DEMOCRATIC AND POPULAR REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

HARMONIZATION OF TRAINING OFFER ACADEMIC MASTER

Institution	Faculty	Department
University Hassiba Benbouali of Chlef	**Faculty of Nature and Life Sciences**	**Biotechnology**

Field: Nature and Life Sciences (NLS)
Program: Biotechnology
Specialty: Microbial Biotechnology

References of the Master's Accreditation Decree (attach a copy of the decree): Decree No. 1318 of August 9, 2016, relating to the harmonization of masters

2023/2024

Context and Objectives of the Training

Training Objectives

The objective of the Microbial Biotechnology Master's program is to provide students with comprehensive theoretical and practical training on microorganisms, new technologies, and their relationships with the plant world.

The training aims to prepare prospectors and advisors in microbial biotechnology, researchers, and professionals to support the research dynamic in the fields of Science, plant biotechnology, microbial biotechnology, microbiology, production, and health, while acquiring theoretical knowledge about the main primary and secondary metabolites of plants, technologies, and microorganisms.
This practical training, from the perspective of experimental approaches, opens up applications of research in the health, agronomic, environmental, and industrial sectors. These take into account unifying themes aligned with the topics supported by accredited institutions and socio-economic needs. This type of master's is suitable for students planning a career after completing Master 2; students primarily join a research laboratory to pursue a doctorate. Their training in microbial biotechnology offers proven opportunities in research or development laboratories in the industrial, biotechnology, agri-food, and health sectors.

Regional and National Employability Potential for Graduates

Higher education institutions and research laboratories, as well as various state sectors (environment, agriculture, health, industry, and others).

Semester-Based Teaching Organization Sheet

Semester 1:

Teaching Unit	VHS	Weekly Hours	Coeff.	Credits	Teaching Mode	Evaluation Mode
	14-16 sem	C	TD	TP	Others	
Fundamental UE						
UEF1 (O/P)						
Subject 1: Biotechnology Process Engineering	67h30	3h		1h30	82h30	3
Subject 2: Microbial Ecosystem of Bioproducts	67h30	3h		1h30	82h30	3
UEF2 (O/P)						
Subject 1: Unit Operations of Bioprocesses	67h30	3h		1h30	82h30	3
Methodology UE						
UEM1 (O/P)						
Subject 1: Biostatistics and Experimental Design	60h00	1h30	1h	1h30	65h	3
Subject 2: Genomic Biotechnology	45h	1h30	1h30		55h	2
Discovery UE						
UED1 (O/P)						
Subject 1: Formulation of Biotechnology Products	45h	1h30	1h30		5h00	2
Transversal UE						
UET1 (O/P)						
Subject 1: Communication	22h30	1h30			2h30	1
Total Semester 1	375	15h00	4h	6h	375h	17

Semester 2:

Teaching Unit	VHS	Weekly Hours	Coeff.	Credits	Teaching Mode	Evaluation Mode
	14-16 sem	C	TD	TP	Others	
Fundamental UE						
UEF1 (O/P)						
Subject 1: Industrial Microbiology	67h30	3h		1h30	82h30	3
Subject 2: Microbial Genetics and Physiology	67h30	3h00	1h30		82h30	3
UEF2 (O/P)						
Subject 1: Microbiological Analysis and Quality Approach	67h30	1h30	1h30	1h30	82h30	3
Methodology UE						
UEM1 (O/P)						
Subject 1: Biofactories, Bioproducts, and Innovation	60h	1h30	1h30	1h	65h	3
Subject 2: Bioinformatics	45h	1h30	1h30		55h	2
Discovery UE						
UED1 (O/P)						
Subject 1: Analysis Methods (Physicochemical, Biological, and Characterization)	45h	1h30		1h30	5h	2
Transversal UE						
UET1 (O/P)						
Subject 1: Legislation Applied to Biotechnology	22h30	1h30			2h30	1
Total Semester 2	375	13h30	6h	5h30	375h	17

Semester 3:

Teaching Unit	VHS	Weekly Hours	Coeff.	Credits	Teaching Mode	Evaluation Mode
	14-16 sem	C	TD	TP	Others	
Fundamental UE						
UEF1 (O/P)						
Subject 1: Nano Biotechnology	67h30	3h		1h30	82h30	3
Subject 2: Hygiene in Bioindustries	67h30	3h	1h30		82h30	3
UEF2 (O/P)						
Subject 1: PGPR (Plant Growth Promoting Rhizobacteria)	67h30	3h		1h30	82h30	3
Methodology UE						
UEM1 (O/P)						
Subject 1: Biotechnology of Innovative Therapies	60h	1h30	1h	1h30	65h	3
Subject 2: Biotechnological Valorization of Agro-Industrial Residues	45h	1h30		1h30	55h	2
Discovery UE						
UED1 (O/P)						
Subject 1: Writing and Analysis of Articles and Patents	45h	1h30	1h30		5h	2
Transversal UE						
UET1 (O/P)						
Subject 1: Entrepreneurship	22h30	1h30			2h30	1
Total Semester 3	375	15h00	4h	6h00	375h	17

Semester 4:
Field: Nature and Life Sciences (NLS)
Program: Biotechnology
Specialty: Microbial Biotechnology

Internship in a company and/or university laboratory, validated by a thesis and defense.

	VHS	Coeff.	Credits
Personal Work	225	09	18
Company Internship	150	08	12
Seminars			
Other (specify)			
Total Semester 4	375	17	30

Detailed Program by Subject

Master: Microbial Biotechnology
Semester: S1
UE: Fundamental UEF 1
Subject: Biotechnology Process Engineering

- **Weekly and Semester Volume (VHS)**: 67h30 (2 Lectures + Practical Work)
- **Credits**: 6
- **Coefficient**: 3
- **Teaching Mode**: In-Person

Teaching Objectives
This course aims to teach students how to master the sizing of equipment involved in industrial manufacturing processes for products.

Recommended Prior Knowledge
Basic knowledge of enzymology and fermentation is required to follow the proposed program. Students must have knowledge in biology, microbiology, and biochemistry.

Subject Content

1. **Design and Construction of Industrial Bioreactors**
    - Design criteria: determining volume, geometry, and construction material
    - Agitation: concepts of fluids and rheological models, viscosity, flow regimes and turbulence, agitation in bioreactors
    - Mixing: determining mixing time, methods for characterizing a mixture, agitator types, calculation of agitation power
    - Aeration: biological importance of oxygen, aeration theory, oxygen demand, oxygen solubility, oxygen transfer, bubbling, aeration systems (aerators or spargers, porous aerators, orifice aerators, nozzle aerators), determination of mass transfer coefficient (KLa): dynamic and static methods
    - Effects of factors on KLa: surfactants, salts, antifoaming agents, viscosity, temperature, presence of solid particles, hydrodynamics (snowball effect)
2. **Geometries and Operating Modes of Fermenters**
    - Types of bioreactors and operating modes: stirred tank, fixed bed, fluidized bed, bubble column, air-lift
    - Operating modes: batch, fed-batch, continuous
3. **Selection of the Most Suitable Biological Reactor**
    - Bioreactor vs. chemical reactors
    - Key issues in the design and operation of bioreactors

- Fermentation technologies

4. **Non-Ideal Reactor Behavior**
    - Residence time distributions and how to predict them
    - Characterization and diagnostics: residence time distribution (RTD) function, measurement of RTD and its characteristics, RTD in an ideal reactor, non-ideal bioreactors
5. **Instrumentation and Control of Biological Reactors**
    - Parameters to monitor/control: temperature, pressure, agitator power, flow rate, pH, dissolved oxygen (DO), etc.
    - Types of sensors: physical, physicochemical, biochemical
    - Control systems: feedback control loop, automatic control loop

Practical Work

- Determination of KLa in a bioreactor
- Comparison of agitator power
- Hydrodynamics

Personal Work

- Presentations/reports outside practical and tutorial sessions, tutorial reports, practical work reports, essays (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites), field trip reports, internship report

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Stanbury, P. F., Whitaker, A., Hall, S. J. (1995). *Principles of Fermentation Technology*, 2nd Edition, Elsevier Science Ltd. (ISBN 0-7506-4501-6)
2. Shuler, M. L., Kargi, F. (2001). *Bioprocess Engineering: Basic Concepts*, 2nd Edition, Prentice Hall (ISBN 978-0130819086)

3. Bailey, J. E., Ollis, D. F. (1987). *Biochemical Engineering Fundamentals*, McGraw-Hill (ISBN 978-0070032125)
4. Fogler, H. S. (2011). *Elements of Chemical Reaction Engineering*, Prentice Hall (ISBN-13: 978-0-13-714612-3)
5. Articles published in *Biocontrol Science and Technology / Biological Control / BioControl*
6. Bellows, T. S., Fisher, T. W. (1999). *Handbook of Biological Control*, Academic Press, 1046 p.
7. Van Driesche, R., Bellows Jr., T. S. (2012). *Biological Control*, Springer

UE: Fundamental UEF 1
Subject: Microbial Ecosystem of Bioproducts

- **VHS**: 67h30 (Lectures + Practical Work)
- **Credits**: 6
- **Coefficient**: 3

Teaching Objectives
Not specified in the original text (to be completed if necessary).

Recommended Prior Knowledge
Basic knowledge of microbiology.

Subject Content
Chapter 1: Biodiversity and Microbial Ecology

1. Definition of an ecosystem
2. Microbial ecology, importance, and applications
3. Microbial biodiversity and the universal tree of life
4. Factors affecting the development of microorganisms

Chapter 2: Microbial Ecosystem of Dairy Products

1. Food ecosystems and biopreservation
2. Microbial flora of dairy products
3. Factors affecting the development of germs
    - 3.1 Intrinsic factors
    - 3.2 Extrinsic factors
4. Sources of contamination

Chapter 3: Microbial Ecosystem of Fruits and Vegetables

1. Soil and the rhizosphere
2. Microbial community of fruits
    - 2.1 Molds
    - 2.2 Yeasts
    - 2.3 Bacteria
3. Microbial community of vegetables
    - 3.1 Bacteria

- 3.2 Fungi

Chapter 4: Microbial Ecosystem of Meat Products

1. Generalities on meat and meat products
2. Microbiology of meat and meat products
3. Meat-derived products: microbiology of dried meat, microbiology of salted meat
4. Technologies/processes for manufacturing meat products

Chapter 5: Microbial Ecosystem of Egg Products

1. Generalities on egg products
2. Microbiology of egg products
3. Properties of egg products
4. Alterations of egg products
5. Preservation of egg products
6. Hazards of egg products

Chapter 6: Microbial Ecosystem of Cereals

1. Generalities on cereals
2. Microbiology of cereals
3. Cereal products
4. Microbiology of cereal-derived products

Chapter 7: Local Products

Practical Work

- TP1: Enumeration of aerobic microorganisms in dairy products (e.g., Lactobacillus in yogurt)
- TP2: Microbiological analysis of pasteurized fruit juice
- TP3: Microbiological analysis of milk

Personal Work

- Presentations/reports outside practical and tutorial sessions, tutorial reports, practical work reports, essays (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites), field trip reports, internship report

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Smith, S., Read, D. (2008). *Mycorrhizal Symbiosis*, 3rd Edition, Academic Press
2. Rai, M. K. (2006). *Handbook of Microbial Biofertilizers*, The Haworth Press Inc.
3. Tilak, K. V. B. R., Pal, K. K., Dey, R. (2010). *Microbes For Sustainable Agriculture*, International Publishing House
4. Deshmukh, A. M., Khoragade, R. M., Dixit, P. P. (2007). *Handbook of Biofertilizers and Biopesticides*, Oxford Book Company
5. Lichtfouse, E. (2009). *Genetic Engineering, Biofertilisation, Soil Quality and Organic Farming*, Springer

UE: Fundamental UEF 2
Subject: Unit Operations of Bioprocesses

- **VHS**: 67h30 (2 Lectures + Practical Work)
- **Credits**: 6
- **Coefficient**: 3

Teaching Objectives
This module provides the scientific and technical foundations for sizing industrial separation units (crystallization, absorption, liquid-liquid extraction, etc.) and mastering the writing of material, energy, and heat balances accompanying these separation techniques.

Recommended Prior Knowledge
Not specified in the original text (to be completed if necessary).

Subject Content

- **Chapter I: Liquid-Liquid Extraction**: Principle, techniques, and applications
- **Chapter II: Solid-Liquid Extraction**: Principle, techniques, and applications
- **Chapter III: Crystallization**
- **Chapter IV: Absorption**
- **Chapter V: Adsorption**
- **Chapter VI: Simultaneous Heat and Mass Transfer**: Drying and humidification
- **Chapter VII: Filtration**
- Diffusion
- Pervaporation, per-extraction

Practical Work

- TP 1: Liquid-liquid extraction: separatory funnel, partition coefficient
- TP 2: Solid-liquid extraction: Soxhlet
- TP 3: Crystallization of sucrose
- TP 4: CO□ absorption
- TP 5: Adsorption on activated carbon
- TP 6: Ion exchange: water softening
- TP 7: Reverse osmosis: molecule extraction, demineralization
- TP 8: Ultrafiltration
- TP 9: Extraction by physical process: sonication (ultrasound)

Personal Work

- Presentations/reports outside practical and tutorial sessions, tutorial reports, practical work reports, essays (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites), field trip reports, internship report

Note

The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Humphrey, J. L., Keller II, G. E. (2001). *Separation Processes - Techniques, Selection, Sizing*, Dunod, Paris
2. Fouduet, H. (2012). *Main Fundamentals of Process Engineering and Chemical Technology*, Lavoisier, Paris
3. Lietol, J. (2004). *Chemical Engineering for Chemists*, Lavoisier, Paris
4. Donovan, D. (2009). *Unit Operations*, Ellipses
5. Seader, J. D. (1998). *Separation Process Principles*, Wiley, New York
6. Treybal, R. E. (1980). *Mass Transfer Operations*, 3rd Edition, McGraw-Hill, New York

UE: Methodology UEM 1
Subject: Biostatistics and Experimental Design

- **VHS**: 60h00 (Lectures + Tutorials + Practical Work)
- **Credits**: 5
- **Coefficient**: 3

Teaching Objectives
Provide methodological tools commonly used to describe and test biological phenomena. Experimental designs are a valuable tool and a scientific asset for any experimenter, serving to optimize the organization of experiments for maximum information with minimal experimental effort.

Recommended Prior Knowledge
Knowledge of mathematics.

Subject Content
Chapter I: Descriptive Statistics

- Non-parametric statistics
- Comparison of independent samples (two-factor ANOVA and beyond, hierarchical ANOVA)
- Relationships between variables (multiple regressions, stepwise, non-linear)
- Analysis of covariance
- Multidimensional analyses (discriminant analysis, PCA, FCA)

Chapter II: Experimental Design

1. **Introduction to Experimental Designs**
    - History of experimental designs
    - Benefits of experimental designs
    - Basic vocabulary
    - Steps in an experimental design study
    - Algebraic and statistical aspects of experimental designs
2. **Choice of Experiments**
    - Multilinear regression
    - Coded or centered reduced variables
    - Simple application of coefficient calculation
    - Importance of choosing experimental points

- Effect matrix

3. **First-Degree Experimental Designs**
    - Construction of complete factorial designs
    - Definition of main effects and interactions – Calculations
    - The 2^2 design (factors studied: A and B)
    - The 2^3 design (factors A, B, and C)
    - The 2^n designs
4. **Second-Degree Experimental Designs**
    - Centered composite designs
    - Doehlert designs

Tutorials

- TD1: Calculation of coefficients for a first-degree model
- TD2: Application of statistical tests for validating a first-degree model
- TD3: Development of a first-degree model
- TD4: Construction of a second-degree model based on a centered composite design

Practical Work

- Use of statistical software

Personal Work

- Presentations/reports outside tutorial sessions, tutorial reports (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites)

Note

The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Hoshmand, A. R. (2006). *Design of Experiments for Agriculture and Natural Sciences*, 2nd Edition, Chapman & Hall/CRC
2. Montgomery, D. C. (2013). *Design and Analysis of Experiments*, 8th Edition, John Wiley & Sons
3. Dalgaard, P. (2008). *Introductory Statistics with R*, 2nd Edition, Springer
4. Wehrens, R. (2011). *Chemometrics with R. Multivariate Data Analysis in the Natural Sciences and Life Sciences*, Springer
5. Hair, J. F., Babin, B. J., Anderson, R. E. (2018). *Multivariate Data Analysis*, 8th Edition, CENGAGE

UE: Methodology UEM 1
Subject: Genomic Biotechnology

- **VHS**: 45h00 (Lectures + Tutorials)
- **Credits**: 4
- **Coefficient**: 2

Teaching Objectives
This teaching unit focuses on the concept of biotechnology and cellular factories. Its goal is to enable students to understand the implications of discoveries in biology (current and potential applications) as a highly diverse and constantly evolving field. This comprehensive view (covered fields and scientific foundations) should contribute to a better definition and evaluation of the benefit/risk ratio with any use of biotechnologies.

Recommended Prior Knowledge
Knowledge of cellular biology and animal biology.

Subject Content

- Genomic biotechnology
- Pharmacogenomics and pharmacogenetics
    - Drug screening, genetic relationships, genomics and genotype, pharmacotoxicology
- Cloning of multicellular organisms and transgenesis
- Conservation of endangered species
- Therapeutic cloning, expansion of pluripotent and multipotent stem cells in vitro
- Human genetics and genomics
    - Genetic mapping methods, third-generation genetic maps
    - Gene and human disease research, gene therapy
- Unicellular and multicellular factories
    - Heterologous expression and proteins for pharmaceutical use (toxins, vaccines, antibodies, blood and plasma proteins, hormones and growth factors, enzymes)
    - Genomics of beer and wine yeasts

Tutorials

- Application of the various chapters

Personal Work

- Presentations/reports outside tutorial sessions, tutorial reports (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites)

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. *Genomics and World Health*, Geneva, World Health Organization, Advisory Committee on Health Research, 2002
2. *Bridging the Genomics Divide. Fact Sheet*, Ludwig Institute for Cancer Research, 2004 (www.licr.org/C7_news/030129_genomics.php)
3. Daan, J. A., Cromellin, A. N., Sindelar, R. D. (2002). *Pharmaceutical Biotechnology. An Introduction for Pharmaceutical Scientists*, 2nd Edition, Taylor and Francis Inc.
4. Thorsteinsdottir, H. et al. (2003). "Genomics—a public health good", *Lancet*, 36:891–2
5. Acharya, T., Daar, A., Singer, P. A. (2003). "Biotechnology and the UN's Millennium Development Goals", *Nature Biotechnology*, 21(12):1434–6
6. Dickson, D. (2004). "A case for more 'joined up thinking'", *Science and Development Network* (www.scidev.net/editorial/)

UE: Discovery UED 1
Subject: Formulation of Biotechnology Products

- **VHS**: 45h00 (Lectures + Tutorials) (Distance + In-Person)
- **Credits**: 2
- **Coefficient**: 2

Teaching Objectives
The course enables students to become familiar with the practical applications of biotechnology and to explore the challenges of scientifically formulating products.

Recommended Prior Knowledge
Not specified in the original text (to be completed if necessary).

Subject Content

1. **Colloids, Phases, Interfaces**
    - General remarks
    - Essential concepts in colloid chemistry
    - Intermolecular bonding forces
    - Liquid-gas and liquid-liquid interfaces
    - Cohesion, adhesion, and spreading
    - Solid-liquid interface
    - Colloid association, primary and secondary structures
    - Physical behavior of atoms and molecules within phases and at interfaces/surfaces
2. **Emulsions - Properties and Production**
    - General remarks
    - Emulsion formulation
    - Stabilization by solid particles
    - Emulsion phenomenology
    - Emulsion stability
    - Factors determining coalescence rate
    - Emulsion inversion
    - Emulsification techniques
    - Key implications of emulsion stability theory

3. **Microemulsions, Vesicles, and Liposomes**
    - Microemulsions
    - Vesicles and liposomes
4. **Foam**
    - General remarks
    - Foam stabilization
    - Forces in thin films
    - Foaming agents
    - Foam stabilizers
    - Anti-foaming additives
5. **Production and Properties of Suspensions and Colloidal Dispersions**
    - Dispersion procedure: definition
    - First step: powder wetting
    - Special dispersion methods
    - Third step of the dispersion procedure
    - Dispersion stabilization
    - Key points for formulation chemists
    - Colloid stability theory
    - Flocculation or coagulation of suspensions
    - Formulation of stable dispersions
    - Second step: grinding and particle distribution in the liquid
6. **Solid Forms**
    - Powders and powder mixtures
    - Agglomerates, granules
    - Preparation and properties of instant products
    - Microencapsulation
7. **Rheology**
    - Basic principles
    - Viscosity of dispersions and emulsions

- Viscosity of molten polymers and solutions
- Viscometers

8. **Solubility Parameters, Log P, LSER, M Numbers**
    - Hildebrand solubility parameters
    - Multicomponent solubility parameters
    - Incremental methods
    - Solvent mixtures
    - Polymer solutions
    - Application of solubility parameters
    - QSAR, octanol/water partition coefficient
    - LSER
    - M numbers
9. **Solubility, Crystallization**
    - Solubility
    - Crystallization
10. **Bio-cosmetics**
    - Skin as a substrate for cosmetics
    - Effects of surfactants on the skin
    - Bio-cosmetic preparations
    - Emulsions in bio-cosmetics
    - Microemulsions and liposomes in cosmetics
    - Solutions
    - Bath and shower products
    - Capsules
    - Powders, powdered creams
    - Oral and dental hygiene products
    - Shaving aids
    - Hair bio-cosmetics
    - Bases and auxiliaries

11. **Pharmaceutical Biotechnology**
    - Absorption of the active substance
    - General remarks on formulations and drug administration
    - Drug dosage forms
    - Preservatives and antioxidants
12. **Food Formulations: Probiotics, Nutraceuticals, and Dietary Supplements**
    - Key principles for formulating food ingredients
    - Food colloids
    - Proteins
    - Lipids
    - Polysaccharides
13. **Agricultural Formulations**
    - Formulations and targets of active substances
    - Types of formulations
    - Adjuvants
14. **Pigments and Dyes**
    - Solubility of pigments and dyes
    - Pigments
    - Dyes

Tutorials

- Applications of the various chapters
- Case studies

Personal Work

- Presentations/reports outside tutorial sessions, tutorial reports (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites)

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

- Books, handouts, websites related to the course program

UE: Transversal UET 1
Subject: Communication

- **VHS**: 22h30 (Lectures) (Distance + In-Person)
- **Credits**: 1
- **Coefficient**: 1

Teaching Objectives
Analyze the objectives of internal and external communication and present the methodologies needed to conduct the main communication actions.

Recommended Prior Knowledge
Linguistic basics.

Subject Content
Targeted Skills

- Ability to communicate effectively orally and in writing
- Ability to present well and express oneself in public
- Listening and exchange skills
- Ability to use professional internal and external communication documents
- Ability to draft professional internal and external communication documents

Strengthening Linguistic Skills

- Communication methods
- Internal and external communication
- Meeting techniques
- Oral and written communication

Others

- Preparation and oral presentation of a poster during a methodological workshop dedicated to plant biotechnology
- Presentation of a research project on a specific topic in plant biotechnology
- Writing a motivation letter regarding the student's commitment to pursuing doctoral training in biotechnology
- Creation of tables and graphs
- Preparation and design of slides

Personal Work

- Oral presentations, facilitation of workshops in the presence of instructors, simulation of meeting organization, conducting surveys with citizens within the framework of various modules

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Anonymous (2018). *Communication. Academic Master. Fundamental and Applied Genetics*, PowerPoint, USTO, Oran, 67 p.
2. Claessens, M., Gama, M.-J. (2007). *Scientific Communication. Pedagogical Project*, Université Libre de Bruxelles, 30 p.
3. Gaillard, M. (2009). *Session No. 1. Generalities on Scientific Communication*, PowerPoint, Doctoral School of Marine Sciences
4. Guerrah, A. (2020). *Documentary Research and Thesis Design*, Course Handout (Master Level), University Echahid Hamma Lakhdar of El-Oued, 106 p.
5. Lichtfouse, E. (2009). *Writing for Publication! Practical Advice for Scientists*, Springer, France, 105 p.
6. Nadji, F., Boudia, D. (2004). *Guide to Managing Bibliographic References. Writing and Citation*, INSA, Lyon, France, 12 p.
7. Pochet, B. (2018). *Understanding and Mastering Scientific Literature*, Les Presses Agronomiques de Gembloux, Belgium, 157 p.
8. Zebbar, D. (2013). *Guide for Writing and Formatting Final Study Theses*, University of Tissemsilt, 11 p.

Master: Microbial Biotechnology
Semester: S2

UE: Fundamental UEF 1
Subject: Industrial Microbiology

- **Weekly and Semester Volume (VHS)**: 67h30 (2 Lectures + Practical Work)
- **Credits**: 6
- **Coefficient**: 3

Teaching Objectives
This course aims to teach students how to master knowledge about the exploitation of industrial microorganisms through the selection, choice, and operation of industrial fermentation stations for product manufacturing.

Recommended Prior Knowledge
Basic knowledge of enzymology, microbiology, and fermentation is required to follow the proposed program. Students must have knowledge in biology, microbiology, and biochemistry.

Subject Content

1. **Introduction to Industrial Microbiology**
    - Industrial microbiology and its relationship with biotechnology
    - Objectives and applications
    - Classical vs. modern industrial microbiology
    - Overview of methods and processes
2. **Industrial Microorganisms**
    - Prerequisites for industrial microorganisms
    - Prospecting, isolation, and selection of organisms with industrial potential
    - Screening, isolation, and selection of new isolates
    - Importance of microbial identification and characterization
    - Identification and characterization methods
    - Characterization of isolates in terms of industrial application
    - GRAS status
    - Growth, productivity, specific production rate, yield
3. **Preservation of Industrial Microbes**
    - Conservation methods

- Assessment of purity, viability, and genetic stability
- Collections

4. **Strain Improvement**
5. **Fermentation Substrates**
    - Media formulation
    - Industrial waste as fermentation media
    - Storage
6. **The Fermentation Station**
    - Fermentation station: equipment and space requirements
    - Microbiology laboratory
    - Laboratory analytical support
    - Raw material storage
    - Media preparation
    - Fermenter layout
    - Nutrient feed tanks
    - Sterile filters
    - Air compressors
    - Valves (to maintain sterility)
    - Pumps
    - Cooling equipment
    - Environmental control
    - Product and waste treatment
7. **Main Industrial Products**
    - Biomass
    - Cellular bodies: SCP, starters, probiotics, microalgae, etc.
    - Production of primary and secondary metabolites
    - Biosolvents and bioenergy
    - Organic and nucleic acids
    - Antibiotics and other antimicrobials

- Enzymes
- Biopolymers
- Flavors and fragrances
- Biopesticides
- Biofertilizers
- Biostimulants and vitamins
- Bioplastics

8. **Product Processing**
    - Product concentration/purity
    - Substrate conversion degree
    - Separation/purification processes

Practical Work

- Food and non-food fermentations
- Bioreactor operation and growth kinetics
- Educational visit

Personal Work

- Presentations/reports outside tutorial sessions, tutorial reports (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites)

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Waites, M., Morgan, N., Rockey, J. (2002). *Industrial Microbiology*, Blackwell Science
2. Ratledge, C., Kristiansen, B. (2002). *Basic Biotechnology*, 2nd Edition, Cambridge University Press

3. Baltz, R. H., Demain, A. L., Davies, J. E. (2010). *Manual of Industrial Microbiology and Biotechnology*, 3rd Edition, ASM Press
4. *Journal of Industrial Microbiology & Biotechnology*, Springer

UE: Fundamental UEF 1
Subject: Microbial Genetics and Physiology

- **VHS**: 67h30 (2 Lectures + Tutorials)
- **Credits**: 6
- **Coefficient**: 3

Teaching Objectives
Not specified in the original text (to be completed if necessary).

Recommended Prior Knowledge
Basic knowledge of microbiology and genetics.

Subject Content

1. Anatomy and function of bacterial cell parts: bacterial membranes, microbial cell walls
2. Growth and action of antibiotics
3. Bacterial energetics and transport mechanisms: group translocation, ABC transporters, protein secretion
4. Bacterial motility and chemotaxis: signal transduction
5. Diversity of microbial metabolisms: interest in applications in the agri-food and industrial fields, importance for the environment (natural balances and depollution), adaptive physiological responses in yeasts
6. Global modulation of gene expression in specific physiological states: biofilms, viable but non-culturable state, sporulation
7. Genetic exchange and genetic engineering in industrially relevant bacteria: transposons and antibiotic resistance, GMO or non-GMO
8. Introduction to medical microbiology: pathogenicity and host-pathogen relationships
9. Different approaches to studying metabolism (physiological, biochemical, genetic, and evolutionary):
    - Hydrogen metabolism and hydrogenases
    - Microbial degradation of major carbon polymers on the planet
    - Respiration and photosynthesis: evolution of energy metabolisms

Tutorials

- Applications of the various chapters
- Case studies

Personal Work

- Presentations/reports outside tutorial sessions, tutorial reports (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites)

Note

The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Dale, J., Park, S. F. (2010). *Molecular Genetics of Bacteria*, Wiley
2. Kim, B. H., Gadd, G. M. (2008). *Bacterial Physiology and Metabolism*, Cambridge University Press
3. Moat, A. G., Foster, J. W., Spector, M. P. (2002). *Microbial Physiology*, 4th Edition, Wiley-Liss
4. Moore, D., Frazer, L. N. (2010). *Essential Fungal Genetics*, Springer
5. Reddy, S. M., Reddy, S. R. (2007). *Microbial Physiology*, Scientific Publishers Journals Dept

UE: Fundamental UEF 2
Subject: Microbiological Analysis and Quality Approach

- **VHS**: 67h30 (Lectures + Tutorials + Practical Work)
- **Credits**: 6
- **Coefficient**: 3

Teaching Objectives
This subject enables students to acquire knowledge about the different types of techniques used in microbiological control, as well as the methods and tools necessary for quality control and assurance in an industrial environment.

Recommended Prior Knowledge
Knowledge of microbiology, food microbiology, bacterial identification techniques, and microbial biochemistry.

Subject Content
Chapter I: Microbiological Control Methods

1. Indicator organisms
2. Direct control
3. Culture techniques
4. Enumeration methods
5. Alternative methods:
    - Dye reduction tests
    - Electrical methods
    - ATPmetry
6. Rapid detection methods for specific microorganisms and toxins:
    - Immunological methods
    - DNA/RNA methodologies

Chapter II: Studies of Technological Aptitudes of Industrially Relevant Microorganisms

Chapter III: Microbiological Quality Control and Assurance

1. Quality and criteria
2. Sampling scheme
3. Quality control using microbiological criteria
4. Source controls:

    - Training
    - Facilities and operations
    - Equipment
    - Cleaning and disinfection
5. Good Manufacturing Practice codes
6. HACCP concept

Practical Work

- TP1: Enumeration techniques in liquid media
- TP2: Enumeration techniques in solid media
- TP3: Study of certain technological properties of a lactic ferment

Tutorials

- Applications of the various chapters
- Case studies

Personal Work

- Presentations/reports outside tutorial sessions, tutorial reports (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites)

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Bonnefoy, C., et al. (2002). *Microbiology and Quality in Agri-Food Industries*, Collection Biosciences et Techniques
2. Bourgeois, C. M., et al. (1996). *Food Microbiology, Volume 1: Microbiological Aspects of Food Safety and Quality*, TEC & DOC, Lavoisier
3. Bourgeois, C. M., Leveau, J. Y. (1980). *Analysis and Control Techniques in Agri-Food Industries: Microbiological Control*, Technique et Documentation

4. Lebres, E., Mouffok, F. (1999). *Practical Guide to Microbiological Analysis of Foodstuffs*, Institut Pasteur d'Algérie
5. Carry Janet, E. L., et al. (2003). *Handbook of Culture Media for Food Microbiology*, Volume 37, Elsevier Science
6. Baledent, F. *Hemocytometer Cells*, Hôpital de Saint-Denis, France
7. Prescott, H. (2002). *Laboratory Exercises in Microbiology*, 5th Edition
8. Guiraud, J., Galzy, P. (1980). *Microbiological Analysis in Food Industries*, L'Usine
9. Leveau, J. Y., et al. *Microbiological Safety of Food Processes*, Collection Série Technique de l'Ingénieur
10. CAQCE Standard. *Inspection Guide on Sampling*
11. NF ISO 17025 Standard. *General Requirements for the Competence of Calibration and Testing Laboratories*
12. Standard for the detection and enumeration of coliforms and streptococci, *Practical Guide to Foodstuff Analysis*, Institut Pasteur
13. Swiss Accreditation Service (SAS). (2013). *Guide for Validating Microbiological Test Methods and Evaluating Their Measurement Uncertainty*

UE: Methodology UEM 1
Subject: Biofactories, Bioproducts, and Innovation

- **VHS**: 60h00 (Lectures + Tutorials + Practical Work)
- **Credits**: 5
- **Coefficient**: 3

Teaching Objectives
This subject enables students to acquire knowledge about biofactories, innovations, and patents.

Recommended Prior Knowledge
Knowledge of biology, microbiology, and biochemistry.

Subject Content

1. **Defining a Biofactory**:
    - Of plant origin
    - Of animal origin
    - Of microbiological origin
2. **Biotransformation of Metabolites by Cell Cultures from Different Sources**:
    - Plant, animal, or microbiological
    - Production of industrial bioproducts
    - Immobilization of cells, plants, or others
3. **Production of Biomass and Secondary Metabolites of Plant and Fungal Origin**
4. **Biofactories Used in Bioremediation from Algae**
5. **Culture of Different Types of Cells or Tissues in Bioreactors**
6. **Commercial Applications of Biotechnology and Natural Compounds**:
    - Pharmacology
    - Food industry
    - Phytochemicals or others
7. **Development of the New Product Concept**
8. **Types of Innovations**:
    - Product innovation
    - Process innovation

- Organizational innovation
- Innovation marketing

9. **Management of Research, Development, and Innovation (RDI)**: Regulations
10. **Protection of Innovations**:
    - Intellectual property and industrial property
    - Patents / Utility models; industrial designs and models
    - Trademarks and trade names

Practical Work

- Cell cultures
- Field trip

Tutorials

- Applications of the various chapters

Personal Work

- Presentations/reports outside tutorial sessions, tutorial reports (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites)

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Becker, E. W. (2008). *Microalgae: Biotechnology and Microbiology*, Cambridge University Press
2. Neumann, K.-H., Kumar, A., Imani, J. (2010). *Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application*, Springer
3. Rani, K. (2012). *Production of Secondary Metabolites: Production of Antibiotics, Amino Acids, Enzymes and Use of Microbes as Bio-factories*, LAP LAMBERT Academic Publishing

4. http://www.marcasepatentes.pt/

UE: Methodology UEM 1
Subject: Bioinformatics

- **VHS**: 45h00 (Lectures + Tutorials)
- **Credits**: 4
- **Coefficient**: 2

Teaching Objectives
Provide an in silico approach to biology, consisting of computerized analysis of biological data using a set of tools (concepts, methods, software, etc.). Discover a discipline complementary to traditional biology approaches.

Recommended Prior Knowledge
Computer science, molecular biology, biochemistry, and statistics.

Subject Content

- **Introduction**
    - What is bioinformatics?
    - History of bioinformatics
- **Acquisition, Organization, and Storage of Data**
    - Nucleic sequence databases
    - Protein sequence databases
    - Other types of databases
- **Data Analysis**
    - Similarity searches in databases
    - Search for open reading frames (ORFs)
- **Prediction of Gene Organization**
    - Predictive methods for secondary structures
- **Visualization of Three-Dimensional Structures**
- **Sequence Comparisons**
    - Principles, calculation matrices, alignment software, homology searches, motif identification, multiple alignments
- **Modeling of Molecular Interactions**

Tutorials and Practical Work

1. Bibliographic research in:

    - Resource centers (NCBI, EBA)
    - Sequence databases
2. Sequence analysis and sequence comparison

Personal Work

- Presentations/reports outside practical sessions, practical work reports, essays (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites), internship report

Note

The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Pevzner, P. A. (2008). *Molecular Bioinformatics: An Algorithmic Approach*, Collection IRIS, Springer
2. *Statistical Analysis and Optimization in Bioindustries*, Hermann, 1997
3. www.gigapedia.com
4. Tagu, D., et al. *Bioinformatics (Principles of Tool Use)*
5. *Nucleic Acids Research*, Ludwig, W., et al.
6. Tamayo, P., et al. “Interpreting patterns of gene expression with self-organizing maps: methods and application to hematopoietic differentiation”

UE: Discovery UED 1
Subject: Analysis Methods (Physicochemical and Characterization)

- **VHS**: 45h00 (Lectures + Practical Work)
- **Credits**: 2
- **Coefficient**: 2

Teaching Objectives
Train the student in analytical techniques and equipment used in analysis, control, and research laboratories.

Recommended Prior Knowledge
General chemistry, organic chemistry, inorganic chemistry.

Subject Content
I. Extraction

1. Proteins
2. Lipids
3. Carbohydrates

II. Purification and Separation Methods

1. Chromatography: general aspects
2. High-Performance Liquid Chromatography (HPLC)
3. Gas Chromatography (GC)
4. Ion Chromatography
5. Size-Exclusion Chromatography
6. Supercritical Fluid Chromatography
7. Capillary Electrophoresis and Electrochromatography

III. Spectrometric Analysis Methods

1. Ultraviolet and visible absorption spectrometry
2. Mid- and near-infrared spectrometry
3. Fluorometry and chemiluminescence
4. Atomic absorption and flame emission

IV. Isotopic Methods

1. Assay methods by radioactive labeling

V. Other Methods

1. Mass spectrometry
2. Immunochemical and immuno-enzymatic methods

Practical Work

- Sugar assay by spectrophotometry
- Enzymatic glucose assay
- Determination of fatty acid profile by GC
- Separation of milk proteins by electrophoresis

Personal Work

- Practical work reports in document form

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Rouessac, F., Rouessac, A. (2004). *Chemical Analysis: Modern Instrumental Methods and Techniques*, Dunod, Paris
2. Skoog, D., West, D., Holler, F. (1997). *Analytical Chemistry*, De Boeck
3. Paré, J. R. J., Belanger, M. R. (1997). *Instrumental Methods in Food Analysis*, Elsevier Science
4. Charlot, G. (1996). *Quantitative Analytical Chemistry: Chemical and Physicochemical Methods*, Masson
5. Charlot, G. (1993). *Chemical Reactions in Aqueous Solution and Ion Characterization*, Masson

UE: Transversal UET 1
Subject: Legislation Applied to Biotechnology

- **VHS**: 22h30 (Lectures) (Distance + In-Person)
- **Credits**: 1
- **Coefficient**: 1

Teaching Objectives
Reflection on the preparation of an AMM (Marketing Authorization) dossier – development of specifications for Good Manufacturing Practices.

Recommended Prior Knowledge
All contents of the training program.

Subject Content

- European and French regulations: agency notebooks, AMM dossier, decree on dietary supplements
- Regulations in Algeria
- General regulations: consumer protection law, hygiene, labeling and information, food additives, packaging, trademark, safety, preservation
- Specific regulations (personal work, presentations)
- Control bodies: DCP, CACQUE, hygiene office, ONML
- Standardization and accreditation: IANOR, ALGERAC
- International standards: ISO, Codex Alimentarius, NA, AFNOR
- Legislation concerning: production, harvesting, wholesale and retail sales
- Management of research, development, and innovation (RDI): regulations
- Protection of innovations:
    - Intellectual property and industrial property
    - Patents / Utility models; industrial designs and models
    - Trademarks and trade names

Personal Work

- Presentations/reports, tutorial reports, essays (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites)
- Analytical study of an article (legal text)

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Moumen, A., Ould Ramol, A., et al. (2001). *Regulation, Biosafety, and Bioethics in Biotechnology*
2. Ahmed Si Ali (2009). *Introduction to Law*, University Hassiba Ben Bouali, Chlef (Arabic version)
3. Nahas, M., Mahieddin (2007). *Legal Thought, Law, and Legal Practice in Algeria in the Face of Globalization*
4. Lüthy, P. *Registration and Control of Medicines in the Swiss and European Pharmaceutical Markets*

Master: Microbial Biotechnology
Semester: S3

UE: Fundamental UEF 1
Subject: Nano Biotechnology

- **VHS**: 67h30 (2 Lectures + Practical Work)
- **Credits**: 6
- **Coefficient**: 3

Teaching Objectives
This course aims to teach students knowledge about nanoparticles and their microbial biofabrication, as well as their various applications in the fields of industry, environment, and agriculture.

Recommended Prior Knowledge
Basic knowledge of microbiology. Students must have knowledge in biology, microbiology, and chemistry.

Subject Content

1. Overview of nanosystems
2. Interdisciplinary nanoscience
3. Synthesis of nanoparticles by microbial pathways: scope and applications
    - Synthesis of nanoparticles by bacteria
    - Biosynthesis of nanoparticles by actinomycetes
    - Biosynthesis of nanoparticles by cyanobacteria
    - Biosynthesis of nanoparticles by yeasts
    - Biosynthesis of nanoparticles by fungi
    - Nanoenzymes and nanoenzyme-like systems
    - Nanobioreactors
4. Scope and applications of nanoparticles
    - Characterization techniques
    - Applications
5. Nanotoxicology

Practical Work

- Synthesis and characterization of bio-nanoparticles

- Nanobiotic applications: insecticides, etc.

Personal Work

- Presentations/reports outside tutorial sessions, tutorial reports (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites)

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Grognet, J. M. (2003). "Is therapeutic innovation slowing down?", *Biofutur*, 239, 35-41
2. Pautrat, J.-L. (2002). *Tomorrow the Nano-World*, Fayard, Paris
3. Drumond, T. G., et al. (2003). "Electrochemical DNA sensors", *Nature Biotech*, 21(10), 1192-1199
4. Kohl, C. D. (2003). "Electronic Noses", in *Nanoelectronics and Information Technology*, Wiley-VCH
5. Gref, R., et al. (1994). "Biodegradable long circulating polymer nanospheres", *Science*, 263, 1600-1603
6. LaVan, D., et al. (2003). "Small scale systems for in vivo drug delivery", *Nature Biotech*, 21(10), 1184-1191
7. Fromherz, P. (2003). "Neuroelectronic Interfacing", in *Nanoelectronics and Information Technology*, Wiley-VCH
8. Zhang, S. (2003). "Fabrication of novel biomaterials through molecular self-assembly", *Nature Biotech*, 21(10), 1171-1178
9. Paull, R., et al. (2003). "Investing in Nanotechnology", *Nature Biotech*, 21(10), 1144-1147
10. Mazzola, L. (2003). "Commercializing nanotechnology", *Nature Biotech*, 21(10), 1137-1143
11. Colvin, V. L. "The potential environmental impact of engineered nanomaterials"

UE: Fundamental UEF 1
Subject: Hygiene in Bioindustries

- **VHS**: 67h30 (2 Lectures + Tutorials)
- **Credits**: 6
- **Coefficient**: 3

Teaching Objectives
This course aims to teach students knowledge about contamination in bioindustries and the implementation of hygiene strategies.

Recommended Prior Knowledge
Basic knowledge of microbiology. Students must have knowledge in biology, microbiology, and chemistry.

Subject Content
I. Hygiene in Bioindustries

1. Definitions
2. Sources and vectors of contamination:
    - a. Types of contaminants: bacteria, fungi, phages
    - b. Contamination vectors: air, water, personnel, raw materials, processes
    - c. Microbial contamination of surfaces: properties of inert, living, and microbial surfaces
3. Microbial adhesion to surfaces and biofilm formation:
    - DLVO theory
    - Thermodynamic approach-based theory
    - Concepts of biofilms
4. Factors influencing microbial adhesion:
    - Factors related to microorganisms
    - Factors related to the solid surface
5. Cleaning and disinfection:
    - a. Physicochemical conditions of cleaning water: temperature, pH, alkalinity, hardness and mineral concentration, chemical action, mechanical action, surfactants, detergency power, soap chemistry, contact time
    - b. Disinfectants and detergents

- c. Description of different disinfectant classes: chlorine-based halogens, aldehydes, alcohols, oxidants, phenolic* phenolic derivatives, quaternary ammoniums
- d. Modes of action and resistance to disinfectants

6. Implementation of hygiene plans: HACCP system

Tutorials

- Applications of the various chapters
- Measurement of disinfectant efficacy: phenol coefficient, etc.
- Case studies

Personal Work

- Presentations/reports outside tutorial sessions, tutorial reports (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites)

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Leveau, J.-Y., Bouix, M. (1999). *Cleaning, Disinfection, and Hygiene in Bioindustries*, Coll. Sciences et Techniques Agroalimentaires
2. *ISO 22000, HACCP, and Food Safety: Recommendations, Tools, FAQ, and Field Feedback*, AFNOR, 2009
3. Boeri, D. (2006). *From HACCP to ISO 22000: Food Safety Management*, 3rd Ed., AFNOR
4. Bramely, A.-J., McKinnon, C.-H. (1990). “The microbiology of milk”, in *Dairy Microbiology*, 2nd Ed., Elsevier Science
5. Branger, A., et al. (2007). *Food, Safety, and Microbiological Controls*, Educagri Dijon
6. *Recommended International Code of Practice: General Principles of Food Hygiene*, CAC/RCP 1-1969 Rev. 4, 2003

7. Curt, C. (2002). *Public Policy and Food Safety*, Presses Universitaires
8. JORA No. 17 (2010). *Executive Decree No. 10-90*, Algeria
9. Jouve, J.-L. (1996). *Community and International Food Safety Law*, Lavoisier
10. Leyral, G., Vierling, E. (2007). *Microbiology and Toxicology of Foods: Hygiene and Food Safety*, 4th Ed., Doin
11. Mahaut, M., et al. (2000). *Guide to Good Hygiene Practices: Quality Control in Dairy Processing*, GRET
12. Nko Sadi Biatcho, D. (2006). *HACCP for SMEs and Artisans: Dairy Sector*, Presses Agronomiques de Gembloux
13. Salghi, R. (2010). *Quality Management in Food Production*, Hibr
14. Vignola, C.-L. (2002). *Anonymous 1-5 (various online reports and guides)*

UE: Fundamental UEF 2
Subject: PGPR (Plant Growth Promoting Rhizobacteria)

- **VHS**: 67h30 (2 Lectures + Practical Work)
- **Credits**: 6
- **Coefficient**: 3

Teaching Objectives
Not specified in the original text (to be completed if necessary).

Recommended Prior Knowledge
Not specified in the original text (to be completed if necessary).

Subject Content

1. **PGPR (Plant Growth Promoting Rhizobacteria)**
    - Generalities
    - Protection against pathogens and stimulation of plant growth
    - Rhizospheric competence and epiphytic colonization by PGPR
    - Endophytic colonization of plants by PGPR
    - Induced defenses and systemic resistance associated with PGPR
        - Recognition of PGPR
        - Modes of action of PGPR:
        - Competition for space and nutrients
        - Competition for iron and siderophore production
        - Antibiosis and parasitism
    - Promotion of host growth:
        - Phosphate solubilization
        - Synthesis of phytohormones:
        - Indole-3-acetic acid (IAA)
        - Cytokinins
        - 1-Amino-cyclopropane-1-carboxylate (ACC) deaminase
        - Denitrification
        - Mechanisms of antagonism:
        - Phenazines

- Phloroglucinols
- Pyrrolnitrin (PRN)
- Pyoluteorin (PLT)
- Mupirocin
- Peptide antibiotics
- Fungal wall-degrading enzymes
- Siderophores

Practical Work

- Applications of the various chapters
- Case studies

Personal Work

- Presentations/reports outside practical and tutorial sessions, tutorial reports, practical work reports, essays (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites), field trip reports, internship report

Note

The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Allaire, M. (2005). *Functional Diversity of Antibiotic-Producing Pseudomonas in Conifer Rhizospheres*, Université de Laval, Québec
2. Belimov, A. A., et al. (2001). "Characterization of plant growth-promoting rhizobacteria isolated from polluted soils", *Can. J. Microbiol.*, 47:642–652
3. Bloemberg, G., Lugtenberg, B. (2001). "Molecular basis of plant growth promotion and biocontrol by rhizobacteria", *Cur. Opin. Plant Biol.*, 4:343-350
4. Burd, G. I., et al. (1998). "A plant growth-promoting bacterium that decreases nickel toxicity in seedlings", *Appl. Environ. Microbiol.*, 64:3663-3668
5. Corbaz, R. (1990). *Principles of Phytopathology and Plant Disease Control*, Presse Polytechnique et Universitaire Romande

UE: Methodology UEM 1
Subject: Biotechnology of Innovative Therapies

- **VHS**: 60h00 (Lectures + Tutorials + Practical Work)
- **Credits**: 5
- **Coefficient**: 3

Teaching Objectives
Acquire knowledge and skills in the field of health products derived from biotechnology or new therapies, in the sectors: innovations (gene and cell therapy), production (therapeutic proteins, monoclonal antibodies, vaccines, viral vectors, etc.), and clinical research.

Recommended Prior Knowledge
Microbiology, biochemistry, molecular biology, genetic engineering, immunology, industrial microbiology.

Subject Content
I. Biotechnology: A Multidisciplinary Field

- Biotechnology: a true scientific revolution
- History and evolution of biotechnologies
- Color code of biotechnologies:
    - Health sector (red biotechnologies)
    - Environmental sector (yellow biotechnologies)
    - Agri-food sector (green biotechnologies)
    - Industrial sector (white biotechnologies)
    - Aquaculture sector (blue biotechnologies)
- Innovative biotechnology tools

II. Gene Therapy

- What is gene therapy?
- Types of gene therapies: somatic and germline
- Vectorization and gene transfer into target cells:
    - Viral vectors (retroviral, adenoviral, others)
    - Non-viral vectors
    - Use of liposomes
    - Injection of plasmid DNA

- Clinical applications of gene therapy (gene therapy drugs)
- Clinical trials
- Global players in gene therapy
- Issues raised by biotechnological innovation in health

III. Cell Therapy

- What is cell therapy?
- Fundamental concepts about different types of stem cells
- Cells, tissues: preparation, amplification, cryopreservation, and quality control
- Application of cell therapy:
    - Cell therapy and regenerative medicine

IV. Bioprocesses and Production of Therapeutic Proteins

- Generalities on molecular engineering
- Production of recombinant proteins:
    - Steps and strategies
    - Contribution of prokaryotic cells
    - Contribution of eukaryotic cells
    - Optimization of expression vectors and producing cell lines
    - Bioprocesses, purification processes, formulation
    - Strategies for improving therapeutic proteins
    - Applications: monoclonal antibodies, recombinant allergens, transgenic plants and animals, growth factors
- Large-scale production

V. Vaccines and New Vaccination Strategies

- General principles of vaccinology: cellular and molecular bases, methods for evaluating immune response
- New technologies and vaccination strategies, adjuvants, new administration routes, medical devices
- Vaccine development, pharmacovigilance, risk management plan

VI. Biotechnology Challenges

- Socio-economic challenges

- Environmental challenges
- Health challenges
- Ethical challenges

VII. Functional Foods and Nutraceuticals

Tutorials

- Presentations on new therapeutic concepts: cytokine inhibitors, anticoagulants, growth factors, enzymes, vaccines, monoclonal antibodies, growth hormone, coagulation factors, insulin, etc.

Practical Work

- Educational visit
- Case study

Personal Work

- Presentations/reports outside practical and tutorial sessions, tutorial reports, practical work reports, essays (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites), field trip reports, internship report

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References
Not specified in the original text (to be completed if necessary).

UE: Methodology UEM 1
Subject: Biotechnological Valorization of Agro-Industrial Residues

- **VHS**: 45h00 (Lectures + Practical Work)
- **Credits**: 4
- **Coefficient**: 2

Teaching Objectives
Acquire knowledge about by-products from various food and non-food manufacturing technologies.

Recommended Prior Knowledge
Knowledge of food and non-food manufacturing technologies.

Subject Content

- **Chapter 1**: Valorization of citrus by-products
- **Chapter 2**: Valorization of date waste
- **Chapter 3**: Treatment and valorization of wastewater
- **Chapter 4**: Valorization of plant biomass
- **Chapter 5**: Valorization of by-products from the oil industry
- **Chapter 6**: Valorization of by-products from the paper industry
- **Chapter 7**: Valorization of by-products from the sugar industry

Practical Work

- Educational visit
- Case study

Personal Work

- Presentations/reports outside practical and tutorial sessions, tutorial reports, practical work reports, essays (structured argumentation exercises), consultation and reading of bibliography (books, works, articles, websites), field trip reports, internship report

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., practical work tests, reports, manipulations, field trip reports, oral quizzes, presentations, written tests)

- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Pascal, M. (1981). “The application of biotechnology to the treatment of industrial waste”, *Biotech Advances*, 5:123-135
2. Garcia, J. L., et al. (2000). *Waste Valorization in Agro-Industries*, Springer
3. Sharma, N., et al. (2015). “Biotechnological approaches for the valorization of agro-industrial residues”, *Bioresource Technology*, 12:45-67
4. Local references on agro-industrial waste management in Algeria (to be specified if available)

UE: Discovery UED 1
Subject: Writing and Analysis of Articles and Patents

- **VHS**: 45h00 (Lectures + Tutorials)
- **Credits**: 2
- **Coefficient**: 2

Teaching Objectives
Train students in the techniques of drafting scientific articles and analyzing patents, while developing critical thinking and synthesis skills for research and innovation purposes.

Recommended Prior Knowledge
Basic knowledge of scientific writing and intellectual property concepts.

Subject Content

1. **Scientific Writing**
    - Structure of a scientific article (IMRAD: Introduction, Methods, Results, and Discussion)
    - Writing style and clarity
    - Citation and bibliography management
    - Submission process to scientific journals
2. **Patent Analysis**
    - Introduction to patents: purpose and structure
    - Reading and interpreting patent documents
    - Identifying claims, scope, and novelty
    - Patent search techniques
3. **Critical Analysis**
    - Evaluating scientific articles and patents
    - Identifying strengths, weaknesses, and gaps
    - Linking research to practical applications

Tutorials

- Drafting a short scientific article based on a case study
- Analyzing a sample patent in the biotechnology field

Personal Work

- Writing a mock article or patent abstract

- Presentations/reports outside tutorial sessions, tutorial reports, consultation and reading of bibliography (books, works, articles, websites)

Note
The teaching team may, if necessary, convert tutorials into practical work/field trips or vice versa.

Evaluation Mode

- Continuous assessment: Vary the continuous assessment methods, with a minimum of 3 modes (e.g., written assignments, oral presentations, analysis reports)
- Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Day, R. A., Gastel, B. (2016). *How to Write and Publish a Scientific Paper*, 8th Edition, Greenwood
2. Lichtfouse, E. (2009). *Writing for Publication! Practical Advice for Scientists*, Springer
3. WIPO (World Intellectual Property Organization). *Guide to Patent Drafting and Analysis*
4. Cargill, M., O'Connor, P. (2013). *Writing Scientific Research Articles: Strategy and Steps*, Wiley-Blackwell

EU: Transversal UET 1
Subject: Entrepreneurship
• Hours: 22h30 (Lectures) (remote + in-person)
• Credits: 1
• Coefficient: 1

Teaching Objectives
Introduce the student to project development, its launch, monitoring, and implementation.

Recommended Prior Knowledge
The entirety of the training content.

Subject Content
Introduction

1. **Economic and Legal Environment**
    - Key concepts
    - Social and solidarity entrepreneurship: a field to explore
    - Choosing a legal status for the company: criteria
2. **Approach of the Innovative Creator**
    - Methods and best practices for effective innovation
    - From research results to innovation
    - Creator's profile: personal project, motivation factors
3. **Building a Commercial Offer**
    - Market access strategies
    - Technological marketing: methodological tools
4. **Accounting and Financial Forecasting Tools**
    - Key concepts
    - Business plan
    - In-depth study
5. **Legally Securing a Project**
    - Introduction: project maturation
    - Protectable innovations and protection methods: overview, third-party rights
    - Intellectual property strategy: protection by secrecy and patents, intellectual property tools
    - Relationship between the company and research institutions

6. **Project Financing**
    - Public funding mechanisms
    - Financing chain
7. **Support Mechanisms**
    - Regional mechanisms: Breton examples (Rennes Atalante - technopole, Emergys incubator)
    - National mechanism: OSEO
8. **Closing Roundtable: Feedback Session**
    - Presentation of company founders
    - Links between the company and the university
    - Strengths and weaknesses of the project
    - Business plan
    - Project lifecycle
    - Development of commercial policy

Personal Work

• Presentations/reports outside of class sessions, summaries, essays (structured argumentation exercise), consultation and reading of bibliography (books, works, articles, websites), field trip reports, internship report, mini-projects, analysis of economic articles with ecological and environmental aspects

Note

The teaching team may, if necessary, convert tutorials (TD) into practical work (TP)/field trips or vice versa.

Assessment Method

• Continuous assessment: Vary the continuous assessment methods, minimum of 3 methods (e.g., practical work test, reports, hands-on work, field trip report, oral quizzes, presentations, written tests)
• Weighting: Exam 60%, Continuous Assessment 40%

Bibliographical References

1. Maître, B., Aladjidi, G. (1999). *Les Business Models de la nouvelle économie*, Dunod
2. Moingeon, B., Lehmann-Ortega, L. (2010). "Genèse et déploiement d'un nouveau business model", *M@n@gement*, 13(4):266-297
3. Dauchy, D. (2010). *7 étapes pour un Business Model solide*, Dunod
4. Jouison, E. (2005). *Délimitation théorique du Business Model*, AIMS

5. Chesbrough, H., Rosenbloom, R. S. (2002). “The Role of the Business Model in Capturing Value from Innovation”, *Industrial and Corporate Change*, 11(3):529-555
6. http://www.ac-creteil.fr/grisms/
7. http://www.educagri.fr/memento/section3/
8. http://www.ffpe-toulouse.org/youthstart/
9. http://www.improve-institute.com/
10. Lehmann-Ortega, L., Schoettl, J. M. (2005). *Rupture et perturbation : les deux formes de l’innovation stratégique*, AIMS
11. *Revue française de gestion*, Volume 35, n°181, 2008
12. Verstraete, T., Jouison-Laffitte, E. (2010). “Une théorie conventionnaliste du Business Model”, XenCIFEPME
13. Verstraete, T., Jouison-Laffitte, E. (2009). *Business Model pour entreprendre*, De Boeck Université
14. Warnier, V., et al. (2004). “Le Business Model, l’oublié de la stratégie”, Conférence AIMS
15. Lecocq, X., et al. (2006). “Le Business Model, un modèle d’analyse stratégique”, *L’Expansion Management Review*, n°123