

# Teaching Activity

## PhD Programme in Biosciences

---

### Teaching Activity 2023-2024

The training activities in our PhD Program are founded upon three primary pillars: course attendance, seminar participation, and involvement in the Journal Club activities.

#### Courses

The courses proposed by our PhD Programme are divided into Interdisciplinary Courses and Thematic Courses, the complete list is reported below. Students are required to enroll in each course they plan to attend by filling the **course enrollment form** that will be available in the moodle web platform and that will be opened by the PhD Office, at the beginning of each semester. Once the student is enrolled in a course his/her attendance will be mandatory. For the courses proposed by our PhD Program, the **Course Certification of the Attendance** (available on moodle) will be signed and approved by the Instructor of the course.

In addition to these courses, external courses may also be considered after approval of a written request signed by the Student and the Supervisor and sent to the PhD Office. At the end of the course, in order to get recognition of attendance for external courses, students shall obtain a certificate of attendance signed by the Instructor.

#### Seminars

Seminars proposed by the PhD Programme are announced by email by the PhD Office. Seminars external to our Course may also be considered. In order to certificate the attendance of the seminar students shall bring with them the **Seminar Certificate of Attendance** sheet (available on moodle), fill it in with the required information and have it signed by the speaker.

#### Journal Club

Journal Club activities are organized by members of the Academic Board within each curriculum. Students have to critically present a recent paper to other PhD students. The topic of the paper has to be general enough to be of broad interest. Attendance to JC meetings must be at least 75%.

## Requirements and duties (until students of the 39° cycle)

Teaching Activity requirements are the following:

- Attendance of **a minimum of three courses within the three-year** period is mandatory. Among the three courses **at least two must be selected among the Interdisciplinary Core Courses** list proposed by our PhD Programme.
- Attendance of **a minimum of 10 seminars per year** is mandatory. Of these **a minimum of 7 have to be proposed by our PhD Programme**.
- Attendance of **a minimum of 75% of the Journal club meetings** is mandatory.

Your training activities will be reported in a Progress Report document, which must be endorsed by your Supervisor and submitted following the indication provided by email by the PhD Office at the conclusion of each year (specific deadlines will be communicated via email by the PhD Office).

## Index of Interdisciplinary Core Courses

### 1. How to design and perform an experiment (12 hours)

Instructors: Prof. Graziano Martello

### 2. Science Communication, Fundraising & Career Development (20 hours)

Instructors: Prof. Ralf Dahm

### 3. Fellowship and grant writing (30 hours)

Instructors: Prof. Luca Scorrano

### 4. Basics of Statistics and of R (8 hours)

Instructors: Prof. Mirko Pegoraro

## Index of Thematic Courses

### 5. Gene Editing Part I: Basics of CRISPR-Cas Genome Editing (4 hours)

Instructors: Prof. Milena Bellin, Dott. Francesco Chemello

### 6. Gene Editing Part II: Advanced gene editing (8 hours)

Instructors: Prof. Milena Bellin, Dott. Francesco Chemello

### 7. Evolution under anthropogenic pressures and conservation (8 hours - one day in Chioggia)

Instructors: Prof. Carlotta Mazzoldi, Prof. Leonardo Congiu, Dott. Marco Munari

### 8. Models in genetic disease research (15 hours)

Instructors: multiple speakers

### 9. Perspectives on fluorescence microscopy (8 hours)

Instructors: Prof. Marta Giacomello

### 10. Microscope imaging analysis (8 hours)

Instructors: Prof. Francesco Argenton, Dott.ssa Nicoletta Plotegher,

### 11. Molecular basis of neurodegeneration: from mechanisms to therapies (14 hours)

Instructors: Prof. Elisa Greggio and Prof. Elena Ziviani (DiBio UNIPD)

Guest speaker: Dott.ssa Chiara Anselmi (Postdoctoral fellow, Stanford University)

### 12. Fundamentals of Evolutionary Biology (10 hours)

Instructors: Prof. Gil Rosenthal

### 13. Properties of adult stem cells across the animal kingdom – current concepts and future directions (10 hours)

Instructors: Prof. Bert Hobmayer

### 14. NextGen DNAseq/RNAseq analysis (4 hours)

Instructors: Dott. Mirko Pegoraro

### 15. Advanced Methods in Biochemistry (8 hours)

Instructors: Prof. Laura Cendron; Prof. Luigi Leanza

### 16. Cancer Metabolism (6 hours)

Instructors: Prof. Massimo Santoro

### 17. Stem cell biology, comparative immunology and cell transplantation (8 hours)

Instructors: Prof. Benyamin Rosental,

## Abstract, Schedule and Location - Interdisciplinary Core Courses

### How to design and perform an experiment (12 hours)

Instructors: Prof. Graziano Martello

Schedule and location:

12th (room H), 19th (room L) and 26th (roomH) January 2024 - 2:30 to 5:30 PM

**Description:** The course comprises both lectures and practical activities, focused on how to design and perform experiments, and how to interpret and present results. I will draw parallels between how we make decisions in our everyday life and how we should perform experiments. We will discuss several examples, ranging from simple biological experiments to bioinformatic analyses.

### Science Communication, Fundraising & Career Development (20 hours)

Instructors: Prof. Ralf Dahm

Location: Fiore di Botta, room 3E

Schedule:

April 15<sup>th</sup> 9:00 – 16:30

16<sup>th</sup> 9:00 – 14:00

May

9<sup>th</sup> 9:00 – 12:30

10<sup>th</sup> 9:00 – 12:30

**Description:** This course explains the fundamentals of science communication and fundraising:

- The basic principles of good communication.
- How to prepare and deliver captivating scientific talks.
- How to design appealing posters.
- How to write clear and convincing scientific texts e.g. papers, applications.
- How to compile a compelling job application.

This course will comprise:

- Introductory lectures on the topics outlined above.
- Practical sessions during which participating students present their projects (in talks or on posters), grant proposals and job applications, and the tutors and other participants give feedback on a student's presentation/other materials.

## **Fellowship and grant writing (30 hours)**

**Instructors:** Prof. Luca Scorrano

**Location:** Vallisneri, room to be defined

**Schedule:**

**June** 17<sup>th</sup> - 20<sup>th</sup>, 14:00 – 15:30

**July** 8<sup>th</sup> - 12<sup>th</sup>, 14:00 – 15:30

15<sup>th</sup> - 19<sup>th</sup>, 14:00 – 15:30

**Description** This course aims at providing PhD students with basic principles on how to write convincing fellowship and grant applications. The course is organized in three intertwined blocks of lessons. The first block deals with the basic principles of the scientific method applied to biology, to provide a conceptual framework for grant applications. The second block of lessons uses hands-on examples of fellowships and grants to explain basic features of grantsmanship. Students are then asked to write a 2-page fellowship proposal on their topic of choice, using an EMBO fellowship like format. These proposals are due before the third block of lessons when we go through them and rank them as if we were a reviewing panel. The course is mostly flipped classroom and group work, except for the fellowship proposal that is of course individual.

## **Basics of Statistics and of R (8 hours)**

**Instructors:** Prof. Mirko Pegoraro

**Location:** Fiore di Botta, room 3E

**Schedule:** March 25<sup>th</sup> 10:00 - 12:30

March 26<sup>th</sup> 10:00 - 12:30

March 27<sup>th</sup> 10:00 - 11:30

**Description:** This workshop will introduce R. An initial description of basic concepts and principles develop into data manipulation and graphical representation using ggplot2. The workshop will also revisit basic statistical concepts and will include statistical analysis (ANOVA and post hoc) and a simple loop. The workshop is hand-on so it requires students to have access to a PC/laptop installed with R (R studio is recommended but not strictly necessary). Access to the internet is necessary.

## **Abstract, Schedule and Location - Thematic Courses**

### **Gene Editing Part I: Basics of CRISPR-Cas Genome Editing (4 hours)**

**Instructors:** Prof. Milena Bellin, Dott. Francesco Chemello

**Location:** Fiore di Botta, room 3E

**Schedule:** April 9<sup>th</sup> and 10<sup>th</sup>, 11.00-13.00

**Description:** CRISPR-Cas system has revolutionized the field of genome engineering. This course will give a broad overview of the different genome editing technologies, focusing on CRISPR-Cas, its discovery, applications, and the latest derived CRISPR-Cas based editing tools. Practical examples will be presented to show the advantages and limitations of the different strategies. Participation is recommended for PhD students that plan to follow the course “Advances in CRISPR-Cas Genome Editing” in the AY 2023/2024.

Teaching program:

1. History of genome editing: meganucleases, ZFN, TALEN, CRISPR-Cas9
2. Discovery of CRISPR-Cas system
3. CRISPR-Cas9 genome editing: DNA repair pathways, double-/single-cut editing
4. CRISPR-Cas based genome editing tools: CRISPRi, CRISPRa, base editing, prime editing.

### **Gene Editing Part II: Advanced gene editing (8 hours)**

**Instructors:** Prof. Milena Bellin, Dott. Francesco Chemello

**Location:** Fiore di Botta, room 3E

**Schedule:** May 7<sup>th</sup> 11:00 – 13:00

16<sup>th</sup> 13:00 – 15:00

17<sup>th</sup> 13:00 – 15:00

21<sup>st</sup> 11:00 – 13:00

**Description:** The development of advanced CRISPR-Cas genome editing technologies has expanded the available gene editing strategies for treating various diseases. The course comprises both lectures and guided journal club activities, discussing the utilization of genome editing as possible treatment for human diseases, and focusing on the optimization of in vivo delivery and safety of the gene editing components. Participation in the course “Basics of CRISPR-Cas Genome Editing” is recommended.

Teaching program:

1. Novel advances in genome editing tools.
2. Delivery strategies of genome editing components.
3. Mitochondrial genome editing.
4. Safety challenges of genome editing.

## **Evolution under anthropogenic pressures and conservation (8 hours - one day in Chioggia)**

**Instructors:** Prof. Carlotta Mazzoldi, Prof. Leonardo Congiu, Dott. Marco Munari

**Schedule:** 23 April 2024

**Description:** The day will consist of a sequence of seminars on the topic mentioned in the title, a visit to the Fish market of Chioggia (with discussion on conservation and species vulnerability to exploitation), and a visit to the Museum of Adriatic Zoology (with discussion of consequences of exploitation on biodiversity, using the Adriatic Sea as an example).

## **Models in genetic disease research (15 hours)**

**Instructors:** multiple speakers [see file](#)

**Schedule:** October 23rd, 24th, 25th, 26th, 2023.

**Description:** The course is organized as a series of seminars in the framework of the ERASMUS+ week. The primary focus of the presentations will be around the benefits and advancements in utilizing model organisms for the study of complex diseases.

## **Perspectives on fluorescence microscopy (8 hours)**

**Instructors:** Prof. Marta Giacomello

**Location:** Vallisneri, room L

**Schedule:** April 17<sup>th</sup> 14:30 – 16:30; 19<sup>th</sup> 14:30 – 16:30; 22<sup>nd</sup> 14:30 – 16:30; 24<sup>th</sup> 14:30 – 16:30

**Description:**

- Basic Principles of microscopy (2h): Diffraction, Resolution and Contrast, Optics of the microscope
- Fluorescence and Confocal Microscopy (2h): Fluorescence microscopy (fluorophores, illumination), Basic Confocal microscopy (Lasers, multi-dimensional Image Recording)
- Fluorescent Probes (for fixed and live samples) (2h); Chemical and genetically encoded; Ratiometric - Non ratiometric
- Advanced techniques in fluorescence microscopy (2h): (FRET, TIRF, FRAP) and Super resolution microscopy

## **Microscope imaging analysis (8 hours)**

**Instructors:** Prof. Francesco Argenton, Dott.ssa Nicoletta Plotegher,

**Location:** Vallisneri, room to be defined

**Schedule: June 25<sup>th</sup> 26<sup>th</sup> 27<sup>th</sup>, 14:30 – 16:30; September 24<sup>th</sup>, 14:30 – 16:30**

**Description:** The aim of this course is to provide a formal understanding of what digital images are and how this makes them suitable to be mathematically handled in order to get more insights into our biological data. This will be done by means of a combination of traditional presentations on the topic, of exercises and discussion on data provided by the teachers or by the students. The course will be organized as follows:

- principles of image analysis, math on images, ImageJ/Fiji, n-dimensional images, image analysis: shape/density, ROIs, background. Examples and exercises based on what was discussed in class. (4 hours)
- most common errors in Image Analysis -> (1) sample preparation; (2) asking the right question; (3) image acquisition; (4) image analysis: automated vs manual analysis, machine learning applications. Discussion about the errors and how to avoid them. (2 hours)
- analysis of images provided by the students. (2 hours)

### **Molecular basis of neurodegeneration: from mechanisms to therapies (14 hours)**

**Instructors:** Prof. Elisa Greggio and Prof. Elena Ziviani (DiBio UNIPD)

**Guest speaker:** Dott.ssa Chiara Anselmi (Postdoctoral fellow, Stanford University)

**Location: Vallisneri, room L**

#### **Schedule:**

May 14, 2024 - Hallmarks of neurodegenerative diseases: a focus on genetics

May 16, 2024 - Mitochondrial dysfunction in neurodegenerative diseases

May 21, 2024 - Protein aggregation in neurodegenerative diseases

May 23, 2024 - Mechanisms of mitochondrial quality control and neurodegeneration: lesson from genetics

May 28, 2024 - Synaptic dysfunction in neurodegenerative diseases

May 30, 2024 - Drosophila as a model in neurodegenerative disease research

June 4, 2024 - Conserved features of neurodegeneration, evolutionary insight from a marine chordate

**Description** The human brain is by far the most complex structure existing in nature. The core component of the brain is the neuron, an electrically excitable cell that elaborates and transfers information by electro-chemical signaling to other neurons. Unlike other cells, the majority of neurons do not divide, lasting for the entire lifespan of one individual. Thus, neuronal loss equals information loss. Although neuronal degeneration is an inevitable process, which ultimately occurs in the aged brain, this process can be anticipated by a number of causes, of environmental nature, genetic origin or both. It is expected that 25% of the European population will be over 65 years of age by 2030, indicating how age-related disorders represent major medical and social challenges. This area of research is rapidly expanding and the discovery of novel molecular targets and diseases biomarkers is offering exciting therapeutics opportunities. The course will offer a critical appraisal of the major themes in the study of neurodegenerative diseases, from genetics and protein aggregation



to dysregulation of mitochondrial quality control, synaptic dysfunction and impaired proteostasis. The closing lecture will be held by a young researcher, Dr. Chiara Anselmi, former PhD student at DiBio, who will discuss how neurodegeneration can also be a physiological process in certain species.

### **Fundamentals of Evolutionary Biology (10 hours)**

**Instructors:** Prof. Gil Rosenthal

**Schedule:**

Giov 19 Ott 2023 17.30-19.15 Room: Residenza Nord Piovego

Mart 24 Ott 2023 18.00-19.45 Room: Residenza Nord Piovego

Giov 26 Ott 2023 17.30-19.15 Room: Residenza Nord Piovego

Mart 31 Ott 2023 18.00-19.45 Room: Residenza Nord Piovego

Giov 2 Nov 2023 17.30-19.15 Room: Residenza Nord Piovego

**Description:** The course focuses on a largely non-mathematical approach to the fundamentals of mathematical evolutionary theory as applied to modern evolutionary problems using next-generation approaches. The course is designed to pair quantitatively oriented undergrad and LM students in the Galilean Academy with PhD level students focused in the life sciences. Each lesson is paired with a problem set and readings from the primary literature. There are no formal prerequisites for the course, though some prior background in probability theory would be helpful.

### **Properties of adult stem cells across the animal kingdom – current concepts and future directions (10 hours)**

**Instructors:** Prof. Bert Hobmayer

**Location:** Room 0G Botta Building

**Schedule** 14-15-16-17 Nov 2023

**Description** Main topic of the proposed course will be the properties of adult stem cells across the animal kingdom. While detailed knowledge about adult stem cells is present in vertebrate organ systems, invertebrate animal models exhibiting unparalleled capacities for regeneration, growth and immortality have obtained more attention only recently. As a result, we know their underlying adult stem cell lineages not nearly as well. This course aims at closing this gap, at uncovering the current open questions and the challenges lying ahead, and at addressing the available experimental approaches. Overall goal of this course is to raise awareness for the most up-to-date topics related to adult stem cells and their role in biological mechanisms and in medical applications.

Types of teaching units:

4 lecture and discussion units (one per day, each 90-120min):

- Introduction to animal adult stem cell lineages – properties and mechanisms of decision making
- Pluripotent interstitial cells in Hydrozoa as a case study of a prototypic adult stem cell lineage

- Epithelial stem cells in growth and morphogenesis
- An evolutionary perspective on adult stem cells – open questions and future approaches

3 practical units (one per day, first three days, each 60-90min):

- How to recognize stem cells in light microscopy
- Life imaging of adult stem cells using transgenic animals
- Analysis of stem cell-specific gene expression in a single cell transcriptome database

### **NextGen DNaseq/RNaseq analysis (4 hours)**

**Instructors:** Dott. Mirko Pegoraro

**Location:** Vallisneri, Room L

**Schedule:** March 25<sup>th</sup> 15:00 – 16:30; 26<sup>th</sup> 15:00 – 16:30

**Description:** The workshop presents how to process next generation DNaseq/RNaseq data. The workshop consists of a lesson to understand the questions we are answering with Next gen seq and to understand the files generated by both the sequencing technology and data analysis. The lesson is then followed by a demonstration of the process of analysing and visualising RNA-Seq data. Required access to PC/laptop, internet linux.

### **Advanced Methods in Biochemistry (8 hours)**

**Instructors:** Prof. Laura Cendron; Prof. Luigi Leanza

**Location:** Vallisneri

**Schedule:** May 23<sup>rd</sup> and 24<sup>th</sup> (Prof. Cendron), 12:30 - 14:00 **Room A**

June 11<sup>th</sup> and 12<sup>th</sup> (Prof. Leanza), 14:30 - 16:00 **Room L**

#### **Description:**

The course aims at offering a general overview to the methods, approaches and novel technologies to develop a project based on biomolecular interactions, consisting of: 1) the capture of a network of interactions and the identification of interacting partners; 2) physical-chemical characterization of the interactions and 3) application of display technologies to the generation of libraries of high affinity and specificity binders.

Main topics in brief:

- Techniques to identify/study interactions:
  - o Co-immunoprecipitation/co-affinity purification coupled to quantitative mass spectrometry (w/o cross-linking)
  - o Label free Proximity Ligation assays techniques
- Techniques to measure interactions (HT and non-HT):
  - o Surface Plasmon Resonance- Principles and Assays: applications in protein research, Kinetic analysis of protein-protein interaction using SPR
  - o Interferometry techniques, Biomolecular interactions using Bio-Layer

- Interferometry (BLI): applications in protein research, Kinetic analysis of protein-protein interaction using BLI
- Techniques to generate novel binders by libraries screenings:
    - o Naïve, immunization vs synthetic libraries, libraries diversity, main applications
    - o Introduction to Phage display
    - o Introduction to Yeast display

### **Cancer Metabolism (6 hours)**

**Instructors:** Prof. Massimo Santoro

**Location:** Vallisneri, Room L

**Schedule:** June 26<sup>th</sup> and 27<sup>th</sup>, 10:00 – 12:00

**Description:** The aim of this course is to give an overview of the most recent advances in cancer metabolism with a perspective on possible therapeutic interventions. Metabolism will be revisited as adaptations imposed by the activation of oncogenes, the loss of tumor suppressors, or the mutations of metabolic genes. We will become familiar with the concept of cancer heterogeneity related to metabolism, understand molecular, cellular and biochemical mechanisms leading to metabolism-guided cancer resistance, and acquire resistance to therapy. Specific aspects of cancer spreading and metastasis-related metabolic adaptation will be discussed.

### **Stem cell biology, comparative immunology and cell transplantation (8 hours)**

**Instructors:** Prof. Benyamin Rosental,

**Location:** Fiore di Botta, room 3E

**Schedule:** April 10<sup>th</sup>, 9:00-11:00

11<sup>th</sup>, 9:30-11:30

12<sup>th</sup>, 9:30-12:30

**Description:** The proposal regards a series of 8 lectures with the following title and content:

1) Evolutionary aspects of stem cells and regeneration.

Content: stem cell and stem cell niche presentation, stem cell role in development and regeneration in invertebrates and vertebrates.

2) Flow cytometry, sorting and imaging at the base of biomedical research.

Content: technical and historical presentation of FACS, method potentials and limits, breakthrough biomedical applications.

3) Cellular functionality using flow cytometry approaches.

Content: Functional immune assays, such as cytotoxicity and phagocytosis. Cellular markers such as low pH vesicles, lysosomes, ROS, protease activity etc. including examples from research and latest publications.

4) Cell populations isolation and differentiation in non-classical model organisms.

Content: examples on cell isolation using exogenous markers and not specific antibodies. Examples will be given in tunicates, planarians, cnidarians, urchins, fish, etc.

5) Functional evolutionary immunology.

Content: evolution of the immune system and its functionality, with emphasis on tissue rejection in vertebrates and invertebrates. Methods of analyzing immune cellular function in non-classical models.

6) Use of evolutionary approaches for medical applications in stem cell therapies.

Content: understanding basic conserved mechanisms of immune activation and resolution. Examples of discovered mechanisms in tunicates, where a resolution mechanism is used to improve bone marrow transplantations, and the activation mechanism to induce cancer cells lysis.

7) Biomedical tools to understand ecological issues.

Content: examples of current NSF-BSF Rosental's projects to show the immune system at the base of coral bleaching phenomena.

8) Approach of using stem cell therapies for endangered species, with emphasis on coral reefs.

Content: examples of the use of induced pluripotent stem cells (iPSCs) and gonadal stem cells to bring endangered species. The example will be taken from the current ERC Rosental's project of the development of stem cell therapy for corals.

The seminars will require as prerequisites knowledge on cell biology, developmental biology, ecology, and evolutionary biology.