



北京大學
PEKING UNIVERSITY

有机化学 (B)

ORGANIC CHEMISTRY

主讲人：莫凡洋

材料科学与工程学院

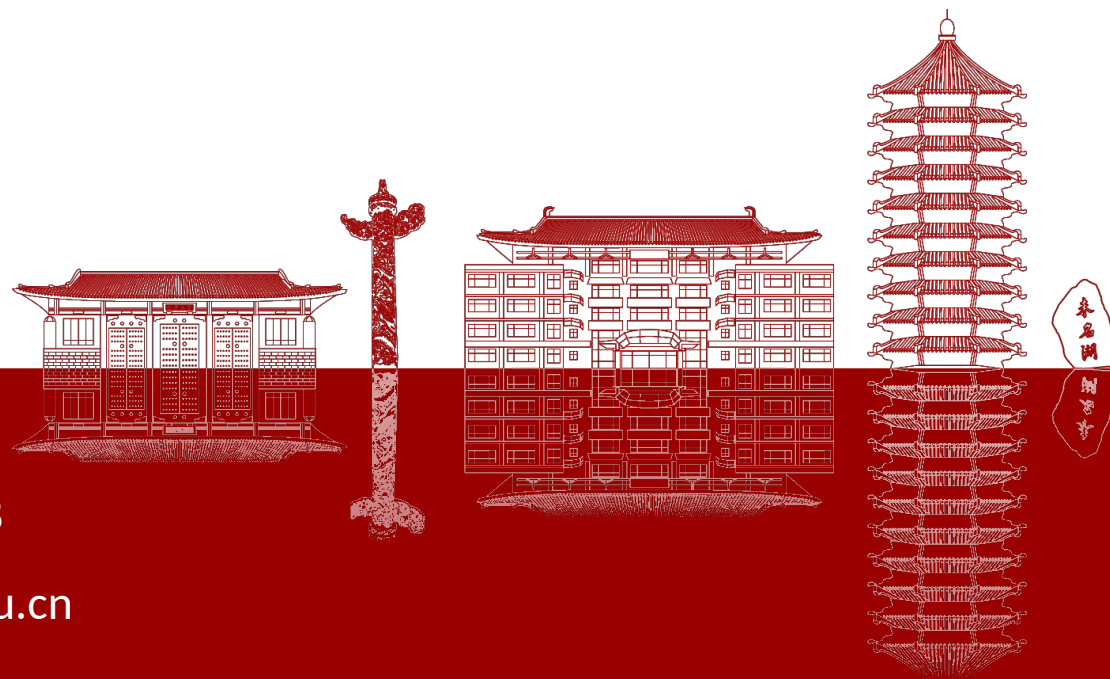
助教：连畅 工学院能源系 2020 级博士生 lianchang@stu.pku.edu.cn



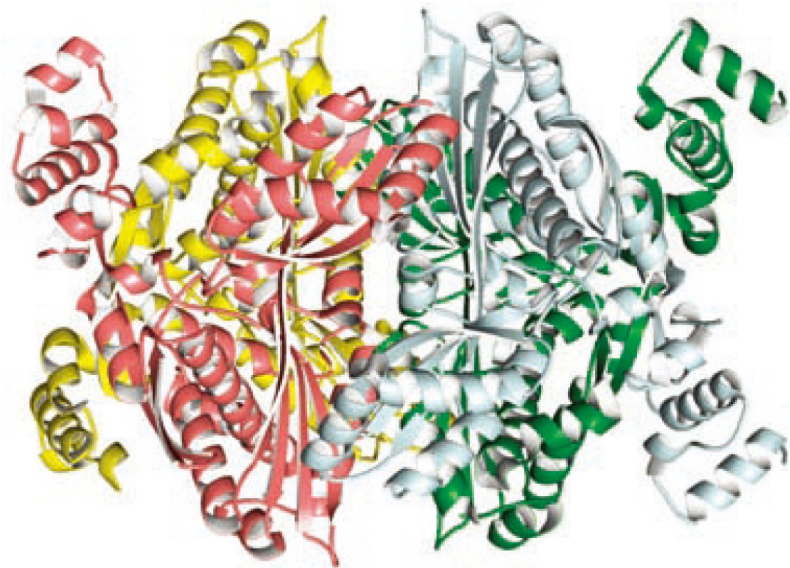
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fmo@pku.edu.cn



0 绪论



The enzyme HMG-CoA reductase, shown here as a so-called ribbon model, catalyzes a crucial step in the body's synthesis of cholesterol. Understanding how this enzyme functions has led to the development of drugs credited with saving millions of lives.

0.1 目的和要求

- 为工学院能源、材料、生医专业本科生开设
- 系统地、较好地掌握有机化合物的命名、结构、物理性质、化学性质及应用。
- 掌握有机立体化学的基础知识和基本概念。
- 了解各类化合物的基本性质。
- 了解官能团对化合物性质的影响，分析化合物的结构与性能的关系及其重要反应的反应机理和规律，初步掌握用电子理论、立体化学、空间效应等分析解释反应机理。
- 了解分离、提纯有机混合物的一般方法，掌握有机化合物官能团的特征及定性鉴定方法。



0.2 教学安排与参考书

- 本课程 4 学分，64 个学时。按照有机化合物的分类逐章讲解。
- 中文参考书：《基础有机化学》邢其毅、裴坚等；英文参考书：<Organic Chemistry>, John McMurry, the 8th Ed.



8e

Organic Chemistry

John McMurry
Cornell University

BROOKS/COLE
CENGAGE Learning

Australia • Brazil • Japan • Korea • Mexico • Singapore • Spain • United Kingdom • United States

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0.3 成绩评定

- 平时成绩：出勤及课堂表现，占总成绩的 15%。
- 作业情况：占总成绩的 15%。
- 课堂 *pre*：15 分钟，占总成绩 20%。
- 期末考试：占总成绩 50%。



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How dangerous is the pesticide being sprayed on this crop?

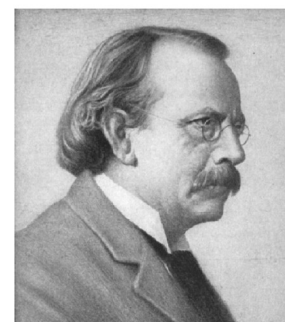
Organic Foods: Risk versus Benefit | A DEEPER LOOK

Contrary to what you may hear in supermarkets or on television, *all* foods are organic—that is, complex mixtures of organic molecules. Even so, when applied to food, the word *organic* has come to mean an absence of synthetic chemicals, typically pesticides, antibiotics, and preservatives. How concerned should we be about traces of pesticides in the food we eat? Or toxins in the water we drink? Or pollutants in the air we breathe?

Life is not risk-free—we all take many risks each day without even thinking about it. We decide to ride a bike rather than drive, even though there is a ten times greater likelihood per mile of dying in a bicycling accident than in a car. We decide to walk down stairs rather than take an elevator, even though 7000 people die from falls each year in the United States. Some of us decide to smoke cigarettes, even though it increases our chance of getting cancer by 50%. But what about risks from chemicals like pesticides?



Ernest Rutherford
(1871-1937)
1908 Nobel Chemistry Prize



J. J. Thomson
(1856-1940)
1906 Nobel Physics Prize



Erwin Schrödinger
(1887-1961)
1933 Nobel Physics Prize



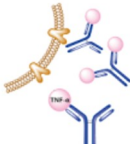
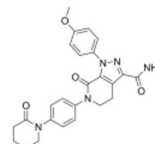
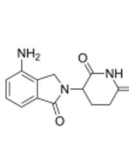
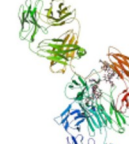
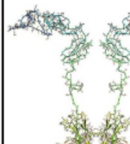
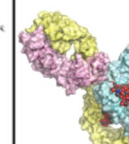
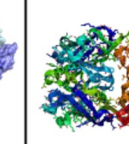
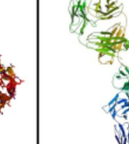
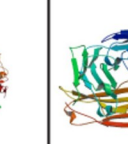
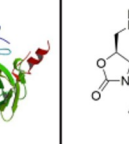
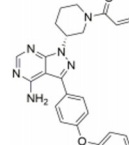
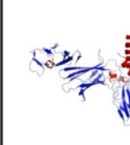
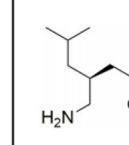
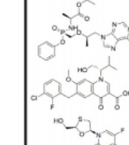
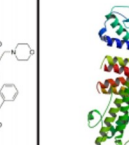
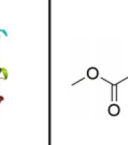
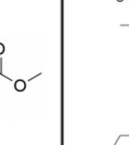
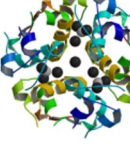
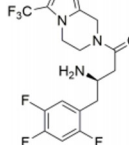
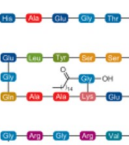
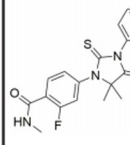
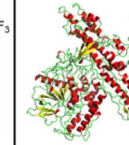
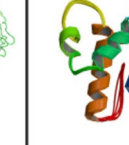
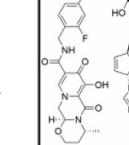
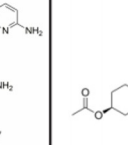
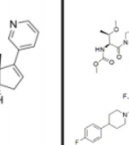
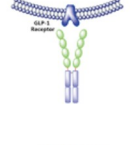
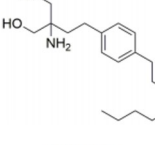
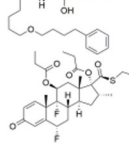
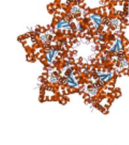
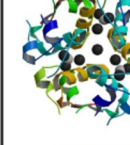
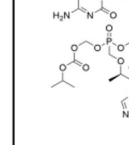
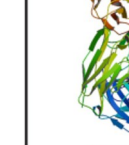
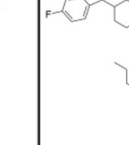
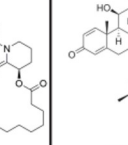
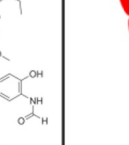
0.4 为什么要学习有机化学

- 有机化合物与人们今天的物质生活息息相关。



0.4 为什么要学习有机化学

- 2018 年零售销售额最高的 200 种药品中，有 124 种有机小分子药物。

1 Humira (Adalimumab)  \$20.467 Billion Immunology	2 Eliquis (Apixaban)  \$9.871 Billion Cardiovascular Diseases	3 Revlimid (Lenalidomide)  \$9.685 Billion Oncology	4 Opdivo (Nivolumab)  \$7.566 Billion Oncology	5 Enbrel (Etanercept)  \$7.45 Billion Immunology	6 Keytruda (Pembrolizumab)  \$7.171 Billion Oncology	7 Herceptin (Trastuzumab)  \$7.051 Billion Oncology	8 Avastin (Bevacizumab)  \$6.917 Billion Oncology	9 Mabthera (Rituximab)  \$6.819 Billion Oncology	10 Xarelto (Rivaroxaban)  \$6.58 Billion Cardiovascular Diseases
11 Eylea (Aflibercept)  \$6.545 Billion Ophthalmology	12 Remicade (Infliximab)  \$6.442 Billion Autoimmune Disorders	13 Imbruvica (Ibrutinib)  \$6.205 Billion Oncology	14 Pprevnar 13 (Pneumococcal 7-Valent Conjugate)  \$5.803 Billion Vaccine	15 Stelara (Ustekinumab)  \$5.25 Billion Immunology	16 Lyrica (Pregabalin)  \$5.216 Billion Neurological Disorders	17 Genvoya (Biltegravir, Cobicistat, Emtricitabine, Tenofovir Alafenamide)  \$4.624 Billion Infectious Diseases	18 Neulasta (Pegfilgrastim)  \$4.475 Billion Blood Disorders	19 Tecfidera (Dimethyl Fumarate)  \$4.274 Billion Neurological Disorders	20 Ibrance (Palbociclib)  \$4.118 Billion Oncology
21 Lantus (Insulin Glargine)  \$4.028 Billion Diabetes	22 Lucentis (Ranibizumab)  \$3.721 Billion Ophthalmology	23 Januvia (Sitagliptin)  \$3.686 Billion Diabetes	24 Victoza (Liraglutide)  \$3.649 Billion Diabetes	25 Xtandi (Enzalutamide)  \$3.649 Billion Oncology	26 Botox (Onabotulinumtoxin A)  \$3.577 Billion Renal Disorders	27 Soliris (Eculizumab)  \$3.563 Billion Blood Disorders	28 Triumeq (Abacavir, Dolutegravir & Lamivudine)  \$3.521 Billion Infectious Diseases	29 Zytiga (Abiraterone Acetate)  \$3.498 Billion Oncology	30 Mavyret (Glecaprevir & Pibrentasvir)  \$3.438 Billion Infectious Diseases
31 Trulicity (Dulaglutide)  \$3.392 Billion Diabetes	32 Gilenya (Fingolimod)  \$3.341 Billion Neurological Disorders	33 Advair (Fluticasone Propionate & Salmeterol)  \$3.221 Billion Respiratory Disorders	34 Gardasil 9 (HPV 9-Valent Vaccine)  \$3.151 Billion Vaccine	35 Humalog (Insulin Lispro)  \$2.997 Billion Diabetes	36 Truvada (Emtricitabine & Tenofovir Disoproxil)  \$2.997 Billion Infectious Diseases	37 Xolair (Omalizumab)  \$2.97 Billion Respiratory Disorders	38 Invega Sustenna (Paliperidone Palmitate)  \$2.928 Billion Neurological Disorders	39 Symbicort (Budesonide & Formoterol)  \$2.925 Billion Respiratory Disorders	40 Cosentyx (Secukinumab)  \$2.837 Billion Immunology

0.4 为什么要学习有机化学

- 有机化学作为重要基础学科仍然充满活力，是一门极具创新性的学科。
- 有机化学自身的发展，为相关学科的发展奠定基础。
- 有机化学是一门实用性很强的科学，是一系列相关工业的基础。



0.5 有机化学的定义

- 有机化学 (*Organic Chemistry*) 这个名词是在 1806 年由瑞典化学家 *J. Berzelius* 贝采里乌斯首先提出来的。意思是指“有生机之物”。
- 当时所有已知的有机物都是从生物体内分离出来的。

1769-1785年:

葡萄汁 → 酒石酸

酸牛奶 → 乳酸

苹果 → 苹果酸

尿 → 尿素

柠檬汁 → 柠檬酸

1802年:

离析出植物碱类药物-金鸡纳碱, 辛可宁等

1805年:

鸦片 → 吗啡

1815年:

动物脂肪 → 胆固醇



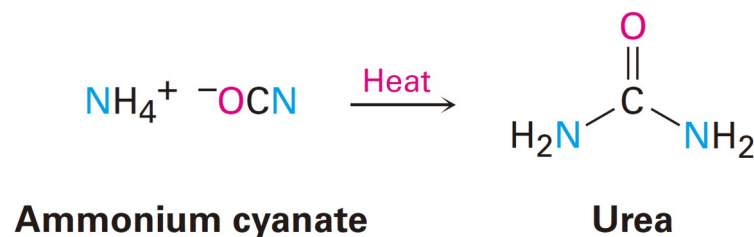
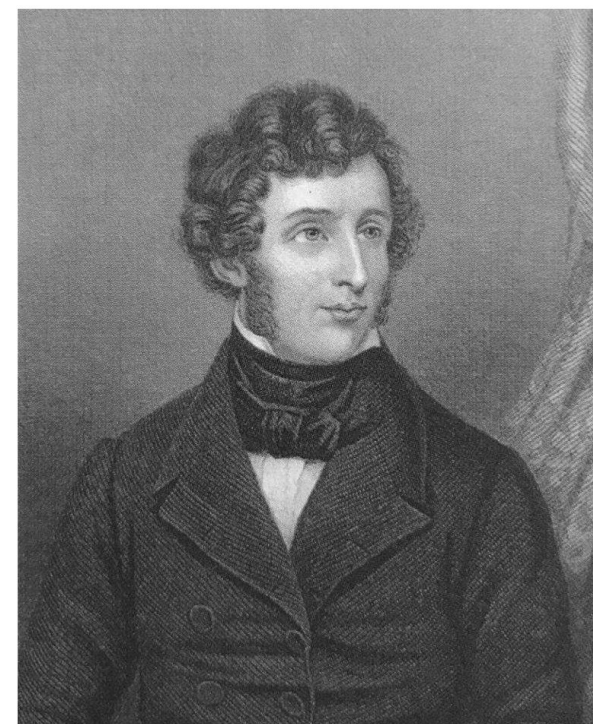
Jons Jakob Berzelius
(1779 - 1848)



0.5 有机化学的定义

- 人们认识到，有机物与矿石、金属盐等物质在组成、结构上有很大的区别。
- 当时人们对生命现象的本质没有认识，认为有机物只能在生物细胞中受一种特殊力量的作用才能产生出来，是“生命力”创造的。然而

Little more than a decade later, the vitalistic theory suffered still further when Friedrich Wöhler discovered in 1828 that it was possible to convert the “inorganic” salt ammonium cyanate into the “organic” substance urea, which had previously been found in human urine.



Friedrich Wöhler
(1800-1882)



0.5 有机化学的定义

- 有机化学是研究碳的化学——*Gmelin* 葛美林 (1848) ；有机化学是研究碳氢化合物及其衍生物的化学——*C. Schorlemmer* 肖莱马 (1874) 。
- 有机化学是研究含碳化合物的结构、性能与合成的科学。

Figure 1.1 The position of **carbon** in the periodic table. Other elements commonly found in organic compounds are shown in the colors typically used to represent them.

Group 1A																		8A	
H																		He	
Li	Be											3A	4A	5A	6A	7A		Ne	
Na	Mg											Al	Si	P	S	Cl		Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br		Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I		Xe	
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At		Rn	
Fr	Ra	Ac																	



0.6 有机化合物的特征

- 都含有碳原子 (CO 、 CO_2 、 H_2CO_3 等除外)。
- 种类繁多，约有几千万种以上。比较于无机化合物，虽涉及的元素遍布整个周期表，但却只有几万种。
- 碳原子可以形成比较稳定的共价键，包括直链、支链、环状、单键、双键、三键等。
- 易燃 (最终燃烧产物为 CO_2 和水)、熔点低、难溶于水。
- 通常反应速度慢、易发生副反应。



0.7 有机化学与能源

- 化石能源——煤，石油和天然气——都是有机化合物。



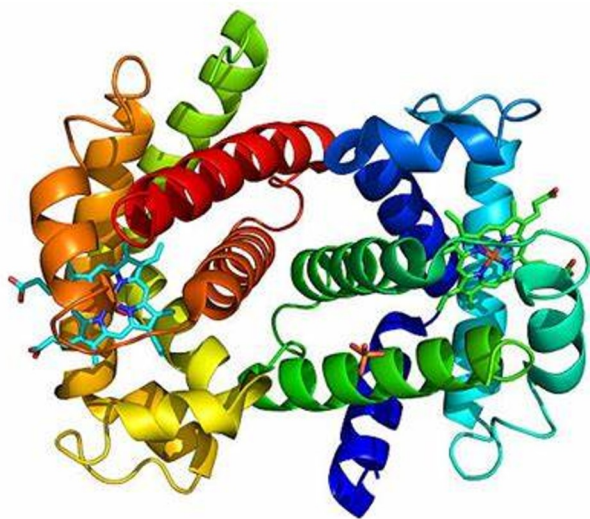
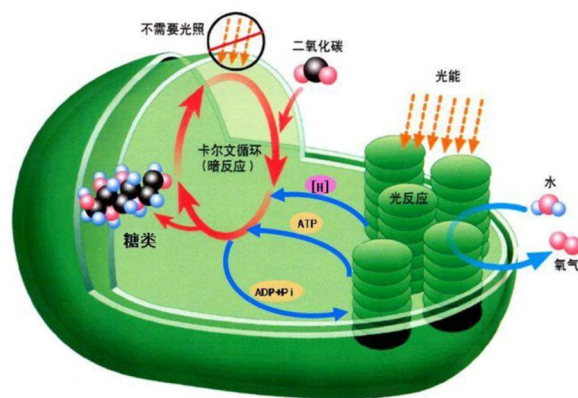
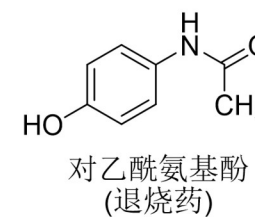
0.8 有机化学与材料

- 90% 以上的日用品都是有机材料构成的。



0.9 有机化学与生医

- 生命的物质基础是有机化合物；生命活动底层是分子的化学反应；药品绝大部分上都是通过有机合成得到的。



北京大学的有机化学学科

- 1958 年，胰岛素化学结构的解析工作获得诺贝尔化学奖。《自然》发表评论文章说：合成胰岛素将是遥远的事情。可能是在同时，遥远的中国却正式开启了这个“遥远”的事情——人工合成胰岛素。几年后，由**中国科学院生化所、有机所以及北京大学**精干技术力量组成的中国团队成功将“遥远”锁定为 7 年。后来的《科学》杂志登载了题为《红色中国的胰岛素全人工合成》的数页长评。



中国是世界上第一个合成蛋白质的国家！



左二为 邢其毅 先生

0.10 正式开始学习

- 让我们一起开始有机化学的学习吧！

