



MASTER IN PHYSICS

Curriculum in BioSystems

General information on the different curricula can be found at

<https://corsidilaurea.uniroma1.it/it/corso/2023/32384/programmazione>

where available courses and the detailed programs of each course can be found

Curriculum in BioSystems

The curriculum provides a **comprehensive knowledge of the principles and applications of physical modelling in biology**. Besides a core background in physics (Intro to QFT and Condensed Matter) the student will develop a deep understanding of the physical mechanisms driving biological systems at all levels and scales, and of the techniques to analyze them.

- ➔ the origin of intra and inter molecular forces, of the self-assembly processes, the physics of polymers and of colloidal solutions.
- ➔ the basic principles of response theory and the main techniques in spectroscopy and microscopy to investigate biological systems at the microscopic scale.
- ➔ the theory of low Reynolds number hydrodynamics and how to study - through various experimental techniques - dynamical processes in cells and living systems.
- ➔ theoretical concepts in stochastic processes and the statistical physics of interacting systems and how to use them to describe signal amplification, regulation and collective phenomena in multi-scale biological processes, from neural networks to animal groups.
- ➔ computational methods to analyze data and make sense of them

Corso di laurea in Fisica (LM-17) - Curriculum Biosistemi

N.	Insegnamenti	CFU	anno	sem.	SSD	eng	ambito
1	Condensed Matter Physics	6	1	1	FIS/03	Y	caratt.
2	Soft and Biological Matter	6	1	1	FIS/03	Y	caratt.
3	Physics Laboratory I (propedeutico a Physics Laboratory II)	6	1	1	FIS/01	Y	caratt.
4	Physics Laboratory II	9	1	2	FIS/01	Y	caratt.
5	Theoretical Biophysics	6	1	2	FIS/02	Y	caratt.
6	Biophysics	6	1	2	FIS/03		caratt.
7	English language	4	1	2		Y	AAF
8	Facoltativo (da Gruppo A)	6	1 / 2	1 / 2			aff.-int.
9	Facoltativo (da Gruppo A)	6	1 / 2	1 / 2			aff.-int.
10	Corso a scelta libera	6	1/2	1/2			
11	Introduction to Quantum Field Theory	6	2	1	FIS/02	Y	caratt.
12	Facoltativo (da Gruppo A)	6	1 / 2	1 / 2			aff.-int.
13	Corso a scelta libera	6	1/2	1/2			
14	Internship	3	2	1		Y	AAF
15	Thesis Project	38	2	2		Y	AAF

Gruppo A (aff.-int.)

1	Biochimica	6	1	1	BIO/10	N	
2	Computational Biophysics	6	1	1	INF/01	Y	
3	Computing Methods for Physics	6	1	1	INF/01	Y	
4	Statistical Mechanics and Critical Phenomena	6	1	1	FIS/02	Y	
5	Nonlinear and Quantum Optics	6	1	1	FIS/03	Y	
6	Molecular biology	6	1	2	BIO/11	Y	
7	Mathematical Physics	6	1	2	MAT/07	Y	
8	Nonlinear Waves and Solitons	6	1	2	FIS/02	Y	
9	Neural Networks	6	1	2	FIS/02	Y	
10	Meccanica statistica del non equilibrio	6	1	2	FIS/02	N	
11	Photonics	6	1	2	FIS/03	Y	
12	Physics of Liquids	6	1	2	FIS/03	Y	
13	Spectroscopy Methods and Nanophotonics	6	1	2	FIS/03	Y	
14	Advanced Machine Learning for Physics	6	1	2	FIS/01	Y	
15	Statistical Physics and Machine Learning	6	2	1	FIS/02	Y	
16	Many-Body Physics	6	2	1	FIS/03	Y	
17	Medical Applications of Physics	6	2	1	FIS/01	Y	
18	Physics of Complex Systems	6	2	1	FIS/03	Y	
19	Statistical Mechanics of Disordered Systems	6	2	1	FIS/02	Y	
20	Surface physics and nanostructures	6	2	1	FIS/03	Y	
21	Theory of Stochastic Processes	6	2	1	FIS/02	Y	

CFU = number of credits
 Anno = year (first or second year)
 Sem. = semester in which the course is taught
 Eng = in English (Y) or in Italian (N)

SSD:

FIS: Physics course
 CHIM: Chemistry course
 BIO: Biology course
 INF: Computer science course
 MAT: Mathematics course

7 Mandatory Courses

4 common to all curricula
 3 specific to the Biosystem CV

3 Courses from Group A

2 Elective Courses

(BIO, INF, MAT etc)

Mandatory Courses:

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14	Internship	3	2	1		Y	AAF
15	Thesis Project	38	2	2		Y	AAF

Condensed Matter Physics
Lab I
Lab II
Intro to QFT

Soft and Biological Matter
Theoretical Biophysics
Biophysics

Note:

Introduction to Quantum Field Theory is scheduled for the 2 year in the standard Biosystems plan (it is instead in the 1 year in the other master curricula).

Students who want to take this course in the first year MUST present an 'individual' plan where the course is inserted in the first year.

The general rule is that second year courses MUST be scheduled at the second year (Introduction to Quantum Field Theory is a special situation)

Mandatory Courses specific to the Biosystem curriculum

- Soft and Biological Matter (Prof. Sciortino, year 1- sem 1)

intramolecular forces, the role of water, polymers (structure and self-assembly), micelles, membranes, gels, colloidal suspensions, structure of DNA and proteins

- Biophysics (Prof. Di Leonardo, year 1 – sem 2)

What's inside: genetic parts and circuits (gene expression – single molecule exp techniques – genetic editing)

What's outside: single cell movements (flagella, cytoskeleton, cell substrate - exp technique to probe movement)

Multicellular dynamics (growth and division, branching, tissue dynamics, quorum sensing – exp techniques)

- Theoretical Biophysics (Prof. Giardina, year 1 – sem 2)

The role of noise: signal detection, signal amplification and statistical reliance

(background in stochastic processes, bio cases: from chemoreception to chemotaxis; fotoreception)

The role of interactions and collective phenomena

(background in critical phenomena, bio cases: proteins, neural networks, animal groups and living active matter)

- LAB II- BioSystems (Prof. Nucara, year 1 – sem 2)

linear response theory/scattering/spectroscopy/microscopy/imaging/NMR

LABORATORY COURSES

LAB I (propaedeutic to LAB II) Prof. Ortolani

LAB II Prof. Nucara

Different Lab Courses:

- A) Particle and Astroparticle (Prof. Cavoto/Prof. Majorana)
- B) Condensed Matter (Prof. Mariani/Prof. Betti)
- C) BioSystems (Prof. Ortolani / Prof. Nucara)

linear response theory/scattering/spectroscopy/microscopy/imaging/NMR

Assignment/internship in one of the various labs working in biophysical research at the Department (presentation of available projects during the course LAB II)

Group A Courses

Gruppo A (aff.-int.)							
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BIO

THEO

COMP

EXP

no anxiety: you can change your plan at year II.....

Structure of a reasonably balanced plan

First year:

9-11 courses (+ English)

Second year:

1-3 courses + internship and Thesis Project

Thesis Project: 38 cfu – Typically students ask the Thesis in the first semester of the second year, and start working on it when almost all exams are passed.

Internship: how does it work?

After 2 months of working on the thesis, the thesis advisor gives the student a signed form to certify the work done.

The student registers on Infostud for the 'Internship' exam

The day of the exam the students bring the signed form to the responsible of the Internship, who registers the exam.

Internship Responsible for the BioSystem Curriculum: Prof. Giardina

MORE INFORMATION:

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More info

<https://sites.google.com/uniroma1.it/irene-giardina/teaching/curriculum-biosistemi>