UNIVERSITY OF L'AQUILA

Department of Health, Life and Environmental Sciences

2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES

Laurea Magistrale in BIOTECNOLOGIE MOLECOLARI E CELLULARI

Course Catalogue

Academic year starts the last week of September and ends the first week of June.
1st Semester - *Starting date:* first week of October, *end date*: 4rd week of January
2nd Semester - *Starting date:* first week of March, *end date:* 1st week of June
Exams Sessions: I) first week of February to 4rd week of February, II) from 2nd week of June to end of July, III) from 1st to 3rd week of September

Comprehensive Scheme of the 2nd Cycle Degree in *MOLECULAR AND CELLULAR BIOTECHNOLOGIES*				
YEAR	**CODE**	**COURSE**	**Credits (ECTS)**	**Semester**
I	B0428	Gene therapy and molecular basis of the diseases	6	1
	B0411	Epidemiology	6	1
	B0497	Experimental models and cellular therapy	12	1
	B0414	Biomolecular Technologies	6	1
	B0496	Molecular Pharmachology and Toxicology	6	2
	DM0140	Genetic Engineering, Genomics and Epigenomics	7	2
	B0495	Molecular Mechanisms and Biomarkers in the Cellular Response to Stress	6	2
	B0493	Proteomic, molecular targets and bioinformatic applications	7	2
	B0292	*Free choice Courses*	8	1/2
II	B0446	Molecular Imaging Methods	6	1
	B0292	Development and Production of Biotechnological Drugs	12	1
	B0499	Biochemistry of Nutrition	6	2
	B0292	*Free choice courses*	8	1 and/or 2
	B0488	*Internship*	2	1 and 2
	B0280	*Thesis*	30	2

Programme of "BASI MOLECOLARI DELLE MALATTIE E TERAPIA GENICA"
"GENE THERAPY AND MOLECULAR BASIS OF THE DISEASES"

This Course is composed of two Modules: 1) Gene Therapy, 2) Molecular Basis of Diseases

B0428, COMPULSORY
2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 1st Year, 1st Semester

Number of ECTS credits: 6 (total workload is 150 hours; 1 credit = 25 hours)

1) GENE THERAPY (3 ECTS)

Teacher: Antonietta FARINA

1	Course objectives	The goal of this Module is to provide knowledge on the basic concepts of gene therapy e therapeutic strategies. On successful completion of this course, the students, should understand the fundamental principle of gene therapy and should be aware of the potential application for this type of therapy on human diseases.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - Molecular bases of gene therapy: Fundamentals of gene transfer, viral vectors for gene therapy, non-viral gene transfer: Plasmids and DNA vaccines; Balistic methods; Liposomes; Engineered zinc-finger nucleases. Targeting: Transductional targeting; Transcriptional targeting; Inducible and tissue-specific promoters. Ablative strategies. - Cancer gene therapy: Specific aspects of cancer gene therapy: Normal and tumoral cell recipients; Proliferation-dependent vectors; Transduction efficiency and bystander effects. Gene therapy of the transformed phenotype: Oncosuppressor gene transfer; Oncogene inhibition; Genes over-expressed in tumour cells; Gene therapy targeting cancer neo-angiogenesis. Immunological cancer gene therapy: Fundamental tumour immunology and immunotherapy; Changing drug response, - Gene therapy of inherited or acquired diseases: Monogenic inherited diseases: General aspects; Specific diseases (Primary immunodeficiencies; Cystic fibrosis; ecc). Gene therapy of infectious diseases: HIV infection. On successful completion of this module, the student should o have profound knowledge of basic concepts of the aetiology and the pathogenetic mechanisms of human diseases and gene therapy, technologies of gene transfer, therapeutic strategies, efficiency and safety issues; o have knowledge and understanding of inherited and acquired diseases that could benefit from gene therapy; o understand and explain principles of regulatory issues for gene therapy; demonstrate skill in identify potential targets and ability to choose the relevant approach for gene therapy approach; o be able to present an approach for gene therapy, from the description of the pathology using conventional and biotechnological strategies; o demonstrate capacity in current laws, methods, techniques and instrumentation used in gene therapy.
3	Prerequisites and learning activities	The student must know the basis notion of Molecular Biology and General Pathology.
4	Teaching methods and language	Powerpoint presentations in Italian. Language: Italian Ref. Text books - Pierluigi Lollini, Carla De Giovanni e Patrizia Nanni, *'Terapia genica'* - Didactic material supplied by the teacher - Pontieri, Russo, Frati. *Patologia Generale*, voll. Piccin.
5	Assessment methods and criteria	Oral exam with a short report.

2) MOLECULAR BASIS OF DISEASES (3 ECTS)

Teacher: Antonietta FARINA

1	Course objectives	The goal of this Module is to provide knowledge on aetiology and the pathogenetic mechanisms of human diseases, in particular at a molecular level, the basic functional consequences for the organism, and basic concepts of gene therapy e therapeutic strategies. On successful completion of this course, the students, should understand the fundamental principle of gene therapy and should be aware of the potential application for this type of therapy on human diseases.

2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - Molecular Pathology : Nucleic acid molecular pathology. SNPs. - Molecular basis of human diseases. Alzheimer, Parkinson, Huntington, Amyotrophic Lateral Sclerosis, Muscular Dystrophy (Duchene-Becker), Cystic fibrosis. - Molecular Pathology of Cancer: Colon cancer, Pancreas cancer, Prostate cancer, Breast cancer, SNC tumours of the CNS. On successful completion of this module, the student should: o have profound knowledge of basic concepts of the molecular pathogenetic mechanisms of human diseases; o know and understand the role of tumor suppressors and oncogenes in oncogenesis, invasion and metastasis of cancer cells; o have knowledge and understanding of the use of molecular markers in cancers; o understand and explain principles of regulatory issues for pathologic process; demonstrate skills in identifying potential targets and ability to choose the relevant strategy for molecular therapy approach; o be able to present the principal diseases denomination and of their molecular aspects.
3	Prerequisites and learning activities	The student must know the basis notion of Molecular Biology and General Pathology.
4	Teaching methods and language	Powerpoint presentations in Italian. Language: Italian Ref. Text books - Pierluigi Lollini, Carla De Giovanni e Patrizia Nanni, *'Terapia genica'* - Didactic material supplied by the teacher - Pontieri, Russo, Frati. *Patologia Generale*, voll. Piccin.
5	Assessment methods and criteria	Oral exam with a short report.

Programme of "METODOLOGIA EPIDEMIOLOGICA" *"EPIDEMIOLOGY"*		
F0411, COMPULSORY 2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 1st Year, 1st Semester		
Number of ECTS credits: 6 (workload is 150 hours; 1 credits =25 hours)		
Teacher: Emma ALTOBELLI		
1	Course objectives	To provide the methodological tools required to plan an epidemiological investigation, analyze the data and interpret the results, a body of operative knowledge that is indispensable for the profession. To enable students to read critically a scientific paper.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - The main occurrence measures. The principal risk measures. Use of standardized rates. Design of observational and experimental epidemiological studies; ethical aspects of clinical research. - Epidemiological study design phases and their management. Study design bias. Control of confounding variables in study design and data analysis. - Diagnostic tests: reliability, validity and reproducibility. Assessment of the methodological quality of science papers: useful orientation elements. - Reading of scientific papers with special emphasis on result interpretation after application of statistics applied to epidemiology. On successful completion of this module the student should: o have profound knowledge of measuring disease occurrence; o have knowledge and understanding of type of epidemiologic study; o understand and explain biases in study design; o be able to apply epidemiology in clinical settings using diagnostic test; o demonstrate skills on how to design, analyze and interpret epidemiologic research study, and how to deal with the fundamental problems that epidemiologists face, including confounding.
3	Prerequisites and learning activities	The student must know the basic notions of biostatistic.

4	Teaching methods and language	Lectures, exercises and report Language: Italian Ref. Text books - C. Signorelli. *Elementi di Metodologia Epidemiologica*. Ed. SEU. - F. Di Orio. *Elementi di Metodologia Epidemiologica Clinica*. Ed. Piccin. - K. J. Rothman, *Epidemiology: An Introduction*. Oxford University Press.
5	Assessment methods and criteria	Written and a short report.

Programme of "MODELLI SPERIMENTALI E TERAPIA CELLULARE" ***"EXPERIMENTAL MODELS AND CELLULAR THERAPY"*** **This Course is composed of two Modules: 1) Cellular Therapy, 2) Cellular and Animal Experimental Models**		
B0497, COMPULSORY **2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 1st Year, 1st Semester**		
Number of ECTS credits: 12 (total workload is 300 hours; 1 credit = 25 hours)		
1) CELLULAR THERAPY (6 ECTS)		
Teacher: Elisabetta BENEDETTI		
1	Course objectives	The goal of this Module is to provide the students with rational and scientific bases of cellular methods and skills for designing experiments useful in cell therapy research. On successful completion of this module, the student should be aware to choose the correct model for cell therapy studies, with special focus on those related to *in vitro* studies of stem cells.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - Basis of the stem cells cultures: growth conditions, cryopreservation, types of stem cell cultures, their advantages and limitations; - Staminal niches; - Mesenchymal, adipose and neural stem cells; - Induced Pluripotent Stem cells (IPs); - Tumor stem cells; - Biomaterials and scaffolds; - Skin repair; - Cardiac regeneration; - Cartilage regeneration; - Axonal repair. On successful completion of this module, the student should: o have profound knowledge of cell cultures techniques; o have knowledge and understanding of the cell therapies available; o demonstrate skill in design experiments useful in cell therapy research and ability to perform cell cultures; o demonstrate capacity for reading and understand other texts on related topics; o demonstrate capacity to be critical and self-critical in choosing the right system for cell therapy study.
3	Prerequisites and learning activities	The student must know the basic notions of Cell Biology and Molecular Biology.
4	Teaching methods and language	Seminars, Team work, Laboratory experience Language: Italian/English Ref. Text books - Scientific articles provided by the teacher.
5	Assessment methods and criteria	Oral exam: preparation of a research project.
2) CELLULAR AND ANIMAL EXPERIMENTAL MODELS (6 ECTS)		
Teacher: Carla TATONE		
1	Course objectives	The goal of this module is to provide the students with rational and scientific bases of some applications of cell cultures and animal experimental models in biotechnology. On successful completion of this module, the student should know the basic and advanced techniques of cell culture and animal systems for applied research.

2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - In vitro models: cell cultures - In vivo models for the study of human pathologies - Transgenic animals models - the application of technologies related to the development of sub-cellular, cellular and animals experimental models On successful completion of this module, the student should: o have profound knowledge of cellular and animal models; o have knowledge and understanding of the experimental in vitro and in vivo models; o demonstrate skill in design experiments useful in cell biology research and ability to perform cell cultures; o demonstrate capacity for reading and understand other texts on related topics; o demonstrate capacity to be critical and self-critical in choosing the right system for cell and animal models study
3	Prerequisites and learning activities	The student must know the basic notions of Cell Biology and Molecular Biology.
4	Teaching methods and language	Lectures, Seminars, Team work, Laboratory experience Language: Italian/English Ref. Text books Scientific articles provided by the teacher
5	Assessment methods and criteria	Oral exam

Programme of "TECNOLOGIE BIOMOLECOLARI" "*BIOMOLECULAR TECHNOLOGIES*"		
F0414, COMPULSORY 2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 1st Year, 1st Semester		
Number of ECTS credits: 6 (workload is 150 hours; 1 credits =25 hours)		
Teacher: Rodolfo IPPOLITI		
1	Course objectives	The goal of this course is to provide the students with the molecular basis of DNA analysis and manipulation, gene cloning and expression, protein engineering. On successful completion of this module, the student should be familiar with the molecular techniques that allow the identification, isolation and manipulation of genes, with particular attention to the procedures suitable for the production of medical/pharmaceutical recombinant proteins.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - Preparation and analysis of nucleic acids; - Nucleic acid manipulations; - Restriction enzymes and restriction analysis; - PCR techniques and their applications; - Gene cloning and expression; - Transgenic cells/organisms fro the production of recombinant proteins; - Bioinformatics tools; - Protein analysis and engineering; Practical exercises will be done by the students as virtual gene cloning and laboratory experience. On successful completion of this module the student should: o have profound knowledge of the molecular basis of DNA separation, extraction, purification and manipulation; o have knowledge and understanding of the main procedures to be adopted for gene cloning and expression, with particular attention to the choice of organisms, vectors, expression conditions; o be able to explain the rationale of each step in the cloning procedures aiming at the production of medical/pharmaceutical products; o demonstrate skills in designing a cloning strategy process and ability to overcome possible difficulties and obstacles in using a defined theoretical procedure of gene cloning;

		o demonstrate capacity in explaining the most significant scientific experiments that deal with the molecular basis of a specific gene cloning project, also reading original scientific articles; o be able to apply the acquired knowledge to expand his/her scientific formation to the most advanced applications of molecular biology techniques, specifically in the field of recombinant pharmaceutical products (gene cloning, gene therapy, molecular diagnostics, etc); o demonstrate concern to health, well-being and safety; o be able to work in team showing commitment to tasks and responsibilities; o demonstrate capacity to be critical and self-critical.
3	Prerequisites and learning activities	The student must know the basic notions of Chemistry, Organic Chemistry, Biochemistry, Molecular Biology, and Informatics.
4	Teaching methods and language	Lectures. Language: Italian (on request it can be offered in English) Ref. Text books - T. A. Brown, *BIOTECNOLOGIE MOLECOLARI*, Zanichelli editore S.p.A. - J.W. Dale & M. von Shantz, *Dai geni ai genomi*, EDISES. - Research articles and other materials given by the teacher.
5	Assessment methods and criteria	Oral exam and virtual cloning at the PC.

Programme of "FARMACOLOGIA E TOSSICOLOGIA MOLECOLARE": "*MOLECULAR PHARMACOLOGY AND TOXICOLOGY*"		
F0496, COMPULSORY **2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 1st Year, 2nd Semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credits =25 hours)		
Teacher: Anna Rita VOLPE		
1	Course objectives	This course aims to provide the students with the molecular and cellular bases that are needed to explain the biological effects of drugs and toxic compounds. In this regard, the competences acquired by the students in basic biological disciplines (e.g., Biochemistry, Genetics, Molecular Biology, Physiology) are valorized within an integrated scientific dimension helping to interpret and manage complex biological problems.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - General principles and definitions. Receptors and signal transduction: channel receptors, protein-coupled receptors; regulation of intracellular calcium homeostasis; receptors that mediate cell adhesion; phosphorylation of proteins; modulation of receptor responses. Intracellular and extracellular proteolysis. - Pharmacological control of transport across cell membranes: ion channels; pumps and transporters; neurotransporters; transport macromolecules. Modulation of gene expression: pharmacology of gene transcription; intracellular receptors; inhibitors of the genetic code; gene therapy. Control of cell proliferation: cell cycle, apoptosis and drugs; mechanisms of action of anticancer drugs. Intercellular communication and drugs. Pharmacological modulation of physiological processes and integrated defense processes. Control of the drug plasma concentrations. - Pharmacology of organs, systems and apparata. Principles of toxicology. Chemo-physical properties and toxicity; stereochemistry and toxicity; structure-activity relationships (SAR, QSAR); biotransformations and their role in the toxicity of xenobiotics. Mechanisms of toxicity: markers of cell damage; ion homeostasis and cell toxicity; cell death and apoptosis; genotoxicity; embryonic toxicity; signal transduction and oncogenesis. - Carcinogenesis: multistep process and related mechanisms of DNA damage and repair; metabolic activation of carcinogens; extrinsic and intrinsic causing agents. Evaluation of the carcinogenic risk. On successful completion of this module the student should: o have profound knowledge of the molecular and cellular mechanisms responsible for the pharmacological and toxicological effects of xenobiotics; o have knowledge and understanding how the biological functions may be positively or

		negatively modulated by xenobiotics; o be able to explain the relevant techniques in Molecular Pharmacology and Toxicology using appropriate scientific language; o demonstrate concern to health, well-being and safety; o demonstrate skills in analytical evaluation and ability to perform pharmacological and toxicological tests; o demonstrate capacity to read and understand texts on related topics and to be critical and self-critical; o demonstrate ability to design and manage scientific protocols.
3	Prerequisites and learning activities	The student must have adequate knowledge of basic Pharmacology and Toxicology.
4	Teaching methods and language	Lectures Language: Italian Ref. Text books: - F. Clementi, G. Fumagalli. *Farmacologia generale e molecolare*, UTET, Torino (last edition) - G. Cantelli Forti, C.L. Galli, P. Hrelia, M. Marinovich. *Tossicologia molecolare e cellulare*. UTET, Torino (last edition). - L. Annunziato, G. Di Renzo. *Trattato di Farmacologia*. Idelson-Gnocchi, Napoli (last editon)
5	Assessment methods and criteria	Oral exam.

Programme of "INGEGNERIA GENETICA, GENOMICA E EPIGENOMICA" ***"GENETIC ENGINEERING, GENOMICS AND EPIGENOMICS"***		
DM0140, COMPULSORY **2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 1st Year, 2nd Semester**		
Number of ECTS credits: 7 (workload is 175 hours; 1 credits =25 hours)		
Teacher: Anna M. G. POMA		
1	Course objectives	The goal of this course is to provide the students with the basis of genomics such as study of mapping and anatomy of genomes, induction of genome mutations by chemical and physical agents in the environment, evolution of genomes. Other course objectives: to integrate basic genomics with applied research in genomes damage and repair, toxicogenomics, nutrigenomics and epigenetics/epigenomics.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - The mapping of genomes. The sequencing of genomes. How to interpret a genome sequence. - Anatomy of genomes: the eukaryotic nuclear genome, genomes of prokaryotes and eukaryotic organelles. Viral genomes and mobile genetic elements. - Functioning of genomes: as you enter the genome. Genetic engineering applied to the study of genomes. Regulation of the genome. - Genome mutation and DNA repair. - Evolution of genomes. Molecular phylogeny. - Elements of pharmacogenomics, toxicogenomics and nutrigenomics. - Epigenetics and epigenomics: chromatin, chromatin and DNA modifications that help to define the molecular basis of epigenetic phenomena. On successful completion of this module the student should: o have knowledge of basic and applied genomics and genetic engineering; o have knowledge and understanding of the fundaments of the genes and genomes mutations and environmental factors related; o be able to explain the fundaments of pharmacogenomics, toxicogenomics and nutrigenomics; o demonstrate skills in finding connections and ability to perform genomic, epigenomic and mutagenicity testing; o demonstrate capacity in explaining the most significant scientific experiments that deal with applied genomics; o demonstrate capacity for reading and understand other texts on related topics; o be able to apply the acquired knowledge to concrete cases as occurring in the

		professional life; o demonstrate concern to health, well-being, safety and environment; o be able to work in team showing commitment to tasks and responsibilities; o demonstrate capacity to be critical and self-critical.
3	Prerequisites and learning activities	The student must know the basic notion of Genetics, Cell Biology, Plant Biology, Biochemistry and Molecular Biology.
4	Teaching methods and language	Lectures Language: Italian/English Ref. Text books - T. A. Brown. Genomi 3. Edises. - B. Lewin, J. E. Krebs, E.Goldstein, S. T. Kilpatrick. Il gene. Zanichelli.
5	Assessment methods and criteria	Oral exam and a short report.

Programme of "MECCANISMI MOLECOLARI E BIOMARCATORI DELLA RISPOSTA ALLO STRESS" ***" MOLECULAR MECHANISMS AND BIOMARKERS IN THE CELLULAR RESPONSE TO STRESS"***		
B0495, COMPULSORY **2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 1st Year, 2nd Semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credits =25 hours)		
Teacher: Fernanda AMICARELLI		
1	Course objectives	The course is aimed at providing the cellular and molecular mechanisms underlying the cellular response to stress. The course will also focus on the involvement of cellular stress in the development of pathological conditions and in accelerating the aging process.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - Mechanisms triggered by eukaryotic cells in response to stress. The Heat Shock Protein (HSP) family. Role and cellular localization of HSPs. Stress-mediated HSP synthesis in the cell. Role of HSPs in aging, cancer and other diseases. - Redox signals and redox-modulated signaling pathways. The antioxidant systems. The oxidative stress. Cell adaptive response to oxidative stress. The dicarbonyl stress. - Non-enzymatic glycation of proteins and AGEs production. AGE-dependent signaling pathways. Vitagenes. Hormesis. Role of stress in aging and diseases. On successful completion of this module the student should: o have profound knowledge of the biological significance of cell stress; o have knowledge and understanding of the various aspects of cell stress; o understand and explain the adaptive response of organisms to stress conditions; o demonstrate capacity for reading and understanding other texts on related topics; o apply the knowledge gained to biological and biotechnological research.
3	Prerequisites and learning activities	The student must know the basic notions of Cellular Biology.
4	Teaching methods and language	Lectures, team work, exercises, home work, reports Language: Italian Ref. Text books : Original articles provided by the teacher.
5	Assessment methods and criteria	Oral exam.

Programme of "PROTEOMICA, BERSAGLI MOLECOLARI E APPLICAZIONI BIOINFORMATICHE" ***"PROTEOMIC, MOLECULAR TARGETS AND BIOINFORMATIC APPLICATIONS"***
B0493, COMPULSORY **2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 1st Year, 2nd Semester**
Number of ECTS credits: 6 (workload is 150 hours; 1 credits =25 hours)
Teacher: Nicola FRANCESCHINI

1	Course objectives	The goal of this course is to provide the student with rational and scientific bases of the techniques for proteome analysis and skills for the application of basic bioinformatics methods. On successful completion of this course, the student should be able to plan a strategy for protein characterization, to understand the role of potential molecular targets and access the most important databases to handle biological data.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - The basis of the proteic sample manipulation. Main analytical techniques used in the laboratory of proteomics: 2D protein electrophoresis, DIGE, HPLC; Mass spectrometry fundamentals: ionization techniques (EI, ESI, FAB, MALDI); Quantitative proteomics: labelling techniques (SILAC, ICAT, iTRAQ); phosphoproteomics (enrichment strategies and analysis of post-translational modifications). - Techniques for molecular targets and biomarkers characterization: SELDI-TOF. Functional proteomics: chromophore assisted laser inactivation (CALI) and Fluorescence Resonance Energy Transfer (FRET). MMPs: target or anti-target. Natural products as inhibitors of MMPs: salvianolic acid. Sulindac a drug with alternative target. - Retrieval system for research in primary and derived biological databases. Substitution matrix used for sequence alignment (BLOSUM, PAM) similarity search (BLAST; FASTA); multi alignment analysis; structural features of proteins (Protein Data Bank). On successful completion of this module the student should: o have good knowledge of techniques for proteome analysis; o have knowledge and understanding of the principal biological assays and their significance; o be able to explain the relevant techniques in proteomic using appropriate scientific language; o demonstrate skills in analytical evaluation and ability to perform biological tests; o demonstrate capacity for reading and understand other texts on related topics; o be able to apply the acquired knowledge to concrete cases as occurring in the professional life; o be able to work in team showing commitment to tasks and responsibilities; o demonstrate capacity to be critical and self-critical.
3	Prerequisites and learning activities	The student must know the basic notions of Biochemistry and Molecular Biology.
4	Teaching methods and language	Lectures. Language: Italian Ref. Text books - Twyman RM *"Principles of Proteomics"* - *BIOS scientific publishers, (http://www.garlandscience.com)* - Pascarella S, Paiardini A.*"Bioinformatica",* Casa Editrice Zanichelli (http://www.zanichelli.it).
5	Assessment methods and criteria	Oral exam.

Programme of "SVILUPPO E PRODUZIONE DI FARMACI BIOTECNOLOGICI"
"*DEVELOPMENT AND PRODUCTION OF BIOTECHNOLOGICAL DRUGS*"

This Course is composed of 3 Modules: 1) Development of biotechnological drugs 2) Process Design of Biotechnological Production of Drugs and Pharmaceutical Products I 3) Process Design of Biotechnological Production of Drugs and Pharmaceutical Products II

B0492, Compulsory
2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 2nd Year, 1st and 2nd Semester

Number of ECTS credits: 12 (total workload is 300 hours; 1 credit = 25 hours)

1) *DEVELOPMENT OF BIOTECHNOLOGICAL DRUGS* (6 ECTS)

Teacher: Lidia LEPORINI

1	Course objectives	The goal of this course is to provide the student with rational and scientific bases of the pharmaceutical thought and skills for the application of a correct knowledge of approaches, techniques and methodologies in the various fields of pharmaceutical biotechnology, for the

		design and optimization of drugs, diagnostics, and vaccines. This is a foundation course whose aims are to provide an introduction to the principles of medicinal chemistry, pharmacology - including an understanding of the drug structure-activity relationships, prediction of the physicochemical properties of a drug, basic knowledge of the major pathways of drug metabolism, and factors that can contribute to drug-drug interactions.
2	Course content and Learning outcomes (Dublin descriptors)	Module's content: Students are shown how to predict the solubility, structure-activity relationships, basic synthesis routes for selected structures, metabolism and pharmacological activity/potency of drug classes and individual members of classes based on the contribution of their functional groups to their structures. In particular, anticoagulants, ACE inhibitors, adrenergics, cholinergics, diuretics, anesthetics, antihyperlipidemics, anxiolytics, antidepressants, sedative hypnotics, antidiabetics, anticonvulsants, H1 and H2 antagonists, analgesics, nonsteroidal anti-inflammatory drugs, hormones, antibiotics, antiviral agents, vaccines, and antineoplastic agents are covered. On successful completion of this module the student should: o have profound knowledge of biochemical and molecular biology structure; o have knowledge and understanding of the functional groups of principal drugs and their significance; o be able to explain the relevant techniques in biotechnology using appropriate scientific language; o demonstrate skills in analytical evaluation and ability to perform biological tests; o demonstrate capacity for reading and understand other texts on related topics; o be able to apply the acquired knowledge to concrete cases as occurring in the professional life; o demonstrate concern to health, drugs, and safety; o be able to work in team showing commitment to tasks and responsibilities; o demonstrate capacity to be critical and self-critical.
3	Prerequisites and learning activities	The student must know the basic notions of Chemistry, Pharmacology and Molecular Biology.
4	Teaching methods and language	Lectures. Language: Italian. Ref. Text books - William O. Foye, Thomas L. Lemke, David A. Williams, *Principi di Chimica Farmaceutica*, Piccin-Nuova Libraria, 2009
5	Assessment methods and criteria	Oral exam.
2) PROCESS DESIGN OF BIOTECHNOLOGICAL PRODUCTION OF DRUGS AND PHARMACEUTICAL PRODUCTS I (3 ECTS)		
Teacher: Maria CANTARELLA		
1	Course objectives	The main objective of the course is to give the main information and tools on the design of biochemical processes with particular attention to biotechnological production of drugs and pharmaceutical products. General criteria of design of bioreactors, mixing, up-stream and downstream technologies are summarised discussing some practical and existing biotechnological applications in the pharmaceutical industry. The general approach to carry out process analysis and its technical-economical feasibility are considered on these examples. In this manner the students should be able to carry out some simulation studies of biotechnological operations and to design biochemical processes until to the estimation of the technical and economical feasibility studies. The module is integrated with a second module of 30 hours of Project Management and is linked to other teaching modules of the second year because it gives some practical instruments to manage fermentation data obtained in lab and pilot scale, design chemical and biochemical processes and at the same time it gives some useful and practical skills often required in laboratory and in the industrial practical experience.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - Summary of Biochemical process as a stoichiometry and kinetic models of microbial growth. - Bioreactors configuration. Stability of bioreactors. Oxygen mass transfer and mixing. - Up-stream and downstream processes: cell rupture, filtration, centrifugation, sedimentation, membrane processes (micro and ultra filtration, nano filtration and

		reverse osmosis), and sterilization. - Process analysis and use of commercial software for technical and economical feasibility studies for some selected biotechnological applications for pharmaceutical productions. On successful completion of this module, the student should: o have profound knowledge of bio reactors and downstream design procedures; o have knowledge and understanding of theoretical and practical principles of process analysis of pharmaceutical and biotechnological applications; o understand and explain the meaning of complex and integrated processes in the ambit of biochemical and biotechnological industrial sectors; o understand the fundamental concepts of criteria of design of several equipment and their use in the ambit of several pharmaceutical industrial applications; o demonstrate critical awareness of cell culture authentication, growth control and inactivation and critically evaluate the application of aseptic production and quality control within the biotechnology industry; o be able to compare and contrast different modes of operation of bioreactors and apply those principles in different cell expression systems; o be able to apply principles of various unit operations used in bioseparations in downstream processing and enhance problem-solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion. o demonstrate skills in the use of some commercial software to carry out technical and economical feasibility studies; o demonstrate capacity for reading and understanding other texts on related topics.
3	Prerequisites and learning activities	Prerequisites: Applied Chemistry, Mathematics, Physics, Biology, Unit Operations. The student must know the notions of design and simulation of biochemical reactors with the related unit operations for downstream processes.
4	Teaching methods and language	Lectures and exercises. Language: Italian / English. Ref. Text books: - James Edwin Bailey, David F. Ollis, *Biochemical engineering fundamentals*, Mc Graw-Hill, 1986. - Shuichi Aiba, Arthur Earl Humphrey, Nancy F. Millis*, Biochemical engineering,* Academic Press, 1973. - Didactic materials and scientific papers published by the teacher.
5	Assessment methods and criteria	Written and oral examination, realization and discussion of a technical report realized by students before the final examination.
3) PROCESS DESIGN OF BIOTECHNOLOGICAL PRODUCTION OF DRUGS AND PHARMACEUTICAL PRODUCTS II (3 ECTS)		
Teacher: Laura NARDONE		
1	Course objectives	The course will provide a consolidated methodological approach to the problem of project management, organizational procedures at the base of the industrial production of biopharmaceuticals, from the moment a drug, a biopharmaceutical or healthcare product consumption is only a good idea in someone's mind until the moment it reaches the shelves of the pharmacy.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - Processes, programs and projects. - Project management: ✓ Logic and tools ✓ The roles and motivation in project management ✓ The life cycle of projects ✓ The system of stakeholder and its management - The guarantee of compliance with the time and tools for planning, programming and control: ✓ WBS (Work Breakdown Structure) ✓ The Matrix-Activities Responsibility ✓ Techniques reticular project management, chart GANTT, PERT, CPM - The cost plan: ✓ Control of project management ✓ The project budget ✓ The S-curve

		✓ PERT costs. - The management of project risks: ✓ Identify risks ✓ Qualitative analysis ✓ Plan the actions risk response ✓ Monitor and control the risks - The control of the progress of the task and the project. On successful completion of this module, the student should o know and understand various techniques used in the biopharmaceutical industry o be able to develop a plan, and to conduct and report on any aspect in the design and manufacture of pharmaceutics; o demonstrate the ability to qualitatively and quantitatively address specific areas of the discipline, ranging from drug manufacture and separation to regulatory issues and drug design; o be able to apply academic theory and knowledge together with work experience to the solution of a real-life research, plant operational or management problem; o demonstrate capacity to reflect and interpret key information from technical procedures and published works in order to improve practice; o be able to discuss advanced pharmaceutical engineering operations and be able to handle most practical (drug manufacturing related) aspects involved in the subject; o be able to analyse and quantify data and present them in a scientific fashion; o demonstrate to be familiar with the latest research in the area of the project.
3	Prerequisites and learning activities	Prerequisites: Applied Chemistry, Mathematics, Physics, Biology, Unit Operations. The student must know the notions of design and simulation of biochemical reactors with the related unit operations for downstream processes.
4	Teaching methods and language	Lectures and exercises. Language: Italian / English. Ref. Text books: - Bassi, Sampietro, Villa, *Partecipare a un progetto*, Etas, Milano 2010 - Didactic materials will be distributed by the teacher.
5	Assessment methods and criteria	Oral examination on the topics covered by the course.

Programme of "BIOCHIMICA DELLA NUTRIZIONE" ***"BIOCHEMISTRY OF NUTRITION"***		
B0499, COMPULSORY **2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 2nd Year, 2nd Semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credits =25 hours)		
Teacher: Giuseppina PITARI		
1	Course objectives	The main objective of the course is to give the students a thorough understanding of the Biochemical properties of foods. The biochemistry of food is the foundation on which the research and development advances in food biotechnology are built. Laboratory experimentation and exercises complete the Module.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of this Module include: - Carbohydrates and Glycobiology, Lipids, Aminoacids and proteins, vitamins, oligoelements; Chemistry and Biochemistry, Absoption, transport and catabolism. Enzymes in health and disease. Physiological and chemical functions of food components; - Food Composition: Fruits, Vegetables, Cereals, Milk, Meat. Food additives; - Laboratory sections: FOOD ANALYSIS On successful completion of this module, the student should o have profound knowledge of food biochemistry; o have knowledge and understanding of the biochemistry and food adsorption; o understand and explain food digestion and composition; o demonstrate skill to integrate the principles of biochemistry into real world of Food Science and nutritional studies;

		o demonstrate capacity for **reading critically other texts** and understanding health implication.
3	Prerequisites and learning activities	The student must know cellular biology, general and organic chemistry, biochemistry
4	Teaching methods and language	Lectures, exercises, home work, experimental. Language: Italian Ref. Text Books - Nelson David L., Cox Michael M.: *Principi di Biochimica* - *Food Biochemistry* http://www.scribd.com/doc/24125134/FoodBiochemistry-and-Food-Processing
5	Assessment methods and criteria	Oral exam

Programme of "METODOLOGIE DI IMAGING MOLECOLARE" ***"MOLECULAR IMAGING METHODS"***		
B0446, COMPULSORY **2nd Cycle Degree in MOLECULAR AND CELLULAR BIOTECHNOLOGIES, 2nd Year, 1th Semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credits =25 hours)		
Teacher: Marcello ALECCI		
1	Course objectives	The course will provide the essentials of molecular imaging methods, encompassing the non-invasive *in vivo* production of multi-modal images providing detailed pictures of what is happening inside the body at the molecular and cellular level, and how this information can be used for developing research models of disease and also for clinical applications.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - Analog and digital images. - Digital image processing. - Fourier analysis. - Introduction to ImageJ. - Spatial and temporal resolution of images. - Principles of Molecular Imaging (MI). - Nuclear Magnetic Resonance Spectroscopy. - Magnetic Resonance Imaging. - Positron Emission Tomography (PET). - Bioluminescent Imaging (BLI). - Ultrasound Imaging (USI). - Contrast agents for molecular imaging (MRI, PET, BLI, USI). - Applications of MR-based molecular imaging for pre-clinical studies (cancer, neurodegenerative diseases). - Practical work with a 2.35T MRI scanner used for MI applications. On successful completion of this module, the student should: o have a detailed **knowledge** of the potential and effective applications of MI methods in preclinical research; o have a detailed **knowledge and understanding** of the theoretical principles of molecular imaging; o have a good **knowledge** of the practical aspects of molecular imaging methods; o have a good **knowledge** of the main contrast agents used for molecular imaging applications; o **demonstrate skills** in digital image processing; o **demonstrate skills** in NMR spectroscopy; o **demonstrate skills** in MRI; o **demonstrate ability** in reading and understanding scientific papers and textbooks presenting molecular imaging techniques and applications; o **demonstrate ability** in applying molecular imaging methods in the everyday laboratory work. o **demonstrate ability** in presenting orally the content of a selected paper on MI.

3	Prerequisites and learning activities	The student must have a solid knowledge of General Physics, Mathematics and Computer Science. An introductory knowledge of Excel or Matlab is beneficial.
4	Teaching methods and language	Lectures, exercises, home work, excel reports and practical demonstrations. Language: Italian (on request it can be offered in English) Ref. Text books: 1) G. Valli, G. Coppini, "Bioimmagini". Patron Editore, Bologna, 2002, ISBN 88-555-2662-6 2) R.C. Gonzales, R.E. Woods, "Digital Image Processing"; Prentice Hall. [Chaps: 1, 2, 3, 4]. 3) Coursework on "Tutorial ImageJ": http://rsb.nfo.nih.gov. 4) Coursework on "Fourier series and Fourier Transform". 5) G.S. Rule, T. K. Hitchens, "Fundamentals of Protein NMR Spectroscopy", Springer, 2006, ISBN 1-4020-3499-7. [Chaps. 1, 2, 3, Appendix A-D]. 6) D.G. Nishimura, "Principles of Magnetic Resonance Imaging", Stanford University, 1996. 7) A. Merbach, L. Helm, E. Toth, "The Chemistry of Contrast Agents in Medical Magnetic Resonance Imaging", Wiley, 2013, ISBN 978-1-119-99176-2 [Chaps.1, 2, 3, 4, 7, 8, 9, 10, 11]. Reviews on Molecular Imaging: 1) S.R. Cherry, "Topical Review - In vivo molecular and genomic imaging: new challenges for imaging physics", Physics in Biology and Medicine, vol. 49, pag. R13-R48, 2004. 2) R. Weisleder, et al, "Molecular Imaging", Radiology, vol. 219, pag. 316-333, 2001. 3) C.S. Levin, "Primer on Molecular Imaging Technology", Eur J Nucl Med Mol Imaging, vol. 32, pag. S325–S345 (2005). 4) R. Weisleder, et al, "In vivo magnetic resonance imaging of transgene expression", Nature Medicine, vol. 6, pag. 351-354, 2000. Useful web pages: 1) European Society of Molecular Imaging: http://www.e-smi.eu 2) World Molecular Imaging Society: http://www.wmis.org 3) Society of Biophysics: http://www.biophysics.org/ 4) Centre for Molecular Imaging: www.mgh-cmir.org 5) Viscover Imaging: http://www.miltenyibiotec.com/en/products-and-services/viscover-imaging.aspx 6) Molecular Imaging (journal) http://mi.deckerpublishing.com 7) Molecular Imaging and Biology (journal) http://www.springer.com/medicine/radiology/journal/11307
5	Assessment methods and criteria	Written exam, followed by an oral presentation (power point) of a scientific paper selected by the student and reporting at least one molecular imaging method applied to pre-clinical research.