Courses

1 CFU = 6 hours

Introduction to Data analysis and data formats

Teacher: Gianluigi Cardinali

Total hours: 12

Year: 1st year

Course description: During the course, various types of data are addressed from a mathematical, computer science, and biological perspective. Advanced data formats used in metagenomics are also explained and illustrated. The course then covers data storage

structures: vector, matrix, tensor, array. From the various types of matrices or tensors, it moves on to the discussion of various types of distances for continuous, categorical, DNA/RNA/Proteins, and classified data. Finally, some forms of data representation with dimensionality reduction algorithms, e.g., PCoA, are presented. Throughout the course, students work on their own PCs in the R environment, ideal for illustrating the various aspects of data and their structures, as well as for teaching the basics of programming.

Curriculum: Biomateriali e biodispositivi, Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test

Femtobiology

Teacher: Benedetta Carlotti

Total hours: 12

Year: 1st year

Course description: Femtosecond Lasers. LASERs. Femtosecond Lasers to follow events in molecular time. How to produce femtosecond laser impulse. How to tune their wavelenght. Fluorescence Up Conversion. Fluorescence. Time resolved fluorescence spectroscopy. Fluorescence Up Conversion: single wavelenght and broadband detection. Polarization and fluorescence anisotropy. Femtobiology. Ultra-fast dynamics in nucleic acids and proteins: biomolecules hydration; photoinduced electron transfer processes; Forster resonance energy transfer processes.

Curriculum: Biomateriali e biodispositivi

Final test: YES

Notes: The course has a final test

Safety in Biotechnology

Teacher: Assunta Marrocchi

Total hours: 12

Year: 1st year

Course description: The course aims to inform about the risks arising from the use of chemicals, biological agents and physical agents in biotechnology research laboratories: (1) Concepts of hazard, risk, prevention, protection, risk perception and assessment, risk

management and communication. (2) Main regulatory references. (3) Chemical risk: definition of dangerous chemical agents; hazard classes; hazard symbols and identifications; safety data sheets; the concept of exposure to chemical agents: the exposure limit value (TLV); absorption pathways of chemicals and parameters affecting absorption; chemical risk assessment, prevention and protection measures. (4) Biological risk: definition of biological agent, micro-organism, cell culture; classification of biological agents; assessment of biological risk; prevention and protection measures. (5) Physical hazard: definition of a physical agent; relevant physical agents in biotechnological laboratories; in-depth study on artificial optical radiation; health and safety effects of exposure to artificial optical radiation.

Curriculum: Biomateriali e biodispositivi, Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test

Introduction to Basic Programming in Biotechnologies

Teacher: Gianluigi Cardinali

Total hours: 6

Year: 1st year

Course description: 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 the various aspects of data and their structures, as well as for teaching the basics of programming.

Curriculum: Biomateriali e biodispositivi, Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test

Bioprocesses

Teacher: Bioprocesses

Total hours: 6

Year: 1st year

Course description: The course aims to provide basic knowledge related to bioprocesses in the biotechnology industry; more specifically, the main fermentation and enzymatic processes will be discussed. In addition, an overview of the impact of industrial biotechnology, an overview of the products of the biotechnology industry (biofuels and bioenergy, chemicals, new materials, etc.), and a brief mention of the key role of industrial biotechnology in the context of environmental sustainability will be provided. Directions to relevant websites in this field and suggestions for further scientific readings will be provided. The course includes frontal lectures, which require the active participation of the PhD students.

Curriculum: Biomateriali e biodispositivi

Final test: YES

Notes: The course has a final test

Two-photon absorption for bio-applications

Teacher: Alessio Cesaretti

Total hours: 6

Year: 1st year

Course description: 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 classical single-photon excitation. The TPA process can be exploited to develop new, non-invasive bioimaging technologies that achieve higher spatial resolution and perform optical sectioning in the sample at different depth levels. The TPA phenomenon can be used in photodynamic therapy through selective excitation of specific compounds. When high TPA cross sections are coupled with significant production of triplet states, these molecules, once excited, can lead to the formation of ROS and, therefore, selective death of tumor cells. Examples of the use of TPA in both bioimaging and photodynamic therapy are discussed.

Curriculum: Biomateriali e biodispositivi

Final test: YES

Notes: The course has a final test

Cancer Immunotherapy

Teachers: Stefano Bruscoli, Efisio Puxeddu

Total hours: 6

Year: 2nd year

Course description: Part One - Introduction to immunotherapy for the treatment of cancer; concepts of immunotherapy and chemotherapy; main approaches of oncological immunotherapy. Part Two - Description of the “immuno-escape” of tumor cells and immune checkpoints; notes on thyroid immuno-oncology; summary of the results of clinical trials of immunotherapy in thyroid cancer; ongoing clinical trials 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 subtype of PDTC

Curriculum: Biotecnologie mediche

Final test: YES

Notes: The course has a final test

Advanced databasing and programming in biotechnology

Teacher: Vincent Robert

Total hours: 18

Year: 2nd year

Course description: The course is based on the use of advanced databases used in biotechnology and uses all the concepts taught in the Bioinformatics I course, in fact the two courses are designed and modified in concert by the two instructors. The course presents database management systems, using mainly the VB.net language and, in part, Python, with the intent to show in parallel the differences and similarities between two different languages, but widely used in professional applications (VB.net) and in the construction of scripts and pipelines (Python). The main programming mechanisms are presented and explored. The use of libraries in programming a standalone (VB.net) or a script (Python) is then illustrated. The systems for subjecting database data to the main statistical and/or, in the case of DNA, phylogenetic treatments are then explained. Students will have to carry out a personal project, partly in class, partly as work to be done outside of class hours. The course assessment is carried out on the basis of the results of the assigned project.

Curriculum: Biomateriali e biodispositivi, Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test in oral and written form

Transcriptomics Data mining theory

Teacher: Giuseppe Nocentini

Total hours: 6

Year: 2nd year

Course description: TRANSCRIPTOMICS DATA MINING Prognosis and personalization of treatment of patients with solid tumors; infiltration of the tumor microenvironment by cells of the immune system; organization of the “public repositories” Array Express and GEO; information obtainable through the free access software “Gepia”; information obtainable through the paid software “GeneVestigator”.

Curriculum: Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test

Transcriptomics Data mining practice

Teacher: Luigi Cari

Total hours: 6

Year: 2nd year

Course description: Introduction to the use of “Big Data” in biomedical research, from bulk data to spatial biology; organization and examples of use of the “public repositories” of transcriptomic data “BioStudies” (Array Express) and “Gene Expression Omnibus” (GEO); structure and examples of use of the open access analysis software “GEO2R” and “Gepia2” for gene expression analysis, survival analysis, correlation analysis and dimensionality reduction; theoretical bases of the qualitative validation process and normalization of data produced with microarrays (evaluation of sources of variability, quality controls, multi-array normalization, normalization between multiple experiments); structure and examples of use of the software “GeneVestigator” (free in the basic plan, paid for in the more advanced functions) in the analysis of samples of healthy tissue, diseased tissue (tumor and non-tumor) and cell lines; practical exercise relating to the use of these tools for the prognosis and personalization of the treatment of patients affected by solid tumors and for the evaluation of the infiltration of the tumor microenvironment by cells of the immune system.

Curriculum: Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test

Bioassays in Biotechnologies

Teacher: Laura Corte

Total hours: 6

Year: 2nd year

Course description: Framing of the concept of bioassay as a tool for microbiological-genetic biomonitoring. Types of bioassays and biological sensors. Comparison of bioassay/biosensor. Main bioassays of medical, pharmaceutical, agri-food and environmental interest.

Curriculum: Biomateriali e biodispositivi, Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test

Introduction to Biomarkers

Teacher: Lorena Urbanelli

Total hours: 6

Year: 2nd year

Course description: Introduction to the concept of biomarker; descriptive characteristics of a biomarker and main types (diagnostic, monitoring, pharmacodynamic, predictive, prognostic, susceptibility or risk, safety). Overview of biomarker discovery pipelines; biomarkers and liquid biopsy.

Curriculum: Biomateriali e biodispositivi, Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test

Medical Gene Editing

Teacher: Stefano Bruscoli

Total hours: 6

Year: 3rd year

Course description: Basic principles of molecular biology; Genetic modification of somatic and germ cells; Basic mechanism of the CRISPR/Cas9 genetic engineering technology; CRISPR/Cas9 strategies to genetically modify experimental animal models; New applications of the CRISPR/Cas9 technique; Limits and defects of the CRISPR/Cas9 technique: 'off-target' events and mosaicism; Practical examples of clinical applications: treatment of genetic diseases, infectious diseases, tumor pathologies, potential treatments in patients with HIV; Ethical aspects

Curriculum: Biotecnologie mediche

Final test: YES

Notes: The course has a final test

Plant Gene Editing

Teacher: Francesco Paolocci

Total hours: 6

Year: 3rd year

Course description: Application for the study of basic mechanisms, for the genetic improvement of plants of agricultural interest and as a tool for neodomestication; Issues related to the acceptance by civil society of plant organisms derived from "New Breeding Technologies" (NBT).

Curriculum: Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test

Machine Learning applied to Gene Editing

Teacher: Francesco Morena

Total hours: 6

Year: 3rd year

Course description: The course aims to provide knowledge on the functioning of Gene Editing through CRISPR-Cas9 and its potential. The potential and critical aspects of this technique will be addressed and how genome editing could be made more precise through artificial intelligence (Machine Learning). The course will allow students to acquire knowledge of current genome engineering techniques, in particular the CRISPR-Cas9 system and its variants, and understand their potential for biomedical purposes and biotechnological

applications. Furthermore, through the guided analysis of crucial experiments, students will acquire the basic skills necessary to face them and apply genome engineering techniques through CRISPR-Cas9 to experimental studies.

Curriculum: Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test

Functional Foods

Teacher: Florentina Matei

Total hours: 6

Year: 3rd year

Course description: Introduction to the principles of nutrition and nutrients. Probiotic, prebiotic and symbiotic foods. Specific fermentations for probiotic enrichment. Functional foods. Products aimed at specific population groups with particular nutritional needs (FSG): EU Regulation 609/2013. ADAP.

Curriculum: Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: The course has a final test

Introduction to robotic and AI-based surgery

Teacher: Fabio Rondelli

Total hours: 6

Year: 3rd year

Course description: The aim of the course is to evaluate the new technological frontiers in the medical and surgical field, with particular attention to the minimally invasive robotic approach. As widely demonstrated in the international scientific literature, the minimally invasive robotic approach, when compared to the purely laparoscopic surgical approach, has a lower conversion rate in the most complex oncological interventions. This naturally leads to less intraoperative blood loss and a reduction in postoperative hospital stay, complication rates of the surgical wall and, consequently, significant cost savings. For PhD students in Medical Biotechnology, a 7-hour course is proposed, held in a single day and divided into theoretical and practical parts. The theoretical part includes the outline of the current guidelines for the use of robots in abdominal visceral surgery, accompanied by the

description and explanation of the most recent devices on the market (Alpi-tube, Suture Tri-Staple...). This is accompanied by a brief discussion of some cases with reconstruction of preoperative images (CT and MRI), following the current concept of "tailor-made surgery". The practical part allows participants to personally perform robotic movements in the operating room; each student will be able to perform simple gestures on the simulator, in 3D vision, to personally test the real precision and freedom of movement of the latest generation robots.

Curriculum: Biotecnologie mediche

Final test: YES

Notes: The course has a final test

School on Biotechnologies

Total hours: 90

Year: 1st, 2nd, 3rd year

Course description: The School on Biotechnology is a school taught in English by national and, predominantly, international teachers who are experts in the various topics proposed. The school therefore includes frontal lessons with extensive student participation in discussions, technical sessions, workshops, brainstorming simulations and student communications. All laboratory parts, or everything that is not related to frontal lessons, are aimed at placing the student in an international research environment situation with regard to language, methods and environment. The course must be attended in each of the three years of the course. Each year a central theme is promoted, of a purely interdisciplinary nature, which acts as a "hub" for the entire school divided into five working days, within the school, then, each day is dedicated to a specific theme, which acts as a "spoke", to fit the interdisciplinary aspect into the specificity of the various aspects covered in the doctoral training path.

Curriculum: Biomateriali e biodispositivi, Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: NO

Notes: Participation certificate

Ethics of the scientific research

Teacher: Marco Moschini

Total hours: 18

Year: 1st, 2nd, 3rd year

Course description: The course is taught by a professor of philosophy and a professor of biology in a semi-joint manner. The first two lessons will be dedicated to the ethical foundations applicable to scientific research and to the methodological foundations for the ethics of research. The other two lessons will be held together by the two professors to discuss the case studies presented by the professors themselves or by the students.

Curriculum: Biomateriali e biodispositivi, Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: Final interview

Writing EU Projects

Teacher: Sara Alimenti

Total hours: 6

Year: 2nd, 3rd year

Course description: European research programmes: access strategies, research project management tools and paths for valorising results

Today, more than ever, European funds represent an opportunity for researchers who, thanks to these channels, can benefit from resources to finance activities, but also build and consolidate networks and enter paths for valorising research results and maximising impacts. From this perspective, researchers need skills that allow them to know the funding opportunities, develop successful proposals and manage funded projects in the most effective way. The training activity proposes a path of approach to European funds structured as follows:

· Knowing the main European research funding programmes;

· Planning the scouting and analysis of funds to intercept the measures most suitable for your research needs;

· The life cycle of the research project: the pre-award phase; management of projects admitted to funding; processes for valorising results; maximising impacts;

· Organize networking activities with institutions and research bodies, with organizations and the business world;

· Manage relationships with administrative and scientific-professional figures involved in research design and management.

Curriculum: Biomateriali e biodispositivi, Biotecnologie mediche, Biotecnologie molecolari e industriali

Final test: YES

Notes: Final interview