FACULTY of CHEMISTRY

SUBJECT CARD

Name of subject in Polish: Naturalne Produkty Medyczne
Name of subject in English: Medicinal Natural Products
Main field of study (if applicable): Chemistry
Specialization (if applicable): Medicinal chemistry
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code CHC024015
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	Examination		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes	0.5		1		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of organic chemistry

SUBJECT OBJECTIVES

O1. To acquaint students with building blocks of primary plant metabolic pathways
O2. To familiarize students with building blocks of secondary plant metabolic pathways
O3. To acquaint students with the nature of active vegetal substances
O4. To acquaint students with the application possibilities of active vegetal substances
O5. To familiarize students with English terminology regarding natural medicinal products
O6. To familiarize students with the methods of isolation and identification of natural medicinal products

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 - knows the basic concepts of phytochemistry and chemistry of natural products,
PEK_W02 - can correctly classify plant building blocks,
PEK_W03 - has basic knowledge about plant metabolic pathways,
PEK_W04 - has general knowledge about coumarins,
PEK_W05 - has general knowledge about flavonoids and stilbenes,
PEK_W06 - has general knowledge about terpenes and steroids,
PEK_W07 - has general knowledge about alkaloids and glycosides,
PEK_W08 - has general knowledge about natural anticancer agents.
PEK_W09 - has knowledge of English terminology regarding natural medicinal products

relating to skills:

PEK_U01 - knows the basic rules of behavior while working in the organic chemistry laboratory,
PEK_U02 - knows practical methods of isolation of a biologically active compound from plant material,
PEK_U03 - is able to use distillation and extraction methods in the processes of natural product isolation,
PEK_U04 - can use chromatographic methods to identify and clean the isolated product
PEK_U05 - has the ability to determine the number of ester and acid

Lectures		Number of hours
Lec 1	**The development of phytochemistry and chemistry of natural products**. The lecture concerns the history of the use of biologically active substances of plant origin in the treatment of various diseases.	1
Lec 2-3	**Biologically active compounds found in plants.** Chemicals - biologically active compounds contained in plants with regard to sulfur compounds will be discussed.	2
Lec 4-5	**Building blocks.** The principle features of the biosynthesis of natural products have been elucidated during the past thirty years by the use of isotopic methods. It was discovered that large groups of natural products originate from the same biosynthetic precursor—the key building block. The conversion of key building blocks into biologically active natural products serves as a model for the development of more efficient syntheses in chemistry.	2
Lec 6-7	**Coumarins**. Coumarins are a group of active compounds that are characterized by a wide variety of pharmacological activities. This is directly related to differences in molecular structure of individual compounds. The most important properties of these active substances are: anticoagulant, spasmolytic, sedative, photosensitizing and light-absorbing. In terms of construction, coumarin is divided into: coumarin, furanocoumarins, piranocoumarins. Coumarins occur in nature as glycosides, but often under the influence of enzymes contained in dried raw materials, they hydrolyse. Coumarin solutions, except for unsubstituted coumarin, are characterized by their fluorescence capability.	2
Lec 8-10	**Flavonoids and stilbenes**. Flavonoids are substances commonly found in plants. Currently, we know about 7,000 flavone compounds, which are divided into: flavones, flavonols, flavanones, flavanols, isoflavones, anthocyanins, chalcones, aurons, flavonolignans and procyanidins. The basic structure of the molecule are benzene rings with a heterocyclic ring of pyran or pyrron. The presence of a large number of hydroxyl groups in the molecules makes the flavonoids exhibit antioxidant properties, and their strength depends on the number and position of hydroxyl groups - the more they are, the stronger the antioxidant effect. Flavonoids are natural, water-soluble chemicals, which in plants are dyes, antioxidants and provide protection against insects and fungi. They are common in all parts of plants: fruits, stems, flowers, leaves, roots and seeds. The most are in fruits (citrus), vegetables (beets), as well as in herbs, vines and cannabis, in which the content of flavonoids in leaves and flowers reaches even up to 2.5% of dry matter. The main task of flavonoids is plant protection, while at the cellular level they act as regulators of the cell cycle. Supplied with food to the human body, they exhibit high biological activity and have antioxidant, anti-inflammatory, antiallergic and anticancer properties. Stilbens are phytoestrogens - a group of non-steroidal vegetal compounds with structure and function similar to natural estrogens. They are present in all parts of plants - flowers, fruits, leaves, seeds and roots. They are usually in the form of inactive glycosides or in precursor form. Their active forms are formed in the digestive tract as a result of complex enzymatic and metabolic changes.	3
Lec 11-12	**Terpenes and steroids**. Terpenes (isoprenoids) are natural hydrocarbons of plant origin. Due to the physicochemical properties and biological activity shown by many compounds from the group terpenes and terpenoids, they have been successfully used in the cosmetics and pharmaceutical industries for a very long time. Terpenes and terpenoids are one of the largest classes of natural chemical substances. Over 30,000 of these compounds have been isolated from microorganisms, plants and animals. Steroids are organic chemical compounds, specific lipids, whose common feature is the presence in their molecules of a carbon skeleton in the form of four conjugated rings (sterane). In the tissues of plants and animals, up to now several hundred different steroids	2

	have been detected that perform various functions in their bodies. In physiology and medicine, the most important steroids are cholesterol and its derivatives as well as steroid hormones. Depending on the type of steroid, the skeleton may be extended in various ways by additional carbon atoms, forming, for example, the system of estran, androstane, pregnane, cholate and cholestan. Various functional groups can be attached to these systems, changing their biological activity to a wide extent.	
Lec 13-15	**Alkaloids and glycosides**. Alkaloids are a group of naturally occurring chemical compounds (generally heterocyclic), mainly of vegetable origin, containing nitrogen. Amino acids, peptides, proteins, nucleotides, nucleic acids, aminosugars and antibiotics are not usually included in alkaloids. In addition to this group of compounds are included some neutral chemical compounds biogenetically associated with alkaline alkaloids. Alkaloids usually have a strong, sometimes poisonous physiological effect on the human body. From a physiological point of view, alkaloids are "production wastes" that are not actively involved in cell metabolism. Glycosides - a group of organic chemical compounds made of sugar and aglycone parts. These are derivatives of sugars, whose semi-acetal -OH groups at the first carbon are replaced by other organic groups, e.g. -OR or -NR2. The binding between sugar and aglycon is called a glycosidic bond/linkage. Glycosides are compounds widely distributed in nature. Some of them have pharmacological significance, e.g. cardiac glycosides.	3
	Total hours	15
	Laboratory	**Number of hours**
Lab 1	**Organizational classes -** health and safety regulations, discussion of the program of classes and the conditions for passing the course.	2
Lab 2	**Alkaloids**, piperidine derivatives - isolation of piperine from black ground pepper. Application of TLC to product identification.	4
Lab 3	**Alkaloids -** nicotine, isolation of nicotine from tobacco leaves (cigarettes). Steam water distillation process.	4
Lab 4	**Vegetable fats** - isolation of trimyristin from nutmeg. Determination of the ester number. Hydrolysis of trimyristin to myristic acid. Determination of the acid number. I test.	4
Lab 5	**Steroids** - isolation of cholesterol from egg yolk.	4
Lab 6	**The role of lycopene and β-carotene in the body** - isolation of lycopene and β-carotene from tomatoes and carrots. Column chromatography.	4
Lab 7	**Triterpene alcohol** - isolation of betulin from birch bark. Continuous extraction.	4
Lab 8	**Terpenes** - eugenol from clove oil. Second test.	4
	Total hours	30

TEACHING TOOLS USED

N1. Lecture with multimedia presentation
N2. Laboratory classes - performing of experiments
N3. Laboratory classes - preparation of reports

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P (lecture)	PEK_W01-PEK_W09	Examination
F1 (laboratory)	PEK_U01-PEK_U03	I test
F2 (laboratory)	PEK_U03-PEK_U05	II test
F3 (laboratory)	PEK_U01-PEK_U05	The correctness of the

		performing of experiments and the preparation of reports
P (laboratory) = F1+F2+F3		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] P.M. Dewick, *Medicinal natural products*, Wiley 2009

[2] J. Sołoducho, J. Cabaj, *Medicinal natural products – laboratory*, elektroniczny skrypt do zajęć laboratoryjnych; **http://zasobynauki.pl/**

SECONDARY LITERATURE:

[3] St. Kohlmunzer, *Farmakognozja*, Wydawnictwo Lekarskie, PZWL 2003

[4] J. McMurry, *Chemia organiczna*, PWN 2012

[5] A.I. Vogel, *Preparatyka organiczna*, NT, 2006

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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