



**UNIVERSITA' DEGLI STUDI DI MILANO**  
**PROGRAMME DESCRIPTION - ACADEMIC YEAR 2022/23**  
**IN**  
**QUANTITATIVE BIOLOGY (Classe LM-8)**  
**Enrolled from 2020/2021 academic year**

### **HEADING**

<b>Degree classification - Denomination and code:</b>	LM-8
<b>Degree title:</b>	Dottore Magistrale
<b>Length of course:</b>	2 years
<b>Credits required for admission:</b>	180
<b>Total number of credits required to complete programme:</b>	120
<b>Course years currently available:</b>	1st , 2nd
<b>Access procedures:</b>	open, subject to entry requirements
<b>Course code:</b>	F5B

### **PERSONS/ROLES**

#### **Head of Study Programme**

Prof. Marco Nardini (marco.nardini@unimi.it)

#### **Tutors - Faculty**

Academic guidance tutor: Prof. Anna Moroni

Master's degree admission tutor: Prof. Anna Moroni

Internship tutor: Prof. Anna Moroni

Study plan tutor: Prof Anna Moroni, Dr. Matteo Brilli

Erasmus and international mobility tutor: Prof. Veronica Gregis

#### **Degree Course website**

<http://qbio.cdl.unimi.it>

<http://www.unimi.it/en/education/faculties-and-schools/science-and-technology/industrial-biotechnology>

<https://www.unimi.it/en/education/quantitative-biology>

#### **Academic Services Office**

Milan - Via Celoria, 26 Tel. 0250314870 By appointment. Email: biotecindamb@unimi.it

#### **Boards**

Proff. Anna Moroni, Michele Mazzanti, Matteo Brilli (Master's degree admission); Prof. Marco Buscaglia (Student Mobility).

#### **Disability manager**

Prof. Matteo Chiara

#### **International Students Office**

Milan - Via S. Sofia, 9/1 <https://www.unimi.it/en/international/coming-abroad/international-students-office-welcome-desk>

#### **Student administrative office**

Milan - Via Celoria, 18 Tel. 0250325032 <https://www.unimi.it/en/node/360> <https://www.unimi.it/en/node/359>

### **CHARACTERISTICS OF DEGREE PROGRAMME**

#### **General and specific learning objectives**

The Master's degree course in Quantitative biology (QB) prepares graduates in biological and biotechnological disciplines to operate at the intersection between biology and physics. The quantitative approach requires a physical understanding of biological phenomena and the development of mathematical and computational tools for the analysis, understanding, and redesign of biological systems. The aim is to train a new generation of experts with integrated skills in biology, chemistry, physics, mathematics and computer science, able to perform accurate experimental measurements and apply predictive theoretical models, to explain biological complexity. Quantitative biology uses emerging technological and computational

capabilities to model biological processes for biotechnological applications such as protein and metabolic engineering, drug discovery and synthetic biology. It is therefore proposed a path that includes training activities aimed at acquiring in-depth knowledge of:

- (a) biochemical and biophysical aspects of cellular processes and molecular interactions;
- (b) experimental methodologies for the study and measurement of these processes;
- (c) analytical techniques and protocols used in structural biology and molecular and cellular biophysics studies;
- (e) technical bases of modelling in systems biology for the study of interactions in complex biological systems;
- (f) linear algebra, matrix calculus and its use in the description of dynamic biological phenomena and to understand the basis of artificial intelligence (machine learning);
- (g) Python programming language and its use for statistical data analysis;
- (h) formal logic elements

Characteristic and related mandatory teachings (72 CFU, of which 6 CFU with guided choice) include teachings on quantitative aspects of the main molecular and cellular biological disciplines, teachings on chemistry involving spectroscopy and its applications in biology; aspects of statistical analysis of data and errors, measurements of nanoscale interactions between biomolecules, programming elements in Python and machine learning aspects, linear and matrix algebra, description of dynamic systems using differential equations. In addition, 12 CFU will be freely chosen by the students among all the teachings activated by the University of Milan, provided they are consistent with the training project and 3 CFU for other activities (Italian language skills for foreigner students or seminars and orientation to the world of work). Finally, the course includes, as a qualifying moment of training and acquisition of skills, an experimental thesis lasting at least 33 CFU. The Thesis Internship must be carried out in research laboratories of the University of Milan or in other public or private institutions, national or foreign, after approval, and provides for the production of a written thesis, in which the original results of the research are reported.

### **Expected learning outcomes**

#### **1. Knowledge and understanding**

Master graduates in "Quantitative Biology" will apply biomolecular-cellular, mathematical, chemical and physical instruments to understand and describe complex and dynamic biological systems. Students will be guided in the generation of predictive models, simulations and their experimental analysis and verification.

#### **2. Applying knowledge and understanding**

A fundamental objective of the Master's Degree in "Quantitative Biology" is the constant experimental practice of the theoretical knowledge acquired. This will be achieved both through the teaching classes, that will include a hands-on part of laboratory practice and through the dissertation work, which has been reserved the large part of CFU (33) in the second year of the course. The experimental project carried out as part of the dissertation work will be instrumental to increase the students' ability to apply their acquired knowledge.

#### **3. Autonomy/judgment (Making judgments)**

To foster the acquisition of autonomous judgment by the students, teaching classes will discuss recent issues and 'hot topics' in their subject and will include a problem-solving approach. Through reading and discussing teaching material and research papers, students will be stimulated to evaluate notions and information critically.

#### **4. Communication skills**

The students will improve their communication skills in teaching classes, which will include activities such as journal clubs, seminars, etc., as well as in their experimental project leading to their dissertation, which will include oral presentation and discussion of their results and writing their dissertation work in English.

#### **5. Learning skills**

The students will develop their ability to understand, discuss, and transfer the taught subjects in the English language, and their ability to access and organize databases and other information on the net. The quality of the teaching classes and the time devoted to the experimental project leading to the dissertation will allow the students to learn through 'hands-on' approach and the constant interaction both with their peers and the instructors.

### **Professional profile and employment opportunities**

The Master's degree in Quantitative Biology provides employment opportunities in research institutes and industry in the areas of bio-nano-technologies, bio-pharmaceutical research, and in the development of high-tech research instrumentation.

- Primary duties of a graduate in QB can range from analyse and optimize pre/clinical trials and predict outcomes using modelling and simulation, integration and interpretation of data from many sources to help drive project decisions, apply molecular modelling and computer aided drug design techniques, basic use and maintenance of laboratory instrumentation, literature review.

- Skills: Autonomy, precision, ability to synthesize, problem solving through modelling and simulation, goal orientation and excellent predisposition to work in team, good/excellent level of written and spoken English, good direct intervention capacity on the instrumentation on both, the hardware and the software of the instrument.

- The graduate in QB can be hired as junior research scientist, product scientist, junior research project manager, scientific application specialist, scientific equipment services specialist.

### **Pre-requisites for admission**

- Qualifications and knowledge required for admission

#### **1. Bachelor's Degree:**

Italian or foreign citizens with a Bachelor's degree (Italian Laurea Triennale or equivalent) in Biotechnology (L-2 class and previous class 1) and Biological Sciences (L13 class) are admitted.

Italian or foreign citizens with a Bachelor's degree (Italian Laurea Triennale or equivalent) in the following classes:

- Chemical sciences and technologies (L27 class)
- Physical sciences and technologies (L30 class);
- Mathematical sciences (L35 class)
- Food Science and Technology (L26 class);
- Pharmaceutical science and technology (L29 class)
- Agriculture and forestry industry (L25 class)

can be admitted ON CONDITION that they have obtained sufficient knowledge, not less than 12 University credits (CFU), in at least one of the following biology and biotechnology core disciplines: Biochemistry (BIO/10), Molecular biology (BIO/11), Cell biology (BIO/06).

#### **2. Language Requirements:**

Knowledge of English is a requirement for the access to the QB Master degree. Students should have acquired beforehand a B2 level certification (vantage or upper intermediate, as defined by the Common European Framework of Reference for Languages: Learning, Teaching, Assessment). Students without a B2 level certification may be accepted on condition that their level of English proficiency, assessed during the interview, is evidently good.

- Admission assessment

The adequate personal preparation of the candidates, their ability to communicate in English and their motivation are decisive elements for the admission and they are going to be verified and tested during an admission interview. Knowledge of Italian is not required for attendance.

Particular attention will be given to the knowledge in Biological subjects of candidates with non-biological backgrounds. In this case, the admission interview will identify gaps requiring extra study to be levelled off by the student with the support of tutors, before the official start of the courses.

### **Programme structure**

- Teaching organization and delivery mode

The QB Master degree is a 2-year course; each year is divided in two terms (semesters). The programme includes different activities, such as frontal lectures, practical classes, and experimental project leading to the final dissertation. 120 educational credits (CFU, Crediti Formativi Universitari) are required to complete the Master's degree. A CFU corresponds to a standard student workload of 25 hours, and it is calculated as follows:

- for frontal lectures, 1 CFU= 8 hours of lectures and 17 hours of personal elaboration;
- for practical classes, 1 CFU= 16 hours of laboratory activities and 9 hours of personal elaboration;
- for experimental projects, 1 CFU= 25 hours of laboratory and/or training activities.

Students will acquire 72 CFU from 11 mandatory courses, scheduled in the first and second year, and a minimum of 12 CFU that can be freely chosen. At least 6 out of these 12 CFU must be acquired through attendance of a course (and passing the exam): the course can be chosen either from the list of the QB elective courses or from any course offered by the University of Milan, as long as it is considered consistent with the aims of the QB degree and is not a repetition of courses already offered by the degree program. Students can also choose classes taught in Italian as freely chosen CFU. The remaining 6 CFU can be acquired by additional laboratory activity, (namely, short internship in research laboratories) upon submission of a written request that must be approved by the QB Study Plan Committee.

33 CFU are assigned to the individual experimental project leading to the final dissertation, to be started in the second year. Finally, 3 CFU will be assigned for knowledge of the Italian language for foreign students, or for other useful training activities for entering the job market.

- Courses

Compulsory courses:

Mathematical modelling for Biology

Programming in Python

Cell Biophysics

Measurement of nanoscale interactions in biological systems and data analysis

Principle of spectroscopy and applications to quantitative biology  
Advanced molecular biology  
Integrated structural biology  
Molecular biophysics  
Imaging in living cells  
Introduction to Logic

Elective courses:

Non linear dynamics in quantitative biology  
Structural bioinformatics  
Cell population dynamics

- Conscientious objection policy

In the QB Master degree, the use of animals for teaching purposes is not allowed as stated by the law: art. 5f of the Legislative Decree 26/2014. Such procedures are allowed during the traineeships for thesis preparation. However, they must be carried out exclusively by authorized staff, since, in this case, the Legislative Decree 26/2014 does not apply. According to Italian law n. 413, October 12 1993, “Norme sull’obiezione di coscienza alla sperimentazione animale”, students have the incontestable right to conscientiously object to participation in any experimental activity using animals. In this case, the Teaching Board will suggest alternative traineeships, that are consistent with the educational goals of the MB&B course, to ensure the correct acquisition of the study credits necessary for degree completion.

- Study plan submission

The students will submit a “Study plan”, with the indication of elective courses they intend to attend, and how they want to utilize the 12 CFU of freely chosen activities, by the end of the first semester of the first year. The Study plan must be approved by a Study Plan Committee, composed of QB lecturers. The Study plan can be changed upon request; however, it represents the official record of the degree and the list of courses must correspond to the exams passed by the student in order to grant admission to the final dissertation.

- Lecture timetable

The first Semester starts on September 26th, 2022 and ends on January 20nd, 2023.

The second Semester starts on March 1st, 2023 and ends on June 16th, 2023.

Lesson timetables are available at the URL:

<https://easystaff.divisi.unimi.it/PortaleStudenti/>

or by downloading the official student Class timetable app of the University of Milan “Lezioniunimi”

- Exams

Each course is followed by an exam, usually a written or an oral test (or a combination). Credits for a course are only granted upon passing the corresponding exam. Courses can be taught by more than one instructor: in this case, only one lecturer will be responsible for the final assessment of the student.

- Exam sessions and assessment methods

Exam sessions are scheduled during a recess at the end of each term. For each course, at least 6 tests are scheduled per academic year. Although in principle there is no limit in the number of tests that the student can take per year, some limitations can occur for exams not managed within the MB&B Master degree. Course exams must be passed, with grades calculated on a 30-point scale, to obtain course credits, with 18/30 being the minimum pass grade.

- Part-time enrolment

Part-time enrolment aims to offer students with special personal circumstances the opportunity to pursue their university studies on a part-time basis, for work, family or health reasons which make it difficult for them to attend courses and sit exams on a regular basis (<http://www.unimi.it/en/study/bachelor-and-master-study/fees-and-how-pay-them/part-timeenrolment>).

## Campus

Lecture rooms and laboratories are located in the “Città Studi” campus, mostly in the University buildings of Via Celoria, 26 (Edifici Biologici); Via Celoria, 20 (Settore Didattico); Via Golgi, 19 (Edificio Golgi). The Department of Biosciences is the reference structure for all teaching activities related to the QB course.

## Libraries

The main campus library is the “Biblioteca di biologia, informatica, chimica e fisica” (Via Celoria 18). See: <http://www.sba.unimi.it/en/libraries/13453.html>

## Tutoring

Tutors will provide students with academic advice, guidance on their course choices and personal advice. They will be available for one-to-one meetings with the students. For the academic year 2022/2023 students can contact prof. Anna

Moroni, profMichele Mazzanti, Matteo Brilli, Thomas Vaccari and prof. Marco Buscaglia at their standard institutional e-mail addresses (name.surname@unimi.it). Students that need tutoring may also contact the secretary's e-mail address: biotecindamb@unimi.it

### **Compulsory attendance**

Attendance to lessons and practicals is strongly recommended. The experimental project leading to the final dissertation is mandatory for the Master Degree.

### **Internship criteria**

The students will carry out an experimental project leading to writing a dissertation in English, whose discussion will constitute the final exam. The experimental project involves the attendance of a research laboratory either at University of Milan or in other research laboratory, upon previous authorization of the Coordinator of the Master degree. The experimental project accounts for 33 CFU and thus it represents a fundamental moment of the Master degree program. The dissertation will describe the original research or project carried out by the student under the supervision of a lecturer within the QB Master degree, and its subject must be consistent with the goals and the disciplines taught in the Master degree.

### **Degree programme final exam**

The final exam consists of the oral presentation and discussion of the main results of the thesis project in front of a dissertation committee and it contributes with a maximum of 10 points to the final grade. The final grade will be thus assigned as the weighted average of the grades in the lecture courses, calculated on a scale of 110, to which the points of the final dissertation will be added. The 120 CFU required to take the final test for the achievement of the master's degree are acquired, in compliance with these regulatory rules.

## ***EXPERIENCE OF STUDY ABROAD AS PART OF THE DEGREE PROGRAM***

The University of Milan supports international mobility by providing its students with the opportunity to spend study and internship periods abroad. It is a unique chance for students to enrich their educational path in a new and exciting environment.

The agreements entered into by the University with over 300 universities from the 27 EU member countries and other Extra-EU countries under the European Erasmus+ programme allow regularly enrolled students to carry out part of their studies at one of the partner universities or to undertake internships at companies, training and research centres and other organizations.

Similar international mobility opportunities are provided outside Europe, through agreements with a number of prestigious institutions.

### **Study and internships abroad**

The QB degree program supports the international mobility of the University program: QB lecturers (for the academic year 2022/2023, Proff. Veronica Gregis and Marco Buscaglia) act as tutors for students interested in the Erasmus + program, in order to guide students in their choice of the most suitable program for their formation. Every January, the Erasmus + program is presented to the QB students through a local event organized by the coordinator of the Erasmus + program of the Industrial Biotechnology area (Prof. Veronica Gregis).

In the frame work of the Erasmus+ program, the QB Master course has in place agreements with Universities in Germany, Spain, France, Norway, and The Netherlands, all offering courses in English.

Calls for participation to Erasmus Studio can be found at the following link: <https://www.unimi.it/en/international/study-abroad/studying-abroad-erasmus>.

The time spent abroad can be used to attend courses and pass the relative exams, thus collecting credits towards the Master's degree, as well as to carry out the experimental project for the dissertation. Students admitted to the mobility program must submit a study plan detailing the training activities that they plan to carry out, with the corresponding credits. The number of credits should correspond as much as possible to the number of credits that the student should acquire in a similar time at the home University. The proposed activities must be consistent with the goals and the contents of the Master's degree. The study plan must be approved by the QB Student Mobility Committee, which can request changes or integrations. At the end of the mobility program, according to the guidelines provided by the University of Milan, the courses attended (with a passed exam) by the student are registered in his/her career record, preferably with its original name and with an indication of the ECTS (European Credit Transfer and Accumulation System) and their conversion in CFU (usually 1 ECTS= 1 CFU). The students willing to carry out their dissertation work as part of a mobility program abroad must have an internal supervisor (chosen among the MB&B lecturers) and the study plan must be approved by the MB&B board.

### **How to participate in Erasmus mobility programs**

The students of the University of Milan can participate in mobility programmes, through a public selection procedure.

Ad hoc commissions will evaluate:

- Academic career
- the candidate's proposed study programme abroad
- his/her foreign language proficiency
- the reasons behind his/her application

Call for applications and informative meetings.

The public selection for Erasmus+ mobility for study generally begins around February each year with the publication of a call for applications specifying destinations and requirements. Regarding the Erasmus+ Mobility for Traineeship, the University of Milan usually publishes two calls a year enabling students to choose a destination defined by an inter-institutional agreement or to find a traineeship position on their own.

The University organizes informative meetings to illustrate mobility opportunities and rules for participation.

#### Erasmus+ scholarship

The European Union grants the winners of the Erasmus+ programme selection a scholarship to contribute to their mobility costs, which is supplemented by the University funding for disadvantaged students.

#### Language courses

Students who pass the selections for mobility programmes can benefit from intensive foreign language courses offered each year by the University Language Centre (SLAM).

<https://www.unimi.it/en/node/8/>

Learn more at <https://www.unimi.it/en/node/274/>

For assistance, please contact:

International Mobility Office

Via Santa Sofia 9 (second floor)

Tel. 02 503 13501-12589-13495-13502

Contacts: InformaStudenti; [mobility.out@unimi.it](mailto:mobility.out@unimi.it)

Student Desk booking through InformaStudenti

## **ADMISSION CRITERIA: 1ST YEAR OPEN, SUBJECT TO ENTRY REQUIREMENTS**

### **Application and enrolment information and procedures**

Candidates holding, or due to complete, a bachelor's degree by 31 October 2022 may submit an admission application.

The application must be submitted online according to the general University rules, following the instructions at this URL:

<https://www.unimi.it/en/study/bachelor-and-master-study/degree-programme-enrolment/enrolment-masters-programme/open-admission-master-programmes>

#### Eligibility assessment

The personal curriculum of the applicants will be evaluated by an Admission Committee composed of the coordinator and at least two lecturers of the Master's degree. Applicants satisfying the criteria will be invited to an Interview (see below) for the assessment of motivation, scientific background knowledge and English language skills. After the interview, successful applicants will receive notice of their eligibility and will be allowed to enroll in the Master degree program.

#### Admission Interview

For the Academic year 2022-23 the admission interview will be held online on a video conference platform and the candidate will receive an email with the date and instructions for connecting.

The interview will evaluate the motivation, the expertise of the candidate in topics related to their bachelor degree and the English language skills.

The committee will evaluate each applicant on a 100-point scale:

1) Up to 50/100 points will be awarded for the applicant resume (type of bachelor degree attended, exam grades, further courses attended, additional degrees, etc.)

2) Up to 50/100 points will be awarded for the interview.

The minimum score required for admission is 60/100.

At the beginning of the interview, students must show a valid ID card or passport for identification.

#### Terms for submitting an application

The deadline for application for Italians and EU-candidates is August 26th, 2022.

For extra-EU candidates applying for visas, the deadline for application is May 31, 2022, in consideration of the particular timing related to the issuance of the visa and the need to select a limited number of places, as required by current regulations.

#### Excellence Scholarships for international students

All candidates with a foreign qualification (EU and extra-EU) who will apply for admission to the Master's degree within May 31, 2022 are eligible for these scholarships.

Link: <https://www.unimi.it/en/study/financial-support/international-scholarships>

<b>1st COURSE YEAR Core/compulsory courses/activities</b>				
Scheduling	Learning activity	Module/teaching unit	Ects	Sector
year	Principle of spectroscopy and applications to quantitative biology		10	CHIM/01, CHIM/03, CHIM/02, CHIM/06
1 semester	Cell biophysics		6	BIO/09, BIO/04
1 semester	Mathematical modeling for Biology		6	MAT/09, MAT/05, MAT/06, MAT/07, MAT/08
1 semester	Measurement of nanoscale interactions in biological systems and data analysis		6	FIS/03, FIS/02, FIS/01
1 semester	Programming in Python		6	INF/01
2 semester	Advanced molecular biology		9	BIO/11, BIO/18
2 semester	Integrated structural biology		6	BIO/10
2 semester	Molecular biophysics		6	FIS/07
Total number of compulsory credits/ects			55	
<b>2nd COURSE YEAR Core/compulsory courses/activities</b>				
Scheduling	Learning activity	Module/teaching unit	Ects	Sector
1 semester	Imaging in living cells		5	FIS/07, BIO/04
1 semester	Introduction to Logic		6	M-FIL/02
Total number of compulsory credits/ects			11	
<b>Further elective courses</b>				
<b>The student must choose one of the following courses:</b>				
1 semester	Non linear dynamics in quantitative biology		6	BIO/11, BIO/19, BIO/18
1 semester	Structural bioinformatics		6	FIS/07
2 semester	Cell population dynamics		6	BIO/06, BIO/17, BIO/13
<b>Open choice courses: 12 CFU</b>				
<b>End of course requirements</b>				
year	Other training activities		3	ND
year	Thesis project and final dissertation		33	ND
Total number of compulsory credits/ects			36	