For more detailed information, please refer to the PhD program page on Unistudium

1 CFU = 6 hours

Courses	Module	SSD	Lecturer	Hours	CFU	Year	Suggested dates* (and hours)	Room	Final exam	*Curriculum*
Bioinformatics	Introduction to data analysis and data formats	AGR/16	Gianluigi Cardinali	12	2	I	17-19 Feb. 2025 (9-13)	TBD	Yes	AC
	Introduction to basic programmming in biotechnologies	AGR/16		6	1		20-21 Feb. 2025 (15-18)	TBD	Yes	
Photonics	Femtobiology	CHEM/06	Benedetta Carlotti	12	2	I	24-26 Mar. 2025 (14.30-17.30)	TBD	Yes	C-BB
	Two-photon absorption for bio-applications	CHEM/06	Alessio Cesaretti	6	1		16-17 June 2025 (14.30-17.30)	TBD	Yes	
Safety in biotechnology lab	Safety in biotechnology	CHEM/06	Assunta Marrocchi	12	2	I	TBD	TBD	Yes	AC
	Bioprocesses	CHEM/06		6	1		18-19 June 2025 (10-13)	TBD	Yes	C-BB
Advanced informatics	Advanced databasing and programming in biotechnology	AGR/16	Vincent Robert	18	3	II	June 2025	TBD	Yes	AC
Advanced medical biotechnology	Transcriptomics data mining theory	BIO/14	Giuseppe Nocentini	6	1	II	26-27 June 2025 (14.30-17.30)	7	Yes	C-MB C-MIB
	Transcriptomics data mining practice	BIO/14	Luigi Cari	6	1		30 June – 1 July 2025 (14.30-17.30)	7	Yes	C-MB C-MIB
	Cancer immunotherapy	BIO/14 MED/13	Stefano Bruscoli - Efisio Puxeddu	6	1		23-24 June 2025 (14.30-17.30)	TBD	Yes	C-MB
	Introduction to biomarkers	BIOS-07/A	Lorena Urbanelli	6	1		7-8 May 2025 (15-18)	Aula B3	Yes	AC
Writing EU research projects	Writing EU research projects	SPS/02	Sara Alimenti	6	1	All	27-29 May 2025 (15-18)	TBD	Yes	T
Bioessay in biotechnologies	Bioessay in biotechnologies	AGR/16	Laura Corte	6	1	II	24-25 Sept. 2025 (TBD)	Aula C – S. Pietro	Yes	C-BB C-MIB
Gene editing	Medical gene editing	BIO/14	Stefano Bruscoli	6	1	III	6-7 Oct. 2025 (14.30-17.30)	TBD	Yes	C-MB
	Plant gene Editing	AGR/07	Francesco Paolocci	6	1		9-10 Oct. 2025 (14.30-17.30)	TBD	Yes	C-MIB

	Machine learning applied to gene editing	BIOS-07/A	Francesco Morena	12	2		12-15 May 2025 (14.30-17.30)	Aula Bioinformatica	Yes	C-MB C-MIB
Food and environmental biotechnology	Functional foods	AGR/16	Florentina Matei	6	1	III	TBD	TBD	Yes	C-MB C-MIB
Introduction to robotics and AI-based surgery	Introduction to robotics and AI-based surgery	MED/18	Fabio Rondelli	6	1	III	TBD	TBD	Yes	C-MB
Ethics of the scientific research	Scientific and technological foundation	AGR/16	Gianluigi Cardinali	6	1	All	27 May 2025 (10-13; 15-18)	TBD	Yes	T
	Ethical foundations	M-FIL/01	Marco Moschini	6	1		28-29 May 2025 (15-18)	TBD		
HT data generation	HT data generation	BIO/10	Jacopo Lucci	6	1	III	TBD	TBD	Yes	T

Legend
AC = tutti i curricula / all curricula
C-BB = curriculum Biomateriali e Biodispositivi / curriculum on Biomaterials and Biodevices
C-MB = curriculum Biotecnologie Mediche / curriculum on Medical Biotechnologies
C-MIB = curriculum Biotecnologie Molecolari e Industriali / curriculum on Molecular and Industrial Biotechnologies
T = trasversale / transversal

*Please always check on the **Unistudium** page or contact the professor (email contacts are provided below) for eventual changes in the schedule

COURSES

BIOINFORMATICS

Lecturer: Gianluigi Cardinali (gianluigi.cardinali@unipg.it)

INTRODUCTION TO DATA ANALYSIS AND DATA FORMATS – INTRODUCTION TO BASIC PROGRAMMING IN BIOTECHNOLOGIES

The course consists of two modules taught one after the other. In the first module, "Data and Formats," various types of data are discussed from mathematical, computational, and biological perspectives. Advanced data formats used in metagenomics are also explained and illustrated. This is followed by the treatment of data storage structures: vector, matrix, tensor, array. From various types of matrices or tensors, the discussion moves to various types of distances for continuous, categorical, DNA/RNA/Proteins, and classified data. Lastly, some forms of data representation with dimensionality reduction algorithms such as PCoA are presented.
The second part of the course deals with the basic mechanisms of programming (conditional testing, loops, indexing, etc.) to automate the main analyses carried out in the biotechnological field. Throughout the course, students work on their own PCs in the R environment, ideal for illustrating various aspects of data and their structures, as well as teaching the basics of programming. Learning assessment occurs through the proposal of problems that must be solved using the algorithms and procedures studied in R

PHOTONICS

Lecturers: Benedetta Carlotti (benedetta.carlotti@unipg.it), Alessio Cesaretti (alessio.cesaretti@unipg.it)

FEMTOBIOLOGY

Femtosecond Lasers. LASERs. Femtosecond lasers are necessary to track events over time at the molecular level. How to generate femtosecond laser pulses. How to tune their wavelength. Fluorescence Up Conversion. Fluorescence. Time-resolved fluorescence spectroscopy. Fluorescence up-conversion: single wavelength and broad-band detection. Fluorescence polarization and anisotropy. Femtobiology. Ultrafast dynamics in nucleic acids and proteins: hydration of biomolecules; photoinduced electron transfer processes; Forster resonance energy transfer processes.

TWO-PHOTON ABSORPTION FOR BIO-APPLICATIONS

Two-photon absorption (TPA) is a nonlinear optical phenomenon in which two photons of half the energy are used to excite small organic molecules, typically in the near-infrared, as opposed to the common UV-Vis radiation used in conventional single-photon excitation. The TPA process can be exploited to develop new non-invasive bio-imaging technologies, allowing for higher spatial resolution and optical sectioning in the sample at various depths. The TPA phenomenon can be utilized in photodynamic therapy through the selective excitation of specific compounds. When high cross-sections of TPA are coupled with significant production of triplet states, these molecules, once excited, can lead to the formation of ROS and thus selective death of tumor cells. Examples of the use of TPA in both bio-imaging and photodynamic therapy are discussed. At the end of the course, a final test will be administered with some questions on LibreEol.

SAFETY IN BIOTECHNOLOGY LAB

Lecturer: Assunta Marrocchi (assunta.marrocchi@unipg.it)

SAFETY IN BIOTECHNOLOGY

The course aims to inform about the risks associated with the use of chemical substances, biological agents, and physical agents in biotechnological research laboratories: (1) Hazard, risk, prevention, protection, risk perception and assessment, risk management, and communication concepts.
(2) Main regulatory references. (3) Chemical risk: Definition of hazardous chemical agents; hazard classes; the concept of exposure to chemical agents: the threshold limit value (TLV); routes of absorption of chemical agents and parameters influencing absorption; chemical risk assessment, prevention, and protection measures.

(4) Biological risk: Definition of biological agent, microorganism, cell culture; classification of biological agents; Physical risk assessment: Definition of physical agent; relevant physical agents in biotechnological laboratories; in-depth analysis of artificial optical radiation; health and safety effects of exposure to artificial optical radiation.
At the end of the course, a final test will be administered with some questions on LibreEol.

BIOPROCESSES

The course aims to provide basic knowledge related to bioprocesses in the biotechnological industry; more specifically, the main fermentation and enzymatic processes will be discussed. Additionally, an overview of the impact of industrial biotechnologies, a panorama of products from the biotechnological industry (biofuels and bioenergy, chemicals, new materials, etc.), and a brief mention of the key role of industrial biotechnologies in the context of environmental sustainability will be provided. Guidance will be given regarding relevant websites in this field and suggestions for further scientific readings.
The course will involve frontal lectures, requiring active participation from doctoral students. To assess learning outcomes, at the end of the training period, a evaluation test will be administered to the doctoral students, consisting of closed and/or open-ended questions, on the LibreEol platform

ADVANCED BIOINFORMATICS

Lecturer: Vincent Robert

The course is based on the use of advanced databases used in biotechnology and uses all the concepts taught in the course Bioinformatics I, in fact the two courses are designed and modified in concert by the two instructors. The course presents the systems of database m
anagement, mainly using language VB.net and, partly, Python, with the intention of showing in parallel the differences and similarities between two different languages, but of wide use in professional applications (VB.net) and building scripts and piplines (Python). The main programming mechanisms are presented and explored in depth. It comes then illustrated the use of libraries in programming one standalone (VB.net) or a script (Python). We then move on to explanation of the systems for submitting database data to main statistical treatments and/or, in the case of DNA, phylogenetic. Students will have to conduct a personal project, part in class, part as work to be done outside of school hours lesson. The course verification is carried out based on results of the assigned project.

ADVANCED MEDICAL BIOTECHNOLOGY

Lecturers: Giuseppe Nocentini (giuseppe.nocentini@unipg.it), Luigi Cari (luigi.cari@unipg.it), Stefano Bruscoli (stefano.bruscoli@unipg.it), Efisio Puxeddu, Lorena Urbanelli (lorena.urbanelli@unipg.it)

TRANSCRIPTOMICS DATA MINING

First part - Prognosis and personalized treatment of patients with solid tumors. Infiltration of the tumor microenvironment by cells of the immune system.
Second part - Introduction to the use of "Big Data" in biomedical research, from bulk data to spatial biology; organization and examples of the use of "public repositories" of transcriptomic data such as "BioStudies" (Array Express) and "Gene Expression Omnibus" (GEO); structure and examples of the use of freely accessible analysis software such as "GEO2R" and "Gepia2" for gene expression analysis, survival analysis, correlation analysis, and dimensional reduction; theoretical basis of the qualitative validation and normalization process of data produced with microarrays (assessment of variability sources, quality controls, multi-array normalization, normalization across multiple experiments); structure and examples of the use of the software "GeneVestigator" (free in the basic plan, paid in more advanced functions) in the analysis of healthy tissue samples, diseased tissue (tumoral and non-tumoral), and cell lines; practical exercise related to the use of such tools for the prognosis and personalization of treatment for patients with solid tumors and for the evaluation of tumor microenvironment infiltration by cells of the immune system.

CANCER IMMUNOTHERAPY

First Part - Introduction to immunotherapy for cancer treatment; concepts of immunotherapy and chemotherapy; main approaches of oncological immunotherapy.
Second Part - Description of tumor cells' 'immuno-escape' and immune checkpoints; insights into thyroid immuno-oncology; synthesis of results from clinical studies of immunotherapy in thyroid cancer; ongoing clinical studies of immunotherapy in thyroid cancer; data on immunoprofiling of thyroid carcinoma; advanced immunophenotypes of thyroid carcinoma (ATC and PDTC); Role of the beta-catenin pathway in the development of a PDTC subtype.

INTRODUCTION TO BIOMARKERS

Introduction to the concept of biomarkers; descriptive characteristics of a biomarker and main types (diagnostic, monitoring, pharmacodynamic, predictive, prognostic, susceptibility or risk, safety). Overview of pipelines for biomarker discovery; biomarkers and liquid biopsy. At the end of the course, a final test will be administered with some questions on LibreEol.

WRITING EU RESEARCH PROJECT

Lecturer: Sara Alimenti (sara.alimenti@unipg.it)

European programs for research: access strategies, research project management tools, and pathways for valorizing research results European funds represent today more than ever an opportunity for researchers who, thanks to these channels, can benefit from resources to finance activities, but also to build and consolidate networks and engage in pathways for valorizing research results and maximizing impacts. In this perspective, researchers need skills that allow them to understand funding opportunities, develop successful proposals, and manage funded projects most effectively. The training activity proposes an approach to European funds structured as follows:

- Understanding the main European funding programs for research;
- Planning scouting and analysis activities of funds to intercept the most suitable measures for research needs;
- The lifecycle of the research project: the pre-award phase; management of funded projects; processes for valorizing results; maximizing impacts;
- Organizing networking activities with institutions and research entities, organizations, and the business world;
- Managing relationships with administrative and scientific-professional figures involved in research design and management.

BIOASSAYS IN BIOTECHNOLOGIES

Lecturer: Laura Corte (laura.corte@unipg.it)

Introduction to the concept of biosensing as a tool for microbiological-genetic biomonitoring. Types of biosensing and biological sensors. Comparison between biosensing and biosensors. Main biosensing applications in medical, pharmaceutical, agri-food, and environmental fields. At the end of the course, a final test will be administered with some questions on LibreEol.

GENE EDITING

Lecturers: Stefano Bruscoli (stefano.bruscoli@unipg.it), Francesco Paolocci (francesco.paolocci@unipg.it), Francesco Morena

GENE EDITING

First Part - Basic principles of molecular biology; Genetic editing of somatic and germ cells; Basic mechanism of CRISPR/Cas9 genetic engineering technology; CRISPR/Cas9 strategies for genetically modifying animal experimental models; New applications of CRISPR/Cas9 technique; Limitations and flaws of CRISPR/Cas9 technique: 'off-target' events and mosaicism; Practical applications examples in clinics: treatment of genetic diseases, infectious diseases, tumor pathologies, potential treatments in patients with HIV; Ethical aspects.

Second Part - The Plant Genome Editing course, starting with a brief overview of basic principles and methodologies, as well as the results achieved through traditional breeding, will focus on the techniques and potential advantages offered by new breeding technologies (NBT) for the genetic improvement of agriculturally relevant species. Specifically, the course will center on the various possibilities offered by CRISPR/Cas technology in obtaining improved varieties for both qualitative and quantitative traits, as well as in the introgression of genetic traits from ancestral species and wild relatives into modern varieties to enhance biodiversity and address new environmental challenges due to climate change. The potentials of NBT in expanding the foundational knowledge of plant genetics will be illustrated, and finally, how and in which cases they can be considered as new techniques of assisted evolution (TEA) for a clear and substantive distinction between edited plants and transgenic plants will be discussed.

MACHINE LEARNING APPLIED TO GENE EDITING

The course aims to provide knowledge on the functioning of Gene Editing through CRISPR-Cas9 and its potentials. It will address the potentials and critical aspects of this technique, and how genomic editing could be made more precise through artificial intelligence (Machine Learning). The course will enable students to acquire knowledge on current genomic engineering techniques, particularly the CRISPR-Cas9 system and its variants, and understand their potentials for biomedical and biotechnological applications. Additionally, through guided analysis of crucial experiments, students will acquire the basic skills necessary to address and apply genomic engineering techniques through CRISPR-Cas9 to experimental studies. At the end of the course, a final test will be administered with some questions on LibreEol.

FOOD AND ENVIRONMENTAL BIOTECHNOLOGY

Lecturer: Florentina Matei (florentina.matei@biotechnologii.usamv.ro)

FUNCTIONAL FOODS

Introduction to the principles of nutrition and nutrients. Probiotic, prebiotic, and symbiotic foods. Specific fermentations for probiotic enrichment. Functional foods. Products aimed at specific groups of the population with particular nutritional needs (FSG): Regulation EU 609/2013. ADAP. At the end of the course, a final test will be administered with some questions on LibreEol.

INTRODUCTION TO ROBOTIC AND AI-BASED SURGERY

Lecturer: Fabio Rondelli

The aim of the course is to assess the new technological frontiers in the medical and surgical fields, particularly focusing on the mini-invasive robotic approach. As extensively demonstrated in international scientific literature, the robotic mini-invasive approach, when compared to purely laparoscopic surgical approach, results in a lower conversion rate in most complex oncological interventions. This naturally leads to lower intraoperative blood loss, reduced post-operative hospital stay, lower rates of surgical wall complications, and consequently, significant cost savings.

For medical biotechnology doctoral students, a 7-hour course is proposed, held in a single day and divided into theoretical and practical parts. The theoretical portion involves outlining current guidelines for the use of robots in abdominal visceral surgery, accompanied by a description and explanation of the latest devices on the market (Alpi-tube, Tri-Staple Sutures...). This is accompanied by a brief discussion of some cases with pre-op image reconstruction (CT and MRI), following the current concept of 'tailored surgery.'

The practical part allows participants to personally perform robotic movements in the operating room; each student can carry out simple gestures on the simulator, in 3D vision, to test firsthand the real precision and freedom of movement of the latest generation robot. At the end of the course, a final test will be administered with some questions.

HT DATA GENERATION

Lecturer: Jacopo Lucci (jlucci@biostherapy.it)

In the context of the course 'High Throughput Data Generation and Interpretation,' dynamics related to the generation of -omic data, their interpretation, and presentation in preclinical and clinical settings will be explored. With a particular focus on transcriptomic data generation, organizational aspects of workflow, the unique characteristics of different techniques and available machinery, and the necessary basic and advanced bioinformatics tools will be discussed. With specific reference to this latter set of activities, computer exercises will be conducted. Finally, fundamental principles of project management, budgeting, and financial reporting will be discussed.