DIDACTIC HANDBOOK

Degree Course in Pharmacy

Academic Year 2021-2022

Our ***Degree course in Pharmacy***, held in the **University of Rome Tor Vergata**, is taught entirely in English with the purpose to provide the necessary knowledge in any and all aspects of drug and medicine use, from the discovery to the drug's development, or its supply to patients.

The course was founded by our School of Medicine and School of Science in partnership with the prestigious School of Pharmacy of the ***University of Nottingham*** and ***Alliance Boots***, as a highly interdisciplinary school involving professors and experts from different sectors, from Chemistry to Medicine, Economics, Law as well as all subjects concerned in a complex traditional Pharmacy Course.

This relationship provides the opportunity, to our best students, to perform a stage in Nottingham University, as well as in other well organized European Universities through the *Erasmus Mundus Project,* emphasizing the internationalization and making this course highly competitive and innovative.

COURSE OBJECTIVES

The ***master's degree course in Pharmacy*** intends to provide students with knowledge and skills suitable to work as a pharmacist and in many other related fields.
Together with a specific program focused on pharmacy, other subjects belonging to the medicine field are part of the programs; these are: internal medicine, dermatopharmacology and dietary sciences, as well as subjects related to the rules governing the medicine, such as Italian pharmaceutical legislation, European legislation and commercial law. The course also includes *lectio magistralis*, workshops, seminars and conferences held by experts of national and international reputation.
In addition, a number of visits to pharmaceutical industries will be organized in the course of the so-called "additional activities", as they are considered of great importance. This network, at national and international level, has contributed to increasingly encourage relations with professionals and representatives belonging to the pharmaceutical world. Also the growing attention to the quality of the different pharmaceutical products is contributing to the inclusion of technical-pharmaceutical skills in a number of productive sectors and in areas of recent evolution; this enhances one of the objectives of the course, i.e. the possibilities for graduates in Pharmacy to be employed in firms working in areas indirectly connected with the pharmaceutical ones. This degree course aims to give the future pharmacist not only the skills typical of the pharmacy sector, but also those ones diversified and at the same time closely interconnected with the pharmaceutical sector, such as monitoring the use of drugs on a given territory and evaluating therapies (Health Technology Assessment and Pharmaceutical economics), the reports concerning the safety of drugs (pharmaco-vigilance), and the knowledge of managerial tools such as planning, control, marketing and sales.

STRUCTURE OF THE COURSE AND UNIVERSITY CREDITS

The *master's degree course* includes lessons, laboratory practice, seminars and conferences, also held at suitable public and private institutions both in Italy and abroad, which provide information, language and cultural relevance skills consistent with the topics of the course. Each university credit (CFU) corresponds to a **25-hour** student commitment, of which, normally, ***8 hours of lectures***.

In compliance with the European directives, the skills acquired by the student, defined as specific, peculiar and characterizing, are then consolidated during vocational training periods spent in pharmacies open to the public or in-hospital ones as well as thanks to grants to study abroad according to international agreements or conventions established by universities.

Among them, the School of Pharmacy in Nottingham or the Erasmus project give the possibility to take exams or to carry out experimental degree theses abroad. The course is complemented by lessons providing the knowledge of medical- surgical, dietetic, cosmetic, diagnostic and chemical-clinical products, keeping in mind also the employment opportunities offered in the Community.

This master's degree course is divided into *29 courses* (and activities chosen by the student, final exam and orientation training course) to which a number of CFUs is allocated, as determined by the Council of Degree Course in compliance with the provisions contained in the table of the compulsory courses.
In order to achieve the aforementioned educational objectives, the master's degree course in Pharmacy provides that the total of **300 CFUs** is distributed as follows:

- lectures (including numerical and/or laboratory practice) for a total of **243 CFUs**;
- vocational internship for a total of **30 CFUs**;
- final degree exam for a total of **15 CFUs**;
- additional activities (chosen by the student) for a total of **12 CFUs**.

ENROLLMENT AND ATTENDANCE

The master's degree course in Pharmacy is intended for students who have an upper secondary school diploma or other qualification obtained abroad and recognized as equivalent in accordance with the legislation in force. The diploma or other qualification must have been achieved by the dates set in the course call for applications.
The number of available posts is up to **80** of which ***50*** for Italian citizens, EU citizens and non-EU citizens legally residing in Italy as per art. 26 of the law no. 189 dated 2002 and ***30*** reserved for non-EU citizens residing abroad (of which 2 have been reserved for students of the People's Republic of China participating in the Marco Polo program).
The posts reserved for non-EU citizens residing abroad that are not assigned will be made available to eligible subjects belonging to the category of Italian citizens, EU citizens and non-EU citizens legally residing in Italy.
Any Italian citizens, EU citizens and non-EU citizens legally living in Italy, can participate to the admission test only if owners of a five years Diploma of Secondary School, issued by any Italian

Institutes, or a qualification obtained abroad and valid for the admission to any Italian University.

The EU and non-EU citizens, legally living in Italy, in possession of a foreign certificate, will be admitted to the test after the evaluation of the certificate. In case they should be winners, their registration will be subject to the validity of the documents and qualification obtained abroad, see Circular MIUR prot. 1291 of 16/05/2008 and current laws.

Non-EU students living abroad, will formalize the procedure for the enrolment through the University Foreign Student Office, Via Cracovia 50, 00133 Rome Ground floor, building D, room n.1. email: Rome, Studenti.stranieri@uniroma2.it

ATTENDANCE

The attendance of the courses is compulsory for a minimum **percentage of 70%**, in accordance with the Directive 85/432/EEC.Therefore no forms of total exemption from attendance are permitted, with the exception of serious diseases that have *to be documented*. During the courses each student has to sign an attendance sheet that will document his/her actual presence in class. The attendance for laboratory courses is also mandatory and no exemption can be requested.

STUDENT PART-TIME

The part-time request must be appropriately *motivated* and *certified* (work, family, medical and similar reasons).
The part-time request can be submitted once only and is irreversible during the year. Information about enrollment on the website http://delphi.uniroma2.it, at the link “enrollment as a part-time student” (“iscrizione come studente a tempo parziale”), where regulations, tables and procedures provided for this type of enrollment are available.
Students who do not have much time to dedicate to the study can enroll part-time, paying university fees to a limited extent, provided they are in line with a satisfactory standing (“in corso” students). This facility is not allowed for outside prescribed time students (“fuori corso” students).
In order to avoid the obsolescence of the acquired CFUs, no more than 8 repetitions of course are allowed during the whole master’s course, both for full-time and part-time students. The suspension of attendance for a number of years greater than 6 requires the enrollment to the year of course approved by the competent Council of Degree Course, both for full-time and part-time students.

ADMISSIONS

In order to be admitted to the Degree of Pharmacy it is necessary to take and pass a specific test.
The test consists of 50 multiple-choice questions divided into five sections according to the chart below.
Only those candidates who have obtained a score equal to or higher than 18.0 points out of 50 in the total of the Biology, Chemistry, Mathematics, Physics, Logic sections in the English TOLC-F CISIA test will be considered winners, within the limits of the available places.
The General Ranking list - which will indicate those students who are authorised to enrol - will be published on the University website http://web.uniroma2.it/, on the Macro area of the School of

Science website http: //www.scienze.uniroma2.it, and on the website of the Master's of Science in Pharmacy http://www.farmacia.uniroma2.it.
The publication of the ranking will be valid for all purposes as official communication of the results.

TRANSFERS AND RECOGNITION OF PREVIOUS CURRICULA

Admission under this procedure is also necessary:
- for students enrolled at other universities wishing to request the transfer;
- for students enrolled at the University of Roma 2 ("Tor Vergata") who intend to request a transfer to another course.

After having taken the test (if they will be included in the ranking), these students have to submit the transfer or the admission request.
All information about the transfer procedures are included in the **Student Guide 2021/2022**, published on the official portal of this university http://web.uniroma2.it/, or in the website of the Degree Course in Pharmacy http://www.farmacia.uniroma2.it.
To be enrolled in this course, also those students who have already passed exams (in possession of an academic qualification, or even with careers carried out and not concluded at other degree courses or other universities) of which they want to obtain the recognition have to pass the admission test.
In this case - after having completed the normal enrollment procedure - these students must present at the students' administration office of the Mathematics, Physics and Natural Sciences Department, within the first academic year of the course, a written request, accompanied by the list of the exams taken and the programs of the courses previously attended. These programs must be duly validated by the relating university office.
The recognition can take place after evaluation of the previous curricula considered as consistent with the didactic organization of this course. Based on the number and type of exams passed, a competent Teaching Committee can admit the student to any course year following the first.
The student who is admitted by the committee to a year course after the first will be required to acquire the attendance of the courses and pass the examinations scheduled in the year courses prior to the enrollment.

VOCATIONAL INTERNSHIP

The vocational internship is aimed to complete university education, by integrating it with practical activities carried out in a pharmacy.
This consists of the full-time student engagement in activities carried out at a pharmacy open to the public or at an in-hospital one under the supervision of the hospital pharmaceutical service, for a total duration of at least six months (**30 CFUs**).

The internship is a fundamental and indispensable requirement to participate in the qualifying State examination to work officially as a pharmacist.
The period dedicated to vocational training in a pharmacy must not coincide with that one used to prepare an experimental thesis.
To be admitted to the internship the student must have passed the exams of the first three years of the course and have attended the lessons of the fourth one.

FINAL EXAMINATION

The ***final examination*** consists in drafting, submitting and discussing in **English a written final dissertation**, developed by the student autonomously, in an original way, which documents in an organic and detailed way the research topic chosen by the student under the guidance of an advisor (university professor or researcher).

This dissertation has to be mainly based on the collection and processing of bibliographic material concerning the subject matters of the master's degree course. In order to start preparing his/her thesis, the student must have acquired at least **180 CFUs**.
After a presentation in Power Point (about 15 minutes), the dissertation has to be discussed in the presence of the graduation commission.
To be admitted to the master's degree final examination in Pharmacy, the student must have attended all the courses provided by the Didactic Regulations and have acquired **300 CFUs** in total, divided into **5 years of course**, including those related to the internship (**30 CFUs**) and the preparation of the final dissertation (**15 CFUs**).

COURSE STRUCTURE

I Year	Mod.	CFU	SSD
Applied Mathematics		6	MAT/08
Applied Physics		6	FIS/03
General and Bio-inorganic Chemistry: GENERAL CHEMISTRY	I	9	CHIM/03
General and Bio-inorganic Chemistry: BIO-INORGANIC CHEMISTRY	II	3	CHIM/03
Human Anatomy	I	3	BIO/16
Human Anatomy	II	5	BIO/16
Introduction to Biology: CELLULAR AND DEVELOPMENTAL BIOLOGY	I	6	BIO/06
Introduction to Biology: INTRODUCTION TO GENETICS	II	4	BIO/13
Organic Chemistry		8	CHIM/06

II Year	Mod.	CFU	SSD
Analytical Chemistry		8	CHIM/03
Biochemistry I		6	BIO/10
Drug Analysis	I	8	CHIM/08
Drug Analysis	II	8	CHIM/08
Microbiology and Immunology: GENERAL MICROBIOLOGY	I	2	MED/07
Microbiology and Immunology: SPECIAL MICROBIOLOGY	II	4	MED/07
Microbiology and Immunology: IMMUNOLOGY	III	3	MED/46
Molecular Biology	I	4	BIO/11
Molecular Biology	II	3	BIO/11
Pharmaceutical Botany and Pharmacognosy: PHARMACEUTICAL BOTANY	I	4	BIO/01
Pharmaceutical Botany and Pharmacognosy: PHARMACOGNOSY	II	4	BIO/14

III Year	Mod.	CFU	SSD
Biochemistry II		6	BIO/10
General and Clinical Pathology: GENERAL PATHOLOGY	I	5	MED/04
General and Clinical Pathology: CLINICAL PATHOLOGY	II	5	MED/04
General and Molecular Pharmacology and Toxicology		8	BIO/14
Human Physiology		8	BIO/09
Human Nutrition and Dietistics		6	MED/49
Medicinal Chemistry I		8	CHI/08
Medical Statistics and Clinical Studies Methods		6	MED/01

IV Year	Mod.	CFU	SSD
Chemotherapy (C)		8	BIO/14
Internal Medicine (A)	I	3	MED/09
Dermatopharmacology (A)	II	3	MED/35
Pharmaceutical and Toxicological Chemistry II° (C)	I	6	CHIM/08
Pharmaceutical and Toxicological Chemistry II° (C)	II	6	CHIM/08
Pharmaceutical Technologies (C)	I	5	CHIM/09
Pharmaceutical Technologies (C)	II	5	CHIM/09
Special Pharmacology and Therapy (C)	I	5	BIO/14
Special Pharmacology and Therapy (C)	II	5	BIO/14
Neuropsychopharmacology (C)		8	BIO/14

V Year	Mod.	CFU	SSD
Italian Pharmaceutical Legislation (C)	I	5	CHIM/09
European Pharmaceutical Legislation (C)	II	5	CHIM/09
Commercial Law (A)	III	2	IUS/04
Dietistic Sciences (A)	I	3	MED/49
Food Chemistry (C)	II	5	CHIM/10
Optional Courses		12	
Final Exam		15	
Training		30	

The list of courses with the scientific-disciplinary sectors of reference, the possible articulation in modules, the credits corresponding to each subject matter, the Teachers, the date of beginning and the period where the activities are carried out can be found on the website of the degree course in Pharmacy. A joint Teaching Committee, appointed each year by the Council of the Master's Degree Course (CCLM), ascertains the consistency between the credits assigned to the learning activities and the relating educational objectives.

ADDITIONAL ACTIVITIES

With a view to completing the training activities, students are given the opportunity to attend additional educational activities, for a total of **12 CFUs.**
With regard to these courses, chosen by the student, the examination procedure is the same defined in the Course Regulations.
The students will be able to acquire the **12 CFUs** by choosing any subject matter foreseen in the degree courses. Finally, for the purposes of the aforementioned recognition, students must submit the list of courses attended, as written in the appropriate booklet reserved solely for additional study and/or seminar activities, with the relative marks, to the students' administrative office.
For information about it visit this page on the pharmacy website http://farmacia.uniroma2.it/didactic-area/syllabus/

Course Program

A.Y.2021-2022

Course: **APPLIED MATHEMATICS**
Teacher: **Daniele Bertaccini**
CFU: **6**

Objectives:

LEARNING OUTCOMES: Introduction to applied mathematics: Numbers (naturals, rationals, real and complex). Inverse formulas, change of scales and order of magnitudes in formulas; equivalence relations; errors in measures and calculations. Functions of one real variable: basic concepts, graphs, elementary functions (polynomials, roots, rational functions, trigonometric, exponentials and logarithms); Sequences; Binomial coefficients; Limits; Geometric sums; Continuous functions; Differentiation: derivatives, monotonicity and concavity, extrema, sketching graphs; Riemann Integration; Definite integration: the fundamental theorem of calculus; Techniques; Infinite series (briefly) and their applicability to pharmacy.
KNOWLEDGE AND UNDERSTANDING: The student will be able to work with basic tools of modern calculus and their applicability to pharmacy;
APPLYING KNOWLEDGE AND UNDERSTANDING: The student will be able to recognize and understand basic tools of modern calculus and their applicability to pharmacy;
MAKING JUDGEMENTS: The student will be able to recognize and solve simple calculus problems (see program)
COMMUNICATION SKILLS: The student will be able to communicate and interface with other experts in an interdisciplinary team
LEARNING SKILLS: The student will be able to recognize and understand simple calculus problems (see program).

Program:

Numbers (naturals, rationals, real and complex). Inverse formulas, change of scales and order of magnitudes in formulas; equivalence relations; errors in measures and calculations. Functions of one real variable: basic concepts, graphs, elementary functions (polynomials, roots, rational functions, trigonometric, exponentials and logarithms); Sequences; Binomial coefficients; Limits; Geometric sums; Continuous functions; Differentiation: derivatives, monotonicity and concavity, extrema, sketching graphs; Riemann Integration; Definite integration: the fundamental theorem of calculus; Techniques; Infinite series (briefly)
(preliminary) Introduction to the software for approximating and plotting functions, approximation of definite integrals, linear and nonlinear systems. Introduction to the simulation of Phenomena in Medicine and drug preparation.

Text Books:

- Calculus for biology and medicine (2nd ed.), c. Neuhauser, prentice hall (2nd international edition). Ed. Pearson educational international, 2003.

Course: **APPLIED PHYSICS**
Teacher: **Vittorio Merlo**
CFU: **6**

Objectives:

Provide students with basic concepts of classical physics to be used in the continuation of their studies.

Program:

Introduction to Physics. Measurements and related uncertainties. Vector algebra. Kinematics and dynamics of point-like objects. Work and energy, linear momentum. Fluid mechanics. Hydrostatics and fluid dynamics, Bernouilli principle. Thermodynamics: calorimetry, Boyle law and the ideal gas temperature scale. Thermal expansion of gases, solids and liquids. Heat and internal energy. Isolated systems. The laws of thermodynamics, entropy. Electricity and magnetism: electrostatic fields and interactions, charge, conductors and insulators, concept of capacity, dielectrics. Electrical circuits, Ohm's law. Magnetic fields and interacions, Lorentz law. The Faraday's law of induction, transformers. Waves and sounds: statationary waves.
Ultrasounds and their use in medical diagnostics, the echo principle, Doppler effect, ecography.

Text Books:

- Serway, Jewett: "Physics for scientists and engineers" Halliday, Joseph W. Kane, Morton M. Sternheim "Life Science Physics"
- John Wiley & Sons." Fisica Biomedica", EMSI.
- Bellini Manunzio "Fisica per le scienze della vita", PICCIN

Course: **GENERAL AND BIO-INORGANIC CHEMISTRY:**
Module I: *"General Chemistry"* (CFU **9**)
Module II: *"Bio-Inorganic Chemistry"* (CFU **3**)
Teacher: **Marilena Carbone**
TOTAL CFU*:* **12**

Objectives:

At the end of the course, the students are geared to be conversant with the foundations of chemistry, and familiar with atomic and molecular structures, along with their reactivity. This process goes through the learning of the fundamental outcomes of quantum-mechanics that drive the atomic structures and of the thermodynamic laws and principles that guide the physical and chemical transformations of matter. They are expected to get skilled in stoichiometric issues and to gain technical perspectives to forecast the chemical reactivity based on chemical structures. It is specifically required to get acquainted the chemistry of transition metals and nanostructured material and evaluating their impact in life science.
Basic knowledge of mathematics: logarithms, quadratic equations, exponentiation and rooting.

Program:

Module 0. Definition of intensive and extensive properties, pressure, volume, density. Concept of mole, and calculation of the molarity of a solution. Definition of acids and bases according to the Brönsted theory. Distinction between strong and weak acids. Definition of the pH and calculation of pH variations with dilutions. The low of definite proportions and the calculation of the empirical formula. Reactions balancing. Calculation of the equilibrium constant from equilibrium concentrations. Application of the law of ideal gases. Ionization energy, electronegativity, typical oxidation states of the elements depending on group and period. Balancing of redox reactions.

Naming of salts and acids.

Module I. Basic principles of thermodynamics. The first principle and the concept of enthalpy. Standard enthalpies of formation and of reaction. Hess's law. The second and third principles of thermodynamics. Criteria for spontaneous reactions: entropy, free energy, and equilibrium constants. Principles of chemical equilibria. Dynamic equilibrium. Vapour pressure of liquids and Clapeyron equation. Phase diagrams. Solutions concentrations. Solubility of gases and Henry's law. Vapour pressures of solutions, and Raoult's law. Freezing-point depression and boiling-point elevation of non-electrolyte solutions. Osmotic pressure. Solutions of electrolytes. Definition of acids and bases. Arrhenius theory. Self-ionization of water and the pH scale. Molecular structure and acid-base behaviour: strong acids and strong bases, weak acids and weak bases. Polyprotic acids and bases. Ions as acids and bases. Pauling rules for the estimate of the pKa. Buffer solutions. Lewis acids and bases. Solubility and solubility product constant, Ksp. Common-ion effect in solubility equilibria. Criteria for precipitation and its completeness.

Solubility and pH, fractional precipitation and ion lectrode potentials and their measurement: the Nernst equation. Standard electrode potentials. Electrode potential as a function of concentrations. Cell potentials and equilibrium constants. Batteries: producing electricity through chemical reactions. Electrolysis.

Module II. Elements of quantum mechanical theory, quantum numbers and their correlation, radial and angular distribution function. Hydrogen-like atoms, polyelectron atoms, the Russel and Saunders coupling. Atomic term symbols. The VSEPR theory. The Lewis structures. Hybridization and geometry of the molecules. The LCAO method and molecular orbital theory. Coefficients of linear combinations in homonuclear and heteronuclear molecules. Requisites for molecules formation. Bond order. Molecular orbital diagrams of HF, CO, N2, O2, F2.

Complexes: definition, typical coordination number, types of ligands, complex stability, partial and total formation constants, chelation effect. Naming of complexes. Symmetry elements and chirality. Recognition of the chirality in octahedral complexes. Assignment of the absolute chirality in octahedral complexes. The crystal field theory, applied to tetrahedral, octahedral and square planar complexes. High and low spin complexes. The complexes described through the molecular orbital theory. The spectrochemical series and the □ bonds in complexes. The Racah parameters, the spectroscopic terms, the Tanabe-Sugano and Orgel diagrams. The law of Lambert and Beer, the selection rules of Laporte and the UV-Vis spectra. Substitution reactions in complexes. Carbonyl complexes: properties and reactivity. The definition of apticipy in metallorganic complexes. Bio-inorganic complexes: heme andthe most common chemotherapy drugs. The membrane potential.

Text Books:

- General Chemistry Atkins, or General Chemistry Mahan, or General Chemistry Raymond Chang
- Inorganic Chemistry Atkins, or Inorganic Chemistry Huheey

Course: **HUMAN ANATOMY**
Module I (CFU **3**) **and Module II** (CFU **5**)
Teacher: **Marco Barchi**
TOTAL CFU: **8**

Objectives:
The aim of the corse of human anatomy is to guide the pharmacy student into the study of the human body, with special attention to the morpho-functional correlations.

Program:
MODULE I: Organization levels of human body. HISTOLOGY: Histology and method of study. Preparation of tissues, light microscopy, electron microscopy, scanning microscopy, fluorescent microscopy, confocal microscopy, bright field microscopy. Detection methods using electrostatic staining specific interaction (immunofluorescence, immunohystochemistry). EPITHELIAL TISSUES: basal membrane and basal lamina (kidney glomerule), intracellular adhesion and GAP junctions, microvilli, cilia, classification of covering lining epithelia and their characteristics, skin, glandular epithelia (exocrine glands and endocrine glands). CONNECTIVE TISSUES: cells fibers and ground substance of the connective tissue. Connective tissues: embryonic (Mesenchyme and mucous), Adult (areolar, dense irregular, dense regular, specialized reticular and adipose). Adipose tissue (white and brown). Cartilage (Hyaline, Elastic, Fibrocartilage). Bone: osteoblasts, osteocytes, osteoclasts, bone matrix, periostium and endostium. Type of bone (primary, compact lamellar and spongy bone). Ossification (intramembranous and endochondral), bone growth and remodelling, metabolic role of the bone, joints growth and structure. NERVOUS TISSUE neurons (property and structure), membrane potential, synaptic communication, glial cells. BLOOD: functions, composition physical characteristics, plasma and serum, notes on hematopoiesis, red blood cells, blood group systems, granulocytes, lymphocytes, monocytes (structure and general function in the immune response), platelets. Lymph and lymph nodes. MUSCLE TISSUE: skeletal muscle, cardiac muscle, smooth muscle.
MODULE II: LOCOMOTOR SYSTEM. Skeleton: general organization of the axial and appendicular skeleton, vertebral column and main bones of the trunk, superior limb, inferior limb. Pectoral and girdle and pelvis. Joints structure and classification, movements. Skeleton Muscles: generality, major muscles of the pectoral girdle and trunk. Main respiratory muscles.
CARDIO-SPLANCHNOLOGY. Heart, thoracic aorta, aortic arch, abdominal aorta. The Willi's polygon. Coronary circulation. Main arteries of superior and inferior limbs. Venous system. Superior vena cava, inferior vena cava and their main branches in the thorax and abdomen. Main veins of the superior and inferior limbs. Lymphatic system. Systemic and microscopy anatomy of digestive, respiratory, urinary, reproductive and endocrine Systems.
NEUROANATOMY: Spinal cord: segmental and internal organization: gray matter, ascending and discending tracts. Spinals nerves, plexuses and reflex arcs. Brainstem (Medulla oblungata, Pons, Mesencephalon): internal and external structure. Cranial nerves: nuclei and innervation. Diencephalon (Thalamus, Hypothalamus, Epithalamus): internal and external structure. Thalamic nuclei. Telencephanlon: internal and external structure. Anatomical and functional organization of cerebral cortex. Allocortex. Basal Ganglia. Cerebellum: internal and external structure. Ventricular system. Meninges. Brain blood vessels and dural sinuses. Sensory system: spinothalamic, tacts, fasciculus gracilis and fasciculus cuneatus tracts, spinocerebellar tracts. Pain conduction. Visual, auditory, gustatory, olfactor and limbic system.

Motor system: pyramidal and extrapyramidal tracts. Motor nuclei. Autonomic nervous system: sympathetic and parasympathetic system. Enteric nervous system.

Text Books:

- Martini Timmons Tallitsch: Human Anatomy (Pearson College Div), or
- Gerard J. Tortora: Human Anatomy (Willey), or Students that desire to integrate the histology part may make use of the following text book: 3) Anthony L. Mescer: Junqueira's Basic Histology (McGraw-Hill)

Course: **INTRODUCTION TO BIOLOGY:**
Module I: "Cellular and Developmental Biology" - *Teacher:* **Mauro Piacentini** (CFU **6**)
Module II: "Introduction to Genetics" - *Teacher:* **Cesare Gargioli** (CFU **4**)
TOTAL CFU: **10**

Module I: "Cellular and Developmental Biology" *Teacher:* **Mauro Piacentini** (CFU **6**)

Objectives:

To provide to the students of the Pharmacy Course in English the basic cell biology and an introduction to the cellular and molecular mechanisms of reproduction in mammals.

Program:

The Program in Cell Biology offers to undergraduate students in Pharmacy the basic knowledge on cellular biology, genetic and molecular approaches to address structure-function relationships associated with cell growth, differentiation; chromatin structure; transcriptional control of gene expression; DNA replication; RNA structure. In particular the structure and function of the main organelles is analyzed. In addition an introduction to Reproductive Biology aimed to understand the scientific principles that govern reproduction in humans is also addressed during the course. The students will learn the requirements for reproduction, including the production of sufficient numbers of viable gametes, fertilisation, implantation in the uterus, formation of a placenta.

Text Books:

- The Cell: A Molecular Approach. Cooper G M and Hausman RE

Module II: "Introduction to Genetics" - *Teacher:* **Cesare Gargioli** (CFU **4**)

Objectives:

To provide to the students of the Pharmacy Course in English the genetic essential basis, particularly focusing on human genetic and clinical aspect.

Program:

Introduction to genetic program offers to undergraduate students in Pharmacy the Genetic basic knowledge, as well as chromatin and RNA structure, transcriptional control of gene expression and DNA replication. Moreover, particular attention will be given to human genetic e then to its implication in the clinical field.

Text Books:

- Strachan & Read. "Human Molecular Genetics 4th edition"

Course: **ORGANIC CHEMISTRY**
Teacher: **Pierluca Galloni**
CFU: **8**

Objectives:
Knowledge of nomenclature, of ways to represent molecules, of tridimensional structure (chirality included), of physical and chemical properties of organic molecules. Understanding the rationale of organic reactions in terms of reaction mechanism.

Program:
Introduction to organic molecules and functional groups. Nomenclature. Rules to write molecules. Intermolecular interactions. Relationship between structure and physical properties. Resonance and aromaticity. Electronic substituent effects (inductive and conjugative). Organic acids and bases (Brønsted and Lewis). Conformations and configurations (geometrical and optical stereoisomers). Introduction to chemical kinetics and reaction mechanisms. Reactions of main classes of organic compounds. Alkanes and cycloalkanes, Alkyl halides, Alcohols, Ethers, Amines, Alkenes, Alkynes, Dienes, Aromatic compounds, Aldehydes and Ketones and their nitrogen derivatives, Carboxylic acids and Acylic derivatives (esters, amides, anhydrides, acyl halides, nitriles). Biomolecules.

Text Books:
- Organic Chemistry for Pharmacy, McGraw-Hill Education

Course: **ANALYTICAL CHEMISTRY**
Teacher: **Erica Del Grosso**
CFU: **8**

Objectives:
Quantitative analysis of acid bes equilibria, precipitation equilibria.

Program:
Significant figures, errors, absolute and relative, precision and accuracy of data, standard deviation, coefficient of variation. statistics of data, control paper. Concentrations: %w/w; w/v; v/v; mg/dL, ppm; ppb; ppt. Molarity and normality. How to go from one concentration to another. Acid base titrations: strong acids, weak acids monoprotic, diprotic, triprotic. Strong and weak bases. Precipitation titrations; solubility and solubility product. Complex equilibria of ammonia and EDTA. Titrations with EDTA and metals.
Redox titrations Nernst equation and standard potentials. hydrogen potential as reference. titration of hydrogen Peroxide with EDTA. Batteries and electrolysis.

Text Books:
- Any book of general analytical chemistry at University level.

Course: **BIOCHEMISTRY I**
Teacher: **Massimiliano Agostini**
CFU: **6**

Objectives:

The course is divided in two parts. The first part of the course will provide to the student the basic knowledge (structure and function) of the chemical building block of life including, protein, polysaccharides and lipids. Special emphasis will be given to the central role of enzymes in catalyzing the reactions of life. In the second part, the student will learn how cellular processes such as,membrane excitation, secretion, hormone action, vision, gustation, olfaction, and cell cycle work at molecular level.

Program:

Part I: The Foundations of Biochemistry: Cellular Foundations, Chemical Foundations, Physical Foundations e Genetic Foundations.
Water: Weak Interactions in Aqueous Systems, Ionization of Water Weak Acids and Weak Bases, Buffering against pH, Changes in Biological Systems, Water as a Reactant.
Amino Acids, Peptides, and Proteins: Amino Acids Peptides and Proteins Working with Proteins
The Structure of Proteins: Primary Structure
The Three-Dimensional Structure of Proteins: Overview of Protein Structure, Protein Secondary Structure, Protein Tertiary, Quaternary Structures, Protein Denaturation and Folding
Protein Function: Reversible Binding of a Protein to a Ligand: Oxygen-Binding, Proteins Complementary Interactions between Proteins and Ligands
Enzymes: An Introduction to Enzymes, How Enzymes Work, Enzyme Kinetics as an Approach to Understanding Mechanism, Examples of Enzymatic Reactions, Regulatory Enzymes
Water soluble vitamins: Structure and Function.
Carbohydrates and Glycobiology: Monosaccharides and Disaccharides, Polysaccharides
Glycoconjugates: Proteoglycans, Glycoproteins, and Glycolipids.
Nucleotides: Structure and function, Nucleotides as drugs, Nucleotides and mutation.
Lipids: Storage Lipids, Structural Lipids in Membranes, Lipids as Signals, Cofactors and Pigments.
Part II: Biological Membranes and Transport: The Composition and Architecture of Membranes, Membrane Dynamics, Solute Transport across Membranes.
Biosignaling: General Features of Signal Transduction, G Protein–Coupled Receptors and Second Messengers Receptor Tyrosine Kinases Receptor, Guanylyl Cyclases, cGMP, and Protein Kinase G, Gated Channels, Regulation of Transcription by Steroid Hormones, Regulation of the Cell Cycle by Protein Kinases, Oncogenes,Tumor Suppressor Genes, and Programmed Cell Death, Development of Protein Kinase Inhibitors for Cancer Treatment. Introduction to bioenergetic and metabolism: Bioenergetics and Thermodynamics, Chemical Logic and Common Biochemical Reactions, Phosphoryl Group Transfers and ATP, Biological Oxidation-Reduction Reactions
Introduction to metabolic Pathway Fundamentals of Cancer metabolism Reactive Oxygen Species in cancer therapy.

Text Books:

- Lehninger Principles of Biochemistry of David L. Nelson and Michael M. Cox

Course: **DRUG ANALYSIS:**
Module I (CFU **8**) **and Module II** (CFU **8**)
Teacher: **Gaetano Barbato**
TOTAL CFU: **16**

Module I (CFU **8**)

Objectives:

Standards and safety data sheets in a chemical laboratory; prevention of laboratory risks; PPE, equipment and safety and emergency signs;

- Theoretical aspects of solubilization and precipitation processes (solubility and solubility product, factors that influence the solubility product, precipitation laws, quantitative relationship between solubility and solubility product, common ion effect, selective precipitation); Acid-base equilibria (definition of acid and base, fundamental equations for the study of chemical equilibria, calculation of the pH of solutions of strong and weak acids and bases, buffer solutions); redox balance;
- Coordination compounds and their stability as a function of pH. Dissolution of precipitates by complexation;
- Laboratory equipment; Analytical techniques and basic operations (measurements of weight and volume, solubilization and dilution, pH measurement);
- Introduction to inorganic qualitative chemical analysis; the analytical reactions; tests for the identification of inorganic substances

LEARNING OUTCOMES:

The course allows students to apply their knowledge for the study of different types of equilibria in aqueous solution for the determination of cations and inorganic anions. The aim is also to give to the students the theoretical bases imparted in the first year through theoretical lessons and laboratory practice.

KNOWLEDGE AND UNDERSTANDING:

The course aims to enable the student to approach the chemical experimental practice correctly. In particular, the main objectives of the course are to provide an adequate theoretical knowledge and an adequate modus operandi in the implementation of simple analytical methods for the analysis of inorganic substances (systematic recognition of cations and anions). To achieve this, the fundamental principles of qualitative chemical analysis are illustrated in the lectures and put into practice in subsequent single-laboratory laboratory exercises, with particular regard to inorganic substances of pharmaceutical interest.

APPLYING KNOWLEDGE AND UNDERSTANDING:

The students have the opportunity to demonstrate the knowledge acquired through laboratory tests aimed at the qualitative recognition of cations and anions in aqueous phase.

MAKING JUDGEMENTS:

The laboratory tests will be focused on making the students autonomous in the operational modalities, in the critical attitude of interpreting the results obtained through a test on a sample with an unknown composition.

COMMUNICATION SKILLS and LEARNING SKILLS:

The presentation of a written report and the subsequent oral discussion should help the student communicate his results with a critical spirit.

Program:

The course is organized in theoretical lessons in the classroom and in practical tests in the laboratory.

For safety reasons, the laboratory is organized over several shifts if the number of students enrolled in the course is> 30. Students must attend at least 2/3 of the laboratory to access the exam, which will consist of an unknown laboratory test and an oral test. The lessons are carried out on the blackboard with the aid of the projector to show graphics, figures, etc. relevant to the course. All the graphic and visual material presented will be provided to the students.

- Safety regulations, risk prevention and first aid elements in the chemical laboratory.
- Main techniques and basic operations in experimental chemical practice.
- Introduction to qualitative inorganic pharmaceutical analysis.

Analytical methods for the analysis of inorganic substances (systematic recognition of cations and anions) of pharmaceutical interest.

Text Books:

- Chimica Analitica Qualitativa, A. Araneo, Casa editrice Ambrosiana Milano
- Chimica analitica. Analisi quantitativa e qualitativa, Adelaide Crea, Luisa Falchet, Casa editrice Zanichelli
- Slides used during the lectures and laboratory experiences

Module I (CFU 8)

Objectives:

Acquisition – both theory and practice – of fundamental rationale and chemical techniques that allow the isolation, description, chemical characterisation, wet-chemical and spectroscopical analyses of organic substances after isolating them out of mixtures

Program:

The module will consist of lessons in which the theory behind different techniques for isolating and characterising organic substances (both in wet-lab and spectroscopically) are covered, and a practical part, in which the theoretically discussed separation techniques and wet-chemical analyses are performed in the lab, and results will be analyzed.The following topics are covered:

Safety in the laboratory and good laboratory practices; Forces determining the physical state of substances, Phase Diagrams, determination of physical properties of a sample (including rational solubility tests, melting and boiling point analyses, physical separation techniques: filtration, crystallization/recrystallization, TLC chromatography and retention factors, Raoult's Law, sublimation, fractionation, distillation, azeotropes, Liquid-liquid extraction, soxhlet extraction); systematic qualitative wet-chemical analysis methods targeting specific functional groups: reaction identification tests, analyses and interpretation of collected data sets; links between traditional wet-chemical separation and Instrument-based analyses methods: HCN analysis, MS spectra, IR spectra, 1H-NMR spectra. Structural determination of unknown molecules from the experimental data. Laboratory will be focused on: organoleptic analyses and solubility of chemical samples; calcination; Melting Point determination, Liquid-Liquid extraction, Survey of functional group identification tests reactions in small molecules of pharmacological interest; integration with spectroscopical data to solve molecular structures.

Text Books:

Lesson Slides distributed by the professor and specific chapters from:

- Macroscale andMicroscale Organic Experiments. 7th ed. K. L. Williamson, K.M. Masters, 2016, Cengage Learning. ISBN 978-1-305-57719-0
- Vogel's TextBook of Practical Organic Chemistry, 5th ed., 1989 (or later editions), Longman Scientific & Technical, John Wiley & Sons Inc. New York. ISBN 0-470-21414-7

- The spectrometric identification of organic compounds. Silverstein, Webster, Kiemle. 7th edition (2005) or more recent, Wiley & sons. ISBN-10: 0471393622

Course: **MICROBIOLOGY AND IMMUNOLOGY - Module I and Module II**

Module I: *"General Microbiology" - Teacher:* **Maria Santoro** (CFU **2**)
Module II: *"Special Microbiology" - Teacher:* **Francesca Ceccherini SIlberstein** (CFU **4**)
Module III: "*Immunology" - Teacher:* **Florence Malisan** (CFU **3**)
TOTAL CFU: **9**

Module I: *"General Microbiology" - Teacher:* **Maria Santoro** (CFU **2**) and
Module II: *"Special Microbiology" - Teacher:* **Francesca Ceccherini SIlberstein** (CFU **4**)

Objectives:

The course provides the essential knowledge of the major concepts, principles and applications of microbiology. Through this course you will learn about microorganisms what they are, how they function, and how their related pathogenetic mechanism works. Areas covered are: Microbiology; Bacteriology; Mycology; Parassitology; Virology. These objectives will be achieved through lectures, and educational interactive activities designed to facilitate learning, and to improve the ability to address and resolve the main questions of Medical Microbiology. Some peculiar arguments and topics will be presented and studied in depth.

Program:

General Microbiology:
-General virology: Nature, origin and morphology of viruses. Oncogenic RNA and DNA viruses. Virus-cell interaction. Vaccines. Antiviral therapy and resistance.
-General bacteriology: The bacterial cell. Metabolism and bacterial growth. Host-parasite relationship. Immune sera and vaccines. Principles of microbiological diagnostics. Antibacterial drugs and resistance.
-General parasitology: Host- parasites relationships and pathogenic activity of parasites. Human parasitic infections of clinical relevance.
-General mycology: The mycetes: structure, dimorphism and replication. Mechanisms of pathogenicity.
Special Microbiology:
-Special virology: Adenovirus. Herpesvirus. Poxvirus. Papovavirus. Parvovirus. Picornavirus. Hepatitis viruses. Retrovirus. Ortomyxovirus. Paramyxovirus. Rhabdovirus. Flavivirus and Togavirus and other viruses transmitted by insects. Filoviruses. Rubella virus. Reovirus and rotavirus. Coronavirus. Prions.
-Special bacteriology: Staphylococci. Streptococci. Pneumococci. Enterococci. Bacilli and clostridia. Enterobacteriaceae. Pseudomonas. Vibrios. Helicobacter. Neisseria. Mycobacteria. Treponema Pallidum. Mycoplasma. Rickettsiae. Chlamydia.
-Special parasitology: Protozoan parasites of man. Cestodes, trematodes and nematodes of human relevance. Arthropod pests and vectors of major human parasitic diseases.
-Special mycology: Mycosis by opportunistic fungi. Mycosis superficial, skin, subcutaneous and systemic.

Text Books:

- Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller "Medical Microbiology"

Module III: "*Immunology" - Teacher:* **Florence Malisan** (CFU **3**)

Objectives:

The course provides the essential knowledge of the main concepts, principles and applications of immunology. Through this course the students will learn 1) to understand and communicate the fundamental principles of immunology beginning with the innate immune responses, antigen recognition, development of B and T lymphocytes, their activation and differentiation to raise effector immune responses. 2) to understand and communicate the principal pathogenic mechanisms underlying immune disorders such as hypersensitivity, autoimmunity, tumor immunology, congenital and acquired immunodeficiencies, and transplantation immunology.

Program:

Description of Innate and Adaptive Immunity - Antibodies- B cells- Cytokines- Major Histocompatibility Complex (MHC)- Antigen presentation, dendritic cells- T cell development, thymic selection- T cell subsets- T cell activation - Cell mediated immunity - Humoral immunity -An overview of immunopathology including allergy, immunodeficiency, tolerance, autoimmunity, and tumor Immunity.

Text Books:

- Basic Immunology, Abul Abbas Andrew H. Lichtman Shiv Pillai, 6th Edition, Elsevier

Course: **MOLECULAR BIOLOGY - *Module I and Module II***
Module I - *Teacher:* **Eleonora Candi** (CFU **4**)
Module II - *Teacher:* **Maria Cristina Piro** (CFU **3**)
TOTAL CFU: **7**

Objectives:

LEARNING OUTCOMES:

The course is subdivided into two modules. In the first module (5CFU) it is proposed to provide students with the basic notions of Molecular Biology, aimed at understanding the structure and function of nucleic acids, DNA duplication and learn basic molecular biology techniques. In the II (5CFU) module the molecular mechanisms controlling transcription and transcription regulation and translation.

KNOWLEDGE AND UNDERSTANDING:

At the end of the entire course students must demonstrate knowledge and understanding of: a) the structures of DNA/RNA; b) the molecular mechanism of DNA duplication; the molecular mechanism of transcription; the molecular mechanism of translation.

APPLYING KNOWLEDGE AND UNDERSTANDING:

The aim of the course is to develop in the student the ability to apply the acquired knowledge to understand other courses, in the continuation of studies, and in developing original ideas in interesting research contexts.

MAKING JUDGEMENTS:

At the end of the course the student will have acquired a high degree of independent judgment, which will enable him to tackle the most complex topics of cell and organ molecular biology with awareness and critical ability, an indispensable tool mostly in the choice of subsequent studies.

COMMUNICATION SKILLS:

The student will be able to illustrate in a synthetic and analytical way the main concepts and highlight the most relevant processes of Molecular Biology, in particular the mechanism governing gene expression both in prokaryotes and eukaryotes. He/She will be able to use the specific language of the

subject.
LEARNING SKILLS:
The student must be able to read and understand Molecular Biology textbook and scientific research publications in the sector. He will also be able to choose and correlate different aspects of the subject to ask appropriate questions on the different topics of Molecular Biology.

Module I - *Teacher:* **Eleonora Candi** (CFU **4**)

Program:

RNAs - mRNA: structure and function. Eukaryotic mRNAs structure. Eukaryotic mRNAs splicing and processing. Transfer RNA: structure and function. Ribosomal RNA: structure and function. MicroRNAs. LncRNAs.Transcription and its regulation - Bacterial RNA polymerases. Sigma factors and the control of bacterial transcription. Transcription units. Bacterial transcription: initiation, synthesis and termination. Eukaryotic RNA polymerases. RNA polymerase II promoters. Transcription factors cooperating with RNApol II in transcription initiation. The process of mRNA transcription initiation. Transcription factors: DNA sequences recognition, structures and function. General mechanisms for activation or repression of transcription. Chromatin structure and transcription. Histone methylation and acetylation regulate transcription.

Translation - Genetic code. tRNA and mRNA roles. Ribosomes: structure and function. tRNA activation. Codon-anticodon recognition. Initiation, elongation and termination of protein synthesis. Genome - Sequence components. Repetitive and non-repetitive DNA. Genes: shapes, sizes and structures. Polycistronic bacterial genes. Gene families. Gene isolation - Restriction enzymes. Plasmids. DNA sequences. Vectors for cloning DNA. DNA cloning. DNA technology - Nucleic acids hybridising. Methods for studying mRNA expression. Polymerase chain reaction. DNA/RNA sequencing. Cloned genes can be expressed in prokaryotic and eukaryotic systems. Genome editing and applications.

Module II - *Teacher:* **Maria Cristina Piro** (CFU **3**)

DNA stores biological information - Nucleotides: structure and properties. The double helix. Semiconservative replication. Chemistry of DNA. Supercoiling. DNA packaging. Chromatin components and structure. Histone-DNA interactions. Histone post-translational modifications. Gene expression and methylation.DNA replication - Bacterial genome is a single replicon while eukaryotic chromosomes contains many. Origin of replication. DNA polymerases. Proteins participating to DNA replication. The two DNA strands are replicated in a coordinated manner. Systems that repair DNA. DNA mutation and repair Replication errors and their repair. DNA damage. Base excision repair. Nucleotides excision repair. Repair by Homologous and non- homologous recombination. Translesion DNA Synthesis. Homologous recombination. Homologous recombination models. The proteins involved in homologous recombination. Homologous recombination in eukaryotes. Transposition.

Text Books:

- Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick. Pearson International Edition.
- Scientific seminars on different molecular biology topics organized every year in which the students are invited.

Course: **PHARMACEUTICAL BOTANY AND PHARMACOGNOSY**
Module I: *"Pharmaceutical Botany"– Teacher:* **Angelo Gismondi** (CFU **4**)
Module II: *"Pharmacognosy" – Teacher:* **Dalila Mango** (CFU **4)**
TOTAL CFU: **8**

Module I: *"Pharmaceutical Botany"– Teacher:* **Angelo Gismondi** (CFU **4**)

Objectives:

The course aims to provide students with the basal notions for pharmaceutical botany, focusing on the bioactive properties of the plant molecules and their effect on animal cellular and molecular systems. In detail: study of the anatomical structure of plant districts, analysis of the plant metabolism, description of the extraction techniques of natural compounds, pharmacological and therapeutic function of the phytocomplex on in vitro and in vivo mammalian model systems. Students must understand the molecular and cellular mechanisms activated by plant compounds in animal cells and tissues and show the ability to argue the topics developed during the lessons.
The course want to stimulate student in reflecting about the huge amount of pharmaceutics which are made up of plant metabolites or synthetic molecules that reflect chemical structures naturally occurring in botanical species.

Program:

Plant cell, plant tissues (structure and function), plant metabolism, secondary metabolites (structure, classification and function), extraction and analytical methods of plant compounds, Angiosperms (classification, flower, fruit), plant bioactive molecules: source, geographical distribution of the origin plants, effects on animal and humans
(Apocynaceae, Papaveraceae, Menispermaceae, Cannabaceae, Salicaceae, Solanaceae, Asteraceae, Rubiaceae, Sterculiaceae, Erythroxylaceae, Malvaceae, Scrophulariaceae, Rutaceae, Leguminosae, Zingiberaceae, Orchidaceae, Liliaceae, Aloeaceae,,Iridaceae, Lamiaceae, Theaceae, Araliaceae, Hypericaceae, Valerianaceae, Apiaceae, Loganiaceae, Cactaceae, Dioscoreaceae,,Gimnosperme, Fungi).

Text Books:

- Raven, P. H., Evert, R. F., Curtis, H., Aliotta, G., & Rigano, C. (1988). Biologia delle piante. Zanichelli.
- Dewick, P. M., & Fattorusso, E. (2012). Chimica, biosintesi e bioattività delle sostanze naturali. Piccin.
- The presentations shown at lessons and the name of some pharmaceutical and general botanical texts will be provided to students.

Module II: *"Pharmacognosy" – Teacher:* **Dalila Mango** (CFU **4)**

Objectives:

The course aims to provide students with the basal notions for pharmacognosy. In detail: study of research areas of pharmacognosy, description of the medicinal plants and their markers, phytomedicines used in pharmacy and medicine and European legislation for market of herbal medicinal products.
The course wants to stimulate student in reflecting about the role of pharmacognosy in modern medicine,offering them an overview on the European legislation for herbal medicinal products.

Program:

History, research areas of pharmacognosy, medicinal plants, European Directive on herbal medicinal products, herbal monographs. Phytomedicines used in gastrointestinal and biliary system, cardiovascularsystem, respiratory system, central nervous system, endocrine system.

Text Books:

- Heinrich M., Barnes J., Prieto Garcia J.M., Gibbon s S., Williamson E.M. (2018). Fondamenti di farmacognosia e fitoterapia. Elsevier.

Course: **BIOCHEMISTRY II**
Teacher: **Maria Rosa Ciriolo**
CFU: **6**

Objectives:

The student will learn the aspects of general and applied Biochemistry, with the aim to acquire the knowledge about utilization and synthesis of the molecules involved in biological processes. To understand the mechanisms of metabolic activities at molecular level.The student will know the molecular mechanisms of available drugs in the biological processes, also focusing on the projection and analysis of new drugs mimicking biomolecules or modulating their actions.

Program:

Biocehmistry metabolism. High energy phosphorylated compounds. Catabolism of sugars (glucose, galactose, mannose, fructose). Glycolysis. Pyruvate fate. Pyruvate dehydrogenase complex. The tricarboxylic acid cycle. Degradation and synthesis of glycogen. Pentose phosphate pathway. Regulation of carbohydrate catabolism. Lipid metabolism. Assimilation and transport. Lipoproteins. Oxidation of saturated fatty acids even and odd numbers, mono and polyunsaturated. Propionyl metabolism. Ketone bodies. Regulation of lipid catabolism. The protein complexes of the electron transport of the mitochondria. Oxidative phosphorylation: the chemiosmotic theory, structure and mechanism of action of FoF1-APT synthase, energy yield. Shuttle systems of malate / aspartate and glycerol 3-phosphate. Protein digestion and assimilation of amino acids. Serine proteases. Lysosomes and proteasome. The fate of the amino acid group: generality and mechanism of action of transaminases, the glucose-alanine cycle. The urea cycle and regulation. Gluconeogenesis and Cori cycle. Degradation of glycerol. Biosynthesis of glycoproteins. Fatty acid biosynthesis, elongation, unsaturation and regulation. Triglyceride and phospholipid biosynthesis - ceramide biosynthesis - sphingolipids - arachidonic acid and eicosanoid derivatives. Biosynthesis of cholesterol and its derivatives. Synthesis and degradation of purines and pyrimidines and regulation. Deoxyribonucleotide and thymidine synthesis and regulation.

Text Books:

- Lehninger Principles of Biochemistry of David L. Nelson and Michael M. Cox

Course: **GENERAL AND CLINICAL PATHOLOGY**
Module I:*"General Pathology" – Teacher:* **Maurizio Mattei** (CFU **5**)
Module II:*"Clinical Pathology" – Teacher:* **Giulia Donadel/Camilla Palumbo** (CFU **3**)
TOTAL CFU: **8**

Objectives:

This discipline studies the causes and mechanisms of diseases. The course program provides students with opportunities to elucidate the mechanisms and origins of human diseases at fundamental levels emphasizing systemic processes based on molecular and cellular pathologic events. Knowledge of the fundamental and significant determinants of pathogenic and biological processes in medicine using laboratory testing of blood and other bodily fluids, tissues, and microscopic evaluation of individual cells is also provided.

Program:

MODULE I - Genetic disorders: mutations, mendelian disorders, disorders with multifactorial inheritance, normal karyotype, cytogenetic disorders, single-gene disorders with not-classic inheritance. Diagnosis of genetic diseases.Cellular adaptations, cell injury, and cell death: cellular responses to stress and noxious stimuli. Cellular adaptations of growth and differentiation: hyperplasia, hypertrophy, atrophy, metaplasia. Overview of cell injury and cell death: causes of cell injury. Mechanisms of cell injury. Reversible and irreversible cell injury. Morphology of cell injury and necr sis. Examples of cell injury and necrosis: ischemic and hypoxic injury, ischemia-reperfusion injury, chemical injury. Apoptosis: causes of apoptosis, morphology, biochemical features of apoptosis, mechanisms of apoptosis, examples of apoptosis. Subcellular responses to injury: lysosomal catabolism (heterophagy, autophagy); hypertrophy of smooth endoplasmic reticulum; mitochondrial alterations; cytoskeletal abnormalities. Intracellular accumulations: lipids, proteins, hyaline change, glycogen, pigments (exogenous pigments, endogenous pigments); pathologic calcification (dystrophic calcification and metastatic calcification) Cellular aging: structural and biochemical changes with cellular aging, replicative senescence, genes that influence the aging process, accumulation of metabolic and genetic damage (Amyloidosis). General features of inflammation: - Acute inflammation: historical highlights, stimuli for acute inflammation; vascular changes (changes in vascular flow and caliber, vascular leakage); cellular events: leukocyte extravasation (leukocyte adhesion and transmigration) and phagocytosis. Adhesion molecules involved in the inflammatory response. Chemotaxis. Defects in leukocyte functions. Chemical mediators of inflammation: vasoactive amines, plasma proteins, arachidonic acid metabolites: prostaglandins, leukotrienes, and lipoxins, platelet-activating factor (PAF), cytokines and chemokines, nitric oxide (NO), lysosomal constituents of leukocytes, oxygen-derived free radicals, neuropeptides. Disorders of the complement system. Outcomes of acute inflammation. Morphologic patterns of acute inflammation. - Chronic inflammation: causes of chronic inflammation, morphologic features, mononuclear cell infiltration, cells in chronic inflammation. Granulomatous inflammation, lymphatics in inflammation. Systemic effects of inflammation, consequences of defective or excessive inflammation. Tissue renewal and repair. Regeneration, healing, and fibrosis: Definitions. Control of normal cell proliferation and tissue growth. Mechanisms of tissue regeneration. Extracellular matrix and cell-matrix interactions. Repair by healing. scar formation and fibrosis. Cutaneous wound healing, fibrosis. Overview of repair responses after injury and inflammation Thermoregulation: Neurophysiology of thermoregulation. Body's thermoregulatory set-point. Pirogens. Fever. Types of fevers. Neoplasia: Definitions. Nomenclature of tumors. Biology of tumor growth: benign and malignant neoplasms. Differentiation and anaplasia, rates of growth, cancer stem cells and cancer cell lineages. Epidemiology: cancer incidence, geographic and environmental factors, genetic predisposition to cancer, chronic inflammation and cancer, precancerous conditions.

Molecular basis of cancer: essential alterations for malignant transformation, the normal cell cycle, self-sufficiency in growth signals: oncogenes. Insensitivity to growth inhibitory signals: tumor suppressor genes. Retinoblastoma as a paradigm for the two-hit hypothesis of oncogenesis. Selected tumor suppressor genes involved in human neoplasms. p53: guardian of the genome. Evasion of apoptosis. DNA repair defects and genomic instability in cancer cells. Limitless replicative potential: telomerase. Development of sustained angiogenesis. Invasion and metastasis. Stromal microenvironment and carcinogenesis. Dysregulation of cancer-associated genes. Molecular basis of multistep carcinogenesis gatekeeper and caretaker genes. Tumor progression and heterogeneity. Carcinogenic agents and their cellular interactions: chemical carcinogenesis, metabolic activation of

carcinogens. Molecular targets of chemical carcinogens. Major chemical carcinogens. Radiation carcinogenesis: ultraviolet rays, ionizing radiation. Microbial carcinogenesis: oncogenic DNA viruses, oncogenic RNA viruses. Host defense against tumors: tumor immunity, tumor antigens, antitumor effector mechanisms. immune surveillance. Effects of tumors on the host local and hormonal effects Grading and staging of tumors.

MODULE II - **Infectious diseases**: general principles of microbial pathogenesis. Viral infections. Bacterial infections. Fungal infections. Parasitic infections. **Environmental pathology**: recognition of occupational and environmental diseases. Mechanisms of toxicity. Phase I reactions. Common environmental and occupational exposures. Personal exposures: tobacco use, alcohol abuse, therapeutic drugs, outdoor air pollution, industrial exposures, agricultural hazards, natural toxins. Radiation injury: ionizing radiation, ultraviolet radiation. Physical environment: mechanical force, thermal injuries (hyperthermia. Hypothermia). Electrical injuries. Decompression (caisson) disease. **Hemodynamic disorders, thromboembolic disease, and shock**: Edema. Hyperemia and congestion. Hemorrhage. Hemostasis and Thrombosis. Embolism. Infarction. Shock. **Heart pathophysiology**: heart failure, cardiac hypertrophy: pathophysiology and progression to failure. Ischemic heart disease. Angina pectoris. Myocardial infarction. **Hypertension. Atherosclerosis:** risk factors for atherosclerosis, pathogenesis. **Red blood cell disorders**: anemias, polycythemia.

Bleeding Disorders: Hemorrhagic diatheses. **Diseases of white blood cells:** leukopenia. Neoplastic proliferations of white cells.

Lung pathophysiology: Respiratory failure. Respiratory distress syndromes. Obstructive pulmonary diseases.

Gastrointestinal tract pathophysiology.

Liver pathophysiology:

general features of hepatic diseases. Patterns of hepatic injury. Hepatic failure. Cirrhosis. Portal hypertension.

Bilirubin and bile formation. Causes and classification of jaundice. Hereditary hyperbilirubinemias. Cholestasis. Viral hepatitis. Ascites.

Kidney pathophysiology: Pathogenesis and clinical manifestations of main glomerular and tubulo-interstitial diseases. Acute renal failure, chronic renal failure and uremia.

Endocrine system pathophysiology: Hypotalamus-pituitary gland axis, thyroid gland, parathyroid glands, endocrine pancreas (diabetes mellitus and pancreatic endocrine tumors), adrenal glands.

Necrosis Index: myocardio, skeletal muscle, thyroid, liver, kidney

Blood and Urine test: serum protein electrophoresis; liquor protein electrophoresis; protidogram; Electrophoresis of urinary proteins.

Text Books:

- Robbins & Cotran Pathologic Basis of Disease
- Techers will provide the material using during lessons

Course: **GENERAL AND MOLECULAR PHARMACOLOGY AND TOXICOLOGY**
Teacher: **Robert Giovanni Nisticò**
CFU: **8**

Objectives:

The course aims to provide learning on the fundamental aspects of general pharmacology and in particular the pharmacokinetics (ADME) and pharmacodynamics. In addition, students must acquire the molecular basis of drug action and the factors that influence the pharmacological effects and adverse drug reactions. The course also has the task of providingthe molecular basis of toxicology, as well as the phases of clinical development and the regulations of clinical trials.
To know the main examples already implemented in clinical practice of pharmacogenomics biomarkers, evaluating their clinical validity and clinical utility and related regulatory issues. Understanding the role of pharmacogenomics in the development of newdrugs.
KNOWLEDGE AND UNDERSTANDING:
Knowledge of the fundamental elements of pharmacokinetics and pharmacodynamics, as well as the general concepts of molecular pharmacology, the basic pharmacogenomics elements and variability in response to drugs. Further information on the basic principles of general and molecular toxicology.
ABILITY TO APPLY KNOWLEDGE AND UNDERSTANDING:
At the end of the course, the student must demonstrate to have acquired knowledge and skills related to generalpharmacology, toxicology and pharmacogenomics.
In particular, students must be able to:
Know the processes of absorption, distribution, metabolism and excretion of drugs, in addition to the mechanism ofaction of drugs, and the possible interactions between drugs;
Know the principles of molecular pharmacology and molecular toxicology;
Understand the main classes of drugs;
The student should demonstrate the ability of applying this knowledge to the aim of a more personalized therapy.
AUTONOMY OF JUDGMENT:
The student must acquire the ability to define the principles of general pharmacology and molecular pharmacology withparticular attention to the factors that modify the action of drugs. He/she will also have to acquire the ability to recognize side effects and adverse drug reactions.
COMMUNICATION SKILLS:
The student must be able to clearly present the results and the learning obtained during the course and study also to anon-expert public.
The student must be able to understand and communicate in English.
LEARNING ABILITY:
The student's ability to learn is acquired through the knowledge of:
fundamental notions about the principles that regulate pharmacodynamics (action mechanism) and pharmacokinetics(absorption, distribution and elimination);
fundamental notions about the main types and modes of occurrence of the toxic effects of xenobiotics, the relative mechanisms of action (at the cellular and molecular level) and on the main clinical manifestations of adverse reactions toxenobiotics;
knowledge of pharmacogenomic skills through the ability to make connections and apply the aforementioned knowledge for personalized medicine.vdf
The knowledge obtained during the course can be acquired through Pharmacology texts,

participation to initiatives (seminars), and the reading of scientific articles useful for expanding the field and the therapeutic applications of drugs.

Is necessary for the student to have the fundamental concepts of basic subjects, with particular regard to Anatomy,Physiology, Biochemistry, Molecular Biology and basic Human Genetics Elements. Students should also possess a good knowledge of written and spoken English (B2 level).

Program:

Principles of pharmacokinetics: routes of administration and absorption of drugs. Distribution, biotransformation and excretion of drugs. Drug interactions.

Principles of pharmacodynamics: drug-receptor interaction, agonists and antagonists, allosteric modulators. Classification of receptors, adaptive responses to drugs. Mechanisms underlying signal transduction pathways. Voltage-dependent and voltage-independent ion channels.

Intercellular transmission: glutamate, GABA, acetylcholine, catecholamines, serotonin, nitric oxide, cannabinoids, opioid peptides. Basic principles of normal and pathological synaptic plasticity.

Principles of cellular and molecular toxicology. Drug addiction.

Text Books:

- Goodman and Gilman: The pharmacological basis of therapeutics, XII ed. McGraw-Hill
- Bertram Katzung, Anthony Trevor: Basic & Clinical Pharmacology, XIII ed. McGraw-Hill
- Casarett & Doull's Toxicology: The Basic Science of Poisons, VIII ed. McGraw-Hill
- Suggested websites:
- www.ncbi.nlm.nih.gov/pubmed
- Scientific articles indicated by the Teacher

Course: **HUMAN PHYSIOLOGY**
Teacher: **Gianfranco Bosco**
CFU: **7**

Objectives:

LEARNING OUTCOMES: The course aims to provide students with general knowledge about the organization and functioning of the human organism starting from the cellular level up to integrated systems, focusing on the general mechanisms of homeostatic control, essential for life and health of the individual.

KNOWLEDGE AND UNDERSTANDING: In order to pass the exam, the student must demonstrate that he has reached a knowledge and an ability to understand the issues concerning the functioning of organs and systems of the human body that allow him to set the discussion of theoretical problems in a logical and complete way.

APPLYING KNOWLEDGE AND UNDERSTANDING: The student will have to demonstrate to have developed competences to set up the treatment of application problems in the field of human Physiology.

Program:

Physiology of the membranes. Cellular membrane structure and functions. Membrane potential and ionic concentrations. Nernst law and Goldman equation. Electrical model and passive properties of the cell membrane. The ionic basis of action potential. The ionic channels: Na+, K+ and Ca++ channels. The Neurons: cellular and network properties. The structure of neurons. The graduate potential and the electrotonic propagation. Action potentialpropagation. Saltatory conduction of the action potential. Synaptic transmission: electrical and chemical synapses. Quantale release of

neurotransmitter. Inhibitory and excitatory synapses. Neurotransmitters and their receptors. Synaptic integration: temporal and spatial. Synaptic plasticity.
Muscle Physiology.Structure of skeletal muscle. Molecular basis of skeletal muscle contraction. Cycles of cross-bridge binding. Electro-mechanical coupling. Muscle twitch and tetanus. Skeletal muscle mechanics. Isometric and isotonic contraction. Tension-length and speed-load relationships. Muscle power. Skeletal muscle metabolism and muscle fatigue. Motor units and muscle fiber types. Smooth muscle. Control and modulation of smooth muscle contraction. Cardiac muscle. Electro-mechanical coupling in the cardiac muscle.
Cardiovascular Physiology.Morphofunctional features of the heart. Electrical activity of the heart. Pacemaker activity of the sinoatrial node. Spread of cardiac excitation. Electrocardiogram (ECG). Mechanical events of the cardiac cycle. Heart sounds and murmurs. Cardiac output and its control. Morphofunctional characteristics of blood vessels: Arteries, arterioles, capillaries, veins. Patterns and physics of the blood flow. Microcirculation and capillary exchange. Diffusion and filtration. Venous return. Lymphatic system. Vasoactive substances. Special vascular districts: coronary, pulmonary, cutaneous, brain.
The respiratory system. Respiratory anatomo-functional characteristics. Respiratory mechanics. Respiratory muscles and movements. The pleural sac. Intrapleural pressure. Intra-alveolar and transmural pressure. Boyle's law and pressure-volume relationship. Pulmonary compliance. Airways resistance. Alveolar stability and pulmonary surfactant. Ventilation: lung volumes and capacities. Anatomic and functional dead space. Breathing work. Gas exchange. Diffusion and partial pressure gradients of O2 and CO2. Alveolar perfusion and ventilation / perfusion ratio. Gas transport. Hemoglobin and transport of oxygen. Transport of CO2. Respiratory contribution to acid-base balance. Control of respiration: respiratory centers and respiratory muscles innervation. Reflex mechanisms. Peripheral and central chemoceptors. Baroceptors. Physiological and pathological adaptation of respiratory function.
The urinary system. Fluid compartments: distributionand exchange of water and solutes. Functional anatomy of the kidneys. Homeostatic functions of the kidneys. Glomerular filtration. Extrinsic control and autoregulation of glomerular filtration. Tubular reabsorption and secretion. Urine excretion and plasma clearance.
Concentration of the urine: medullary osmotic gradient and countercurrent multiplication. Countercurrent exchange and vasa recta. Water reabsorption and vasopressin. Actions of vasopressin, aldosterone and natriuretic peptides on kidneys' function. Endocrine functions of the kidneys: renin-angiotensin- aldosterone system and erytropoietin. Physiology of the bladder and micturition.
The digestive system.General aspects of digestion. The mouth: chewing and salivary secretion. Pharinx and esophagus: control of swallowing. Functions of the stomach. Gastric secretion and its control. Pancreatic and biliary secretions: composition and control. Small intestine: digestion and absorption of nutrients. Functions of the large intestine. The enteric nervous system and the control of gastrointestinal motility. Overview of gastrointestinal endocrine and immune functions. Food intake and energy balance.
Systems neurophysiology. General organization of sensory systems. The somatosensory system: touch, proprioception, thermoception and nociception. Vision: Retinal functions. Central processing of visual information: analysis of shape, colour and motion. Hearing: functional properties of the external and middle ear. Functions of the cochlea. Central processing of auditory signals. Chemical senses: taste and smell. General principles of motor control. Spinal reflexes: stretch reflex and

withdrawal reflex. Locomotion. The vestibular system and the control of balance. The cerebellum and the basal ganglia. Motor learning. Cortical control of action. Cognitive function: language and memory. Neurophysiology of sleep. The endocrine system. The hypothalamus and the control of homeostatic functions. Circumventricular organs. The pineal gland: melatonin and circadian rhythms. The autonomic nervous system. Endocrine control of fluid balance. Endocrine control of calcium metabolism. Endocrine control of fuel metabolism: pancreatic hormones and glycemic / lipostatic control. The pituitary gland and the hypothalamus-pituitary axes. Endocrine control of growth: Growth hormone (GH) and insulin-like growth factors (IGF). The thyroid: hormones (T4, T3) and their functions. Thermogenesis and thermoregulation. The adrenal gland and the stress response. Pro-opiomelanocortin (POMC) e glucocorticoids: target organs and molecular mechanisms. Endocrine control of reproductive functions. Hormones during pregnancy and lactation.

Text Books:

- FUNDAMENTALS OF HUMAN PHYSIOLOGY
- Lauralee Sherwood (PICCIN)
- HUMAN PHYSIOLOGY. An integrated approach Dee U. Silverthorn (PEARSON)

Course: **HUMAN NUTRITION AND DIETISTICS**
Teacher: **Laura Di Renzo**
CFU: **6**

Objectives:

To know the techniques and methods of semiotics and to define the state of health and risk of disease, according to the nutritional status. To know the indicators of nutritional risk predictors of disease. To know the role of diet in the prevention of chronic degenerative diseases. To know the principles of artificial nutrition: enteral and parenteral nutrition. To apply a precision nutrition. To provide information for safety, ways to produce food and food effects on human health: food chemistry and analysis, food preservation and packaging, food technology, food effects on human health.

Program:

Assessment of nutritional status and energy requirements. Principles of diet therapy. Nutrition and non comunicable diseases. Nutritional survey of dietary habits. Personalized nutrition. Dietary treatment: Mediterranean Diet: the Mediterranean Adequacy Index. Ketogenic Diet, Low Carbohydrates Diet, Zone Diet. Artificial Nutrition (Enteral, Parenteral). Food safety and food security: Nutrient and Hazard analysis and critical control point. The browning of foods and the Maillard reaction. Clinical case and practice.

Text Books:

Didactic material will be provide to the student.

Course: **MEDICINAL CHEMISTRY I**
Teacher: **Orazio Nicolotti**
CFU: **8**

Objectives:

The main aim is that of providing the molecular rationale behind the drugs currently in clinical use by f ocusing on structure-activity relationships.

Program:

Drugs and drug targets: an overview. Protein,enzymes, receptors and nucleic acids: structure and func tion. Enzymes and receptors as drug targets. Pharmacokinetics and related topics. Drug discovery: fin ding a lead. Drug design: optimizing target interactions. Drug design: optimizing access to the target. Getting the drug to market. Computers in medicinal chemistry. Quantitative structure-activity relationships (QSAR). Antibacterial agents. Antiviral agents. Anticancer agents. Case studies: St atins as anti-cholesterol agents; ACE inhibitors; Artemisinin and related antimalarial drugs; De novo design of a thy midylate kinase inhibitor; Antidepressant agents.

Text Books:

- An introduction to medicinal chemistry (6th edition).

Course: **MEDICAL STATISTICS AND CLINICAL STUDIES METHODS**
Teacher: **Simona Iacobelli**
CFU: **6**

Objectives:

The objective of the course is to provide a basic knowledge of the main objects of interest in medical research and of the correct interpretation of the most frequently statistical tools. At the end of the course the Student should be able to read and understand a research report or medical paper, with particular regards to clinical trials.

Program:

Types of data (including survival data), descriptive tools and measures of impact used in medicine (relative risk evaluation). Statistical estimation and testing (frequentist approach) with examples of application. Multi-variable regression models. Main types of clinical studies: definitions and concepts; statistical elements in clinical trials.

Text Books:

- "Medical Statistics", by M Bland. Editor: Oxford University Press. Slides of the lectures, solved exercises and other material are distributed.

Course: **CHEMOTHERAPY**
Teacher: **Grazia Graziani**
CFU: **8**

Objectives:

LEARNING OUTCOMES:
The course aims at providing the student with the fundamental knowledge of the principles of antimicrobial/antiviral and anticancer treatments (including monoclonal antibodies and small molecule kinase inhibitors), in order to correctly identify and classify the type of drugs dispensed in territorial pharmacies and hospitals or still undergoing evaluation in clinical trials. Special emphasis will be given to pharmacodynamics, pharmacokinetics, adverse effects, drug interactions, therapeutic uses and to biotech drugs with innovative mechanisms of action. An important aim is also to provide the skills for the appropriate use of antibiotics in light of the increase in drug-resistance phenomena concerning hospital- acquired infections and the current lack of effective antibiotics for serious infections caused by Gram- negative bacteria.
KNOWLEDGE AND UNDERSTANDING:
The student must demonstrate the knowledge and understanding of the mechanisms of action,

mechanisms of resistance, adverse effects, relevant drug interactions of antimicrobial, antiviral and antitumor drugs, and the ability to correlate the acquired knowledge concerning the pharmacokinetics and pharmacodynamics with the toxic and therapeutic effects of the various classes of drugs.

APPLYING KNOWLEDGE AND UNDERSTANDING:

The student must be able to apply the knowledge acquired during the course to the identification and critical evaluation of the single drugs or classes of antimicrobial, antiviral and antitumor agents. Moreover, the student will acquire the ability of applying the learned scientific method to the analysis of drugs under clinical evaluation and to the planning and implementation of projects in a research context.

MAKING JUDGEMENTS:

The student must acquire the ability to integrate the knowledge on antimicrobial, antiviral and antitumor drugs and be able to report any adverse reactions, identify drug interactions and propose autonomous assessments of scientific problems concerning these classes of drugs.

COMMUNICATION SKILLS:

Students are expected to speak clearly and fluently in English (level B2) with an appropriate technical language, and to describe the main properties of the drug classes with particular emphasis given to the mechanism of action, resistance, adverse effects, drug interactions and therapeutic uses.

LEARNING SKILLS:

Students are expected to: i) possess the basic multi-disciplinary knowledge for the comprehension of the pharmacological activity in relation to the drug interaction with the targets at the cellular and systemic levels; ii) to know the scientific methodology of investigation applied to antimicrobial, antiviral and anticancer drugs; iii) to develop the ability to keep up to date on these and other drug classes by means of critical reading of scientific articles published in peer-reviewed international journals. Frontal lectures and personal study accompanied by in-depth analysis of specific subjects, selected spontaneously or suggested by the Teacher, contribute to the achievement of the learning outcomes. The assessment of the achievement of the learning outcomes takes place mainly through oral exams and progress testing and, when feasible, discussions of scientific articles.

Program:

General principles of anti-microbial and antiviral therapy. antimicrobial resistance: a threat to public health. The antimicrobial resistance situation in Europe. Mechanisms of resistance to antimicrobial agents. Infections caused by multi-drug resistant Gram negative bacteria, multi-drug resistant *Mycobacterium tuberculosis* and multi-drug resistant *Plasmodium Falciparum*, and therapeutic options available.

Anti-bacterial agents: penicillins; cephalosporins; monobactam; carbapenems; beta-lactamase inhibitors; glycopeptides; glycolipopeptides; cycloserine; fosfomycin; lipopeptides; aminoglycosides; tetracyclines and glycylcyclines; macrolides and ketolides; lincosamides; streptogramins; chloramphenicol; oxazolidinones; sulfonamides; fluoroquinolones; polymyxins; bacitracin; metronidazole, fidaxomicin, bezlotoxumab.

Anti-mycobacterial agents: isoniazid; rifamycins; pyrazinamide; ethambutol; ethionamide; bedaquiline; delamanid; pretomanid; clofazimine; dapsone and other anti-mycobacteria agents. Antifungal agents: amphotericin B; flucytosine; imidazoles and triazoles; echinocandins; griseofulvin; terbinafine; nystatin.

Antiviral drugs: anti-herpes, anti-influenza, anti-hepatitis B and anti-hepatitis C virus agents, repurposed drugs used for controlling SARS-CoV-2 infection, remdesivir (the first EMA-approved anti- SARS-CoV-2 drug);

bamlanivimab/etesevimab; casirivimab/imdevimab; anti-SARS-CoV2 vaccines: general principles.
Anti-retroviral drugs: nucleoside and nucleotide reverse transcriptase inhibitors; non-nucleoside reverse transcriptase inhibitors; protease inhibitors; entry inhibitors; integrase inhibitors; ibalizumab. -Antiprotozoal drugs: metronidazole; pentamidine; eflornithine; suramin; melalsoprol; miltefosine; nifurtimox and benznidazole; sodium stibogluconate; antimalarial agents: artemisinin and derivatives; atovaquone; pyrimethamine; proguanil; quinolines.
Anthelmintics: benzimidazoles; diethylcarbamazine; ivermectin; praziquantel; pyrantel pamoate.
General principles of anti-cancer therapy. Mechanisms of resistance to anticancer drugs. Cytotoxic chemotherapeutic agents versus targeted therapies: differences in the mechanisms of actions, toxicity and clinical development. Basket and umbrella trials, the tissue agnostic approach and the concept of synthetic lethality.
Cytotoxic agents: alkylating and platinum agents; antimetabolites: folic acid analogues, purine and pyrimidine analogues; microtubule damaging agents: vinca alkaloids, eribulin, taxanes, epothilones, estramustine; camptothecin analogues; antitumor antibiotics: dactomycin, anthracyclines, mitoxantrone, bleomycin, mitomycin C, epipodophyllotoxins, trabectedin, L-asparaginase, hydroxyurea. -Differentiating agents: retinoids; arsenic trioxide; histone deacetylase inhibitors; hypomethylating agents.
Targeted therapies: kinase inhibitors, monoclonal antibodies; proteasome inhibitors; mTOR inhibitors; thalidomide, lenalidomide and pomalidomide; DNA repair inhibitors [poly(ADP-ribose) polymerase (PARP inhibitors)]; CAR-T and other immunotherapies.
Hormonal agents for cancer treatment: selective estrogen-receptor modulators and down-regulators, aromatase inhibitors, gonadotropin-releasing hormone agonists and antagonists; anti-androgens.

Text Books:

- The Goodman and Gilman The Pharmacological Basis of Therapeutics, 13th edition, Laurence L Brunton, Randa Hilal-Dandan, Bjorn C.Knollmann, McGraw Hill, 2018
- Basic and Clinical Pharmacology. 14th edition, Bertram G. Katzung, McGraw Hill, 2018

Suggested websites:

- www.ncbi.nlm.nih.gov/pubmed
- https://ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/ears-net
- https://ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/esac-net
- http://www.who.int/topics/en/

Course: **INTERNAL MEDICINE AND DERMATOPHARMACOLOGY**
Module I: "*Internal Medicine*" - *Teacher:* **Manfredi Tesauro** (CFU **3**)
Module II: "Dermatopharmacology" - *Teacher:* **Steven Nisticò** (CFU **3**)
TOTAL CFU: **6**

Module I: "*Internal Medicine*" - *Teacher:* **Manfredi Tesauro** (CFU **3**)

Objectives:

General aspects of internal medicine with particular attention to cardiovascular and metabolic pathologies

Program:

Cardiovascular diseases, Diabetes, Hypertension, Obesity, Osteoporosis, Thyroid disorders, Metabolic syndrome, atherosclerosis

Text Books:

- Notes from the lessons

Module II: "Dermatopharmacology" - *Teacher:* **Steven Nisticò** (CFU **3**)

Program:

1. Anatomy and Physiology of Skin
2. Elementary lesions
3. Psoriasis
4. Atopic and allergic Dermatitis
5. Nevi and Pigmentation Disorders
6. Skin Cancer and Melanoma
7. Pharmaceutical Formulae in Dermatology
8. Cosmetology (Industry and Galenic Lab)
9. Drugs used in Dermatology
10. Skin Drug Reaction

Text Books:

- Lecture Slides Rook Textbook of Dermatology

Course: **PHARMACEUTICAL AND TOXICOLOGICAL CHEMISTRY II**
Module I (CFU: **6**) **and Module II** (CFU **6**)
Teacher: **Beatrice Macchi**
TOTAL CFU: **12**

Objectives:

The main objective of the course is to stimulate the student to a rational understanding of the drug through the knowledge of the chemical structure and of the structure- activity relationship influencing its pharmacokinetic properties including administration routes,absorption,distribution, metabolism ,excretion and its mechanism of action. During the frontal teaching it will be emphasized how the physico-chemical properties of the drug is able to influence its therapeutic activity and its toxicity in the different anatomical sites. For an easy understanding of the described topics and in order to achieve the objectives set, it is necessary that the student have taken the basic exams of inorganic and organic chemistry and also all the biological exams. In addition the pharmaceutical and toxicological chemistry I is absolutely propaedeutic to the second part.In order to a better understanding of the described topics it is useful to have taken the exam of General Pharmacology,toxicology and pharmacogenomic.

Program:

General introduction on importance of pharmaceutical chemistry of drugs used to cure disease at the level of different compartments. Possible classification of drugs used in different anatomical compartment on the basis of the disease and of the target features. The description of the various drug classes will be associated to an elucidation of the toxic effects and to a brief description of clinical use.

Text Books:

- Foye's Principles of Medicinal chemistry 8th Edition Wolters-Kluwer
- Patrick GL An introduction to Medicinal chemistry 6th edition Oxford University press
- Goodman Gilman's The Pharmacological basis of Therapeutics 13th edition Ed. Laurence L.Brunton

Course: **PHARMACEUTICAL TECHNOLOGIES**
Module I: *Teacher:* **Franco Alhaique** (CFU **5**)
Module II: *Teacher:* **Gabriella De Martino** (CFU **5**)
TOTAL CFU: **10**

Objectives:

This course, which gives detailed information on the various types of pharmaceutical formulations, both from the theoretical and practical points of view, will allow the formation of students provided with a valid background together with the constructive criticism needed by the pharmaceutical technologists when facing their professional responsibilities. The experience acquired from the lessons should give the possibility to find, after the final degree, an appropriate job within private or public pharmacies, but also in the field of industrial production and control of medicines as well as in innovative research.

Program: Introduction to biopharmaceutics Blood levels and therapeutic effects. Routes of administration. Mechanisms of drug dissolution and absorption. Compartment models and pharmacokinetic parameters. Apparent distribution volume. Drug-protein interaction.
Glass for pharmaceutical uses.
Isotonic and iso-osmotic solutions and calculations.
Alcohol in pharmaceutical formulations. Ethyl alcohol dilution. Alcohol determination in pharmaceutical preparations.
Lyophilization
Interfacial phenomena. Surface tension. Surfactants. Wetting. Micelles. Disperse systems: emulsions and suspensions.
Basic principles of rheology Classification of dosage forms. Dermal formulations.
Transdermal formulations.
Powders, granules, tablets, capsules. Suppositories. Rectal and vaginal formulazions Dosage form controls.
Innovative dosage forms. Modified release dosage forms. Drug targeting. Outlines of homeopathic formulations
Filtration Sterilization Distillation
Ophthalmic formulations Nasal formulations
Lab works: preparation of Galenic formulations most commonly used in pharmacies.

Text Books:

- Aulton's Pharmaceutics: The design and manufacture of medicines" 5th Edition. Elsevier
- "Principi di tecnologia farmaceutica" (Second Edition) P.Colombo, F. Alhaique, C. Caramella, B. Conti, A. Gazzaniga, E.Vidale, Casa Editrice Ambrosiana
- Italian Pharmacopoeia and European Pharmacopoeia (last edition and supplements)
- http://dctf.uniroma1.it/galenotech/
- site (in Italian) with information and explanations about many topics of the program

Course: **SPECIAL PHARMACOLOGY AND THERAPY**
Module I: *Teacher:* **Claudia Ceci** (CFU **5**)
Module II: *Teacher:* **Saverio Muscoli** (CFU **5**)
TOTAL CFU: **10**

Module I: *Teacher:* **Claudia Ceci** (CFU **5**)

Objectives:

Knowledge of therapeutic uses, mechanism of action, pharmacokinetics and side effects of different classes of drugs. Acquisition of the necessary tools to adopt the best therapeutic treatment against different pathological conditions.

Program:

Non-steroidal (NSAIDs) and steroidal (SAIDs) anti-inflammatory drugs; disease modifying anti-rheumatic drugs (DMARDs): traditional DMARDs and biologics; pain transmission and pain relief: opioids.

Pulmonary and gastrointestinal pharmacology. Endocrine pharmacology and contraceptives. Analysis of scientific articles concerning these topics.

Text Books:

- Goodman & Gilman's. The pharmacological basis of therapeutics
- Brunton - Basic and clinical pharmacology – Katzung

Module II: *Teacher:* **Saverio Muscoli** (CFU **5**)

Objectives:

Offer to students the chance to acquire and or study in detail the mechanism underlying the effect of drugs and their therapeutic applications.

Program:

Cardiovascular Pharmacology: Inotropic Drugs, Diuretics, Vasodilators, Antihypertensive drugs, Antiarrythmic drugs, Antiplatelet drugs, Thrombolytic drugs, Drugs in the treatment of dyslipidemia. Drugs used in treating Diabetes Mellitus, Drugs used in pulmonary hypertension

Text Books:

Manual of Pharmacology and Therapeutics, Goodman&Gilman's

Course: **NEUROPSYCHOPHARMACOLOGY**
Teacher: **Robert Giovanni Nisticò**
CFU: **8**

Objectives:

The teaching activity will be provided through interactive frontal lessons with general discussion aimed at stimulating the participation of students in order to consolidate and deepen the knowledge of the biological basis of neuropsychiatric disorders and understand the PK/PD profile of psychoactive drugs and their main adverse effects. Resources to support the teaching method will be the presentation of slides and the reading of scientific articles.

LEARNING OUTCOMES:

The course aims to discuss the biological basis of neurological and psychiatric disorders and the mechanism of action of psychoactive drugs, in particular the acquisition of skills related to:

1) Biological bases of neurological and psychiatric disorders;
2) Pharmacokinetics and pharmacodynamics of the main classes of psychotropic drugs;
3) Pharmacotherapeutic aspects of neurological and psychiatric disorders;

4) Side affects of the main classes of psychotropic drugs;
5) Drugs of abuse.

KNOWLEDGE AND UNDERSTANDING:
The student will have to demonstrate the knowledge of the biological basis of neurological psychiatric disorders with particular regard to the understanding of the pharmacokinetics/pharmacodynamics and pharmacotherapeutic aspects of the individual classes of drugs proposed; as well as adequate knowledge of the pharmacology and toxicology of the most common substances of abuse and possible innovative approaches to improve their therapeutic efficacy.

APPLYING KNOWLEDGE AND UNDERSTANDING:
At the end of the course the student must be able to:
1) to understand the biological basis of the main psychopathologies;
2) to know the PK/PD of the main classes of psychoactive drugs;
3) to comprehend the main toxic effects of psychotropic drugs and the most common substances of abuse;
4) to know the principal interactions of the main classes of psychoactive drugs.

MAKING JUDGEMENTS:
The student must acquire the ability to integrate the knowledge of the neurobiological basis of neuropsychiatric disorders, with the methods of study in
neuropsychopharmacology, as well as the pharmacotherapeutic and/or undesirable effects of psychotropic drugs.

COMMUNICATION SKILLS:
The student should be able to present the knowledge acquired during the course in an appropriate language, focusing on the mechanism of action, the undesirable effects of drugs and possible innovative approaches to improve their therapeutic efficacy.
The student must be able to understand and communicate in English.

Program:

Basic mechanisms of synaptic transmission. Adrenergic and cholinergic agents.
Treatment of Parkinson's disease, Alzheimer's disease and multiple sclerosis. Treatment of affective and anxiety disorders.
Pharmacotherapy of psychotic illness and mania. Antiepileptic agents.
General and local anesthetics. Antimigraine agents.
Drugs of abuse.

Text Books:

- Goodman and Gilman: The pharmacological basis of therapeutics, XIII ed. McGraw-Hill
- Bertram Katzung, Anthony Trevor: Basic & Clinical Pharmacology, XIII ed. McGraw-Hill
- Suggested websites:
- www.ncbi.nlm.nih.gov/pubmed
- https://acnp.org/digital-library/neuropsychopharmacology-5th-generation-progress/
- Scientific articles indicated by the Teacher.

Course: **ITALIAN AND EUROPEAN PHARMACEUTICAL LEGISLATION AND COMMERCIAL LAW**
Module I: "*Italian Pharmaceutical Legislation*" – *Teacher:* **Emanuele Cesta** (CFU **5**)
Module II: "*European Pharmaceutical Legislation*" – *Teacher:* **Armando Magrelli** (CFU **5**)
Module III: "*Commercial Law*" – *Teacher:* **TO BE DEFINED** (CFU **2**)
TOTAL CFU: **12**

Module I: "*Italian Pharmaceutical Legislation*" – *Teacher:* **Emanuele Cesta** (CFU **5**)

Objectives:

Provide a basic legal-regulatory training on the provisions and procedures in force in the pharmaceutical sector, to the purpose of obtaining a useful knowledge for both the HC professional and those interested to operate in the public regulatory environment or in the private sector.

Program:

1. Sources of pharmaceutical law in Italy (at international, community, national, regional and technical-regulatory level). The National Health System.
2. Marketing Authorization (MA) of a pharmaceutical product: clinical trials, MA granting (national, MR, DC or centralized procedure), negotiation of price and reimbursement class (A, H, C, Cnn), prescription regime, MA ex officio suspension or revocation, voluntary withdrawal, expiration.
3. Pharmacovigilance (adverse reactions, purpose, roles, forms).
4. Quality defects and precautionary measures for health protection; manufacturing and distribution dysfunctions: shortages and unavailability of medicines, import, reports and controls.
5. Pharmaceutical crime (counterfeiting, illegal drugs, thefts, on line sell and purchase, illegal import).

Text Books:

- Handouts and PPT presentations provided by the Teacher; legal texts in force.

Module II: "*European Pharmaceutical Legislation*" – *Teacher:* **Armando Magrelli** (CFU **5**)

Objectives:

The course has the task of learning the basics of European pharmaceutical legislation with particular attention to the regulatory authorization procedure for medicines. Principles of GMP, GCP and GPhP. Preparation of a registration dossier, eCTD. Principles of pharmaceuthical legislation concerning clinical trials, orphan drugs, advancing therapies, pediatric drugs, biological drugs. Principles of protection of intellectual property applied to drugs.

Program:

The pharmaceutical legislative framework is made up by Directives and Regulations as the basis for a general guideline for the EU community with the scope of setting up "harmonized standards" throughout the European Union and at the same time maintain an appropriate level of protection for public health.

The course aims to analyze in depth the rules governing the pharmaceutical sector, starting from those that regulate the development of a new product up to the rules relating to the introduction of the medicinal product in the market.

Text Books:

- Sally Shorthose ed.,Bird & Bird LLP, Guide to EU Pharmaceutical Regulatory Law, Wolters Kluwer, 2013.

Module III: "*Commercial Law*" – *Teacher:* **TO BE DEFINED** (CFU **2**)

Objectives: The course claims to provide to the participating students both practical and theoretical basic legal knowledges on the Italian commercial legal system.

Program: The context of the degree course suggests an introductory part regarding the Italian legal system in general, also taking in account it differences from common law systems. Subsequently, a review of the Italian and European principal sources of the commercial law will follow. After such introductory lectures, the main part of the course will consider the basic legal institutions of corporate law, with particular attention to the industrial and competition legal systems. The conclusive part of the course will concern the fundamentals of the Italian company law.

Text Books: Notes specifically drafted for the benefit of the students will be provided.

Course: **DIETISTIC SCIENCES AND FOOD CHEMISTRY**

Module I: "*Diestistic Sciences*" – *Teacher:* **Antonino De Lorenzo** (CFU **3**)

Module II: "*Food Chemistry*" – *Teacher:* **Laura Di Renzo** (CFU **5**)

TOTAL CFU: **8**

Module I: "*Diestistic Sciences*" – *Teacher:* **Antonino De Lorenzo** (CFU **3**)

Objectives:

To know the techniques and methods of semiotics and to define the state of health and risk of disease, according to the nutritional status. To know the indicators of nutritional risk predictors of disease. To know the role of diet in the prevention of chronic degenerative diseases. To know the principles of artificial nutrition: enteral and parenteral nutrition. To know the principles of nutrigenetics and nutrigenomics.

Program:

Assessment of nutritional status and energy requirements. Principles of diet therapy. Nutrition and non comunicable diseases. Principles of nutritional genomics.

Text Books:

- Didactic material will be provide to the student

Module II: "*Food Chemistry*" – *Teacher:* **Laura Di Renzo** (CFU **5**)

Objectives:

To study all aspects of food, from harvesting and producing to cooking and consumption. To provide information for safety, ways to produce food and food effects on human health: food chemistry and analysis, food preservation and packaging, food technology, food effects on human health.

Program:

Food composition (food chemistry); food additives (vitamins, preservatives, colour, flavour); stability (shelf life, microbiology); food safety (contaminants, food poisoning); and the sensory properties of food (taste, appearance, smell, texture); food effects on human health. Nutrient and Hazard Analysis of Critical Control Point process (NACCP).

Text Books:

- Food Chemistry 4th Edition by Belitz W.
- Didactic material will be provide to the student.