering and handling of bioreactors with the study of the variability of culture processes, control of kinetics and microbial metabolism.

Contents

1. Introduction: The fields of activity of bioengineering
2. Industrial microorganisms. Fermentation, research of new strains, strain improvement, strain conservation
3. Industrial fermentations (fermenter, proteins of unicellular organisms: P.O.U. or SCP, organisms used and the most adapted cheap substrates)
4. The products of industrial fermentations
 - ✓ Primary metabolites obtained by microbial fermentation (amino acids, organic acids, biogas, vaccines)
 - ✓ Secondary metabolites (antibiotics, vitamins, polysaccharides).

Evaluation methods

Continuous assessment and semester exam

Module title: Microbial biotechnology applied to the environment

Credits: 6

Coefficient: 3

Prerequisites

The student must have basic knowledge of microbial biotechnology, microbial ecology, environment and soil microbiology.

Objectives

This course focuses on the use of microorganisms to assess deleterious or toxic environmental changes and bioremediation by various microorganisms.

Contents

1. Bioindicators or biosensors: - Definitions and basic concepts
 - ✓ Types of bioindicators
2. Biosensor microorganisms: - Environmental services
 - ✓ Health services
 - ✓ Agri-food service
3. Biosensors:
 - ✓ The operating principle of biosensors
 - ✓ The development of biosensors for the detection of pathogens
 - ✓ Examples of biosensors commercialized for the detection of viruses and bacteria.
4. Bioremediation of the environment (soil, water, ...)

Evaluation methods

Continuous assessment and semester exam

Module title: Experimentation and data analysis

Credits: 5

Coefficient: 3

Objectives

The objective of the course is to train students in the analysis of biological data. The aim of this module is to show how to apply the concepts and methods of statistical analysis to biological data in various fields.

Contents

1. Design, execution and conduct of an experiment and test
2. Sampling methods
3. Practice of sampling
4. Fundamentals of descriptive statistics
5. Characteristics of central tendency
6. Characteristics of dispersion
7. Methods of representing data: charts and graphs
8. Data analysis tools
 - ✓ Analysis of variance
 - ✓ Factor analysis
 - ✓ Analysis of principal components
 - ✓ Classification
 - ✓ Regressions and correlations

Evaluation methods

Continuous assessment and semester exam

Module title: Molecule characterization techniques

Credits: 4

Coefficient: 2

Objectives

The student must have knowledge of techniques related to sample separation.

Contents

1. Chromatography
 - ✓ Liquid chromatography
 - ✓ Gas chromatography
 - ✓ Partition chromatography
 - ✓ Absorption chromatography
 - ✓ Ion chromatography
 - ✓ HPLC
- ✓ Capillary electrophoresis
2. Atomic absorption
3. UV-visible spectro
4. Infrared spectro (IR)
5. Nuclear magnetic resonance spectroscopy (NMR)
 - ✓ Principle of NMR
 - ✓ The SPIN-SPIN coupling
 - ✓ Decoupling of SPINS
6. Mass spectrometry

Evaluation methods

Continuous assessment and semester exam

Module title: Research and valorization of results

Credits: 2

Coefficient: 2

Objectives

This course aims to provide the future graduate with the mechanisms and procedures related to scientific research

Contents

1. Organization of the research

- ✓ Conditions of scientific production
- ✓ Research and socio-economic environment
- ✓ Organization of research work

2. Valorization of research

- ✓ Publications and dissemination of research results
- ✓ Institutions specialized in the valorization of research
- ✓ Patents of scientific inventors

Evaluation methods

Continuous assessment and semester exam

Module title: Entrepreneurship

Credits: 1

Coefficient: 1

Objectives

i) Understand the basic principles of the business creation process; ii) Give the basic elements of advice in the different phases of business creation; iii) The different types of financing for a micro enterprise in the Algerian context; iv) Concrete realization of a business plan and the financing file

Contents

1. Types of companies
2. The insertion of the company in the productive system.
3. Power and decision in the firm.
4. Information in the company.
5. Decision-making in the company.
6. The company and finance
7. Fiscal policy and monetary policy.
8. Methods of financing

Evaluation methods

Semester exam