

天然药物化学教学大纲（双语版）

课程编号: 03.120.3.2

课程名称: 天然药物化学

Natural Products Chemistry

开课学院: 中药学院

College of herbal medicine

课程性质: 必修课

compulsory course

学 分: 5 分

5 points

学 时: 本课程总学时为 70 学时，其中课堂讲授 42 学时，实验 28 学时。

This course need 70 hours totally, which includes 42 hours lectures and 28 hours experiment training..

前期课程: 无机化学、有机化学、分析化学、色谱分析、波谱分析、药用植物学
Inorganic Chemistry、Organic chemistry、Analytical chemistry、Chromatography、Spectroscopy、Medicinal Botany

授课对象: 药学专业（本科生）

Pharmacy (Undergraduate students)

考核方式: 考试（期末考试）、实验考试、平时成绩主要通过课堂练习、出勤率进行评定。平时成绩占总成绩的 30%，实验成绩占总成绩的 20%，期末考试占总成绩的 50%。

Examination includes course behavior, experimental examinations and terminal examination. Course behavior score mainly depend on attendance rate and classroom quiz. Course behavior score usually accounts for 30%, experimental examinations accounts for 20%, terminal examination accounts for 50% of the total score.

课程简介:

主要讲述天然药物中具有生物活性或能起防病治病作用的化学成分，即有效成分的化学结构、物理化学性质、提取、分离、检识、结构鉴定或确定、生物合成途径和必要的化学结构的修饰或改造，以及有效成分的结构与药效之间的关系等基础理论和基本知识。

This courses is focused on the bioactive chemical components of natural products, which could be used to cure or prevent diseases. The main content of this course contains the fundamental knowledge and theory of the structures, physical and chemical properties, extraction and separation methods, identification methods, biosynthetic pathway, structural modification, structure-function relationships of the active compounds in the natural products.

大纲内容:

一、前言

【课程目的】《天然药物化学》是药学专业学生必修的一门专业课程，该课

程设置在有机化学、分析化学和光谱解析之后。目的在于培养学生掌握天然药物化学成分的理论和提取、分离、纯化方法及鉴定的技能，使之具有从事天然药物的生产和研究的能力。能为继承和发扬祖国中药事业和实现中药现代化服务。

Preface

" Natural Products Chemistry " is a compulsory professional courses to the pharmacy students. The course should be set behind the organic chemistry, analytical chemistry, and the spectral analysis course. The purpose is to train students to master the theories of natural medicine, chemical composition and extraction, separation, purification and identification of the skills so that they are engaged in the production of natural medicines and research capabilities. It is able to inherit and carry forward the achievement of traditional Chinese medicine and develop new drugs from them.

【教学要求】教材中所用的分类法是根据化学分类的原则，如苯丙素类、酮类、黄酮类、萜类、三萜及其苷类、甾体及其苷类、生物碱等。在讲授各类成分时所选择的实例应以能阐述教学内容为目的，从典型化合物的分子结构出发，阐明其理化性质，根据理化性质讲授提取、分离方法及检识方法，同时介绍该类化合物的重要代表成份及其重要中药中的代表成分。适当介绍研究新进展。

天然药物化学是一门理论和实验并重的课程。实验内容应包括重要的天然药物成分类型，如蒽醌、黄酮、萜类、生物碱等。实验内容以提取分离为主，检识鉴定为辅。应选择几种较为典型的提取分离方法，对每种药材原料要求分离得到几种单体成分，并达到一定纯度。检识鉴定方法应包括物理、化学和色谱方法。

Teaching materials used in the classification is based on chemical classification principles, such as phenylpropanoid classes, ketones, flavonoids, terpenoids, triterpenes and their glycosides, steroids and their glycosides, alkaloids and so on. The example structures chosen in every kind of principle should be able to articulate for the purpose of teaching content. Based on the typical example molecular structure, the sorts of structures will be clarified their physical and chemical properties. Then based on these physical and chemical nature, the knowledge of extraction, separation and identification of the sort of compounds will be learned by students. In every chemical classification principles, the important representative compounds and the traditional Chinese medicine which contains the class compounds will be highlight . It is proper to introduced new progress in every classification principles.

Natural Medicinal Chemistry is an equal emphasis on theoretical and experimental courses. Experiments should include the major types of natural medicines, such as anthraquinone, flavonoids, terpenoids, alkaloids and so on. The experiments are the first to train the students on extracting and isolating the constituents from raw herb materials, the second on how to identificate constituent structures. Several typical extraction and separation methods should be chosen in the lab course. , Several main rich constituents in a raw material should be obtained in

pure compounds with isolation. Physical, chemical and chromatographic methods will be used in the constituents identification.

二、教学要求和内容、方法

第一章 总论 Chapter 1 General remarks

【目的要求】

- 1.掌握常用的天然药物化学成分的提取、分离方法。
- 2.了解天然药物化学的任务及与其它课程的关系。
- 3.了解天然药物化学的发展史。
- 4.了解天然化合物分子结构测定的一般方法。

1. Grasp the extraction and separation method of natural medicines compounds commonly used.
2. Understanding of the mandate of Natural Medicinal Chemistry, and the relationship with other courses.
3. Understand the history of the development of natural medicinal chemistry.
4. Understanding of determination of a general way of the molecular structure of natural compounds,.

【教学内容】

- 1.天然药物化学的含义、学习任务及与其它课程的关系。
- 2.天然药物化学的发展史。
- 3.天然药物化学成分的提取分离方法。
- 4.天然药物化合物分子结构测定的一般方法。

1. The meaning of natural medicinal chemistry, learning tasks, and the relationship with other courses.
2. Natural History of Medicinal Chemistry.
3. Extraction and separation methods of Natural medicine chemical .
4. Determination of the molecular structure of natural pharmaceutical compounds in a general way.

【教学方式】

课堂讲授。Classroom teaching.

第二章 糖和苷 Chapter 2 Sugar and glycoside

【目的要求】

- 1.掌握苷的分类、糖的过碘酸氧化反应、苷键构型的测定。
- 2.熟悉苷键裂解的酸催化水解、乙酰解、碱催化水解、酶催化水解及糖的糠醛形成反应。
- 3.了解单糖、低聚糖和多糖的类型、糖的羟基反应、糖和苷的提取分离方法。

1. Master the classification of glycoside, sugar periodic acid oxidation and determination of glycoside bond configuration.

2. Familiar with the glycoside bond cleavage of acid-catalyzed hydrolysis, acetylation solution, base-catalyzed hydrolysis, enzymatic hydrolysis and sugar furfural formation reaction.
3. Understanding of the type of monosaccharides, oligosaccharides and polysaccharides of sugar hydroxyl reaction, extraction and separation of sugar and glycosides.

【教学内容】

- 1.单糖的立体化学。
- 2.糖和苷的分类。
- 3.糖的化学性质。
- 4.苷键的裂解。
- 5.糖的核磁共振性质。
- 6.糖链结构的测定。
- 7.糖和苷的提取分离方法。

1. Monosaccharide stereochemistry.
2. The classification of sugar and glucoside.
3. Chemical properties of sugar.
4. Glycoside bond cleavage.
5. NMR properties of sugar.
6. Determination of sugar chain structure.
7. Extraction and separation methods of sugar and glycosides.

【教学方式】

课堂讲授。Classroom teaching.

第三章 苯丙素类 Chapter3 Coumarins

【目的要求】

- 1.掌握香豆素的结构类型、化学性质（内酯性质和碱水解反应）、荧光鉴别反应。
- 2.熟悉香豆素的提取分离方法、波谱特征（红外光谱、氢核磁共振谱）、木脂素的理化性质。
- 3.了解苯丙素、木脂素的结构类型及提取分离方法。

1. Grasp the structure of coumarin type, chemical properties (lactone nature and alkaline hydrolysis reactions), fluorescent differential response.
2. Familiar with the method of extraction and separation of coumarin, spectral characteristics (IR, H NMR), physicochemical properties of lignans.
3. Understanding of structure types and extraction methods of phenylpropanoid and lignan.

【教学内容】

- 1.苯丙酸类。

2. 香豆素的结构类型。
3. 香豆素的化学性质。
4. 香豆素的分离方法。
5. 香豆素的波谱学特征。
6. 木脂素的结构类型。
7. 木脂素的理化性质。
8. 木脂素的提取分离。

1. Phenyl acids.
2. The structure type of coumarin.
3. Chemical properties of Coumarins.
4. Extraction of Coumarins.
5. The spectral characteristics of coumarin.
6. Structural types of lignans.
7. Physical and chemical properties of lignans.
8. Extraction of lignans.

【教学方式】

课堂讲授。Classroom teaching.

第四章 醌类化合物 Quinonoids

【目的要求】

1. 掌握蒽醌的化学结构、醌类化合物的理化性质、蒽醌的提取分离方法。
2. 熟悉蒽醌的红外光谱测定。
3. 了解苯醌、萘醌、菲醌的基本结构和分类。

1. Grasp the chemical structure of anthraquinone, the physical and chemical nature of quinone compounds, the method of extraction and separation of anthraquinone.
2. Familiar with infrared spectroscopy of anthraquinone.
3. Understanding of the classification and the basic structure of quinones benzoquinone, naphthoquinone.

【教学内容】

1. 醌类化合物的结构类型。
2. 醌类化合物的理化性质。
3. 醌类化合物的提取分离。
4. 醌类化合物的结构鉴定（紫外光谱及红外光谱）。

1. The structure type of Quinones.
2. The physical and chemical properties of Quinones.
3. Extraction and Separation of quinones.
4. Structural identification of quinones (UV spectra and infrared spectra).

【教学方式】

课堂讲授结合实验。Combination of classroom teaching experiment.

【实验内容】

实验二 虎杖中蒽醌类成分的提取、分离和鉴定

Exp.2 Extraction, isolation and identification of hydroxyanthraquinones from rhizomes of *Polygonum cuspidatum* sieb.et Zucc.

【目的要求】

- 1.掌握用溶剂法从虎杖中提取和分离游离羟基蒽醌的方法。
- 2.掌握 pH 梯度萃取法的原理和操作技术。
- 3.熟悉蒽醌类化合物的主要化学和色谱检识方法。

Purpose and request

1. Master the solvent extraction method to extract and isolate the Hydroxyanthraquinones in Rhizoma et Radix Polygoni Cuspidati.
2. Master the pH gradient Extraction.
3. Practise the Identification methods of Hydroxyanthraquinones.

【教学内容】

- 1.虎杖的提取一：用乙醇提取虎杖。
- 2.虎杖的提取二：回收乙醇，制备虎杖中总的乙醇提取物。
- 3.虎杖的分离：用 pH 梯度法及碱溶酸沉法分离不同酸性强弱的羟基蒽醌类化合物。
- 4.虎杖的鉴别：用硅胶 G 层析及显色反应鉴别大黄酸、大黄素、大黄酚及大黄素甲醚。

1. The extraction I : With the ethanol extract *Polygonum cuspidatum*.
2. The extraction II: Recovery ethanol and prepare total ethanol extract of *Polygonum cuspidatum*.
3. Isolation: Separate different acidic of the hydroxy anthraquinone compounds with the pH gradient method and the alkali-soluble acid-separation.
4. Identification: Identificate rhein, emodin, rhein and emodin phenol ether with Silica gel G chromatography and color reaction.

【教学方式】

课堂讲解主要实验内容并示教主要操作，其余内容由学生操作。

Explain the main experimental classroom content and teaching major operation, the rest of the students operate.

第五章 黄酮类化合物 Chapter 5 Flavonoids

【目的要求】

1.掌握黄酮类化合物的理化性质、显色反应、提取分离方法、紫外及可见光在黄酮类化合物鉴定中的应用；

2.熟悉黄酮类化合物的基本结构和分类、色谱检识方法、氢谱在黄酮类化合物结构测定中的应用；

3.了解黄酮类化合物的生物活性、生物合成途径。

1. Grasp the physical and chemical properties, color reaction, extraction and separation methods of flavonoids, UV and visible light in the flavonoids identified in the application;

2. Familiar with the basic structure and classification of knowledge chromatography inspection methods, NMR structure determination of Flavonoids in the application;

3. Understanding of the biological activity of flavonoids, biological pathway.

【教学内容】

1.黄酮类化合物概述；

2.黄酮类化合物的理化性质和显色反应；

3.黄酮类化合物的提取分离；

4.黄酮类化合物的检识与结构测定（色谱法、紫外及可见光谱、氢核磁共振谱）。

1. Overview of flavonoids;

2. Physicochemical properties and the color reaction of flavonoids;

3. Extraction and separation of flavonoids;

4. Inspection knowledge and structure determination (chromatography, ultraviolet and visible spectroscopy, hydrogen nuclear magnetic resonance spectrum) of flavonoids.

【教学方式】

课堂讲授结合实验。Combination of classroom teaching experiment.

【实验内容】

实验一 芦丁的提取和鉴定

Exp.1 Extraction, isolation and identification of Rutin and Quercetin from the buds of *Sophora japonica* L.(Huai hua mi)

【目的要求】

1.掌握通过碱溶酸沉、重结晶操作获得纯品芦丁的方法。

2.掌握通过芦丁的水解和槲皮素的重结晶得到纯品槲皮素的方法。

3.学习通过用化学法、层析法鉴定黄酮类化合物的方法。

1.Master the methods of purifying rutin by alkali dissolving, acid settlement and recrystallization;

2. Master the methods of obtaining pure quercetin by the hydrolysis of Rutin.
3. Study the methods of identification of flavone and flavonoid glycosides by using chemical and chromatographic methods.

【教学内容】

1. 槐花米的提取：用水加热提取槐花米中的芦丁。
2. 槐花米的精制及水解：粗制的芦丁一部分用水重结晶，另一部分加酸水解。
3. 槐花米的鉴别一：用聚酰胺层析鉴别芦丁及槲皮素，用纸层析鉴别葡萄糖及鼠李糖。
4. 槐花米及糖的鉴别二：用显色反应鉴别芦丁及槲皮素。

1. Extraction of rutin from Sophora flowers buds: Extract rutin from *Sophora japonica* L with heated water.
2. Hydrolysis of Rutin to produce quercetin: re-crystallize rutin crude as part of water, and hydrolysis the other part of the added acid.
3. Identification of rutin, quercetin and saccharide (flavonoids nature test) I : Differentiate rutin and quercetin with Polyamide chromatography, and differentiate glucose and rhamnose with paper chromatography.
4. Identification of rutin, quercetin and saccharide (flavonoids nature test) II : Differentiate rutin and quercetin with the color reaction.

【教学方式】

课堂讲解主要实验内容并示教主要操作，其余内容由学生操作。

Explain the main experimental classroom content and teaching major operation, the rest of the students operate.

第六章 萜类和挥发油 Chapter 6 Terpenes and volatile oils

【目的要求】

1. 掌握萜类的理化性质（化学性质：加成反应）、挥发油的化学组成和性质、挥发油的提取分离方法。
 2. 熟悉主要萜类的结构类型以及其重要代表物、萜类的提取分离方法、挥发油成分的鉴定。
 3. 了解萜类化合物的含义和分类、生物合成途径。
1. To master the physical and chemical nature of the terpenoid (chemical properties: addition reaction), chemical composition and nature of volatile oil , the extraction methods of volatile oil.
 2. To familiar with the structure of the major terpene and an important representative of the type as well as its objects, method of extraction and separation of terpenoids, volatile oil components identified.
 3. Learn the meaning of terpenoids and classification and biosynthetic pathways.

【教学内容】

1. 萜类化合物的概述。
 2. 萜类的结构类型及其重要代表物。
 3. 萜类化合物的理化性质。
 4. 萜类化合物的提取分离。
 5. 挥发油的概述和性质。
 6. 挥发油的提取分离方法。
 7. 挥发油成分的鉴定
1. Overview of Terpenes;
 2. Structure types of Terpenoid and their key representatives of objects;
 3. Physicochemical properties and the color reaction of Terpenes;
 4. Extraction and separation of Terpenes;
 5. Overview of volatile oil;
 6. Extraction and separation of volatile oil;
 7. Determination of volatile oil.

【教学方式】

课堂讲授。Classroom teaching.

第七章 三萜及其苷类 Chapter 7 Triterpenoids and their glycosides

【目的要求】

1. 掌握三萜及其苷类的理化性质。
 2. 熟悉三萜类的主要结构类型及其重要代表物、提取分离方法。
 3. 了解三萜类的生物活性及生物合成途径。
1. Master physical and chemical properties of triterpenoids and their glycosides .
 2. Familiar with the main structure types of triterpenes and their key representatives of objects, extraction separation method.
 3. Understanding of the biological activity of triterpenes and biological pathway.

【教学内容】

1. 三萜类化合物的结构类型（四环三萜、五环三萜）。
 2. 三萜类化合物的理化性质。
 3. 三萜类化合物的提取分离
1. Structure types of triterpenoids;
 2. Physicochemical properties and the color reaction of triterpenoids;
 3. Extraction and separation of triterpenoids.

【教学方式】

课堂讲授。Classroom teaching.

第八章 甾体及其苷类 Chapter 8 Steroid and their glycosides

【目的要求】

1. 掌握强心苷及甾体皂苷的理化性质。

2.熟悉强心苷及甾体皂苷的结构类型及其重要代表物、强心苷及甾体皂苷的提取分离方法、强心苷的波谱学特征（紫外可见光谱）、甾体皂苷的波谱学特征（红外光谱）。

3.了解甾体化合物的结构和分类、强心苷的生物合成途径。

1. Master physical and chemical properties of cardiac glycosides and steroidal saponins.
2. Familiar with the structure types of cardiac glycosides and steroidal saponins and important representative of their objects; the extraction method of cardiac glycosides and steroidal saponins; spectral characteristics (UV-Vis spectra)of cardiac glycosides, spectroscopy features (infrared spectroscopy)of steroidal saponins.
3. Understanding of classification of steroid structure and biosynthetic pathway of cardiac glycosides.

【教学内容】

- 1.甾体化合物的概述。
- 2.强心苷的化学结构和实例。
- 3.强心苷的理化性质。
- 4.强心苷的波谱学特征（紫外）。
- 5.强心苷的提取分离。
- 6.甾体皂苷的化学结构和实例。
- 7.甾体皂苷的理化性质。
- 8.甾体皂苷的波谱学特征（红外）。
- 9.甾体皂苷的提取分离。

1. Overview of steroidal saponins;
2. Structure types of cardiac glycosides and their key representatives of objects;
3. Physicochemical properties and the color reaction of cardiac glycosides;
4. Spectral characteristics (UV-Vis spectra)of cardiac glycosides;
5. Extraction and separation of cardiac glycosides;
6. Structure types of steroidal saponins and their key representatives of objects;
7. Physicochemical properties and the color reaction of steroidal saponins;
8. Spectroscopy features (infrared spectroscopy)of steroidal saponins;
9. Extraction and separation of steroidal saponins;

【教学方式】

课堂讲授。Classroom teaching.

第九章 生物碱 Chapter 9 alkaloids

【目的要求】

1. 掌握生物碱的理化性质、提取分离方法。
2. 熟悉生物碱的类型及其重要代表物、主要药用生物碱的提取分离方法。
3. 了解生物碱的定义、存在形式、分布、生物合成原理、生物碱结构鉴定与

测定的相关知识。

1. To master the physical and chemical nature of the alkaloid and extraction separation method.
2. To familiar with the type of alkaloid and their key representatives of objects, the main method of medicinal alkaloids.
3. Understand the definition of alkaloids, forms, distribution, bio-synthesis principle, identification and determination of relevant knowledge.

【教学内容】

- 1.生物碱的概述。
- 2.生物碱的分类。
- 3.生物碱的理化性质。
- 4.生物碱的提取分离。
- 5.生物碱结构鉴定与测定。

1. Overview of alkaloids;
2. Structure types of alkaloids;
3. Physicochemical properties of alkaloids;
4. Extraction and separation of alkaloids;
5. Identification and determination of alkaloids.

【教学方式】

课堂讲授与实验。Combination of classroom teaching experiment.

【实验内容】

实验三 中药化学成分的预试验

Chapter 3 The preparative test on chemical components of TCM

【目的要求】

1. 学习中药化学成分预试验的方法及原理。
2. 掌握中药中未知成分经初步提取分离后进行预试验的程序，熟悉各主要成分的试管（瓷反应板）试验、颜色反应、沉淀反应、荧光性质和纸层析、薄层层析等方法，并根据试验结果判断所含有的化学成分类型。

1. To learn the method and principle of preparative test on chemical component of TCM.
2. From this experiment, students will learn how to extract unknown nature products, know the color test or precipitation reaction of the main constituents, comprehend the method of TLC and PC, and estimate the categories of

constituents depending on the results.

【教学内容】利用系统溶剂提取法制备预实验样品溶液，用各类型化合物的特征显色反应鉴定各类成分的存在：

Preparation of the pre-test sample solution with the solvent extraction system, using the characteristics of various types and the color reaction of compounds, identify the types of components exist.

1. 粉防己中生物碱的鉴别。
2. 虎杖中羟基蒽醌的鉴别。
3. 槐花米中黄酮的鉴别。
4. 秦皮中香豆素的鉴别。
5. 知母中甾体皂苷的鉴别。

1. Identification of alkaloid from *Stephania tetrandra*
2. Identification of hydroxy-antraquinone from *Polygonum cuspidatum*
3. Identification of flavonoids from *Sophora japonica* L.
4. Identification of coumarins form *Cortex Fraxini*
5. identification of steroidal saponins from *Anemarrhena asphodeloides*

【教学方式】

课堂讲解主要实验内容并示教主要操作，其余内容由学生操作。

Explain the main experimental classroom content and teaching major operation, the rest of the students operate.

三、课时分配

教学内容	讲课 时数	实验内容	实验 时数
总论	5	实验一 芦丁的提取和鉴定	10
第二章 糖和苷类化合物	5		10
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四、主要参考书目

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