


地方应用型本科教学内涵建设成果系列丛书

生物化学

简明双语教程

CONCISE BILINGUAL COURSE OF BIOCHEMISTRY

编者 陈梦玲 崔竹梅 翟春

 南京大学出版社

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图书在版编目(CIP)数据

生物化学简明双语教程: 汉、英 / 陈梦玲, 崔竹梅,
翟春编. — 南京: 南京大学出版社, 2016. 12

(地方应用型本科教学内涵建设成果系列丛书)

ISBN 978-7-305-17956-3

I. ①生… II. ①陈… ②崔… ③翟… III. ①生物化
学—双语教学—高等学校—教材—汉、英 IV. ①Q5

中国版本图书馆 CIP 数据核字(2016)第 298523 号

出版发行 南京大学出版社

社 址 南京市汉口路 22 号 邮编 210093

出版人 金鑫荣

丛 书 名 地方应用型本科教学内涵建设成果系列丛书

书 名 生物化学简明双语教程

编 者 陈梦玲 崔竹梅 翟 春

责任编辑 刘 飞 蔡文彬 编辑热线 025-83686531

照 排 南京理工大学资产经营有限公司

印 刷 虎彩印艺股份有限公司

开 本 787×1092 1/16 印张 18.75 字数 433 千

版 次 2016 年 12 月第 1 版 2016 年 12 月第 1 次印刷

ISBN 978-7-305-17956-3

定 价 42.00 元

网 址: <http://www.njupco.com>

官方微博: <http://weibo.com/njupco>

微信服务号: njyuyexue

销售咨询热线: (025)83594756



PPT: 生物化学
简明双语教程

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前 言

全球经济一体化、国际化的快速推进以及我国复合型人才培养的要求对高等教育产生了巨大影响。教育部 2001 年发布《关于加强高等学校本科教学工作提高教学质量的若干意见》(4 号文件)指出:逐步推广和实行本科生教育中公共基础课和专业必修课的双语教学,是培养新时期我国复合型创新人才的重要基础。2007 年教育部启动的“高等学校教学质量与教学改革工程”,将双语课程建设作为拓宽大学生国际视野的一项重要措施。因此,对于高等学校开设双语课程的必要性与重要性已经毋庸置疑。生物化学这门学科具有特殊性,其课程内容建立在英文基础上,因为课程中的实验和理论大多源于国外科学家的研究。此外,生物化学科学研究的最新进展也几乎都以全英文的形式发表在相关的国际专业杂志上。因此,高校开展双语教学有利于学生在系统学习生物化学基础理论的同时提高实际英文应用能力,获取学科前沿知识以及掌握相关的专业英语词汇和表达方式,成为更具有竞争能力的复合型创新人才。对于地方应用型本科高校而言,双语教学显得迫切且具有现实意义。

尽管我国各大高校双语教学探索已有若干年,但教材的跟进始终显得滞后。没有合适的教材是目前双语教学面临的困难之一。虽然多数老牌高校喜欢直接采用外语原版教材,但对于地方应用型本科院校来说,单纯使用外语原版教材往往会出现两大问题:一是“水土不服”,外语原版教材中许多针对西方发达国家的案例不适合直接“拿来”;二是“篇幅大、阅读难度大”,学生由此产生畏惧和退缩心理。另外,以英语原版教材作为主、以中文教材为辅的这种“复线型”教材形式存在缺陷,学生往往会依赖中文教材而忽视原版教材的学习。因此,编写小组经过反复讨论与征求学生意见,坚持以外文“原汁原味”为基础,根据引进的经典英文原版教材改编,保证语言纯正;同时考虑双语教学的课时有限,只选取本学科需要重点掌握的内容进行编写,篇幅适中,减轻学生负担。

生物化学是多个专业的基础课,不同专业对该课程知识需求的侧重不同。本教材包括三大部分内容,即结构生物化学、新陈代谢和信息大分子。对于食品类专业而言,结构生物化学和新陈代谢是食品专业学生学习的重点,为后续



专业课程包括食品化学、食品营养学、食品分析、食品理化检验、食品保藏原理与技术以及功能性食品等奠定基础。对于信息大分子这部分内容,则相对简明扼要,有别于生命科学相关专业,突出应用型人才培养的理念。

本书图文并茂,特别注重双语教学的需要,兼顾学生参差不齐的英语水平,将重要的英文生化专业名词与术语均在文中标出相应的中文。英文段落内容根据其难易程度采取两种方式处理:简单内容用中文进行段落大意归纳,复杂内容采用中文进行段落翻译。本书主要参考的英文教材是 Trudy Mckee 等主编的“Biochemistry: An Introduction(second edition)”。此外,将部分中文教材的内容择其精华编译到本教材中。每个章节之后都附有关键词汇表、思考题等。本书适用于地方应用型本科高校食品科学与工程、食品质量与安全、化学、农学、发酵工程、环境科学等专业进行中英双语教学的学生使用。

由于编者水平有限,时间仓促,书中难免存在不足及疏漏之处,敬请读者批评指正。

编者
2016年8月



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Introduction 引言

Biochemistry, sometimes called **biological chemistry**, is the study of chemical processes in living organisms (生物体), including, but not limited to, living matter. Biochemistry governs all living organisms and living processes. By controlling information flow (信息流) through biochemical signalling (生物化学信号) and the flow of chemical energy (化学能量流) through metabolism (代谢), biochemical processes give rise to (导致) the incredible complexity (难以置信的复杂性) of life. Much of biochemistry deals with the structures and functions of cellular components such as proteins (蛋白质), carbohydrates (糖), lipids (脂质), nucleic acids (核酸) and other biomolecules (生物分子) although increasingly processes rather than individual molecules are the main focus. Over the last 40 years biochemistry has become so successful at explaining living processes that now almost all areas of the life sciences (生命科学) from botany (植物) to medicine (医学) are engaged in biochemical research. Today the main focus of pure biochemistry (纯粹生物化学) is in understanding how biological molecules give rise to the processes that occur within living cells which in turn relates greatly to the study and understanding of whole organisms.

Among the vast number of different biomolecules, many are complex (复合物) and large molecules (called biopolymers 生物大分子, 生物聚合物), which are composed of similar repeating subunits (亚单位) (called monomers 单体). Each class of polymeric biomolecule has a different set of subunit types. For example, a protein is a polymer whose subunits are selected from a set of 20 or more amino acids (氨基酸). Biochemistry studies the chemical properties (化学性质) of important biological molecules, like proteins, and in particular the chemistry of enzyme-catalyzed reactions (酶促反应).

生物化学的含义。

生物化学研究对象的复杂性。

生物化学的成就。

当今纯粹生物化学的主要焦点是了解生物分子在活细胞内如何工作,这极大地关系到对整个生物体的研究和理解。

生物分子以及生物大分子的含义。



人类对生命物质的认识过程。

生物化学的起源及早期发展。

“生物化学”学科术语的确立。

促使生物化学迅速发展的诸多相关科学技术。

The biochemistry of cell metabolism(新陈代谢) and the endocrine system(内分泌系统) has been extensively(广泛地) described. Other areas of biochemistry include the genetic code (DNA, RNA)(遗传密码), protein synthesis(蛋白质合成), cell membrane transport(细胞跨膜运输), cell membrane transfer and signal transduction(信号转导).

It once was generally believed that life and its materials had some essential property(本质属性) or substance distinct from(不同于) any found in non-living matter(非生命物质), and it was thought that only living beings(有机体, 生物) could produce the molecules of life. Then, in 1828, Friedrich Wohler published a paper on the synthesis of urea(尿素合成), proving that organic compounds(有机化合物) can be created artificially(人工地).

The dawn of biochemistry(生物化学的开端) may have been the discovery of the first enzyme(酶), diastase(淀粉糖化酶) (today called amylase 淀粉酶), in 1833 by Anselme Payen. Eduard Buchner contributed(出版) the first demonstration(论证) of a complex biochemical process(复杂的生化反应) outside of a cell in 1896: alcoholic fermentation(乙醇发酵) in cell extracts(细胞萃取物) of yeast(酵母). Although the term “biochemistry” seems to have been first used in 1882, it is generally accepted that the formal coinage(正式使用) of biochemistry occurred in 1903 by Carl Neuberg, a German chemist. Previously, this area would have been referred to as(被称为) physiological chemistry(生理化学). Since then, biochemistry has advanced, especially since the mid-20th century, with the development of new techniques such as chromatography(色谱分析法), X-ray diffraction(X射线衍射), dual polarisation interferometry(双偏振干涉法), NMR spectroscopy(核磁共振波谱法), radioisotopic labeling(放射性同位素的标记), electron microscopy(电子显微镜) and molecular dynamics simulations(分子动力学模拟). These techniques allowed for the discovery and detailed analysis of many molecules and metabolic pathways(代谢途径) of the cell, such as glycolysis(糖酵解) and the Krebs cycle (citric acid cycle 三羧酸循环).



Another significant historic event(有历史意义的事件) in biochemistry is the discovery of the gene(基因) and its role in the transfer of information in the cell(在细胞信息传递中所起的作用). This part of biochemistry is often called molecular biology(分子生物学). In the 1950s, James D. Watson, Francis Crick, Rosalind Franklin, and Maurice Wilkins were instrumental(有帮助的) in solving DNA structure(DNA 结构) and suggesting its relationship with genetic transfer of information(遗传信息的传递). In 1958, George Beadle and Edward Tatum received the Nobel Prize for work in fungi(真菌) showing that one gene(基因) produces one enzyme(酶). In 1988, Colin Pitchfork was the first person convicted of murder(谋杀罪名成立) with DNA evidence(DNA 证据), which led to growth of forensic science(司法鉴定). More recently, Andrew Z. Fire and Craig C. Mello received the 2006 Nobel Prize for discovering the role of RNA interference (RNAi) (RNA 干扰), in the silencing(沉默) of gene expression(基因表达).

生物化学的分支,分子生物学的由来。

分子生物学的研究领域。

分子生物学研究成果及其应用。

Today, there are three main types of biochemistry. Plant biochemistry(植物生物化学) involves the study of the biochemistry of autotrophic organisms(自养有机体) such as photosynthesis(光合作用) and other plant specific biochemical processes(特定的生化过程). General biochemistry(普通生物化学) encompasses(包含) both plant and animal biochemistry. Human/medical/medicinal biochemistry(人体/医疗/医药生物化学) focuses on the biochemistry of humans and medical illnesses(疾病).

生物化学的主要类型及研究对象。

The four main classes of molecules in biochemistry are carbohydrates, lipids, proteins, and nucleic acids. Many biological molecules are polymers(高分子聚合物): in this terminology(术语), monomers(单分子) are relatively small micromolecules(小分子) that are linked together to create large macromolecules(大分子), which are known as polymers. When monomers are linked together to synthesize(合成) a biological polymer, they undergo a process called dehydration synthesis(脱水缩合).

生物分子的类别。

Part I
Structural Biochemistry

结构生物化学



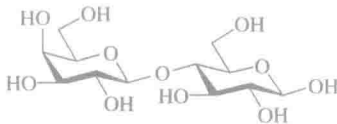
Chapter 1 Carbohydrates 糖类

Carbohydrate (pronounced /kɑː bəˈhaɪdrɪt/) is an organic compound (有机化合物) with the empirical formula (通式) $C_m(H_2O)_n$ (where m could be different from n); that is, consists only of carbon, hydrogen, and oxygen (仅由 C、H、O 组成), with a hydrogen:oxygen atom ratio (氢氧原子比) of 2:1 (as in water). Carbohydrates can be viewed as hydrates (水合物) of carbon, hence their name. Structurally however, it is more accurate to view them as polyhydroxy aldehydes and ketones (多羟基的醛和酮).

糖的化学组成。

The term is most common in biochemistry, where it is a synonym (同义词) of saccharide (糖). The carbohydrates (*saccharides*) are divided into four chemical groupings: monosaccharides (单糖), disaccharides (二糖), oligosaccharides (寡糖), and polysaccharides (多糖). In general, the monosaccharides and disaccharides, which are smaller (lower molecular weight) carbohydrates, are commonly referred to as sugars. The word *saccharide* comes from the Greek word *σάκχαρον* (*sákkharon*), meaning "sugar". While the scientific nomenclature (术语) of carbohydrates is complex, the names of the monosaccharides and disaccharides very often end in the suffix -ose (单糖、二糖通常以后缀 -ose 结尾). For example, blood sugar is the monosaccharide glucose, table sugar (蔗糖) is the disaccharide sucrose, and milk sugar is the disaccharide lactose (see illustration (插图)).

糖的分类。



Lactose is a disaccharide found in milk. It consists of a molecule of *D*-galactose and a molecule of *D*-glucose bonded by *beta*-1-4 glycosidic linkage. It has a formula of $C_{12}H_{22}O_{11}$.

乳糖是一种在牛奶中发现的二糖。它由一分子 *D*-半乳糖和一分子 *D*-葡萄糖通过 β -1-4 糖苷键组成。



糖类在生命体中的重要作用。

糖类是食品的重要组成部分。

以前化学家认为具有通式 $C_m(H_2O)_n$ 的化合物是糖类, 据此一些化学家认为甲醛是最简单的糖。目前“糖”这个术语的生物学意义, 把仅含有一个或两个碳原子的化合物排除在外。

Carbohydrates perform numerous roles(多种角色) in living things. Polysaccharides serve for the storage of energy(贮藏能量) (e. g., starch(淀粉) and glycogen(糖原)), and as structural components(结构成分) (e. g., cellulose in plants(植物中的纤维素) and chitin in arthropods(节肢动物中的几丁质)). The 5 - carbon monosaccharide ribose(核糖) is an important component of coenzymes(辅酶) (e. g., ATP, FAD, and NAD) and the backbone(主链) of the genetic molecule(遗传分子) known as RNA.

The related deoxyribose(脱氧核糖) is a component of DNA. Saccharides and their derivatives(衍生物) include many other important biomolecules that play key roles(重要角色) in the immune system(免疫系统), fertilization(受精), preventing pathogenesis(抗病原体), blood clotting(血液凝固), and development(发育). In food science(食品科学) and in many informal contexts(日常生活中), the term carbohydrate often means any food that is particularly rich in the complex carbohydrate starch(such as cereals, bread, and pasta)(在糖淀粉复合物中含量丰富, 例如谷类、面包、面食) or simple carbohydrates, such as sugar(found in candy, jams(果酱), and desserts(甜点)).

1.1 Structure 结构

Formerly(以前) the name “carbohydrate” was used in chemistry for any compound(化合物) with the formula $C_m(H_2O)_n$. Following this definition(由于这个定义), some chemists considered formaldehyde(甲醛) CH_2O to be the simplest carbohydrate, while others claimed that title for glycolaldehyde(羟乙醛). Today the term is generally understood in the biochemistry sense(生物学意义), which excludes(除了) compounds with only one or two carbons.

Natural(自然界) saccharides are generally built of(由……组成) simple carbohydrates called monosaccharides with general