

## 课程详述

### COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	<b>课程名称 Course Title</b>	有机化学 <b>Organic Chemistry</b>
2.	<b>授课院系 Originating Department</b>	南方科技大学伦敦国王学院医学院 SUSTech-KCL School of Medicine
3.	<b>课程编号 Course Code</b>	JEIS103
4.	<b>课程学分 Credit Value</b>	3
5.	<b>课程类别 Course Type</b>	专业基础课 Major Foundational Courses
6.	<b>授课学期 Semester</b>	秋季 Fall
7.	<b>授课语言 Teaching Language</b>	英语 English
8.	<b>授课教师、所属学系、联系方式 (如属团队授课, 请列明其他授课教师) Instructor(s), Affiliation &amp; Contact (For team teaching, please list all instructors)</b>	Hailiang HU, School of Medicine, <a href="mailto:huhl@sustech.edu.cn">huhl@sustech.edu.cn</a>
9.	<b>实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact</b>	To be announced
10.	<b>选课人数限额(可不填) Maximum Enrolment (Optional)</b>	

11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other (Please specify)	总学时 Total
学时数 Credit Hours	48	0	0	0	48
12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	无 N/A				
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite					
14. 其它要求修读本课程的学系 Cross-listing Dept.					

### 教学大纲及教学日历 SYLLABUS

#### 15. 教学目标 Course Objectives

The Organic Chemistry course/module aims to provide students with the basic principles to understand the structure and reactivity of organic molecules, especially the bioorganic macromolecules, with examples illustrating the role of organic chemistry in Biomedical Science.

有机化学课旨在为学生提供基础理论知识以便于学生理解有机分子，尤其是生物有机大分子的结构及反应活性，用实际例子去阐明有机化学在生物医学科学学科的重要性。

#### 16. 预达学习成果 Learning Outcomes

On successful completion of this course, students should be able to:

1. understand basic concepts and employ the vocabulary of organic chemistry;
2. draw correct structural representations of organic molecules;
3. understand the basic principles of structure and reactivity of organic molecules;
4. understand the reactivity of the functional groups; write reasonable mechanisms for transformations of common functional groups (alcohols, ethers, carbonyl compounds, aldehydes, ketones, carboxylic acids, acyl halides, anhydrides, esters, amides, nitriles, and amines);
5. determine structures of organic compounds based on spectroscopic data

修读完本课程的学生应:

1. 能够理解有机化学的基本概念，并能够有效的运用其中的专业名词；
2. 能够形象地画出有机分子的结构表达式；
3. 理解有机分子结构和反应活性的基本原则；
4. 能够理解官能团的反应活性以及合理地解释常见官能团的转换机制（醇、醚、羟基化合物、醛、酮、酰卤化合物、羧酸酐、酯类、酰胺、氰类和胺）；

5. 能够根据色谱数据判断出有机化合物的结构。

17. 课程内容及教学日历（如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）  
**Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)**

(教学内容：中英双语)

## 1. 有机化学 绪论

有机化学的起源；原子结构理论；键的形成；八隅体规则；路易斯结构；多重键；电负性和键极性；形式电荷；离子结构；共振；分子结构；分子式和实验式；阿伦尼乌斯酸碱；路易斯酸碱。

### Introduction and Review

The origins of organic chemistry; Principles of atomic structure; Bond formation: the Octet rule; Lewis structure; Multiple bonding; Electronegativity and bond polarity; Formal charges; Ionic structure; Resonance; Structural formulas; Molecular formulas and empirical formulas; Arrhenius acids and bases; Lewis acids and bases.

## 2. 立体化学

手性；不对称碳原子的(R)、(S)命名；光学活性；外消旋混合物；对映体过量和光学纯度；手性构象的移动系统；没有不对称碳原子的手性化合物；费舍尔投影式；非对映异构体；含两个或更多不对称碳原子分子的立体化学；内消旋化合物；绝对构型和相对构型；非对映异构体的物理性质；对映异构体的拆分。

### Stereochemistry

Chirality; (R) and (S) nomenclature of asymmetric carbon atoms; Optical activity; Racemic mixtures; Enantiomeric excess and optical purity; Chirality of conformationally mobile systems; Chiral compounds without asymmetric atoms; Fischer projections; Diastereomers; Stereochemistry of molecules with two or more asymmetric carbons; Meso compounds; Absolute and relative configuration; Physical properties of diastereomers; Resolution of enantiomers.

## 3. 核磁共振光谱和质谱

核磁的介绍；核磁共振理论；电子的磁屏蔽；核磁共振谱图；化学位移；峰个数；峰面积；自旋裂分；碳谱；解析核磁谱图；质谱的介绍；通过质谱确定分子式；质谱的裂解方式。

### Nuclear Magnetic Resonance Spectroscopy and Mass Spectroscopy

Introduction of nuclear magnetic; Theory of nuclear magnetic resonance; Magnetic shielding by electrons; The NMR spectrometer; The chemical shift; The number of signals; Areas of the peaks; Spin-spin splitting; Carbon-13 NMR spectroscopy; Interpreting carbon NMR spectra; Introduction to Mass spectrometry; Determination of the molecular formula by mass spectrometry; Fragmentation patterns in mass spectrometry.

## 4. 烷烃和烯烃的结构

烷烃的命名；烷烃的物理性质；烷烃的应用及来源；烷烃的反应；烷烃的结构与构象；环烷烃；环己烷的构象；单取代环己烷的构象；双取代环己烷的构象；烯烃的命名。

烯烃双键的轨道描述；不饱和元素；烯烃的商业用途；烯烃的稳定性；烯烃的物理性质；通过卤代烃的消除反应生成烯烃；醇脱水合成烯烃；高温工业合成烯烃。

### Structure of Alkanes and Alkenes

Nomenclature of alkanes; Physical properties of alkanes; Uses and sources of alkanes; Reactions of alkanes; Structure and conformations of alkanes; Cycloalkanes; Cyclohexane conformations; Conformations of monosubstituted cyclohexanes; Conformations of disubstituted cyclohexanes.

Nomenclature of alkenes; The orbital description of the alkene double bond; Elements of unsaturation; Commercial importance of alkenes; Stability of alkenes; Physical properties of alkenes; Alkene synthesis by elimination of alkyl halides; Alkene synthesis by dehydration of alcohols; Alkene synthesis by high-temperature industrial methods.

## 5. 卤代烃

卤代烃的命名; 卤代烃的日常用途; 卤代烃的结构; 卤代烃的物理性质; 卤代烃的制备; 卤代烃的反应; 取代反应与消除反应; 二阶亲核取代;  $SN_2$  反应; 常见的  $SN_2$  反应; 影响  $SN_2$  反应的因素; 亲核试剂的强度;  $SN_1$ :  $SN_1$  反应的立体化学;  $SN_1$  反应中的重排现象; 比较  $SN_1$  和  $SN_2$  反应; 一阶消除反应;  $E1$  反应; 发生消除反应的位置; 扎伊采夫规则; 二阶消除反应;  $E2$  反应的立体化学; 比较  $E1$  反应和  $E2$  反应。

### Alkyl Halides

Nomenclature of alkyl halides; Common uses of alkyl halides; Structure of alkyl halides; Physical properties of alkyl halides; Preparation of alkyl halides; Reactions of alkyl halides: substitution and elimination; Second-order nucleophilic substitution: The  $SN_2$  reaction; Generality of the  $SN_2$  reaction; Factors Affecting  $SN_2$  reactions: strength of the nucleophile; Reactivity of the substrate in  $SN_2$  reactions; Stereochemistry of the  $SN_2$  reaction; First-order nucleophilic substitution: the  $SN_1$  reaction; Stereochemistry of the  $SN_1$  reaction; Rearrangements in  $SN_1$  reactions; Comparison of  $SN_1$  and  $SN_2$  reactions; First-Order elimination: the  $E1$  reaction; Positional orientation of elimination: Zaitsev's Rule; Second-order elimination: the  $E2$  reaction; Stereochemistry of the  $E2$  reaction; Comparison of  $E1$  and  $E2$  elimination mechanisms.

## 6. 醇的结构

醇的命名; 醇的结构及分类; 醇的物理性质; 醇的商业用途; 醇和多酚的酸性; 醇的合成; 简介; 用有机金属试剂合成醇; 醇的合成; 将有机金属试剂加成到羰基化合物上; 有机金属试剂的副反应; 卤代烃的还原; 合成  $1^\circ$ 、 $2^\circ$  醇; 去羰基化; 硫醇。

### Structure of Alcohols

Nomenclature of alcohols; Structure and classification of alcohols; Physical properties of alcohols; Commercially important alcohols; Acidity of alcohols and phenols; Synthesis of alcohols: Introduction and Review; Organometallic reagents for alcohol synthesis; Synthesis of alcohol: addition of organometallic reagents to carbonyl compounds; Side reactions of organometallic reagents: reduction of alkyl halides; Synthesis of  $1^\circ$  and  $2^\circ$  alcohols: reduction of the carbonyl group; Thiols (Mercaptans).

## 7. 醚、环氧化合物和硫化物

醚、环氧化合物和硫化物的命名; 醚的物理性质; 醚的光谱特征; 醚的合成;  $HBr$ 、 $HI$  对醚的碳氧键断裂反应; 醚的自身氧化; 环氧化合物的合成; 酸催化环氧化合物的开环反应; 碱催化的开环反应; 环氧化合物开环反应的取向; 环氧化合物与格氏试剂和有机锂的反应; 环氧树脂; 现代胶水的出现; 硫化物。

## Ethers, Epoxides, and Sulfides

Nomenclature of ethers, epoxides and sulphides; Physical properties of ethers; Spectroscopy of ethers; Synthesis of ethers; Cleavage of ethers by HBr and HI; Autoxidation of ethers; Synthesis of epoxides; Acid-catalyzed ring opening of epoxides; Base-catalyzed ring opening of epoxides; Orientation of epoxide ring opening; Reactions of epoxides with Grignard and organolithium reagents; Epoxy Resins: The advent of modern glues; Sulfides (Thioethers).

## 8. 酮和醛

酮和醛的命名; 羰基的结构; 酮和醛的物理性质; 酮和醛的光谱特征; 醛和酮的工业应用; 合成醛和酮; 醛和酮的反应; 亲核加成; 醛和酮的氢化; 缩醛树脂的形成; 氰醇的形成; 亚胺的形成; 羟胺和胍缩合反应; Wittig 反应; 醛的氧化; 酮和醛的还原。

## ketones and aldehydes

Nomenclature of ketones and aldehydes; Structure of the carbonyl group; Physical properties of ketones and aldehydes; Spectroscopy of ketones and aldehydes; Industrial importance of ketones and aldehydes; Syntheses of ketones and aldehydes; Reactions of ketones and aldehydes: nucleophilic addition; Hydration of ketones and aldehydes; Formation of acetals; Formation of Cyanohydrins; Formation of Imines; Condensations with hydroxylamine and hydrazines; The Wittig reaction; Oxidation of aldehydes; Reductions of ketones and aldehydes.

## 9. 羧酸

羧酸的命名; 羧酸的结构和物理性质; 羧酸的酸性; 羧酸盐; 羧酸的市场来源; 羧酸的光谱性质; 羧酸的合成; 酸和醇的缩合反应; Fischer 酯化反应; 应用重氮甲烷酯化; 酸和胺的缩合反应; 直接合成胺; 酸性氯化物的合成与应用; 羧酸的还原; 羧酸的烷基化生成酮。

## Carboxylic Acids

Nomenclature of carboxylic acids; Structure and physical properties of carboxylic acids; Acidity of carboxylic acids; Salts of carboxylic acids; Commercial sources of carboxylic acids; Spectroscopy of carboxylic acids; Synthesis of carboxylic acids; Condensation of acids with alcohols: the Fischer esterification; Esterification using diazomethane; Condensation of acids with amines: direct synthesis of amides; Synthesis and Use of Acid Chlorides; Reduction of carboxylic acids; Alkylation of carboxylic acids to form ketones.

## 10. 羧酸衍生物

酸衍生物的结构与命名; 羧酸衍生物的物理性质; 羧酸衍生物的光谱特征; 亲和酰取代的羧酸衍生物的相互转化; 酯交换; 羧酸衍生物的水解; 羧酸衍生物的花园; 羧酸衍生物和有机金属试剂的反应; 碳酸酯和酰胺。

## Carboxylic Acids Derivatives

Structure and nomenclature of acid derivatives; Physical properties of carboxylic acid derivatives; Spectroscopy of carboxylic acid derivatives; Interconversion of acid derivatives by nucleophilic acyl substitution; Transesterification; Hydrolysis of carboxylic acid derivatives; Reduction of acid derivatives; Reactions of acid derivatives with organometallic reagents; Esters and Amides of Carbonic Acid.

## 11. 胺

胺的命名；胺的结构；胺的物理性质；胺的碱性；胺碱性的影响因素；胺盐；胺盐是一种相转换催化剂；胺的光谱性质；芳香胺和吡啶的芳香取代；烷基化生成烷基卤代胺；酰化反应生成胺酰氯；磺胺类化合物的形成；胺作为离去基团；Hofmann 消除反应；胺的氧化反应；消除反应的处理；胺与亚硝酸的反应；芳基重氮的反应；还原胺化的作用合成胺；酰化作用生成胺；一级胺的合成限制。

### Amine

Nomenclature of amines; Structure of amines; Physical properties of amines; Basicity of amines; Effects on amine basicity; Salts of amines; Amine salts as phase-transfer catalysts; Spectroscopy of amines; Aromatic substitution of arylamines and pyridine; Alkylation of amines by alkyl halides; Acylation of amines by acid chlorides; Formation of sulphonamides; Amines as leaving groups: the Hofmann elimination; Oxidation of amines; the cope elimination; Reactions of amines with nitrous acid; Reactions of arenediazonium salts; Synthesis of amines by reductive amination; Synthesis of amines by acylation-reduction; Syntheses limited to primary amines.

## 12. 芳基化合物

苯的发现；芳基化合物的命名；苯的结构与性质；苯的分子轨道；芳基化合物、反芳基化合物和非芳基化合物；Hückel's 规则；Hückel's 规则引出分子轨道；芳基离子；杂环芳香族化合物；多核芳香族碳氢化合物；芳香碳的同素异形体；稠杂环化合物；苯及其衍生物的物理性质；芳香族化合物的光谱特征。

### Aromatic Compounds

The discovery of benzene; Nomenclature of aromatic compounds; The structure and properties of benzene; The molecular orbitals of benzene; Aromatic, antiaromatic, and nonaromatic compounds; Hückel's Rule; Molecular Orbital Derivation of Hückel's Rule; Aromatic ions; Heterocyclic aromatic compounds; Polynuclear aromatic hydrocarbons; Aromatic allotropes of carbon; Fused heterocyclic compounds; Physical properties of benzene and its derivatives; Spectroscopy of aromatic compounds.

## 13. 脂

蜡；甘油三酸酯；脂肪和油脂的皂化；肥皂和洗涤剂；磷脂；类固醇；萜烯；前列腺素

### Lipids

Waxes; Triglycerides; Saponification of fats and oils; soaps and detergents; Phospholipids; Steroids; Terpenes; Prostaglandins.

## 14. 碳水化合物-糖类

碳水化合物的分类；单糖；赤式和苏式非对映异构体；异构体；单糖的环状结构；单糖的差向异构体；旋光性；单糖的反应；碱中的副反应；单糖的还原反应；单糖的氧化反应；还原糖；非还原糖；葡萄糖的形成；酯和醚的形成；苯肼的反应；脎的形成；链的缩短；Ruff 降解；链的增长；Kiliani-Fischer 合成；Fischer 证明了葡萄糖的构型；测量和换的大小；高碘酸裂解糖；双糖；多糖。

## Carbohydrates

Classification of carbohydrates; Monosaccharides; Erythro and threo diastereomers; Epimers; Cyclic structures of monosaccharides; Anomers of monosaccharides; mutarotation; Reactions of monosaccharides: side reactions in base; Reduction of monosaccharides; Oxidation of monosaccharides; reducing sugars; Nonreducing sugars: formation of glycosides; Ether and ester formation; Reactions with phenylhydrazine: osazone formation; Chain shortening: The Ruff degradation; Chain lengthening: The Kiliani-Fischer synthesis; Fischer's proof of the configuration of glucose; Determination of ring size; periodic acid cleavage of sugars; Disaccharides; Polysaccharides.

## 15. 氨基酸、多肽和蛋白质

$\alpha$ -氨基酸的结构和立体化学; 氨基酸的酸碱性质; 等电点和电泳; 氨基酸的合成; 氨基酸的拆分; 氨基酸的反应; 多肽和蛋白质的命名以及结构; 多肽结构的鉴定; 液相肽合成; 固相肽合成; 蛋白质的分类; 蛋白质结构的分级; 蛋白质的变性。

### Amino Acids, Peptides, and Proteins

Structure and stereochemistry of the  $\alpha$ -amino acids; Acid-base properties of amino acids; Isoelectric points and electrophoresis; Synthesis of amino acids; Resolution of amino acids; Reactions of amino acids; Structure and Nomenclature of Peptides and Proteins; Peptide structure determination; Solution-phase peptide synthesis; Solid-phase peptide synthesis; Classification of proteins; Levels of protein structure; Protein denaturation.

## 16. 核酸

核酸; 简介; 核糖核苷和核苷酸; 核糖核酸的结构; 脱氧核糖和脱氧核糖核酸的结构; 核苷酸的加成作用。

### Nucleic acids

Nucleic acids: introduction; Ribonucleosides and Ribonucleotides; The structure of Ribonucleic acid; Deoxyribose and the structure of deoxyribonucleic acid; Additional functions of nucleotides.



Section	Topic	Hours
1	Introduction and Review	3
2	Stereochemistry	3
3	Nuclear Magnetic Resonance Spectroscopy and Mass Spectroscopy	3
4	Structure of Alkanes and Alkenes	3
5	Alkyl Halides	3
6	Structure of Alcohols	3
7	Ethers, Epoxides, and Sulfides	3
8	ketones and aldehydes	3
9	Carboxylic Acids	3
10	Carboxylic Acids Derivatives	3
11	Amine	3
12	Aromatic Compounds	3
13	lipids	3
14	Carbohydrates	3
15	Amino Acids, Peptides, and Proteins	3
16	Nucleic acids	3

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**18. 教材及其它参考资料 Textbook and Supplementary Readings**

Textbook:

- *Organic Chemistry for students of Medicine and Biology, Huazhong University of Science and Technology Press 2011*

Supplementary Readings:

- *Organic Chemistry, 9<sup>th</sup> Edition, LU Yang, LUO Meiming, LI Zhulai, LI Fasheng, Ren Min Wei Sheng Press 2018*

### 课程评估 ASSESSMENT

19. 评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance		10		
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments		30		
期中考试 Mid-Term Test		30		
期末考试 Final Exam		30		
期末报告 Final Presentation				
其它（可根据需要 改写以上评估方 式） Others (The above may be modified as necessary)				

### 20. 记分方式 GRADING SYSTEM

- A. 十三级等级制 Letter Grading  
 B. 二级记分制（通过/不通过） Pass/Fail Grading

### 课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过

**This Course has been approved by the following person or committee of authority**

The course has been reviewed and approved by the JEI New Course Review Panel Meeting (新课程审核小组会议纪要)

It is a fundamental physics course/module required by the BMS curriculum. The instructor is competent and has experience teaching the course/module, and the course content and Syllabus are appropriate for the BMS curriculum. The required teaching facility is available.

The teaching materials were reviewed. Their political, ideological, scientific and applicability meet the requirements of the JEI, and no issues are observed in their political standpoint and value orientation.

Signature of the Executive Dean:

Date: