



Course Syllabus

Course Code	Course Title	ECTS Credits
IMPH-360	Pharmacognosy and Chemistry of Natural Products II/ Φαρμακογνωσία και Χημεία Φυσικών Προϊόντων II	6
Prerequisites	Department	Semester
IMPH-151, IMPH-120	Health Sciences	Fall/Spring
Type of Course	Field	Language of Instruction
Compulsory	Pharmacy	Greek/English
Level of Course	Lecturer(s)	Year of Study
1 st Cycle	Dr Aikaterini Koutsaviti	3 rd
Mode of Delivery	Work Placement	Corequisites
Face-to-Face	N/A	N/A

Course Objectives:

The aims of this course are to enable students to:

- Identify the most important medicinal plants
- Define the crude drug and remember the most important ones
- State the phytochemical classification and memorize the main categories of active components, contained in medicinal plants
- Describe the basic methods of extracting the active components from plants and how to identify them
- Define the concepts of ethnobotany and ethnopharmacology and memorize the geographical distribution of the most important pharmaceutical plants
- Describe the quality control methods of herbal medicinal products
- Discuss about the safe use of plants for therapeutic purposes
- Report about the legislation for drugs of plant origin and know to access for information on databases of medicines Agencies

Learning Outcomes:

Botanical classification, crude drugs, isolation of the major components, chemical structures and uses of these substances - belonging to the groups of alkaloids, terpenoids, steroids, anthraquinones, of their derivatives and of their related compounds

To achieve these objectives, the physical, chemical and biological properties of the above substances, their chemical classification, their biosynthetic pathways and their crude drugs, are presented. The uses of these crude drugs will also be described.

Moreover, during the laboratory exercises, the students will learn and experiment themselves with crude drugs, using the appropriate methods of analysis (microscopic and phytochemical control tests)

Course Content:

Anthraquinones: Biosynthesis via the acylpolymalonyl and shikimic pathways, Pharmaceutical use of anthraquinones, Homo-Hetero-dianthrones, O- and C-glycosides

Frangulae cortex*: Plant, major constituents / *Phursianae cortex*: : Plant, major constituents, uses / *Aloe*: Plants, crude drug, major constituents, uses, microscopic imaging / *Rhei radix*: Plant, major constituents / *Senna folium*: Plant, crude drug, major constituents, microscopic imaging / *Chrysarobinum* / *Carmines* – *Carminic acid* / *Hypericum perforatum*: Crude drug, major constituents, uses, microscopic imaging, herb-drug interactions, toxicology / **Macrolides - Erythromycin B - Amphotericin B - Tetracyclines – Griseofulvin*

Products, biosynthetically derived from acetic acid:

Terpenes – Mevalonic acid pathway – Origin of C5 units and formation of I.P.P. / Head-tail and tail-tail bonding in terpenes.

• Monoterpenes: Introduction, chemical structures of monoterpenes. Biosynthetic pathway. *Piper nigrum*: Crude drug, **major constituents, uses, pharmacological action**

• Oleoresins and related products from *Pinus* spp. - *Terebinthinae* – *Mentha piperita* & *arvensis*: Crude drug, **major constituents, uses, microscopic imaging** – ***Rosae aetheroleum* – *Cardamomi fructus* – *Rosmarini folium* – *Lavandulae flos* – *Aurantii pericarpium* – *Citri aetheroleum* – *Camphor* – *Thymol* – *Carvacrol* – *Zingiberene* - *Zingigerol***

• Iridoids and Seco-iridoids: General structure of iridoids, Biosynthesis, Biological and pharmacological properties. Crude drugs containing iridoids: *Valeriana officinalis*, *Harpagophytum procumbens*, *Olea europaea L.*, *Gentiana lutea* (major constituents and their chemical structures, pharmacological uses and properties)

• Pyrethroids: Chemical structures, properties. Crude drugs: *Chrysanthemum cinerariaefolium*. Chemical composition. Biological properties of pyrethroids – Uses – Synthetic analogues

- Cannabinoids: Chemical structures of major cannabinoid compounds, . *Cannabis indicae* and *Cannabis sativa* herba. Plant, categories, isolation of the resin, chemical composition and different qualities of Δ^1 -THC products, Fructus Cannabis. CBD and Δ^1 -THC: Potential uses and biosynthesis of Δ^1 -THC, Cannabis smoking, Metabolism of Δ^1 -THC and its analogues as drugs. Cannabis smoking and psychotic conditions
 - Sesquiterpenes C15: *Cnicus benedictus*, Cnicin, *Artemisia absinthun L.*, Absinthin, Chamazoulene, Artapsine. *Matricaria recutica*, *Anthemis nobilis*, *Artemissia annua*: Crude drug, **major constituents, uses** - Cantharidin.
 - Diterpenes: General information, major constituents of this class, Origin. Cyclic, Bicyclic, Tri- and Tetracyclic diterpenes. Diterpenes and therapeutics.
 - Gibberellins – Vitamin E – antioxidant and prooxidant balance – Vitamin K – Forskolin – Phorbol – Stevioside – *Gingo biloba* – Crude drug and uses. Taxus spp. Chemical structures and biosynthesis of taxol. Toxicity of the plant Taxus. Taxol, semisynthetic derivatives. Pharmacological action
 - Triterpenes and steroids: General information, tetracyclic-pentacyclic triterpenes and steroids: General structures. Biosynthetic pathways of triterpenes and steroids
 - Saponins: Structures of aglycone saponins: Steroidal and triterpenoidal structures. *Glycyrrhiza glabra*, *Aesculus hippocastanum*, *Quillaja saponaria*, *Ruscus aculeatus*, *Polygala senega*, *Saponaria officinalis*, *Panax Ginseng*, *Quassia amaria*: Crude drug, chemical composition, uses
 - Tetraterpenes (C40), Carotenoids, Biosynthesis and properties of carotenoids, uses, specific examples (zeaxanthin, lutein, cryptoxanthin, α -, β -carotene). Vitamin A - general. Effects of lack. Crude drugs with carotenoids: *Capsicum spp.*, *Magnifera indica*, *Psidium guajava*, *Zea mays*. *Crocus sativus* L., Chemical composition, Properties, Uses, Collection
 - Steroidal hormones - Categories, Progesterone, Sarmentogenin, Biosynthesis and partial synthesis of steroids, Stigmasterol, Sitosterol
 - Cardiac glycosides - General – Mechanism of action – Categories – Chemical structures: Aglycones. Glycosides. Structure activity relationship. Biosynthetic origin. Pharmacokinetics of Digoxin and Digitoxin. Undesired effects. Uses and pharmacological actions, Therapeutic digitalis and digitalis toxicity state, Treatment
 - Crude drugs with cardiac glycosides - *Digitalis spp.*, *Strophanthus gratus*, *Adonis vernalis*, *Urginea maritima*: major compounds, crude drug, uses – other crude drugs with cardiac glycosides (folia *nerii*, rhizoma *Hellebori nigri*). Poison toad, Bufotoxin. Fusidic acid. Vitamin D: Uses, properties
 - Natural products biosynthetically-derived from aminoacids. Bromelain, Papain, Ficin, Lectins (Abrin, Ricin). Toxins from *Amanita* mushrooms (Amatoxins, Phallotoxins), Peptide antibiotics (Gramicidins, Bacitracin A, Cyclosporine)
 - Cyanogenic glycosides and Glucosinolates. Amygdalin, Sinigrin, Sinalbin, Alliin: Plants and crude drugs that contain them, cleavage reactions, uses
- Alkaloids. Definition by Pelletier. Distribution in the plants, Historical background, Role in plant, characteristics, isolation, types of alkaloids (depending on the precursor aminoacid), Pharmacological action (general), Detection reagents, General classification of alkaloids
- Aminoalkaloids. Ephedrine, Mescaline, Capsaicin: Crude drug, plant, biosynthetic pathway, pharmacological action - uses. Cathinone – Cathine, Muscarine, Muscimol, Ibotenic acid: Crude

drug, plant, pharmacological action - uses. Colchicine: Crude drug, plant, mechanism of action, uses

- Piperidine and Pyridine alkaloids. Coniine: Crude drug, plant, biosynthetic pathway, pharmacological action - uses. Lobeline, Carpaine, Pelletierine: Crude drug, plant, pharmacological action - uses. Piperine: Crude drug, plant, pharmacological action - uses. Nicotine: Crude drug, plant, chemical properties, biosynthetic pathway, pharmacological action, therapeutical uses, pharmacokinetics, contraindications, tobacco alkaloids

- Tropane alkaloids. Tropane biosynthesis. Hyoscyamine, scopolamine: Crude drugs, plants (*Atropa belladonna* L., *Datura stramonium* L., *Hyoscyamus niger*, *Mandragora officinarum*), biosynthetic pathway, pharmacological action, uses, undesirable actions. Cocaine: Crude drug, plant, pharmacological action - uses, pharmacokinetics, biosynthetic pathway, metabolism, *Cocae folium*, decocainized products, *Coca truxillo* extract, chewing coca.

- Pyrrolizidine alkaloids. Structural characteristics and therapeutic interest. Crude drug and plants with pyrrolizidine alkaloids (*Cynoglossum officinale*, *C. amabile*, *Heliotropium indicum*, *H. europaeum*, *H. amplexicaule*, *Symphytum officinale*, *S. consolida*, *Borago officinalis*, *Tussilago farfara*, *Senecio vulgaris*, *Senecio jacobaea*, *Eupatorium cannabinum*, *Crotalaria quinquefolia*, *Crotalaria spectabilis*, *Crotalaria retusa*): uses, biosynthetic origin of senecionine derived from its precursor amino acid (ornithin)

- Quinolizidine alkaloids. Biosynthetic pathway. Sparteine, Cytisine Crude drug, plant, biosynthesis, pharmacological action - uses. Lupinine, anagyrine (*Lupinus luteus*, *Lupinus perrenis*, *Chelidonium majus*)

- Isoquinoline alkaloids and Opioids. Historical review. Pharmacological action of opioids (general). Papaverine. Morphine: actions, pharmacokinetics, biosynthesis, indications, contraindications, interactions, overdose of morphine and opioids, alkaloids and geopolitics, Codeine: uses, biosynthesis. Noscapine: uses. Opium: Historical background, cultivation, extraction, International Narcotics Control Board, morphine purification process. Tests for the determination of alkaloids of this category

- Bisbenzylisoquinoline alkaloids. Tubocurarine, Emetine, Cephaeline: Crude drug, plant, pharmacological action – uses

- Tryptophane alkaloids – indole alkaloids. Psilocybin, Psilocin: Origin, pharmacological effects. Physostigmine: Crude drug, plant, biosynthesis, pharmacological action - uses, synthetic derivatives. Ergot alkaloids – Lysergic acid alkaloids (Ergometrine, Ergotamine, Ergotoxin, Lysergic acid diethylamide - LSD): Biosynthesis of lysergic acid, pharmacological effect, crude drug, ergotism, ergot life cycle. Monoterpene indole alkaloids. Yohimbine: Crude drug, plant, pharmacological action - uses. Rauwolfia alkaloids – Reserpine, Strychnos alkaloids – Strychnine, Catharanthus alkaloids – Vinblastine, Vincristine: Crude drug, plant, pharmacological action - uses

- Quinoline alkaloids – Cinchona alkaloids: Quinine, Quinidine, crude drug, plant, biosynthesis of cinchona alkaloids, pharmacological action - uses

- Imidazole alkaloids – Pilocarpine: Crude drug, plant, biosynthesis of cinchona alkaloids, pharmacological action - uses, Veratrum alkaloids, Aconitum alkaloids

- Purine alkaloids: General, chemical structures, pharmacological action and uses, crude drugs with purine alkaloids. Caffeine, Theophylline, Theobromine, cultivation, processing of the crude drugs and output. Plants

- Fats and Waxes: Groups. Lipids: Categories, properties, industrial processing, role of lipids. Olivae oleum – Olive oil, Arachidis oleum – Arachis oil, Sesami oleum – Sesame oil, Amygdale oleum – almond oil, Gossypii oleum – Cottonseed oil, Sojae oleum – Soyabean oil, Maydis oleum – Maize oil, Lini oleum – Linseed oil, Ricini oleum – Castor oil, Cacao oleum – Cocoa butter: Drogue, plant, oil composition, uses. Adepts suilus (Lard). Waxes: Bees wax, Cetaceum – Spermaceti

- Licensing and quality control for drugs of plant origin, specifications of Pharmacopoeia, nutritional supplements, definition of herbal medicinal product – herbal substances – herbal preparations, Herbal Medicinal Products Committee: Authority, members and observer – countries of the Committee. Discrimination among “Well-Established Use” and “Traditional Use” herbal medicines, quality checks of herbal medicines, phytotherapy

Lab exercises:

LAB 1: INTRODUCTION – SAFETY PROTOCOLS

LAB 2: ISOLATION OF CAFFEINE FROM TEA LEAVES (1/2)

LAB 3: ISOLATION OF CAFFEINE FROM TEA LEAVES (2/2)

LAB 4: ISOLATION OF CAFFEINE FROM COFFEE BEANS

LAB 5: QUALITATIVE IDENTIFICATION OF ANTHRAQUINONES IN SENNA LEAVES

LAB 6: ISOLATION OF LYCOPENE FROM TOMATO

LAB 7: COLUMN CHROMATOGRAPHY OF SPINACH LEAVES

LAB 8: SEPARATION OF AMINOACIDS

LAB 9: Laboratory examination

Learning Activities and Teaching Methods:

Lectures, laboratory exercises, class discussion - tutorials

Assessment Methods:

Final exam, Midterm exam, Lab exam

Required Textbooks / Readings:

Title	Author(s)	Publisher	Year	ISBN
Drugs of Natural Origin: A Treatise of Pharmacognosy	Gunnar Sammuelson, Lars Bohlin	Swedish Pharmaceutical Press	2017	978-9198094251

Recommended Textbooks / Readings:

Title	Author(s)	Publisher	Year	ISBN
Natural Products and Drug Discovery	Subhash Mandal Vivekananda Mandal Tetsuya Konishi	Elsevier	2018	9780081020814
<i>Pharmacognosy: Fundamentals, Applications and Strategies</i>	Simone Badal McCreath Rupika Delgoda	Elsevier Science	2016	9780128021040
Textbook of Pharmacognosy and Phytochemistry	Shah Biren, Seth Avinash	Elsevier India	2014	9788131232606
Fundamentals of Pharmacognosy and Phytotherapy	Michael Heinrich, Joanne Barnes, Simon Gibbons, Elizabeth M. Williamson	Elsevier Health Sciences	2012	9780702052316, NOOK Book (E- Book)
Trease and Evans' Pharmacognosy	William Evans	Saunders Ltd.	2009	9780702041891 (eBook)
Medicinal Natural Products : A Biosynthetic Approach	Paul M. Dewick	Wiley	2009	978-0-470- 74168-9
WHO Monographs on Selected Medicinal Plants	World Health Organization		2002	9789240681651