

Algerian Democratic and Popular Republic
Ministry of Higher Education and Scientific Research
University Hassiba Benbouali of Chlef
Faculty of Natural and Life Sciences
Department of Biology

Doctoral Training in Biological Sciences

Start Date of Training: 2023

Status of the Training: Ongoing

Authorized Training Specialties :

1. Microbiology
2. Applied Microbiology
3. Applied Biochemistry
4. Animal Biology and Physiology

1. Overview of the Program

This doctoral training is organized around four specialties in the Biological Sciences field: Infectious Microbiology, Applied Microbiology, Biochemistry, and Animal Biology and Physiology.

The research themes proposed within these four authorized specialties in Biological Sciences address microorganisms that impact human and animal health as well as the environment (biocorrosion), as well as microorganisms of biotechnological interest (acting as antagonists or producing bioactive molecules).

From a public health perspective, the proposed thesis topics focus on several zoonotic diseases caused by bacterial and viral pathogens, which represent significant threats to animal and human health: brucellosis, mastitis in dairy cows, avian bronchitis, and *Clostridioides difficile* infections, which typically occur in healthcare settings (nosocomial infections) and may also be transmitted from animals to humans.

The main objectives of these projects are to isolate and characterize the microorganisms responsible for these diseases, establish their antibiotic resistance profiles, assess their genetic diversity, determine the prevalence and associated risk factors for each disease, and, finally, compare these results with those reported at the national and international levels.

Within applied and environmental microbiology, a research theme aims to characterize bacterial communities involved in biocorrosion—a phenomenon causing substantial economic losses across all industrial sectors, especially in petroleum installations and water storage tanks.

Three other projects in this context aim to research and produce bioactive molecules from actinobacteria, which demonstrate antimicrobial, anti-biofilm, and anti-biocorrosion activities. The studies conducted within all the above-mentioned projects combine several complementary approaches, primarily microbiology, molecular biology, epidemiology, statistics, genomics, and bioinformatics.

On the other hand, research themes proposed in the biochemistry, animal biology, and physiology specialties focus on assessing the impact of various environmental pollutants on health. The objective is to determine how chemical pollutants act on living organisms, the mechanisms underlying their harmful effects (toxicity), and how these effects can be evaluated, prevented, or minimized.

Beyond providing future trainers and researchers with a solid foundation in the theoretical and practical aspects relevant to their research projects, this doctoral training also aims to develop other essential skills in doctoral students, such as:

- Conceive and implement studies: Know how to generate and process data.
- Conduct critical and independent analyses.
- Apply scientific approaches to explore and solve problems within their fields of expertise.
- Communicate with peers, the scientific community, and society at large regarding their domains of expertise.

2. Strengths of the Program

The research themes proposed in the Microbiology specialty address microorganisms that impact human and animal health and the environment (biocorrosion), as well as microorganisms of biotechnological interest (acting as antagonists or producing bioactive molecules).

From a public health standpoint, the proposed thesis topics focus on several zoonotic diseases caused by bacterial and viral pathogens, which represent significant threats to animal and human health, including brucellosis and mastitis in dairy cows, avian bronchitis, and *Clostridioides difficile* infections, which generally occur in healthcare settings (nosocomial infections) and may also be transmitted from animals to humans. The main objectives of these projects are to isolate and characterize the microorganisms responsible for these diseases, establish their antibiotic resistance profiles, assess their genetic diversity, determine the prevalence and risk factors associated with each disease, and compare these results with those reported at the national and international levels.

Within applied and environmental microbiology, research focuses on characterizing bacterial communities responsible for biocorrosion, which causes significant economic losses in various industrial sectors, especially in petroleum installations and water storage tanks. Other projects

in this context aim to research and produce bioactive molecules from actinobacteria, demonstrating antimicrobial, anti-biofilm, and anti-biocorrosion activity.

All studies within these projects combine complementary approaches, primarily microbiology, molecular biology, epidemiology, statistics, genomics, and bioinformatics.

Research projects proposed in biochemistry and animal biology and physiology focus on assessing the impact of environmental pollutants on health, with the goal of understanding their harmful effects and how these effects can be evaluated, prevented, or minimized.

Beyond providing solid theoretical and practical training, the program also develops skills such as study design, data generation and processing, critical analysis, problem-solving using scientific approaches, and effective communication.

3. Admission Information

The doctoral training in Biological Sciences requires candidates to hold a Master's degree in one of the following fields:

Microbiology and Applied Microbiology: Master's degree in Microbiology, General Microbiology, Molecular or Infectious Microbiology, Applied Microbiology, Fundamental Microbiology, Industrial Microbiology, or an equivalent degree.

4. Core Courses

The doctoral program in Biological Sciences aims to train autonomous researchers capable of leading innovative projects, publishing in international journals, and adapting to the evolving scientific landscape. It provides a solid education in advanced methodologies (genomics, bioinformatics, modeling), transversal competencies (communication, management, ethics), and an interdisciplinary perspective (ecology, health, environment, biotechnology).

This program integrates fundamental disciplines, state-of-the-art methodologies, and essential transversal competencies for doctoral research in biology, microbiology, biochemistry, and cell biology.

4.1. Fundamental Courses

- Molecular Microbiology: Isolation and characterization of pathogenic strains from humans and animals, study of their resistance mechanisms using molecular and bioinformatics methods.
- Applied Microbiology: Microbial diversity, bacterial physiology, host-pathogen interactions, environmental microbiology, characterization of bioactive molecules with antimicrobial, anti-biofilm, anti-biocorrosion, and antifungal activity, as well as in silico studies (molecular docking, MD, etc.).

- Applied Biochemistry: Structure and function of biomolecules, enzymology, metabolic pathways (glycolysis, Krebs cycle, etc.), metabolic regulation.
Genetics: Molecular genetics, population genetics, functional and comparative genomics.
- Animal Biology and Physiology: Cellular organization and dynamics, membrane trafficking, cell signaling, cell cycle, apoptosis, differentiation.

4.2. Transversal and Scientific Skills

- Scientific Communication : Scientific writing, oral presentations, poster sessions, science popularization, grant writing.
- Research Ethics: Good laboratory practices, scientific integrity, copyright, intellectual property. Planning, teamwork, data and documentation management.
- Introduction to University Teaching: Student supervision, leading practical sessions.
- Scientific Language Skills: Strengthening scientific English, writing and presenting in a foreign language.
- Philosophy: Philosophy of dialogue and communication, methodology, and philosophy of science.
- Workshops, Conferences, and Knowledge Transfer: Patents, entrepreneurship, industry partnerships, collaborative research.

4.3. Specialized Training Workshops

- Bioinformatics: Metagenomics, comparative genomics, phylogenetics, etc.
- Medical Microbiology: Molecular bacteriology, antibiotic resistance, emerging diseases.
- Microbial Biotechnology: Production of bioactive molecules with antimicrobial, anti-biofilm, and anti-biocorrosion activity.
- Advanced Biostatistics: Statistical modeling, multivariate analysis, management and analysis of large datasets (big data), use of R and SPSS.

4.4. Other Complementary Training

- Research Seminars: Presentation and discussion of advances in the field, participation in thematic doctoral schools.
- Internships in Laboratories or Industry: Immersion in various professional environments, international collaboration.

5. Advanced Topics

The Microbiology training program is specifically designed to provide in-depth knowledge and specialization in the most recent fields of microbiology. The courses are tailored for students seeking to develop expertise in scientific research, industry, or applied microbiology. Each course has advanced objectives, such as:

5.1. Advanced Microbial Physiology and Metabolism

Study of complex microbial metabolic pathways, advanced topics in metabolic engineering for biofuel production, adaptations of microorganisms to extreme environments (extremophiles), and the role of secondary metabolites in microbial reactions and applications.

5.2. Microbial Genomics and Bioinformatics

Comparative genomics of microorganisms, functional and transcriptomic genomics, metagenomics, bioinformatics tools for the analysis of microbial genomic data.

5.3. Environmental Microbiology

Roles of microorganisms in biogeochemical cycles, microbial degradation of pollutants, applications of microbial communities in wastewater treatment, and microbial interactions in soil and plant microbiomes.

5.4. Clinical and Medical Microbiology

Mechanisms of antimicrobial resistance and development of new antibiotics, host-pathogen interactions and immune evasion strategies, emerging and re-emerging infectious diseases, the microbiome and its role in human health and disease, and diagnostic and therapeutic applications of microbiology (e.g., phage therapy).

5.5. Industrial Microbiology and Biotechnology

Microbial production of enzymes, biofuels, and bioplastics, fermentation technologies and improvement strategies, applications of synthetic biology in microorganisms for industrial purposes.

5.6. Molecular Analysis of Microbial Diversity

Use of various molecular and bioinformatics techniques to analyze microbial diversity.

5.7. Antimicrobial Resistance and Drug Discovery

Mechanisms of antimicrobial resistance and global challenges, strategies to overcome antimicrobial resistance including combination therapies.

6. Tuition Fees

No tuition fees.

7. Language of Instruction

French / English

8. Degree

