Quantitative Biology: Molecular Mechanisms of Living Systems (qBio)

Explore this IDIL Master's track in detail, including its academic objectives, curriculum, research opportunities, admission requirements and career prospects.

TRACK OVERVIEW & LEARNING OBJECTIVES

The *Master in Quantitative Biology – Molecular Mechanisms of Living Systems (qbio)* is positioned at the interface of biology, physics, chemistry, and computer science. It trains students to study living systems using **quantitative and interdisciplinary approaches**. The program is fully taught in English and is part of the **IDIL Graduate School** at the University of Montpellier.

Quantitative Biology is an emerging discipline that addresses the complexity of living systems by integrating experimental biology with mathematical modeling, computational analysis, and physical principles. This approach enables a deeper understanding of biological processes beyond descriptive methods, fostering predictive and mechanistic insights.

The curriculum is highly innovative, emphasizing active learning through personalized mentoring, project-based activities, and hands-on laboratory experiences. Students benefit from close interaction with faculty, collaborative teamwork, and exposure to cutting-edge research environments.

Main themes and strengths:

- **Step-by-step introduction to the Quantitative Biology field**: Students gain a solid foundation in the principles and methodologies that define quantitative approaches to biological systems, bridging molecular biology with physics, mathematics, and computational sciences.
- **Advanced imaging and biophysics**: Training in state-of-the-art microscopy and biophysical techniques to explore cellular and molecular dynamics.
- **Structural biology and synthetic biology**: Understanding and engineering biological systems at the molecular level through structural analysis and genetic design.
- **Computational modeling and data analysis**: Developing skills in Python programming, simulation, and quantitative interpretation of complex biological data.

- **Hands-on laboratory experience and project-based learning**: Emphasis on practical work and collaborative projects to foster autonomy and creativity.
- **International environment with strong mentorship and networking opportunities**: Most students come from abroad, creating a diverse and stimulating academic community supported by personalized guidance.

Educational objectives: Graduates will be able to:

- Formulate and analyze biological questions using quantitative methods
- Design, conduct, and interpret experiments
- Apply computational tools for modeling and data analysis
- Communicate scientific results effectively in oral and written form
- Work collaboratively in interdisciplinary teams

KNOWLEDGE, SKILLS & COMPETENCIES

Scientific and technical skills:

- Quantitative analysis of biological systems
- Modeling and simulation (differential equations, stochastic processes)
- Advanced microscopy and imaging techniques
- Structural biology methods
- Synthetic biology and genetic engineering
- Python programming for data analysis

Methodological and transversal skills:

- Project management and teamwork
- Scientific communication and writing
- Critical thinking and problem-solving
- Ethical and responsible research practices

DETAILED CURRICULUM

- **Semestre 1 (S7)**
  - Bootcamp — 2 ECTS
  - Structural Biology — 4 ECTS
  - Introduction to Quantitative Biology — 4 ECTS
  - Imaging Biological Systems — 4 ECTS
  - In-Lab (Computational Biology & Wet Lab Introduction) — 2 ECTS
  - Personal Project: Research Project — 10 ECTS
  - Transversal Training Units (IDIL) — 2 ECTS
  - Non-core IDIL Training Units — 2 ECTS

  Total: 30 ECTS

- **Semestre 2 (S8)**
  - Research Internship — 30 ECTS

  Total: 30 ECTS

- **Semestre 3 (S9)**
  - Applied Structural Biology — 4 ECTS
  - Synthetic Biology – Practicals — 4 ECTS
  - Practical Modeling and Simulation of Biological Systems — 4 ECTS
  - Workshop and Introduction to Academia — 4 ECTS
  - Non-Core Training Unit (IDIL, choice) — 2 ECTS
  - Multidisciplinary Team Project — 10 ECTS
  - Transversal Training Units (IDIL) — 2 ECTS

  Total: 30 ECTS

- **Semestre 4 (S10)**
  - Research Internship — 30 ECTS

  Total: 30 ECTS

In-Labs :

- Computational Biology – Introduction to python and data analysis
- Introduction to wet lab

ADMISSION REQUIREMENTS & STUDENT PROFILE

- Bachelor's degree (or equivalent) in Biology, Physics, Chemistry, Computer Science, Mathematics or related fields.
- Recommended knowledge: molecular biology, biochemistry, basic mathematics and physics, programming fundamentals.
- English proficiency: no language certificate is required. Interviews will be carried out in English.
- Strong motivation to study biological systems with quantitative approaches.
- Admission based on academic record, CV, motivation letter, and recommendation letters.

CAREER OPPORTUNITIES

- **Nearly all graduates pursue a PhD** in fields such as quantitative biology, biophysics, systems biology, bioinformatics,...
- **International opportunities**: Graduates often join research institutes, universities, and companies worldwide, benefiting from the program's global network and interdisciplinary training.
- **Potential career paths include**:
  - R&D positions in biotechnology, pharmaceutical, and medical technology industries
  - Roles in data analysis, imaging, structural biology, and synthetic biology
  - Scientific project management and communication

RESEARCH LABORATORIES & ACADEMIC PARTNERS

The program is closely connected to the Quantitative Biology research community within the Biology-Health Research Cluster at the University of Montpellier, which brings together more than 40 research teams across different units (e.g. CBS, CRBM, IGF, IGH, IGMM, IRIM, IRCM, LBN, LPHI).

Beyond official partnerships, our strong academic and research network enables students to carry out internships in laboratories in Montpellier, across France, and internationally, fostering global exposure and collaboration.