MANIFESTO OF STUDIES 2014

1st YEAR - MANDATORY COURSES -				
Course	**Teacher**	**Hours**	**Synopsis**	**Evaluation procedure**
Laboratory Safety Course	Prof. Mancini I. Dr. Provenzani A.	12	General Laboratory Procedures, Equipment Use, and Safety Considerations. The course consists of lectures and hands-on activities and provides training in chemical manipulation, laboratory activity, biology hazard, fire, and radiation safety.	Biology part: written exam.
Laboratory Techniques	Various	24		Written report by the teacher
1st year students must attend at least **60** hours during the first year by filling the remaining hours with one optional course (see below).				

2nd YEAR - MANDATORY COURSES -				
Course	**Teacher**	**Hours**	**Synopsis**	**Evaluation procedure**
Scientific Publishing & Communication	Dr. Dahm R.	24	The proposed course aims to convey the basic skills needed to publish and communicate scientific results. It combines lectures, which will explain the basic principles of good writing practice and presentation skills, with practical parts during which the students will apply their newly acquired knowledge. The target audiences of the course are PhD students, but the course will also be open to select Master's students and junior postdoctoral scientists.	
Preclinical research and clinical development programs of drugs	Prof. Borlak J.	12	The main objective of this course is to provide an overview of biomedical research strategies and clinical development programs in the drug/ biotech industry. The students will be made familiar with some basic experimental concepts as well as legal requirements for the development of novel drugs. Emphasis is given to the knowledge gain from genome biology and complex data analysis arising from high throughput technologies. *1.* Introduction into basic concepts in preclinical drug research and development *2.* Methods in experimental drug research and clinical development with emphasis on microarray , mass spec, high throughput cell biology assays and in vivo imaging	Group exam of n=4 students; students are requested to prepare a 20 min presentation followed by in-class discussion; upon request students can be examined individually.

			modalities *3.* Genetic models of disease with emphasis on cancer biology and validation of such disease models for the development of novel anticancer drugs *4.* The molecular basis for drug metabolism and disposition including case studies *5.* The molecular basis for drug induced toxicities including case studies *6.* Basic concepts in pharmacogenetics and pharmacogenomics and its application to individualised drug therapies *7.* The application of genomic sciences for improved and individualized drug therapies *8.* Round table discussion with students – and 2 to 3 short presentations from students on selected topics of the course objective.	

2st year students must attend at least **60** hours during the first year by fill the remaining hours with optional courses (see below).

OPTIONAL COURSES

Course	Teacher	Hours	Synopsis	Evaluation procedure
Scientific English* Extra credits	CLA –Centro Linguistico d'Ateneo	24 (18 in class)		
Statistics	Prof. Pugliese A.	12	Populations and samples; data types; description of data: histograms, measures of centre and spread. Basics of probability: probability models, random variables, probability distributions and their properties: binomial, Poisson and normal distribution. Indipendence. Parameter estimates; confidence intervals; one and two sided confidence intervals of the mean. Hypothesis testing; comparing one mean with a fixed one, or comparing two means; size of the sample and power of the test. Test of independence of two factors. Introduction to analysis of variance and regression models. Students will be invited to perform statistical computation through computer software (esp. Excel or R, depending on aims), but this will not be described in detail in the course.	Written exam.
Bioinformatics	Prof. Blanzieri E. Dr. Passerini A.	12	Design of microarray experiments. Normalization of microarray data. Loess. Significance of Analysis of microarray data, t-test, SAM, Cluster Algorithms. Kmeans. Hierachical Clustering. Distances used in clustering. Use of R for microarray data analysis. Probabilistic graphical models: probabilistic inference, structure and parameter learning. Hidden Markov Models for biological sequence analysis: Pair-HMMs, Profile HMMs.	Probabilistic graphical models: Bayesian network project.
Business Planning for biotech leaders	Dr. Milani S.	12	The course prepares PhD students to become potential leaders gaining an understanding of the fundamentals of organizational effectiveness-management finance, entrepreneurship and project management Course topics include: 1. Income statement Introduction for biotech projects	

			2. Balance Sheet Introduction for biotech projects 3. Free cash flow Introduction for biotech projects 4. How venture capitalists evaluate biotech projects 5. How to write a business plan for private/venture funding The course goes beyond the traditional debate over costs and grants as it will examine the critical processes required to develop and deliver biotech projects/products into biotech global market. The students will also work on a biotech project business plan by evaluating alternative financial/sustainability approaches.	
Molecular Spectroscopic Techniques	Prof. Guella G.	12	The lessons include principles and applications of molecular spectroscopy for the elucidation of bioorganic structures and binding phenomena. Main emphasis will be on modern applications of Nuclear Magnetic Resonance and Mass Spectrometry in biochemical contexts but fundamentals of electronic and vibrational spectroscopy will be also presented. *Molecular spectroscopy***.** *Mass Spectrometry* *Principles of Nuclear Magnetic Resonance (NMR).*	Individual reports and discussion on assigned topic & participation.
RNA Molecular Biology and Biotechnology	Dr. Denti M. Dr. Giovanni Stefani	12	The course aims to familiarize the students with cutting-edge new discoveries in the field of RNA biology, and we expect the students to be familiar with the major topics of RNA-based regulation by the conclusion of the course. Topics will include an introduction to RNA structure, folding and dynamics, RNA/RNA and RNA-protein interactions, the role of RNA in catalysis of biological reactions, pre-mRNA splicing, and viral replication. The course also covers the recently discovered micro RNAs, RNA regulatory switches, large noncoding regulatory RNAs, and the role of RNA in human diseases and novel, RNA- based therapeutics (RNA interference, antisense RNA, ribozymes). In addition, these new discoveries will have a significant impact on our understanding of human development and disease, and open up new avenues for development of therapeutics. The last topics of the course cover these medically-relevant aspects of RNA biology.	Presentation of cutting-edge papers, suggested by the teacher and presented by a 30 min journal club by the student.
Stem cell Biology	Dr. Conti L.	12	The course aim is to introduce the students to the biological properties of different stem cell populations and the molecular pathways that control their stemness and developmental potency. Students will discover how stem cell biology is revolutionizing the biomedical field with its fundamental contributions to regenerative medicine and biopharmaceutical industries. Main emphasis will be on recent literature and applications.	Group discussion on assigned topic & participation.
Introduction to metagenomics	Prof. Jousson O. Dr. Segata N.	12	The course will present the state-of-the-art metagenomic approaches for studying the microbial communities (microbiomes) populating the human body and the environment, and will describe the main recent microbial ecology findings, with a focus on those related to human diseases. On the methodological viewpoint, we will present metagenomic tools based on microarray chips, 16S rRNA sequencing surveys, and shotgun high-throughput sequencing from both the experimental and	Presentation and critical discussion of a paper (during the last 2-hours lecture)

			technological viewpoints. An overview of the challenges and solutions for computationally analyzing metagenomic data will be presented including methods for taxonomic characterization, functional profiling, genome assembly, phylogenetic inference of microbiomes. Advanced sequencing-based approaches for pathogen detection and characterization will also be presented. Recent findings about the relation between human associated microbial communities and complex diseases will be discussed as well as the mechanisms of vertical microbiome transmission (e.g. from mother to neonate) and gut microbial colonization.	
Chemical modifications and organic synthesis of biomolecules	Prof. Mancini I.	12	The course will focus on the core principles of synthetic strategy and methodology, with the discussion of recently published topics in the field and the possibility to verify some practical aspects in the laboratory. Strategies in total synthesis: linear and convergent sequence, conversion of functional groups, protective groups, carbon-carbon reactions, application of organometallic reagents; workup and isolation of the products. New methodologies: solvent role and choice, solid supported synthesis, microwave irradiation and other eco-friendly techniques. Asymmetric synthesis: stereoselectivity and introduction of new desired elements of chirality. Asymmetric and bio- catalysis using enzymes and chiral natural molecules. Examples of natural product synthesis. Design and synthesis in modern drug discovery: combinatorial and biomimetic approaches. Synthesis of supra-molecular systems, also with the involvement of proteins and DNA.	
Synthetic Biology	Dr. Mansy S.	12	The course will explore different aspects of the new field of synthetic biology. Topics ranging from top-down and bottom-up perspectives, BioBricks (parts, devices, and chassis), genetic circuits, bioengineering, minimal genomes, minimal cells, orthogonal systems, as well as combinatorial and directed evolution methods will be covered. Students will learn how synthetic biology is changing the biotechnology industry, e.g. in the pharmaceutical and biofuels industries, and how work on synthetic biology is helping to reveal how the chemical and physical complexities of a cell give rise to the emergent behavior of life.	Oral exam & participation
Machine learning in systems biology	Dr. Sanguinetti G.	12	We discuss the network perspective and the basics of network analysis in biology. Classical and novel methods will be presented, describing the structure and dynamics of directed, weighted and signed graphs. It will be discussed how to characterize networks by local (e.g. node centrality) and global (e.g. link distribution) measures. We discuss biological relevance and applications from molecular biology to systems ecology. Consultancy and exam will follow the course.	Oral exam
Epigenetics in Neurotherapeutics	Dr. Basso Manuela	12	The ability of a cell or an organism to respond to injury or prolonged stress requires the activation of intracellular responses able to assure its protection. One strategy comprises the modulation of gene levels favoring the transcription of pro-survival toward pro-death genes. Interestingly, the capacity of cells to know what to express is determined by transcription factors and epigenetic marks. Epigenetics literary means “above the genome” and it is defined by modifications occurring at the DNA and chromatin level. The course will introduce the concept of epigenetic control of gene expression describing the role played by specific epigenetic modifications like DNA methylation, post-translational histone modification, chromatin remodeling, histone	Written test with multiple choices and one open question

			variants, non coding RNAs. Examples of neurological diseases linked to alterations in epigenetic processes and therapies voted to modulate the epigenetic modifications in the central nervous system will be discussed.	
Introduction to metabolomics	Dr. Mattivi F.	12	A comparison of metabolomics vs conventional analytical techniques. Sample handling and extraction: a difficult compromise NMR-based experiments MS-based experiments Metabolic profiling vs. metabolic fingerprinting or accuracy vs coverage Gas chromatography in metabolomics High performance liquid chromatography in metabolomics Quality control flowchart for metabolomics Study design and planning of the sequence Features extraction, data alignment, structural annotation Introduction to MS imaging Examples of biological applications of metabolomics: i) biofluids and fecal water; 2) plants and fruits	
Beyond the central dogma: epigenetics, non-coding RNA, protein post-translational modifications and human disease.	Ferrari S.	12	This course will explore three aspects of molecular biology (epigenetics, noncoding RNA, and protein post-translational modifications) that complement and extend the basic knowledge of the upward causation of life (i.e., DNA->mRNA->Protein). Studies in these fields have now established that downward causation is equally important for life. The epigenome is exponentially larger (in informational terms) than the genome: it actually plays the music of life using the notes of the genome. Crucial effectors of the epigenome are cytosine methylation at CpG site in the DNA, the histone code, and chromatin structure and behaviour. Genetic and expression changes of dozens factors governing the homeostasis of each of these features have been recently identified in a large variety of human diseases, especially cancer. The course will also introduce students to the post-transcriptional signaling mechanisms by non-coding RNA, specifically microRNA, with a focus on their importance for the control of cellular and whole-body metabolism. The students will also learn about technologies to quantify and alter microRNA expression and how microRNAs can be used as drug targets in human diseases. Components of signal transduction pathways are hierarchically organized and form networks through which information flows. Reversible post-translational modifications (PTMs) generate protein variants displaying distinct biological properties and, as such, they are a major determinant of network complexity. In the third part of the course, students will become familiar with PTMs whose hierarchical, synergistic or antagonistic combination defines a code that translates into well-defined outputs. Starting from the historically most studied PTM, namely phosphorylation, students will be guided through the discovery of PTMs that put us now in the position of explaining processes as distant as the immune response, the DNA damage response, cell proliferation and cell cycle regulation. For each PTM, special emphasis will be put on pharmacological approaches that aim at targeting pathway components in the therapy of cancer.	Written test consisting of a mixture of short essay-type questions and multiple-choice questions.

The students enrolled at the International Doctoral School in Biomolecular Sciences are obliged to attend courses, seminars, symposia and practical courses organized by the Doctorate School.

Seminars. National and international researches are invited to present their research within the seminar cycle. Internal seminars (journal clubs and progress report) must regularly organized in order to present and discuss new published results or to shown data of ongoing research activities. The students must attend at least 15 seminars per year.

Symposia. A symposium (named *work in progress*) which all the doctorate students have to attend is organized once a year. All PhD students will give a short presentation of their results. For the doctorate student, this meeting is the occasion to socialize and in particular to know the projects and the results of his/her colleagues. Moreover, students have the opportunity to gain experience in communication and presentation of scientific results.

COURSE	SPEAKER	HOURS		YEAR
Journal Club	PhD candidate	3	The Journal club is an important scientific update and discussion and it is part of the teaching program of the PhD student. The Journal Clubs aim to guide the students to a critical reading of a scientific work, with particular attention to the methodological approaches, research and analysis, other than those normally used in their specific field of research and interpretation of data as well as to implement the knowledge of young researchers. Period: twice a year.	1-2-3
Progress Report	PhD candidate	3	Twice a year, the student must present a summary of the results achieved as well as the status of the project.	1-2-3

Doctoral students must obtain 14 learning credits during the first and second year, corresponding to:
- 60 educational hours (1 credit every 6 hours)
- 15 seminars (2 credits),
- 2 Journal clubs (1 credit),
- 2 progress reports (1 credit).