DIDACTIC HANDBOOK

Degree Course in Pharmacy

Academic Year 2019-2020

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, written and oral, is held in **September 2019**.
The admission test consists of 60 multiple choice questions, aimed at ascertaining the preparation on the topics already studied at the secondary schools as provided for in the master's degree program in Pharmacy (biology, chemistry, physics and mathematics), and an oral test, aimed at verifying the knowledge of the English language.

To pass the written test, student must correctly answer at least 24 questions.
Students who have obtained the minimum score of 24/30 are therefore admitted to the first year of the course, up to a maximum of 80 posts. Information about the terms and methods of admission on the website http://www.scienze.uniroma2.it/?cat=385 or at the English page of the master's degree course in Pharmacy website http://farmacia.uniroma2.it/

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 2019/2020**, published on the official portal of this university (http://web.uniroma2.it) or in the website of the Degree Course in Pharmacy.

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 program

1st Year

Subject	Mod.	CFU
General and Bio-inorganic Chemistry: GENERAL CHEMISTRY	I	6
General and Bio-inorganic Chemistry: BIO-INORGANIC CHEMISTRY	II	6
Applied Mathematics		6
Applied Physics		6
Human Anatomy	I	3
Human Anatomy	II	5
Introduction to Biology: CELLULAR AND DEVELOPMENTAL BIOLOGY	I	6
Introduction to Biology: INTRODUCTION TO GENETICS	II	4
Organic Chemistry		8

2nd Year

Subject	Mod.	CFU	SSD
Analytical Chemistry (Lab.) (B)		8	CHIM/03
Microbiology (B)	I	5	MED/07
Immunology (B)	II	1	MED/07
Molecular Biology (C)	I	5	BIO/11
Molecular Biology (C)	II	5	BIO/11
Drug analysis I° (C)	I	5	CHIM/08
Drug analysis I° (C)	II	5	CHIM/08
Pharmaceutical Biology and Pharmacology (C)		7	BIO/14
Statistics (B)		5	MED/01
Biochemistry (C)	I	6	BIO/10
Biochemistry (C)	II	5	BIO/10
Chemistry of Equilibria (B)		6	CHIM/01

3rd Year

Subject	Mod.	CFU	SSD
General Pathology (B)	I	5	MED/04
General Pathology (B)	II	3	MED/04
Plant Biochemistry and Physiology (A)		4	BIO/04
Medicinal plants (A)		4	BIO/01
Drug Analysis II° (C)	I	6	CHIM/08
Drug Analysis II° (C)	II	6	CHIM/08
Pharmaceutical and Toxicological Chemistry I° (C)	I	7	CHIM/08
Pharmaceutical and Toxicological Chemistry I° (C)	II	7	CHIM/08
General Pharmacology: Toxicology (C)	I	10	BIO/14
General Pharmacology: Pharmacogenomics (A)	II	2	MED/03

Subject	Mod.	CFU	SSD
Physiology (B)		7	BIO/09

4th Year

Subject	Mod.	CFU	SSD
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
Chemotherapy (C)		8	BIO/14

5th Year

Subject	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)		3	MED/49
Food Chemistry (C)		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

Course: **GENERAL AND BIO-INORGANIC CHEMISTRY:**
MODULE I: General Chemistry (6 Credits)
MODULE II: Bio-Inorganic Chemistry (6 Credits)
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. It is expected to get skilled in stoichiometric issues, to gain technical perspectives to forecast the chemical reactivity based on chemical structures. Furthermore, it is required to get an insight in the fundamental properties of inorganic materials and evaluating their impact in life science.
Elements of quantum mechanical theory and electronic structure of atoms. The periodic properties of the elements. The oxidation number and formal charge. Ionic and covalent bonds. Valence bond theory, molecular geometry and hybridization of atomic orbitals. Bond orders, lengths and energies.
Program: 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. The expression of the equilibrium constant. 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. Brönsted-Lowry theory of acids and bases. 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. Acid-base equilibrium calculations. Buffer solutions. Lewis acids and bases. Solubility and solubility product constant, K_{sp}. Common-ion effect in solubility equilibria. Criteria for precipitation and its completeness. Solubility and pH, fractional precipitation and ion separation. Electrochemistry: free energy of reduction reactions, electrode 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.

Coordination chemistry: main coordination numbers, complexes nomenclature, optical isomery, absolute configuration of octahedral complexes and chelates, the chelation effect. Molecular orbital theory applied to transition metals and crystal field theory. The bases of chemical kinetics. Substitution reactions of square-planar and octahedral complexes. Metal-related phenomena: metal induced fibrillation, photo dynamic therapy of metallated macrocycles. Nanoparticles and their applications as antibacterial tools and carriers for drug delivery. Optical spectroscopy applied to complexes, macrocycles and nanoparticles.

Text Books:

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

Course: **APPLIED MATHEMATICS**

Teacher: **Daniele Bertaccini**

CFU: **6**

Objectives: 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

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: **Massimiliano Lucci**

CFU: **6**

Objectives: Provide to the students the basic laws and concepts in classical physics consistent with the knowledge and skills required by the degree course in Pharmacy

Program: **Introduction to physics; SI System of units, Error Analysis:** Statistical errors, Systematic errors, Error Propagation. weighted mean. Vectors and Scalars. Dot Products, Vector Cross Product.

Kinematics and Dynamics of point-like objects: Methods of Motion, Displacement, Velocity, Acceleration, Graphical Analysis of Motion: Slope, Area. Projectile Motion Newton's First & Second Law, Free body diagrams, Friction, Newton's Third Law, Newton's Law of Gravitation, Newton's First Law and Physical Therapy, example of Cervical Traction. Circular Motion, Impulse and Momentum, Law of Conservation of Momentum, Elastic Collision, Inelastic Collision. Work, energy, Potentials, Power. Elastic Potential Energy & Springs, Simple Harmonic Motion, Hooke's Law, Conservation of Energy,

Fluid Mechanics – Hydrostatics, States of Matter, Density, Fluid, Pressure, Pascal's Principle, Archimedes's Principle, Fluid Dynamics, Bernoulli's Principle,
Thermodynamics: Calorimetry, Heat, Internal Energy, Isolated, Closed and Open Systems, Internal vs. "External" Energy, Absolute Zero & the Kelvin Scale, Heat Transfer Processes, Laws of Thermodynamics: Zeroth Law, First Law, Second Law, entropy, Boyle's Law and the Ideal Gas Scale, The Ideal Gas Law. Thermal Expansion for gas, liquid, solid.
Electricity and magnetism: Electric Fields and Forces, Charge, Conductors and Insulators, Induction and Grounding, Electrical Energy, Potential and Capacitance, Dielectric, Electric Circuits, Ohm's Law, example - Iontophoresis, Magnetic Fields and Forces, Lorentz Force, Right Hand Rule, ElectroMagnetic Induction, Faraday's Law, Transformers, Microphones, Lenz's Law
Waves and Sound: Standing Waves, Closed Pipes, Open Pipes, Harmonics, Example – Note, Ultrasound in diagnostics and therapy, propagation parameters, pulse- eco principle, velocity of sound, intensity and attenuation, reflection, acoustic impedance, transmission, refraction, Example – Ecography, Doppler effect.
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: HUMAN ANATOMY:

Module I: Prof. Giuseppe Sciamanna (Credits 3)
Module II: Prof. Marco Barchi (Credits 5)
Teacher: **Marco Barchi/Giuseppe Sciamanna**
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. These are necessary pre-requisites for the understanding of physiology, patho-physiology and of the interaction of chemical compounds with tissues and organs, necessary knowledge equipment for a pharmacist. To this end, special attention will be given to the study of the microscopic anatomy of tissues and organs and to the study of neuroanatomy. On the other end the essential elements of gross and topographic anatomy of toraco-abdominal organs will be given.
Program: **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, 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). White and brown adipose tissue. 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. MUSCLE TISSUE: skeletal muscle, cardiac muscle, smooth muscle.
ANATOMY: LOCOMOTOR SYSTEM. Skeleton: general organization of the axial and appendicular skeleton, vertebral column and main bones of the trunk, superior limb, inferior limb. Pectoral girdle and pelvis. Joints structure and classification, movements. Skeleton Muscles: generalities, major

muscles of the pectoral girdle. 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. Baby blood circulation. Lymphatic system. Systemic and microscopy anatomy of digestive, respiratory, urinary, reproductive and endocrine System. 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:

1) Martini Timmons Tallitsch: Human Anatomy (Pearson College Div), or
2) 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" - **Mauro Piacentini (Credits 6)**

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

TOTAL CFU: **10**

Module I: Cellular and Developmental Biology - Mauro Piacentini (Credits 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 - Cesare Gargioli (Credits 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 ". GS

Course: **ORGANIC CHEMISTRY**

Teacher: **Pierluca Galloni**

CFU: **8**

Objectives: Conoscenza di nomenclatura, rappresentazione, struttura tridimensionale (inclusa la chiralità) e proprietà chimiche e fisiche delle molecole organiche. Capacità di razionalizzare le reazioni organiche in termini di meccanismo di reazione

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: **Giuseppe Palleschi**

CFU: **8**

Objectives: Knowledge of the quantitative analysis with experiences in the laboratory

Program: Acid base titrations Determination of the unknown concentration of acetic acid. Precipitation titration with Mohr method: Detection of unknown concentration of chloride with silver nitrate. Complexometry titrations Detection of Calcium ions in the water. Redox titration: Detection of hydrogen peroxide with potassium permanganate.

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

Course: **MICROBIOLOGY AND IMMUNOLOGY**

TOTAL CFU: **6**

Module I – "Microbiology": Prof. **Francesca Ceccherini Silberstein (Credits 5)**

Objectives: The course provides the essential knowledge of the major concepts, principles and applications of microbiology. Through this course you will learn about what microorganisms are, how they function, and how their related pathogenetic mechanism work.

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 and special virology: Nature, origin and morphology of viruses. Oncogenic RNA and DNA viruses. Virus-cell interaction. Vaccines. Antiviral therapy and resistance. Adenovirus. Herpesvirus. Poxvirus. Papovavirus. Parvovirus. Picornavirus. Hepatitis viruses. Retrovirus. Ortomyxovirus. Paramyxovirus. Rhabdovirus. Togavirus and other viruses transmitted by insects. Filoviruses. Rubella virus. Reovirus and rotavirus. Prions.

General and special bacteriology: The bacterial cell. Metabolism and bacterial growth. Host-parasite relationship. Immune sera and vaccines. Principles of microbiological diagnostics. Antibacterial drugs and resistance. Staphylococci. Streptococci. Pneumococci. Enterococci. Bacilli and clostridia. Enterobacteriaceae. Pseudomonas. Vibrios. Helicobacter. Neisseria.. Mycobacteria. Treponema

Pallidum. Mycoplasma. Rickettsiae. Chlamydia.
General and special parasitology: Protozoan parasites of man. Cestodes, trematodes and nematodes of human relevance. Arthropod pests and vectors of major human parasitic diseases.
General and special mycology: The mycetes: structure, dimorphism and replication. Mechanisms of pathogenicity. Mycosis by opportunistic fungi. Mycosis superficial, skin, subcutaneous and systemic.
Text Books: Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller "Medical Microbiology"

Module II – "Immunology": Prof. **Florence Malisan (Credits 1)**

Objectives: The course provides the essential knowledge of the main concepts, principles and applications of Immunology.
Program: Description of the innate and acquired immune system; Notions on Antibodies - B and T Lymphocytes - Cytokines - Major Histocompatibility Complex (MHC) -Dendritic Cells. Notions of Immunopathology.
Text Books: Basic Immunology, Abul Abbas Andrew H. Lichtman Shiv Pillai, 6th Edition, Elsevier

Course: **DRUG ANALYSIS I – Module I**

Teacher: **Laura Micheli**

CFU: **5**

Objectives: The course, consisting of lectures and personal practical exercises in the laboratory, has as principal topic the qualitative chemical analysis of inorganic substances of pharmaceutical interest and toxicology. Since this is the first laboratory faced during the course of study, students will be first informed of the safety rules to be followed in the laboratory according to current legislation. During the laboratory work, students will learn the proper execution of some basic laboratory techniques which will be able to use during the course of subsequent years and in the future in their own profession. Besides this the students will learn the mode of analysis of inorganic ions for qualitative analysis.

- ***Program:*** Safety standards, classes and hazard symbols of noxious substances and first aid.
- Basic techniques and operations: solubilization, dilution, filtration, centrifugation, extraction. Description of the laboratory equipment and basic laboratory practice
- Theoretical aspects of the processes of solubilization, extraction and precipitation.
- Preliminary testing. Dry tests: flame tests, preliminary essays.
- Systematic analysis of cations analytical groups.
- Systematic analysis of anions analytical groups.
- analysis of Ions of pharmaceutical interest:
- Analytical reactions of cations (ammonium, silver, lead, mercury, arsenic, antimony, bismuth, iron, aluminum, zinc, calcium, magnesium, sodium, potassium, lithium)
- Analysis of the anions. Assays for the detection of acetates, carbonates, sulfates, iodides, bromides, chlorides, phosphates, nitrates. Separation of chlorides, bromides and iodides by fractional precipitation, selective dissolution and selective oxidation.

Text Books:
- J.J. Lagowski, C.H. Sorum, Semimicro qualitative analysis, Prentice Hall edition;
- W.A. Hardcastle, Qualitative Analysis – a guide to best practice, The Royal Society of Chemistry edition;
- L. Micheli, Drug Analysis I, Create edition.

Course: **DRUG ANALYSIS I – Module II**

Teacher: **Alessandro Terrinoni**

CFU: **4**

Objectives: The aim of this course is to provide the knowledge of theoretical principles and applications of instrumental analytical methods. Provide the theoretical basis of commonly used

quantitative determination methods and methods for evaluating the accuracy and accuracy of experimental data, and the estimation of precision and accuracy of experimental data. To apply basic chemical principles in analytical chemistry. Guide to physical and chemical principles underlying modern analytical technologies in the pharmaceutical laboratory. From spectrophotometry, mass spectrometry, high-pressure chromatography (HPLC), gas chromatography and combinations of these techniques in the analysis and quantization of chemical substances in pharmaceutical preparations.

Program: The course is organized in lectures in the classroom, visits will also be organized for students in laboratories, where theoretically studied technologies will be applied to real laboratory uses. The lessons are carried out with the help of the projector to show graphics, figures, etc. relevant to the course.

Errors in Chemical Analyses.
Systematic Errors
Random Errors in Chemical Analysis, The Nature of Random Errors
Statistical Treatment of Random Errors
Standard Deviation of Calculated Results
Statistical Data Treatment and Evaluation
Confidence Intervals
Statistical Aids to Hypothesis Testing
Analysis of Variance
Detection of Gross Errors
Sampling, Standardization and Calibration
Analytical Samples and Methods, Sampling, Automated Sample Handling
Standardization and Calibration

Spectrochemical Methods:

Introduction to Spectrochemical Methods
Instruments for Optical Spectrometry
Molecular Absorption Spectrometry, Ultraviolet and Visible Molecular Absorption
Spectroscopy. Infrared Absorption Spectroscopy
Molecular Fluorescence Spectroscopy, Theory of Molecular Fluorescence, Effect of Concentration on Fluorescence Intensity, Fluorescence Instrumentation, Applications of Fluorescence Methods
Atomic Spectroscopy, Origins of Atomic Spectra, Production of Atoms and Ions, Atomic Emission Spectrometry, Atomic Absorption Spectrometry
Mass Spectrometry, Principles of Mass Spectrometry, Mass Spectrometers, Atomic Mass Spectrometry, Molecular Mass Spectrometry

Separations:

Introduction to Analytical Separations, chromatografic separations
Gas Chromatography, Instruments for Gas-Liquid Chromatography,
Gas Chromatographic Columns and Stationary Phases, Applications of Gas-Liquid Chromatography, Use of GC/MS to Identify a Drug Metabolite in Blood.
High-Performance Liquid Chromatography, Instrumentation.
Partition Chromatography , Adsorption Chromatography, Ion Chromatography
Size-Exclusion Chromatography.
Comparison of High-Performance Liquid Chromatography and Gas Chromatography

Text Books:

- Fundamentals of Analytical Chemistry, 9th Edition. Douglas A. Skoog, Donald M.
- West, F. James Holler, Stanley R. Crouch. Published by Brooks/Cole © 2014.

Course: **PHARMACEUTICAL BIOLOGY AND PHARMACOLOGY**

Teacher: **Beatrice Macchi**

CFU: **7**

Objectives: The course aims are to provide basic knowledge on drugs and their principal targets,

general principles on mechanisms regulating interaction between drug and its target. Emphasis will be placed on recent research on biological targets and their application in the design of novel therapeutics.

Program: General principles on drug discovery. Rational drug design and druggable targets, drug discovery and development.

How drugs act: general principles: Evaluation of drug –receptor interaction: Agonist, partial agonist, antagonist, allosteric potentiation, allosteric inhibition, inverse agonist.

How drug act: molecular aspects on drug targets: Target for drug action, types of drug targets. Membrane targets: Ionotropic receptors (Nicotinic receptors for Acetylcolin, GABA A), Metabotropic receptors (Muscarinic receptor for Acetylcholine, GABA B receptors), Tyrosine kinases receptor (Insulin, EGF receptor) Tyrosine associated receptors (cytokine receptors). Membrane transporters, Adhesion molecules. Ion channels Intracellular targets: Acid retinoic receptor, glucocorticoid receptors.

Biopharmaceuticals and drug targets:

Therapeutic monoclonal antibodies: classification, IgG structure, Fab and Fc functions, generation of monoclonal antibodies (hybridoma method, recombinant antibodies: transgenic mice, phage display, human memory cell immortalization), differences between murine, chimeric, humanized and human monoclonal antibodies); mechanisms of action [antibody dependent cellular cytotoxicity (ADCC), complement dependent cytotoxicity (CDC); neutralization of secreted growth factors or cytokines, interaction with receptors and block of signal transduction, induction of apoptosis); naked and conjugated monoclonal antibodies targets and mechanism of action, side effects, toxicity.

RNA target: RNA interference: siRNA and microRNA; comparison with oligonucleotide antisense; isoform specific siRNA and allele specific siRNA; modified siRNA to improve efficacy; targeted siRNA; off-target effects of siRNA; clinical trials and siRNA (anti-VEGF: bevasiranib; anti-keratin, anti-VEGF; anti-tat of HIV, anti-tenascin, anti-ribonucleotide reductase); clinical trials with miRNA: microRNA-122.

The proteasome pathway:

General properties; proteasome inhibitor [bortezomib (velcade)]: principal consequences deriving from proteasome inhibition: stabilization of p53, inhibition of NF-kB and inhibition of cell cycle regulators.

Cell cycle checkpoints:

general properties; DNA damage and cell cycle arrest (ATR and ATM kinases); targeting cell cycle kinases for cancer treatment: cycle dependent kinases (CDKs) inhibitors, ATM inhibitors; inhibitors of mitosis: inhibitors of microtubule polimerization (vinca alkaloids), agents inducing microtubule stabilization (taxanes), aurora and polo kinase inhibitors.

Apoptosis: principle of apoptotic mechanisms: Drugs promoting and inhibiting apoptosis.

Mitochondria:

general properties; mitochondria and apoptosis; inhibitors of Bcl2 (obatoclax), anti-sense anti bcl-2 (oblimersen); BH3 mimetic agents; inhibition of the IAP surviving; mitochondria and reactive oxygen species (ROS); anti-oxydant defences and mithocondria protection; targeting mitochondria for Alzheimer disease with MitoQ; mitochondria in ischemia/reperfusion damage and cardioprotection; mitochondria and senescence, mitochondria damage and cardiotoxicity of anthracyclines.

Metabolism:

drug targets in metabolism: glycolysis, 5'-AMP-activated protein kinase, mTOR system, lipids

Interferon. classification. Interferon type I and III: Biological effect and characterization of targets. Jak/Stat pathway.

Epigenetic-enzymes:

general principles; histone acetyltransferase (HAC) and histone deacetylase (HDAC); HDAC inhibitors: mechanisms of action; HDAC inhibitors and retinoic acid for acute promyelocytic leukemia; DNA methylation by DNA methyltransferases (DNMT), inhibitors of DNMT.

Telomere structures and telomerase:

general principles; telomerase inhibitors for cancer treatment (example: imetelstat); telomere damaging agents (G-quadruplex ligands).

DNA: nuclear receptors; DNA damaging agents: principal mechanisms of actions (alkylating agents, antimetabolites, inhibitors of topoisomerase I or II, inhibitor of ribonucleotide reductase)

DNA repair enzymes:

principal DNA repair systems; inhibitors of O6-methylguanine DNA methyltransferase (MGMT) and the methylating agent temozolomide; poly(ADP-ribose) polymerase (PARP) inhibitors

Genome Editing: The CRISPR/Cas system

Drug Targets in Neurodegeneration:

protein folding: general properties. Protein misfolding in neurodegeneration. Beta amyloid: generation, APP metabolism, folding, toxicity. β-secretase, γ-secretase: structure, function. Inhibitors of β-secretase, and γ-secretase complex. Inhibitors of amyloid aggregation. (GSK3β). Tau protein, metabolism, folding, toxicity. Inhibitors of Tau. Models to study drug targeting in neurodegenerative diseases. Authophagy and mTOR system.

Text Books: **Suggested Bibliography**

J. L. Medina-Franco, M. A. Giulianotti,G.S. Welmaker, R. A. Houghten. Shifting from the single to the multitarget paradigm in drug discovery. Drug Discovery Today. 2013. 18: 495-501.

-Beck A, Wurch T, Bailly C, Corvaia N. Strategies and challenges for the next generation of therapeutic antibodies. Nat Rev Immunol. 2010 May;10(5):345-52.

-Rask-Andersen M, Almén MS, Schiöth HB. Trends in the exploitation of novel drug targets. Nat Rev Drug Discov. 2011Aug 1;10(8):579-90.

- Gashaw I, Ellinghaus P, Sommer A, Asadullah K. What makes a good drug target? Drug Discov Today. 2012Feb;17 Suppl:S24-30.

-Watts JK, Corey DR. Silencing disease genes in the laboratory and the clinic. J Pathol. 2012 Jan;226(2):365-79.

De Strooper B, Iwatsubo T,Wolfe MS. Presenilin and Ý-secretase: Structure,Function and Role in Alzheimer disease. Cold Spring Harb Perspect Med 2012Jan 2(1):a006304.

Further bibliography will be supplied for the subjects not exhaustively described within the suggested texts.

Recommended Textbooks:

Rang and Dale's Pharmacology Eighth edition (2016), HP Rang, MM Dale, Ritter JM, Flower RJ, Henderson G. Elsevier

The Cell: A Molecular Approach, 6th Edition (2013) Geoffrey M. Cooper and Robert E. Hausman, ASM Press and Sinauer Associates, Inc.

Course: STATISTICS

Teacher: Simona Iacobelli

CFU: 5

Objectives: The objective of the course is to provide a basic knowledge of the logic setting and correct interpretation of the statistical tools most frequently used in medical research. At the end of the course the Student should be able to read and understand a research report or medical paper, and be aware of the of the complexity of the data analyses necessary for medical research.

Program: Elements of descriptive statistics: basic concepts and terminolgy, classification of variables; frequency distributions, tables and graphs; indexes of position and variability. Elements of probability theory: basic rules and Bayes' formula; main probability distributions. Elements of frequentist statistical inference: the repeated sampling principle; properties of estimators and estimation via confidence intervals; intuitive principles and basic elements of hypothesis testing. Main applications: T-test for the mean and the proportion; analysis of relationships in the case of independent samples (Chi-Squared test, T-Test, ANOVA 1-way); regression and correlation. Intrerpretation of statistical significance, concept of confounding. Notions on some non-parametric methods / for small samples

/for dependent samples. Introduction to multiple regression models. Elements of statistical methods for duration data. Introduction to clinical trials. Elements of error measurement error.
Text Books: "Medical Statistics", by M Bland. Editor: Oxford University Press. Slides of the lectures, solved exercises and other material are distributed.

Course: **BIOCHEMISTRY – Module I**
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: Biochemistry 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: **BIOCHEMISTRY – Module II**
Teacher: **Gennaro Melino**
CFU: **5**

- ***Program:*** Foundations of Biochemistry. Water. Weak interactions in aqueous systems. Ionization of water, weak acids, weak bases. Buffering against pH changes in biological systems. Water as reactant.
- Aminoacids: structure and physical-chemical properties.
- Peptides and proteins. Peptides charge. Methods to analyze, separate and characterize proteins. Primary structure of proteins. Three dimensional structure of proteins. Interactions that stabilize protein's conformation. Peptide bond. Protein secondary structures: Alpha Helix, Beta conformations, Beta turns. Protein Dihedral angles. Protein tertiary and quaternary structures. Fibrous proteins: Alpha keratin and collagen: structure, function and uncommon amminoacid residues. Protein tertiary structure: motifs, folds and domains. Protein denaturation, folding and disease.
- Hemoglobin and Myoglobin: structures, functions, oxygen binding properties and curves. Heme group. R and T states. Allosteric effectors. Hill equation, Hill coefficient and cooperativity. Mechanism of CO2 transport in blood. Bohr effect. Role of 2,3 Biphosphglycerate in oxygen binding.

- Enzymes: structure, classification, mechanism of action. Enzyme's catalytic power, binding energy and specificity. Mechanisms of catalysis: specific, general and covalent. Enzyme's kinetics: Michaelis and Menten equation and constant. Lineweaver and Burk plot. Kcat. Enzyme inhibition, reversible, irreversible, competitive, uncompetitive, mixed. Mechanism of action of chymotripsin. Enzyme regulation: non covalent/allosteric, covalent reversible, covalent irreversible.
- Water soluble vitamins: structure and function.
- Carbohydrates, structures and functions: Monosaccarides and disaccarides. Polysaccarides. Glicoconjugates : Proteoglycans, Glycoproteins and Glycolipids.
- Lipids. Storage lipids. Structural lipids in membranes. Sterols. Eicosanoids. Lipid soluble vitamins :structure and functions. Biological membranes and transport: the composition and architecture of membranes. Solute transport across membranes.
- Biosignaling: G protein-coupled receptors and second messengers. Receptor tyrosine kinases, the insulin signaling. Guanylyl cyclases. Regulation of transcription by steroid hormones.
- Introduction to bioenergetic and metabolism. ***Text Books:***
  Lehninger Principles of Biochemistry 5th, 6th or 7th Edition by David L. Nelson (Author), Michael M. Cox (Author)

Course: **CHEMISTRY OF EQUILIBRIA**
Teacher: **Giuseppe Palleschi**
CFU: **6**

Objectives: Knowledge of the simple equilibria of the chemical reactions
Program: Concentrations % w/w % w/v %v/v ppm ppb ppt How to go from these concentrations to morality and vice versa Acid base equilibria: strong acids weak acids, monoprotic diprotic triprotic. concept of pH and its calculation in the acid base equilibria. Precipitation equilibria and calculation of the solubility product and solubility of less soluble salts. complexation equilibria Ammonia and EDTA and calculation of the heavy metal concentration after complexation. Redox equilibria calculation of the EMF of a redox reaction
Text Books: Any book of general analytical chemistry at University level

Course: **GENERAL PATHOLOGY - *Module I and Module II***
Module I: Prof. **Roberto Bei (Credits 5)**
Module II: Prof. **Maurizio Mattei (Credits 3)**
TOTAL CFU: **8**

Objectives: The learning outcomes of the Course in GENERAL PATHOLOGY are to enable the student to understand the molecular mechanisms of cell damage, the response of the cell and the organism to damage, the molecular basis of the neoplastic transformation, and the causes of human diseases, interpreting the fundamental pathogenetic and pathophysiological mechanisms.
Program: **Etiology:**
Concept of disease: state of health and causes of disease.Concept of etiology and pathogenesis.
Genetic disorders: mutations, mendelian disorders, disorders with multifactorial inheritance, normal karyotype, cytogenetic disorders, single-gene disorders with non classic inheritance. Diagnosis of genetic diseases.
Infectious diseases: general principles of 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.

Cellular Pathology:
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 necrosis. 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.
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 involved 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.
Overview of repair responses after injury and inflammation
Thermoregulation: Neurophysiology of thermoregulation. Body's thermoregulatory set-point. Pyrogens. Fever. Types of fevers.
Neoplasia: Definitions. Nomenclature of tumors. Biology of tumor growth: benign and malignant neoplasms. Differentiation and anaplasia, rates of growth.
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.
Hemodynamic disorders, thromboembolic disease, and shock. Edema. Hyperemia and congestion. Hemorrhage. Hemostasis and Thrombosis. Embolism. Infarction.
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: Atelectasis. 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: acute renal failure, chronic renal failure and uremia
Endocrine system pathophysiology: pituitary gland, thyroid gland, parathyroid glands, endocrine pancreas (diabetes mellitus and pancreatic endocrine tumors), adrenal glands.
Text Books: Robbins & Cotran Pathologic Basis of Disease

Course: **PLANT BIOCHEMISTRY AND PHYSIOLOGY**
Teacher: **Patrizia Aducci**
CFU: **4**

Objectives: The course aims to provide students with knowledge of structural and functional aspects of plant cells and of the biochemical functions and main physiological processes of plants . The students are introduced to the role of plants and drugs derived in pharmacy
Program: **Organization of the Plant Cell:**
Cell Wall, Membranes and Organelles.
Transport:
Water absorption and transport . Water potential and its components.
Membrane Transport Processes. Passive and Active transport of Solutes.
Membrane Potential : Nernst and Goldman Equations.
Membrane Transport Proteins: Channels, Carriers, Pumps.
Translocation of Photosynthates in the Phloem: Phloem loading; The Pressure-Flow Model.
Biochemistry and metabolism
Photosynthesis: the Light Reactions:
Introduction; Organization of the Photosynthetic Apparatus; Mechanism of Electron Transport; Proton Transport and ATP Synthesis; Photoinhibition and Photoprotection. Photosynthesis: the Carbon Reactions:
The Calvin Cycle: Reactions and Regulation; The C2 Oxidative Photosynthetic Carbon Cycle; Adaptations of Photosynthesis: The C4 Carbon Cycle; Crassulacean Acid Metabolism (CAM). Biosynthesis of Starch and Sucrose.
(it is necessary to know and write the reactions and the chemical structures of molecules in the cycles)
Plant Hormones:
Regulatory role and general properties of plant hormones.
Structure, activities and mode of action of Auxin
Text Books: Taiz, Zeiger, Moller, Murphy
Plant Physiology and Development Sixth Edition 2015
Sinhauer Associates Inc Publishers
Sunderland Massachussets
USA

Course: **MEDICINAL PLANTS**
Teacher: **Angelo Gismondi (Credits 3)**
Teacher: **Antonella Canini (Credits 1)**
CFU: **4**

Objectives: Knowledge of plant anatomy, plant metabolism, bioactivity of natural compounds and

effect on physiological and molecular animal systems, including humans

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: Chemistry, biosynthesis and bioactivity of natural compounds. III edition. Piccin. Paul m. Dewick

Course: **DRUG ANALYSIS II -Module I and Module II**

Teacher: **Gaetano Barbato**

CFU: **12**

Objectives: **Mod. I** of the course aim is the acquisition – both theory and practice – of fundamental rationale and chemical techniques that allow the isolation, description, chemical characterisation, and wet-chemical analyses of organic substances after isolating them out of mixtures. Mod. II aim is to acquire the basic knowledge both theory and practice, to complete a molecular structural analysis of an organic compound identifying a pure isolated compound using instrumental techniques.

Program: **Mod. I**

The module will consist of lessons in which the theory behind different techniques for isolating and characterising organic substances are covered, and a practical part, in which the theoretically discussed separation techniques and wet-chemical analyses are performed in the lab.

The following topics are covered:

Safety in the laboratory and good laboratory practices; Survey of functional groups in small molecules of pharmacological interest; organoleptic analyses/scientific and description of chemical samples; general analysis strategies; calcination; physical separation techniques (Staudinger separation, filtration, crystallization/recrystallization, chromatography, TLC, retention factors, sublimation, distillation, Raoult's Law, fractionation, azeotropes, Nernst distribution coefficient, Liquid-liquid extraction, soxhlet extraction); determination of physical properties of a sample (including rational solubility tests, melting and boiling point analyses); systematic qualitative wet-chemical analysis methods targeting elements and specific functional groups tests, analyses and interpretation of scientific data sets; links between traditional wet-chemical separation and analyses techniques with modern instrument-based analyses methods.

Laboratory activities:

Practical "hands on" work in the laboratory will be completed to familiarise with the laboratory techniques and the analyses strategies discussed during the lessons.

Lab experiences will concern:

- fundamentals of analysis (organoleptic, melting point, solubility, calcination etc.)
- Separating mixtures of compounds (extraction, filtration, crystallization, TLC)
- identification of the class of unknown substances functional groups by chemical reactions

Mod. II

1. Elementary analysis: HCN analysis of organic molecules of pharmacological interest.

1.A Laboratory practical exercise: Minimum formula of compounds from HCN analysis data, examples.

1.B Laboratory practical exercise: HCN analysis of 8 unknown compounds and minimum formula proposal.

2. Digitalization of signal: ADC conversion, digitazion process, S/N and its effects.

3. Mass spectrometry: The physics fundamentals, sample introduction techniques, Ionization techniques, Mass analyzers, Resolution; Magnetic and electrostatic sector; Quadrupoles; Time-of-Flight; Ion cyclotron Resonance; Ion trap. Fragmentation and profile use. Mass spectra interpretation

of organic compounds.

Laboratory activity:

3.A Laboratory practical exercise: practical analysis of spectra from 24 different compounds, and molecular ion identification.

3.B Laboratory practical exercise: analysis of the mass spectra of 8 unknown compounds (same as 1.B).

4. IR spectroscopy: vibro-rotational states, the vibrating diatomic molecule model, the diatomic, the vibro-rotation spectrum of carbon monoxide, vibration of polyatomic molecules. IR spectra of organic molecules with characteristic functional groups: aldehyde, ketons, carboxylic acids, esthers, alcohols, primary, secondary and tertiary amines, alkenes, alkines, alkanes, aromatics

Laboratory activities: Each student is lead to acquire a spectra hands on an FT-IR instrument.

4.A Laboratory practical exercise: Recognition of functional groups of 24 different organic compounds by IR spectra (same as 3.A)

4.B Practical aspects of FT-IR acquisition: The scan concept, sum of scans, scan speed and resolution, interferences, difference spectra. Control software to acquire an IR spectra. Transfer of acquired spectra for printing, peak picking.

4.C Laboratory experience: Difference spectra of 8 unknown compounds (same as 1.B) and their solvent. Identification of functional groups.

5. Nuclear Magnetic Resonance (NMR) spectroscopy: the physics fundamentals, Nuclear spin and applied field, vectorial description of the magnetization, radiofrequency pulse effects; 1D NMR signal detection. Chemical shift; spin-spin interaction, scalar coupling and dipolar coupling.Decoupling. 1H and 13C spectra, DEPT. Integration of proton spectra. NMR spectra interpretation of organic compounds.

Laboratory activities: Each student is lead to acquire a spectra hands on the NMR300 MHz instrument.

5.A Laboratory practical exercise: Integration of 1H spectra and matching with minimum formula; practical analysis of spectra from 24 different compounds (same as 3.A), and molecular structure proposal.

5.B Practical aspects of NMR acquisition: The Lock function, Tuning and Matching, pulse calibration. Control software management and essential acquisition parameters for 1D acquisition.

5.C Laboratory experience: NMR spectra of 8 unknown compounds (same as 1.B).

6. Analysis strategies: combined use of different spectroscopic techniques to analyze organic molecules.

Laboratory activity

6.A Combined analysis of HCN, MS, IR and NMR to identify the molecular structure of organic compounds and of molecules of pharmaceutical relevance (specific examples: GABA, Aspirin, Nimensulide).

Text Books:

Mod I: 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

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

Course: PHARMACEUTICAL AND TOXICOLOGICAL CHEMISTRY - Module I

Teacher: **Orazio Nicolotti**

CFU: **7**

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: **PHARMACEUTICAL AND TOXICOLOGICAL CHEMISTRY I - Module II**
Teacher: **Beatrice Macchi**
CFU: **7**

Objectives: The aim of the course is to allow the student to acquire the learning method about chemical structure of antimicrobial and antineoplastic drugs and of their target and on the structure-activity relation. This should make the students able to face and solve the difficulties encountered, during the deepening of the subject.
Program: **Antimicrobial agents:**
History, the bacterial cell, mechanism of action, Classification.
Antimetabolites: Sulfonamide, history structure-activity relationship (SAR), mechanism of action, Sulphanilamide analogues, Trimethoprim,Sulfone.
Inhibitors of cell wall synthesis: Penicillins: history, structure, mechanism of action resistance, SAR, Penicillin analogues,synergism with other drugs. Cephalosporins: synthesis,SAR, classification, resistance. Other beta-lactam antibiotics: Carbapenems,Monobactams. Beta-lactamase inhibitors: Clavulanic acid, Sulbactam, Olivanic acids,Avibactam. Antimicrobial drugs acting at the level of cell wall: Glycopeptides, Vancomycin. Antimicrobial which act on plasma membrane: Valinomycin, Polymyxin B, Cyclic lipopedites.
Protein synthesis inhibitors: Aminoglycosides, Tetracyclines,Chloramphenicol,Macrolides,Lincosamides,Streptogramins,Oxazolidinones, Pleuromutilins.
DNA inhibitors:Quinolones, Fluoroquinolones, Ryfamycins, Nitromidazoles and nitrofurantoin, inhibitors of bacterial RNA polymerase. Drug resistance: mechanisms and targets. Clinical aspect of antimicrobial therapy.
Antiviral agents
History,viruses and viral disease,Structure of viruses, life cycle of viruses, Vaccination. General principles of antiviral drugs, SAR.
DNA inhibitors: inhibitors of viral DNA polymerase, antisense therapy. Retrovirus inhibitors: HIV, reverse transcriptase inhibitors,strategy to desigh a protease inhibitor, protease inhibitors, inhibitors of other targets. Antiviral drugs acting against RNA virus: influenza: Adamantanes,Neuroaminidase inhibitors, developmemt of Zanamavir and Oseltamivir, resistance studies. Antiviral drugs acting against RNA viruses: hepatitis C: Inhibitors of HCV NS3-4A protease, inhibitors of HCV NS5B RNA-dependent RNA polymerase, inhibitors of HCV NS5A protein: Introduction and design. Broad spectrum of antiviral agents: agents against cytidine triphosphate synthetase, Agents acting against S-adenosylhomocysteine hydrolase, Ribavirin, Interferons. Bioterrorism. Clinical aspects of antiviral drugs.
Anticancer agents:Definitions, causes of cancer,Transformation and metastatization processes,oncogenes,cancer treatment, resistance, SAR.
Drugs acting on DNA: intercalating agents,alkylating and metallating agents,Antimetabolites, Hormon-based therapies, Drugs acting on structural proteins. Inhibitors of signalling pathways,

Miscellanea enzyme inhibitors,Agents affecting apoptosis,Antibodies, antibody conjugate, and gene therapy. Clinical aspects.

Text Books:

Patrick An introduction to Medicinal Chemistry Oxford Press fifth edition
Foye's Principles of Medicinal Chemistry Lippincott Williams and Wilkins Seventh edition
Wermuth,Aldous,Roboisson,Rognan The practice of Medicinal Chemistry Elsevier Fourth Edition

Course: **GENERAL PHARMACOLOGY AND TOXICOLOGY AND PHARMACOGENOMICS**

Module I: "General Pharmacology and Toxicology ", Prof. **Robert Nisticò (Credits 10)**

Module II: "Pharmacogenomics" – Prof. **Paola Borgiani (Credits 2)**

TOTAL CFU: **12**

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 providing the 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 new drugs

Program: **Prof. Robert Nisticò:**

General Pharmacology and Toxicology – *Module I* (10 CFU)

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.

Prof. Paola Borgiani: Pharmacogenomics – *Module II* (2 CFU):

Definitions of Key Terms and Basic genetics Principles.
The genetic inter-individual variability and the concepts of polymorphism and mutation. Principal types of genetic polymorphysms. Haplotypes.
Methodological Approaches to study inter-individual genetic variability.
The role of genetic variability in the response to drugs, both in terms of efficacy and toxicity.
Different types of genetic testing and their correct use in clinical practice.
The definitions of pharmacogenetics/pharmacogenomics (PGt, PGx)
Pharmacogenetics testing and clinical utility: various illustrative examples in details of application of Pharmacogenomics in safety and efficacy of drugs in different fields:
-Oncology (Irinotecan, 5FU, Tamoxifen, Cetuximab, Herbitux..)
-Cardiovascular diseases (Warfarin, Statins, Clopidogrel)
-Infectious diseases (Hiv: Abacavir, Nevirapine, HCV: Peg Interferon..)
- Therapy of pain and anhestesia
Applications of PGx in Drug Discovery and Clinical Trials. From Genotyping to Drug Label-Challenges Pharmacogenomics; The ***Regulatory*** Environment.

Text Books:

Prof. Robert Nisticò: General Pharmacology and Toxicology – *MODULE I* (10 CFU)

- 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

Prof. Paola Borgiani: Pharmacogenomics – *Module II* (2 CFU):

PDF Files and articles By Professor and Book:

"Pharmacogenomic Testing in Current Clinical Practice" (Implementation in the Clinical Laboratories Molecular and Translational Medicine

Editors: Wu, Alan H. B., Yeo, Kiang-Teck J. (Eds.); some parts of "Genomic and Personalized Medicine" Pharmacogenomics Ed Geoffrey S Ginsburg

Course: **INTERNAL MEDICINE AND DERMATOPHARMACOLOGY**

Module I: "Internal Medicine "Prof. **Manfredi Tesauro (Credits 3)**

Module II: "Dermatopharmacology" Prof. **Steven Nisticò (Credits 3)**

TOTAL CFU: **6**

Teacher: **Manfredi Tesauro - INTERNAL MEDICINE – *Module* I** (Credits **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

Teacher: **Steven Nisticò- DERMATOPHARMACOLOGY – Module II** (Credits **3**)

Objectives:

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 and Module II**

Teacher: **Lorenzo Botta**

CFU: **12**

Objectives: The course aims to provide theoretical tools to understand the drug discovery and development process.

Program: **General Section:**

Pharmacodynamic, Pharmacokinetic, Receptors classification, Pharmacophore, Drug-Receptor Interaction

Special Section:

Sedative-Hypnotics, Antiepileptic, Local anesthetics, Calcium channel blockers, Antiarrhythmics, Narcotic analgesics, Non Steroidal Anti-inflammatory drugs, Steroidal anti-inflammatory drugs, Cardiotonics, Drugs against angina, Adrenergics, Cholinergics, Drugs acting on the renin-angiotensin

system, Diuretics, Antihistamine drugs, Drugs for treatment of peptic ulcer, Neuroleptics, Antidepressants, Anti-Parkinson's drugs, CNS stimulants, Anti-obesity drugs, Antimigraine drugs, Antilipemic drugs

- ***Text Books:*** Foye (Principles of Medicinal Chemistry - Piccin)

Patrick (Introduction to pharmaceutical chemistry)

Course: **PHARMACEUTICAL TECHNOLOGIES - Module I and Module II**

Module I: Prof. **Franco Alhaique** - **–** (Credits **5**)

Module II: Prof. **Gabriella De Martino -** (Credits **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**

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:*** The pharmacological basis of therapeutics - Goodman&Gillman

General and clinical pharmacology – Katzung

Course: **SPECIAL PHARMACOLOGY AND THERAPY - 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 Nisticò**

CFU: **8**

Objectives: 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.

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

Objectives: The course aims at providing the student with the fundamental knowledge of the principles of antimicrobial and anticancer chemotherapy (including monoclonal antibodies and small molecule tyrosine 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 multi-drug resistant Gram-negative bacteria.

Program: **-General principles of anti-microbial therapy**. Mechanisms of resistance to antimicrobial agents. Infections caused by multi-drug resistance Gram negative bacteria, mutli-drug resistance Mycobacterium tuberculosis and multi-drug resistance 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.
Anti-mycobacterial agents: isoniazid; rifamycins; pyrazinamide; ethambutol; ethionamide; bedaquiline; delamanid; clofazimine; dapsone and other anti-mycobacteria agents.
Antifungal agents: amphotericin B; flucytosine; imidazoles and triazoles; echinocandins; griseofulvin; terbinafine; nystatin.
Antiviral drugs (non-retroviral): anti-herpesvirus, anti-influenza, anti-hepatitis B and anti-hepatitis C virus agents.
Anti-retroviral drugs: nucleoside and nucleotide reverse transcriptase inhibitors; non-nucleoside reverse transcriptase inhibitors; protease inhibitors; entry inhibitors; integrase inhibitors.
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 alkaloyds, 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.
Targeted therapies: kinase inhibitors, monoclonal antibodies; proteasome inhibitors; mTOR inhibitors; thalidomide, lenalidomide and pomalidomide; DNA repair inhibitors [poly(ADP-ribose) polymerase or PARP inhibitors]; CAR-T and other immunotherapies.
Hormonal agents for cancer treatment: selective estrogen-receptor modulators and downregulators, 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.

Course: ***Italian and European Pharmaceutical Legislation and Commercial Law***
TOTAL CFU: **12**

Course: **ITALIAN PHARMACEUTICAL LEGISLATION - Module I**
(Part of ***Italian and European Pharmaceutical Legislation and Commercial Law****)*
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.

1. ***Program:*** 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

Course: **EUROPEAN PHARMACEUTICAL LEGISLATION – Module II**
(Part of ***Italian and European Pharmaceutical Legislation and Commercial Law****)*
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.

Course: **COMMERCIAL LAW – Module III**
(Part of ***Italian and European Pharmaceutical Legislation and Commercial Law***
Teacher: **Gianluca Perone**
CFU: **2**

Objectives: Unfair business-to-consumer commercial practises in the internal market and the pharmaceutical sector; Advertising of medicinal products for human use; Patent medicines and legal protection. In particular Community patent in the Decision 2011/62/EU; Industrial inventions; pharmaceutical inventions; The legal protection of biotechnological inventions; Patents and vegetable crop diversity

Text Books: Didactic material will be provide to the student

Course: **DIETISTIC SCIENCES**
Teacher: **Antonino De Lorenzo**
(*part of* **Dietistic Sciences and Food Chemistry)**
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

Course: **FOOD CHEMISTRY**
(part of **Dietistic Sciences and 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: Didactic material will be provide to the student.