

CORSO DI DOTTORATO IN BIOLOGIA

Ph.D. COURSES

Offerta didattica esclusiva

2026/2027

ADVANCES IN BIOLOGY I

Course coordinator: Daniele Campa (Università di Pisa)

Schedule: yearly course 2026/2027

Duration: 12 hours

Description: The course focuses on cutting-edge topics in the field of Biology and is structured around a series of online oral presentations. The seminar series covers all the major research areas represented within the Ph.D. program, providing students with a broad and interdisciplinary perspective. Whenever possible, the program will also include seminars delivered by speakers from outside academia, offering insights into career paths and applications of biological research beyond the academic environment. The aim of the course is to provide young researchers with an overview of the latest advances in Biology, broaden their scientific perspective, and illustrate how leading scientists overcome challenges in today's multidisciplinary research landscape.

Prerequisites: None required.

Final exam: not provided

RESEARCH METHODS AND EXPERIMENTAL DESIGN IN BIOLOGY

Course coordinator: Margherita Gioria (Università di Pisa)

Schedule: January 2027

Duration: 12 hours

Description: This course explores the principles and practice of designing studies and experiments in biology, an essential skill for early-career researchers in the life sciences. Emphasising the deductive approach, the course will guide students in formulating testable hypotheses, designing experimental and correlational studies, and distinguishing between explanatory and predictive models. Students will explore strategies for addressing spatial and temporal variability in biological systems and selecting appropriate statistical methods based on their study design. By the end of the course, students will submit a written plan and deliver a 5 to 10-minute presentation in which they detail their research questions, explain the rationale behind their experimental design, and describe the statistical methods they plan to use.

Prerequisites: None required

Preliminary Program: The Scientific Method and Hypothesis Formulation. The deductive method and scientific reasoning; Hypothesis formulation and testing; Correlational vs. experimental designs; Observational studies; Experimental Design and Sampling Strategies; Sampling units, replication, randomization, and control; Mitigating the effects of confounding variables; Addressing temporal and spatial variability (factorial, blocked, and repeated-measures designs); Common pitfalls in experimental design. Linking Design to Statistical Methods. Matching experimental design to appropriate statistical approaches; Univariate vs. multivariate analysis; Parametric vs. non-parametric methods; Understanding and checking data assumptions; applying data transformations when needed; Explanatory vs. predictive models; Introduction to mixed-effects models and their



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applications in biological data; Determining adequate sample sizes and test sensitivity; Criteria for selecting the most appropriate analytical methods based on data structure, hypothesis type, and study design. Practical Activities. Throughout the course, students will apply theoretical concepts to their own research by: Defining research questions and initial hypotheses based on their PhD topic; Developing a conceptual model linking observations, hypotheses, and predictions; Designing an experimental or observational study, including: Identification of variables, sampling units, replication levels, and control structure; Specification of randomization and blocking strategies; Consideration of alternative designs and their trade-offs; Proposing a statistical protocol for each hypothesis, including: Analytical approach; Assumptions, transformations, and alternative methods; Potential limitations and solutions.

Final exam: yes (final assessment of the competences acquired)

RESEARCH PROFESSIONAL SKILLS

Course coordinator: Alessandro Massolo (Università di Pisa), Paolo Domenici (CNR)

Schedule: yearly course 2026/2027

Duration: 30-36 hours

Description: The course focuses on core skills that are fundamental for a young researcher to achieve in early stages of her career. The course is organized in three blocks: I) one on scientific writing; II) one on literature search and management, and ethical aspect related to it; III) the last in on general skills on project proposal writing, scientific communication and formal assessment of scientific contributions.

The course is hands-on based, and students will be asked to write up pieces of papers, projects, presentations and to run literature searches and organize their literature using specific software for literature management.

Prerequisites: None required.

Program divided in Blocks:

Specifically, the first block will be centered on the structure, content and style in scientific writing. This will include writing of projects, reports, PhD thesis, and scientific publications. It will be minimally focused on the use of the English language, just provide some basic suggestions on how to improve the writing style in scientific writing to ensure clarity and synthesis.

The second block will deal on where and how to search for scientific literature, and on how to organize it. It will introduce to the three most used citations platforms (Scopus, Web of science, PubMed) and how to elaborate a search string. It will also include a component related to the ethical use of literature, editorial copyright and plagiarism.

The third block is intended to be general in nature and will include lectures and activities related to how to prepare an efficient presentation of a scientific work, and on the statistics used in scientometry to estimate the impact and quality of scientific journals, publications and of the overall production of a researcher. It will also provide lectures on how to prepare the research project proposal needed at the beginning of the program, and to carry out and write up a literature review, starting from the various types of reviews and their structures to the way to actually run it using standard international protocols.

Final exam: yes (final assessment of the competences acquired)



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BIOR - R TOOLS FOR BIOLOGISTS

Course coordinators: Luca Rindi (Università di Pisa), Antonio Profico (Università di Pisa)

Schedule: January - March 2027

Duration: 12 hours

Description: This PhD-level course introduces biology students with practical R programming skills to manipulate, clean and visualize biological data. Through hands-on coding exercises and biological case studies, early career researchers will learn how to manipulate and visualize real-world biological datasets producing reproducible and shareable R scripts. The course is organized into theoretical and practical sessions. The PhD students will be asked to write a complete R script that demonstrates the ability to manipulate and visualize biological data using R tools.

Prerequisites: None required.

Preliminary program: Introduction to R (installation, RStudio, working directory, types of R objects); data manipulation in R (e.g., importing and exporting datasets, subsetting, tidyr and dplyr packages); data visualization in R (e.g., scatterplot, barplot, heatmap, spatial maps, time series, ggplot2 package); introduction to R programming (iterative functions, logical operators); code and data sharing (GitHub and open-access repositories).

Final exam: yes (final assessment of the competences acquired)