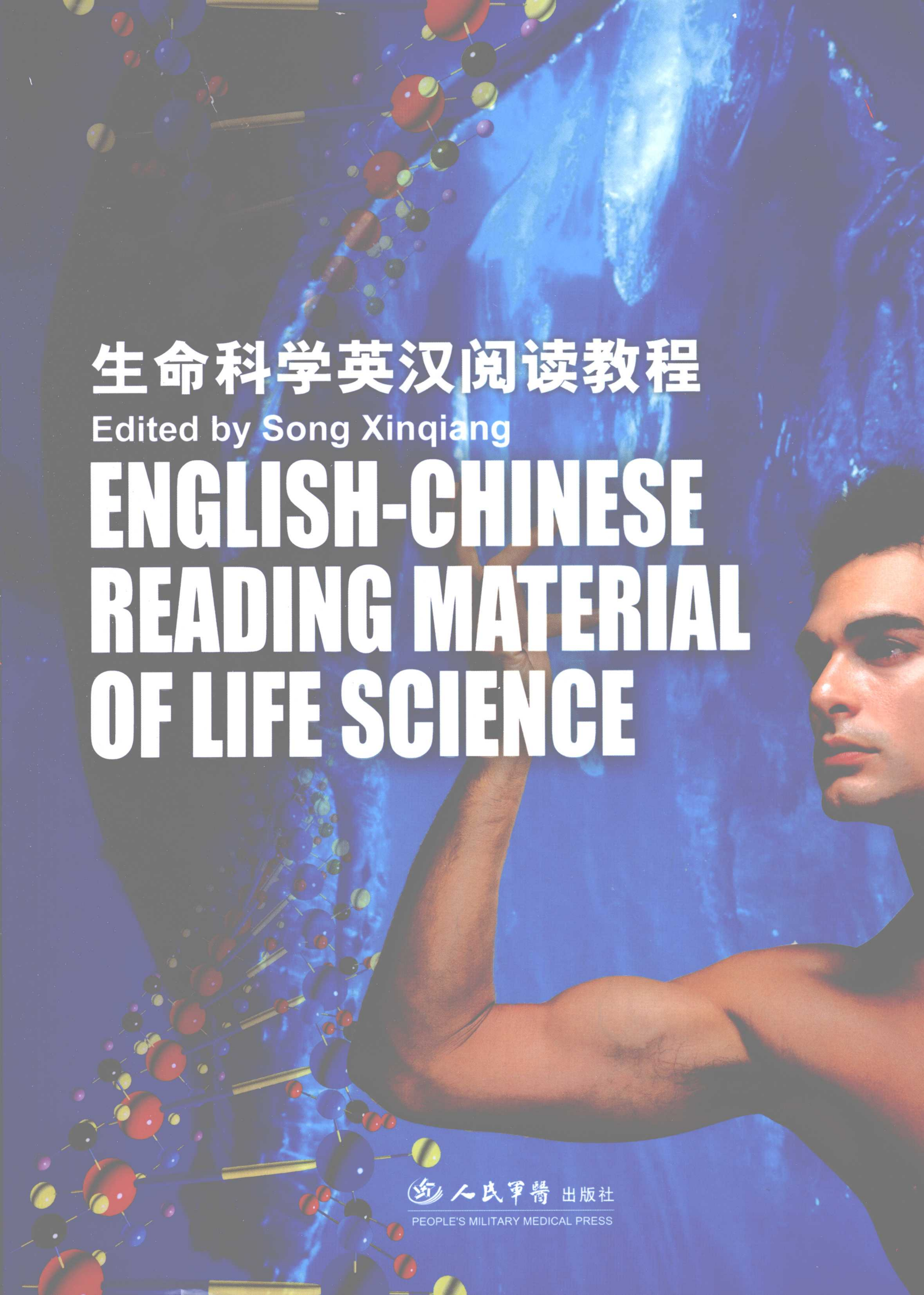

生命科学英汉阅读教程

Edited by Song Xinqiang

ENGLISH-CHINESE READING MATERIAL OF LIFE SCIENCE

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生命科学英汉阅读教程

English - Chinese Reading Material of Life Science

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内 容 提 要

本书由10个单元组成，汉英双语排版，图文并茂，课后有专业英语词汇音标注释。主要内容包括生命的分子、细胞、植物生物学、动物生物学、生物化学、遗传学、免疫学、分子生物学、分子生物学技术原理、分子生物学实验方法，内容基本覆盖了生命科学一级学科的主要分支。通过对本书的学习，不但可以提高实际使用生命科学专业英语的能力，而且可以增加大量生命科学方面的知识。

本书可供综合大学、师范院校、医学院校、农林院校内医学或生物学专业的本科生和研究生使用，也可以作为非生物专业的选修课使用或从事生命科学研究的相关人员参考阅读。

前 言

随着经济全球化的发展，不同文化之间的交流日益加深。多元文化的相互影响，促使教育开始跨越国界，呈现出教育国际化的发展趋势。为适应新的发展形势，教育部印发了《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》(2001年)，指出高等院校应“积极推动使用英语等外语进行教学”。这对双语教学改革的迅速发展起到了推动作用。

21世纪是生命科学的世纪。随着生命科学日新月异的发展，我国与国际科学界的交流日益增多，以英语为载体的专著、期刊及互联网上电子文献等科学信息更是以几何级数增长。这就对新世纪生命科学的研发人员提出了学术和语言两个层面的高标准要求，即在生命科学的理论和应用技术方面走在世界前列，同时又具有及时获取和发布新技术、新信息的语言手段。

为达此目的，我们编写了《生命科学英汉阅读教程》。从学习阶段抓起，从生命科学的基础理论和专业语言基础入手，帮助生命科学领域的未来人巩固专业理论、学习研发原理、提高生命科学专业英语的会话和写作能力，帮助他们成长为懂研发、会阅读、能用世界通用语言开展学术交流的复合型专业人才。

本书具有四个特点：第一，取材原著。我们尽量从国外最新出版的生命科学教科书和专著中选取素材，在体现先进性、科学性和实用性的同时，突出原版英文的写作特点。第二，图文并茂。本书配图150余幅，不仅增加了学习的趣味性，也增强了内容的可读性，使读者在不知不觉中进入生命科学的殿堂。第三，中英文对照。本书将英文置于每页左侧，中文置于每页右侧，严格对照翻译，既有利于教学参考，又有利于读者自学。第四，音标注释，词汇量大。本书收集了专业词汇1 000余个，囊括了生命科学常用词汇的70%～80%。对不熟悉的单词，每个单元后列有“New Words”，并标注国际音标和汉语注释，避免读者只能“意会”不能正确“言传”的尴尬。

本书从培养学生阅读能力、科技论文写作能力及学术交流能力出发，编写了10个单元，内容基本覆盖生命科学一级学科的主要分支，可供综合大学、师范院校、医学院校、农林院校内医学或生物学专业的本科生和研究生使用，也可以作为非生物专业的选修课使用或从事生命科学研究的相关人员参考。全书由宋新强统一校订。

本书在编写和修订过程中，得到了中国人民解放军医学图书馆及军事医学科学院的领导、教师和学生的热情关心和大力支持，在此表示衷心的感谢。参考文献中的部分没有联系上的作者，可以通过 E-mail：xqsong2002@yahoo.com 联系我们。

由于编者水平有限，如有错漏，恳请同行和读者批评指正。

宋新强

于中国人民解放军

军事医学科学院附属医院免疫学研究室

国家生物医学分析中心

2008年5月20日

Contents
目　录

Unit One The Molecules of Life

Although a cell is mostly water, most of the rest of it consists of carbon–based molecules. Carbon is unparalleled in its ability to form the large, complex, diverse molecules that characterize life on Earth. The study of carbon compounds is called organic chemistry.

Carbon Chemistry

Why are carbon atoms so versatile as molecular ingredients? Remember that an atom′s bonding ability is related to the number of electrons it must share to complete its outer shell. A carbon atom has 4 outer electrons in an outer shell that holds 8 carbon completes its outer shell by sharing electrons with other atoms in four covalent bonds (Figure 1–1). Each carbon thus acts as an intersection from which an organic molecule can branch off in up to four directions. And because carbon can use one or more of its bonds to attach to other carbon atoms, it is possible to construct an endless diversity of carbon skeletons varying in size and branching pattern. The carbon atoms of organic molecules can also use one or more of their bonds to partner with other elements, most commonly hydrogen, oxygen, and nitrogen.

第1单元 生命的分子

细胞中大部分是水，但它所含有的其他部分则大多是以碳为基础的分子。碳在形成大的、复杂的、多种多样分子的能力方面是无与伦比的，这些分子是生命的功能所必需的。碳化合物的研究称为有机化学。

碳化学

为什么碳原子在作为分子的组分方面如此万能呢？记得吗，原子形成键的能力与填满其外层所必须共用的电子数目有关。碳原子的外层有4个电子，而这一层可以有8个电子(图1–1)。碳与其他原子形成4个共价键以共用电子填满其外层。所以每个碳都起着一个交叉点的作用，每个有机分子都可从这一点向多达4个方向分开。因为碳原子可以利用一个或多个键与其他的碳原子连接，所以能形成无数种碳骨架，其大小和分支形式各不相同。有机分子中的碳原子也可以利用它的一个或多个键与其他元素组合，最常见的是氢、氧和氮 。

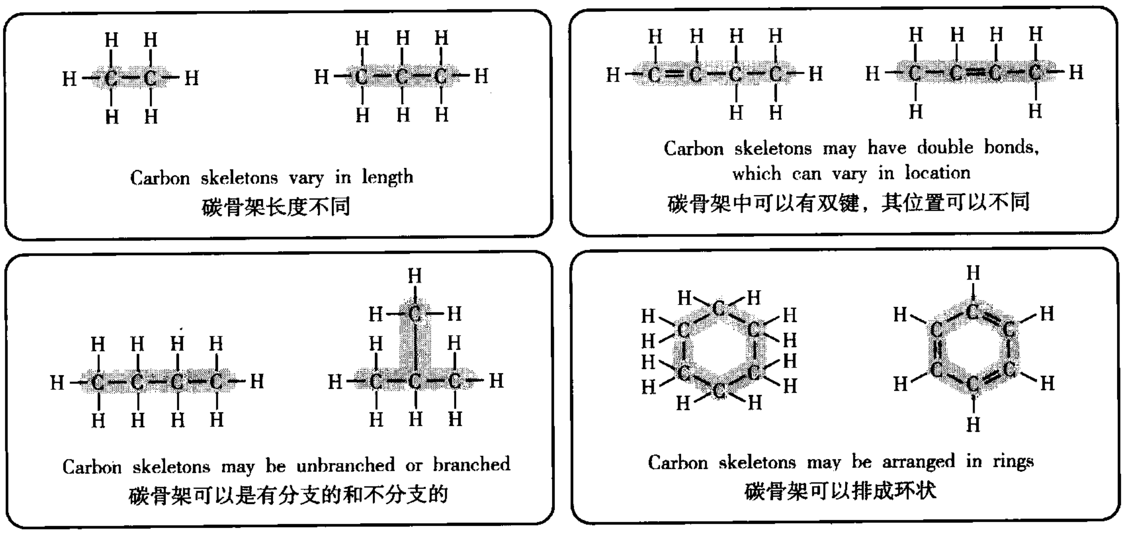


Figure 1–1 Variations in carbon skeletons

All of these examples are hydrocarbons, organic molecules consisting only of carbon and hydrogen. Note that each carbon atom forms four bonds, and each hydrogen atom forms one bond.

图1–1 碳骨架的变化

所有这些例子都是烃类，即仅由碳和氢组成的有机分子；注意每个碳原子形成4个键，而每个氢原子形成1个键

In terms of chemical composition, the simplest organic compounds are hydrocarbons, organic molecules consisting of carbon skeletons bonded only to hydrogen atoms. And the simplest hydrocarbon is methane, a single carbon atom bonded to four hydrogen atoms (Figure 1–2). Methane is one of the most abundant hydrocarbons in natural gas and is also produced by bacteria that live in swamps and in the digestive tracts of cows. Larger hydrocarbons are the main molecules in the gasoline we burn in cars and other machines. Hydrocarbons are also important fuels in your body; the energy–rich parts of fat molecules are hydrocarbon in structure.

就化学组成而言，最简单的有机化合物是烃，仅含有碳和氢原子的有机分子。最简单的烃是甲烷，其中1个碳原子与4个氢原子形成键(图1–2)。甲烷是天然气中最多的一种烃，生活在泥沼和食草动物(如牛)消化道中的细菌也产生甲烷。大的烃则为我们在汽车和其他机器燃烧的汽油中的主要分子。烃也是体内的重要能量，脂肪分子中的高能部分就具有烃的结构。

Each type of organic molecule has a unique three–dimensional shape. Note in Figure 1–2 that carbon's four bonds point to the corners of an imaginary tetrahedron (an object with four triangular sides). This geometry occurs at each carbon "intersection" where there are four covalent bonds, and thus organic molecules much larger than methane can have very elaborate shapes. We'll encounter many cases of how the molecules of your body recognize one another based on their shapes. Just one example is the chemical signaling your brain cells use to "talk" to each other (Figure 1–3).

每一种类型的有机分子都有其独特的三维形状。注意图1–2，碳的4个键指向一个假想的四面体(由4个三角形组成的)的4个角。这种几何图形存在于每个碳的“交叉点”上，此处有4个共价键，因此比甲烷大的有机分子就可能有非常精巧的形状。在生物学中重复出现的一个主题是：体内的分子如何根据其状态互相识别。仅举一个例子，就是脑细胞用以彼此进行“通话”的信号分子(图1–3)。

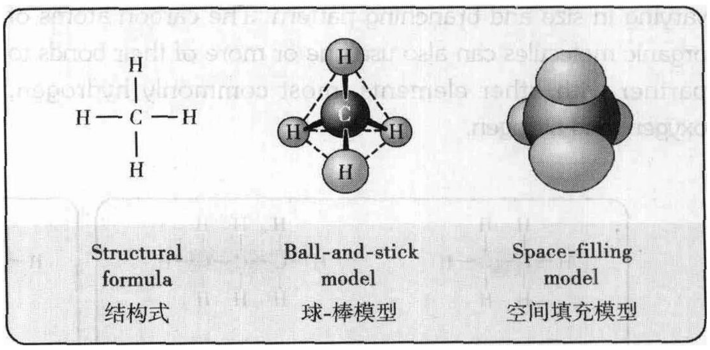


Figure 1–2 Methane, the simplest hydrocarbon

In the ball–and–stick model, note that the four single bonds of carbon point to the corners of a tetrahedron.

图1–2 甲烷，最简单的烃

注意球–棒模型中，碳的4个单键指向1个四面体的4个角

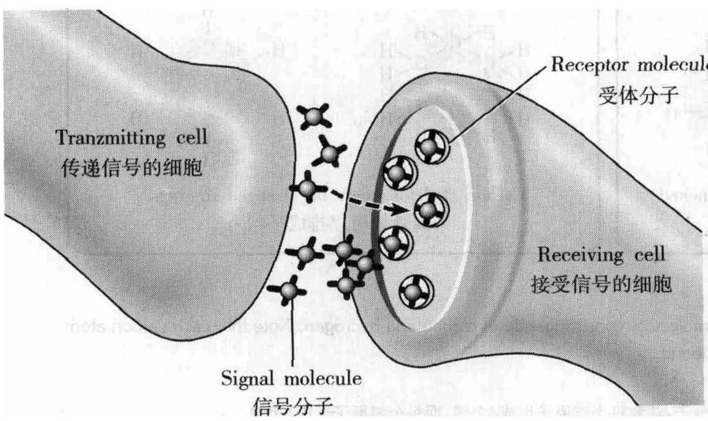


Figure 1–3 Molecular shape and brain chemistry

One nerve cell in your brain "talks" to another by releasing signal molecules with a shape that fits receptor molecules located on the surface of the receiving cell. The signal molecules cross the tiny gap between cells and bind to the receptors, stimulating the receiving cell. (The actual shapes of the signal and receptor molecules are much more complex than represented here.)

图1–3 脑化学中分子形状的重要性

脑中的一个神经细胞对另一个神经细胞“说话”，就是释放一个信号分子其形状正好与位于受体细胞表面的受体分子的形状相匹配，信号分子越过细胞间的狭窄缝隙而与受体结合，从而激活受体细胞(信号分子和受体分子的实际形状比图中所画的复杂得多)

The unique properties of an organic compound depend not only on its carbon skeleton but also on the atoms attached to the skeleton. In an organic molecule, the groups of atoms that usually participate in chemical reactions are called functional groups. Figure 1–4 shows four of the functional groups important in the chemistry of life. Though the examples in the figure each contain only one functional group, many biological molecules have two or more. For example, compounds called amino acids have carboxyl as well as amino groups. Amino acids are the building blocks of the much larger molecules called proteins. We are now ready to see your cells make such giant molecules out of smaller organic molecules.

有机化合物特性不仅决定于其碳骨架，而且也决定于连接在其上的原子。有机分子中，通常参与化学反应的原子团称为功能团。图1–4列有在生命化学中重要的功能团。虽然图中所举的例子各自都只有一个功能团，许多生物分子却有2个或更多个功能团。现在我们已经做好准备，去了解细胞如何用小的有机分子制造大的分子了。

Giant Molecules from Smaller Building Blocks

On a molecular scale, many of life's molecules are gigantic; in fact, biologists call them macromolecules. Examples are proteins, DNA, and carbohydrates called polysaccharides. Your cells make all these macromolecules by joining smaller organic molecules into chains called polymers. A polymer consists of many identical or similar molecular units strung together, much as a train consists of many individual cars. The units that serve as the building blocks of polymers are called monomers.

大分子由小的构件组成

就分子的大小而言，许多生命分子都是巨大的；实际上，生物学家称它们为大分子，例如，蛋白质、DNA、多糖等。细胞组装所有的大分子都是通过连接较小的有机分子形成链状，这些链被称为多聚体。多聚体由许多相同的或相似的被连在一起的单元组成，就好像火车由许多独立的车厢连在一起一样。这些构成多聚体的单元被称作单体。

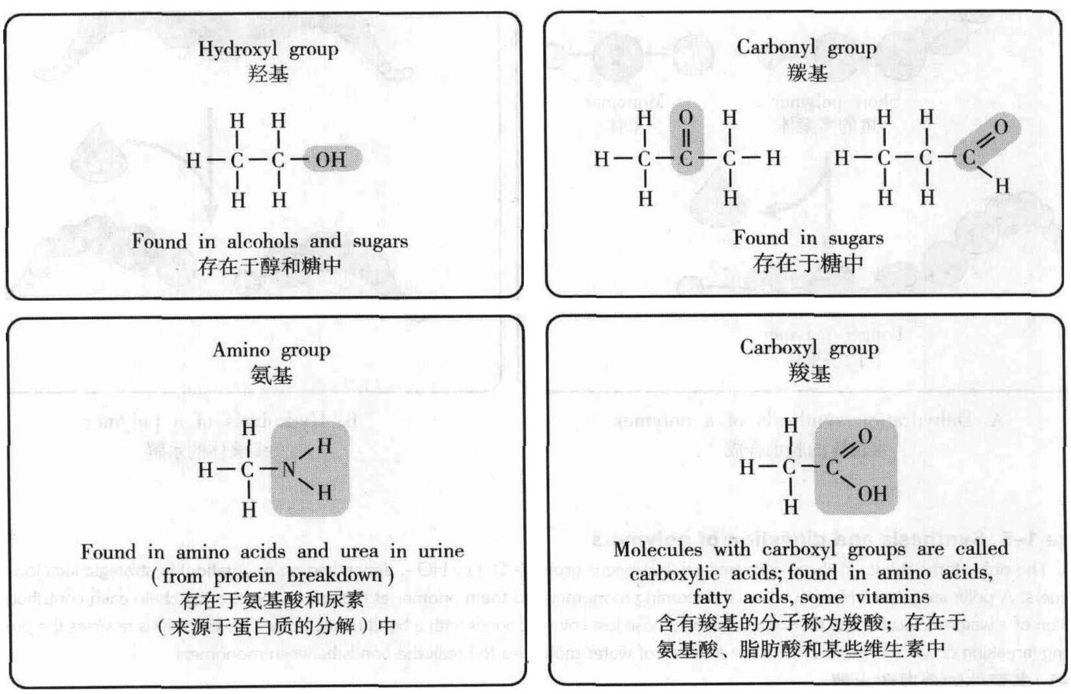


Figure 1–4 Some common functional groups
图1–4 某些常见的功能团

Cells link monomers together to form polymers by a process called dehydration synthesis (Figure 1–5A). For each monomer added to a chain, a water molecule (H_2O) is formed by the release of two hydrogen atoms and one oxygen atom from the monomers (hence the term dehydration synthesis–the monomers lose water). This same basic process of dehydration synthesis occurs regardless of the specific monomers and the type of polymers the cell is producing.

细胞通过脱水合成的过程(图1–5A)将单体连在一起形成多聚体。每有1个单体加到链上，就会从单体上释放2个氢原子和1个氧原子而形成水分子(H_2O)，因此称为脱水合成(单体失去水)。不管是什么特殊的单体以及不管细胞合成的多聚体是什么类型，所发生的基本的脱水合成过程都是相同的。

Organisms not only make macromolecule; they also have to break them down. For example, many of the molecules in your food are macromolecules. You must digest these giant molecules to make their monomers available to your cells for assimilation into your own brand of macromolecules. That digestion occurs by a process called hydrolysis (Figure 1–5B). Hydrolysis means to break (lyse) with water (hydro–). Cells break bonds between monomers by adding water to them, a process essentially the reverse of dehydration synthesis.

生物体不仅要合成大分子，还要将它们分解。例如，食物中就有许多大分子。人们必须消化这些大分子，使之成为小分子，供自身细胞同化，产生自己的大分子。这种消化是由称为水解的过程完成的(图1–5B)。水解意即加水分解。细胞向单体之间的键中加入水而使之断裂，这个过程实质上就是脱水合成的逆转。

Biological Molecules

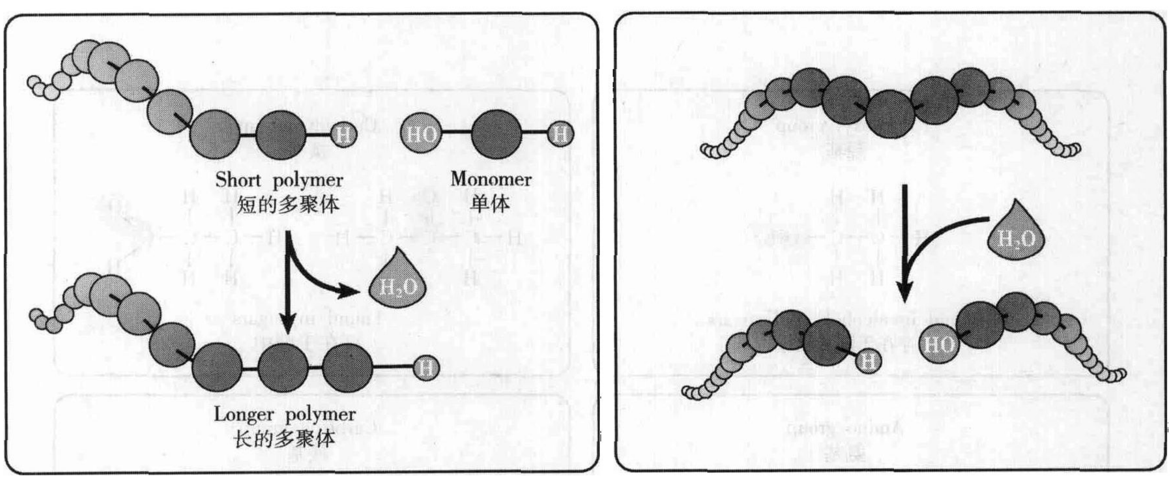
生物分子

Carbohydrates

糖类

Athletes know them as "carbs", Carbohydrates include the small sugar molecules dissolved in soft drinks as well as the long

糖类包括溶于软饮料中的糖分子，以及我们所吃的面食类和马铃薯中的长的淀粉



A. Dehydration synthesis of a polymer
多聚体的脱水合成

B. Hydrolysis of a polymer
多聚体的水解

Figure 1–5 Synthesis and digestion of polymers

A. The only atoms shown in these diagrams are hydrogens groups(–OH or HO–, depending on orientation) in strategic locations on the monomers. A polymer grows in length when an incoming monomer and the monomer at the end of the existing chain each contribute to the formation of a water molecule. The monomers replace those lost covalent bonds with a bond to each other. B. Hydrolysis reverses the process by digesting (breaking down) the polymer with the addition of water molecules to break the bonds between monomers.

图1–5 多聚体的合成和水解

A．此图中仅画了氢原子和羟基(–OH或HO–，因方向而异)，分别位于单体的适当处；当新来的单体和已有的多聚体末端的单体各贡献出H或–OH而形成水分子时，多聚体即增长，单体以新的键取代了原有的共价键，B．水解是上述过程逆转，加入水分子，单体之间的键断裂而使多聚体分开

starch molecules we consume in pasta and potatoes.

分子。

Monosaccharides Simple sugars, or monosaccharides (from the Greek mono–, single, and sacchar, sugar), include glucose, found in sports drinks, and fructose, found in fruit. Both of these simple sugars are found in honey. Generally, monosaccharides have molecular formulas that are some multiple of CH_2O. For example, the formula for glucose is $C_6H_{12}O_6$. Fructose has the same molecular formula as glucose, $C_6H_{12}O_6$, but its atoms are arranged differently (Figure1–6).

单糖 单糖包括运动员饮料中的葡萄糖和水果中的果糖。这两种单糖都存在于蜂蜜中。一般说来，单糖的分子式都是 CH_2O 的倍数。例如，葡萄糖的分子式是 $C_6H_{12}O_6$，果糖的分子式和葡萄糖的一样，但是其中原子的排列不同(图1–6)。

Glucose and fructose are examples of isomers, molecules that match in their molecular formulas but have different structures. Seemingly minor differences like this give isomers different properties. In this case, the differences make fructose taste considerably sweeter than glucose.

葡萄糖和果糖是异构体的例子，异构体就是分子式相同而结构不同的分子。因为形状非常重要，在化学上看似次要的差别却赋予异构体以不同的性质。在此特例中，化学基团的重排使得果糖比葡萄糖甜得多。

It is convenient to draw sugars as if their carbon skeletons were linear. However, in aqueous solutions, many monosaccharides form rings, as shown for glucose in Figure1–7.

假设糖的碳骨架是线形的，很容易画它们的结构。可是，在水溶液中，许多单糖都形成环，如图 1–7 中的葡萄糖所示。

Monosaccharides, particularly glucose, are the main fuel molecules for cellular work. Analogous to an automobile engine consuming gasoline, your cells break down glucose molecules

单糖，特别是葡萄糖，是细胞活动的主要燃料。就像汽车的引擎消耗汽油一样，细胞分解葡萄糖分子，获取其中贮藏的能量，

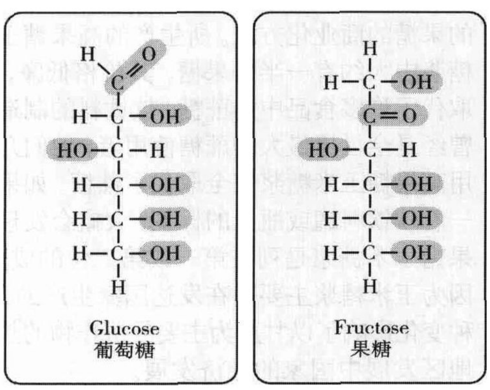
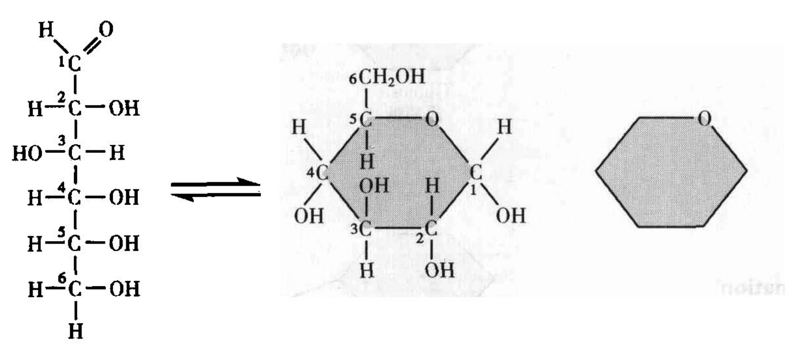


Figure 1–6 Monosaccharides (simple sugars)

These molecules have the two trademarks of sugars: several hydroxyl groups (–OH) and a carbonyl group (>C=O). Glucose and fructose are isomers of each other: They have identical molecular formulas ($C_6H_{12}O_6$), but their structures differ because the atoms are not arranged the same way. The difference in this case is the location of the carbonyl group.

图1–6 单糖

这两个分子有2个明显的特征，若干个羟基(–OH)和 1个羰基(>C=O)；葡萄糖和果糖互为异构体，它们的分子式($C_6H_{12}O_6$)相同，但结构式不同，因为原子排列的方式不同，此例中的不同在于羰基的位置不同



A. Linear and ring structures
线形和环形结构

B. Abbreviated ring structure
简化的环形结构

Figure 1–7 The ring structure of glucose

A. Dissolved in water, one part of a glucose molecule can bond to another part to form a ring. The carbon atoms are numbered here so you can relate the linear and ring versions of the molecule. As the double arrows indicate, ring formation is a reversible process, but at any instant in an aqueous solution, most glucose molecules are rings. B. From now on, we'll use this abbreviated ring symbol for glucose.

图1–7 葡萄糖的环形结构

A. 溶于水时，葡萄糖分子的一部分会与另一部分形成键而呈环状，图中的碳原子标有序号，可看出分子的环形与线形结构之间的关系，如图中的双向箭头所示，形成环是可逆过程，但在溶液中的每一瞬间，大多数葡萄糖分子是环状；B. 从现在起，我们就用这个简化的环形符号代表葡萄糖

and extract their stored energy, giving off carbon dioxide as "exhaust".

Disaccharides Cells construct a disaccharide, or double sugar, from two monosaccharides by the process of dehydration synthesis. An example of a disaccharide is maltose, also called malt sugar, which consists of two glucose monomers (Figure 1–8). Maltose, which is common in germinating seeds, is used in making beer.

The most common disaccharide is sucrose, which consists of a glucose linked to a fructose. Sucrose is the main carbohydrate in plant sap, and it nourishes all the parts of the plant. We extract sucrose from the stems of sugarcane or the roots of sugar beets to use as table sugar.

The history of sugar refining and consumption by humans is a story with important health and economic consequences. Before the 1980s, refined sugar was processed from cane sugar grown in the tropics and beet sugar grown in temperate regions. Occupying only a small part of the sweetener market was corn syrup, which contains glucose. Because glucose is only half as sweet as sucrose, corn syrup was not a serious rival to sucrose.

The balance among sweeteners was drastically upset in the 1980s, when corn syrup producers developed a commercial method for converting much of the glucose in corn syrup to fructose, an isomer of glucose even sweeter than sucrose. The resulting high–fructose corn syrup (HFCS), which is about half fructose, is inexpensive and has replaced sucrose in many prepared foods. Soft drink manufacturers, once the largest commercial users of sucrose in the world, have almost completely replaced sucrose with HFCS. Because corn syrup is produced mainly in developed countries, the change–over hurts the developing economies of tropical countries where sugarcane is a major crop.

并产生“废气”二氧化碳。

二糖 二糖是由2个单糖经脱水缩合而构成。二糖的一个例子是麦芽糖，含2个葡萄糖单体(图1–8)。麦芽糖在萌发的种子中常见，用于制造啤酒、麦芽糖球等糖果(关东糖就是麦芽糖)。乳糖是另一种二糖，由葡萄糖和半乳糖两种单糖组成。

最常见的二糖是蔗糖，是由葡萄糖与果糖连接而成的。蔗糖是植物汁液中主要的糖类，植物体的所有部分都以之为养料。人们从甘蔗茎中或甜菜根中提取蔗糖作为餐桌上的食用糖。

人类制糖和食用糖的历史也是人类健康和经济发展的重要标志。20世纪80年代之前，制糖的原料是甘蔗和甜菜。占据甜味剂市场仅一小部分的是玉米糖浆，其中含有葡萄糖。因为葡萄糖的甜度只有蔗糖的一半，玉米糖浆不是蔗糖的重要竞争对手。

20世纪80年代，甜味剂市场的平衡发生了剧烈变化，这时玉米糖浆的生产者发明了一种把玉米糖浆中的葡萄糖变成为甜得多的果糖的商业化方法。所生产的高果糖玉米糖浆中大约有一半是果糖，其价格低廉，已取代了许多食品中的蔗糖。软饮料的制造商曾经是全世界最大的蔗糖使用者，他们几乎用高果糖玉米糖浆完全取代了蔗糖。如果看一看软饮料罐或瓶上的标签，大概会发现高果糖玉米糖浆是列在第一或第二位的成分。因为玉米糖浆主要是在发达国家生产的，这种变化影响了以甘蔗为主要经济作物的热带地区发展中国家的经济发展。

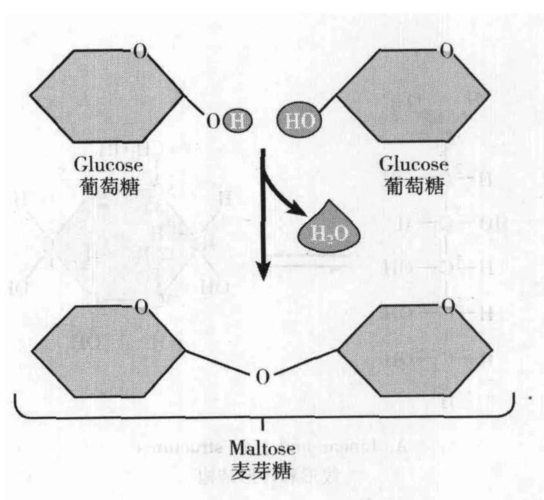


Figure 1–8 Disaccharide (double sugar) formation

The simple sugars a rejoined by dehydration synthesis, in this case forming a bond between two glucose units to make the double sugar maltose.

图1–8 二糖的形成

两个单糖通过脱水合成而形成二糖，此图中是两个葡萄糖单体形成二糖麦芽糖

The United States is one of the world's leading markets for sweeteners, with the average American consuming about 140 pounds per year, mainly as sucrose and HFCS. This national "sweet tooth" persists in spite of growing awareness about possible health effects. Sugars are a major cause of tooth decay. The description of sugars as "empty calories" is accurate in the sense that even the less refined sweeteners such as brown sugar and honey contain only negligible amounts of nutrients other than carbohydrates. For good health, we also require proteins, fats, vitamins, and minerals. And we need to include substantial amounts of "complex carbohydrates" —— that is polysaccharides ——in our diet.

Polysaccharides Complex carbohydrates, or polysaccharides, are long chains of sugar units ——polymers of sugar monomers. Potatoes and grains, such as wheat, corn, and rice, are the major sources of starch in the human diet. Starch, which is found in roots and other plant organs, consists entirely of glucose monomers (Figure1–9A). Plant cells often contain starch granules, which serve as sugar stockpiles. Starch is a storage polysaccharide that cells break down as needed to obtain sugar. Humans and most other animals are able to use plant starch as food by hydrolyzing it within their digestive systems.

Animals store excess sugar in the form of a polysaccharide called glycogen. Glycogen is similar to starch, but glycogen is more extensively branched (Figure 1–9B). Most of our glycogen is stored as granules in our liver and muscle cells, which hydrolyze the glycogen to release glucose when it is needed for energy.

In addition to storage polysaccharides, there are also polysaccharides that serve as building material for structures that protect cells and support whole organisms. Cellulose, the most abundant organic compound on Earth, forms cable like fibrils in the tough walls that enclose plant cells and is a major component of wood (Figure 1–9C). Cellulose resembles starch and glycogen in being a polymer of glucose, but its glucose monomers are linked together in a different orientation. Unlike the glucose linkages in starch and glycogen, those in cellulose cannot be hydrolyzed by most animals. The cellulose in plant foods, which passes unchanged through our digestive tract, is commonly known as "fiber". It may help keep our digestive system healthy, but it does not serve as a nutrient. Most animals that do derive nutrition from cellulose, such as cows and termites, have bacteria inhabiting their digestive tracts that can break down the cellulose.

Simple sugars (such as glucose) and double sugars (such as sucrose) do dissolve readily in water, forming sugary solutions,

美国是世界上甜味剂的最大市场之一，美国人均每年消耗约64 kg甜味剂，主要是蔗糖和高果糖玉米糖浆。虽然我们已经知道糖对健康的负面影响，但美国的龋齿病仍在蔓延。糖是引起龋齿的主要原因。高糖消费也会使人少吃多样化的、营养价值高的食品。从一定意义上来说把糖描述为“空卡值”是准确的，因为甚至包括红糖和蜂蜜在内，糖的营养素的含量微不足道。为了良好的健康，我们还需要蛋白质、脂肪、维生素和矿物质。而且我们还需要膳食中有相当量的“复杂的糖类”——多糖。

多糖 复杂的糖或多糖是糖单位的长链——单糖的聚合物。马铃薯和谷物，如小麦、玉米、稻米是人膳食中淀粉的主要来源。大家都熟知的例子是存在于植物根茎和其他部位中的淀粉，它完全是由葡萄糖单体连接而形成的(图1–9A)。植物细胞以颗粒形式贮存淀粉，在需要提供能量和制造其他分子的原料时将其分解。人和大多数其他动物都能利用植物淀粉作为食物，在消化系统中将葡萄糖单体之间的键水解。

动物将多余的糖以称之为糖原的多糖的形式贮存起来。糖原在结构上类似淀粉，也是葡萄糖单体的多聚体，不过糖原分支更多(图1–9B)。人体内的大部分糖原都贮存在肝和肌细胞中，当需要糖原提供能量时，这些细胞就将糖原水解。

除去营养方面有重要作用外，某些多糖还是结构的组分。纤维素，世界上最丰富的有机化合物，在包被植物细胞的坚固的细胞壁中形成电缆样的纤丝，它也是木材的主要成分(图1–9C)。纤维素和淀粉及糖原一样，都是葡萄糖的多聚体，但其中葡萄糖单体是以不同的取向连在一起的。与淀粉和糖原中葡萄糖之间的键不同，纤维素中的这种键不能被大多数动物所破坏。植物性食物中的纤维素，原样不变地通过我们的消化道，通常称为“膳食纤维”或“粗粝”。因为它不能被消化，所以纤维素不是营养素，尽管它确实有助于使我们的消化系统健康。大多数美国人的膳食中没有足够量的纤维。富于纤维的食物包括水果和蔬菜、全谷粒、麸皮和豆类。食草动物和以木材为食的昆虫如白蚁能够从纤维素中获得营养物质，这是因为它们的消化道中有能分解纤维素的原核生物。

单糖(如葡萄糖)和二糖(如蔗糖)易溶于水，

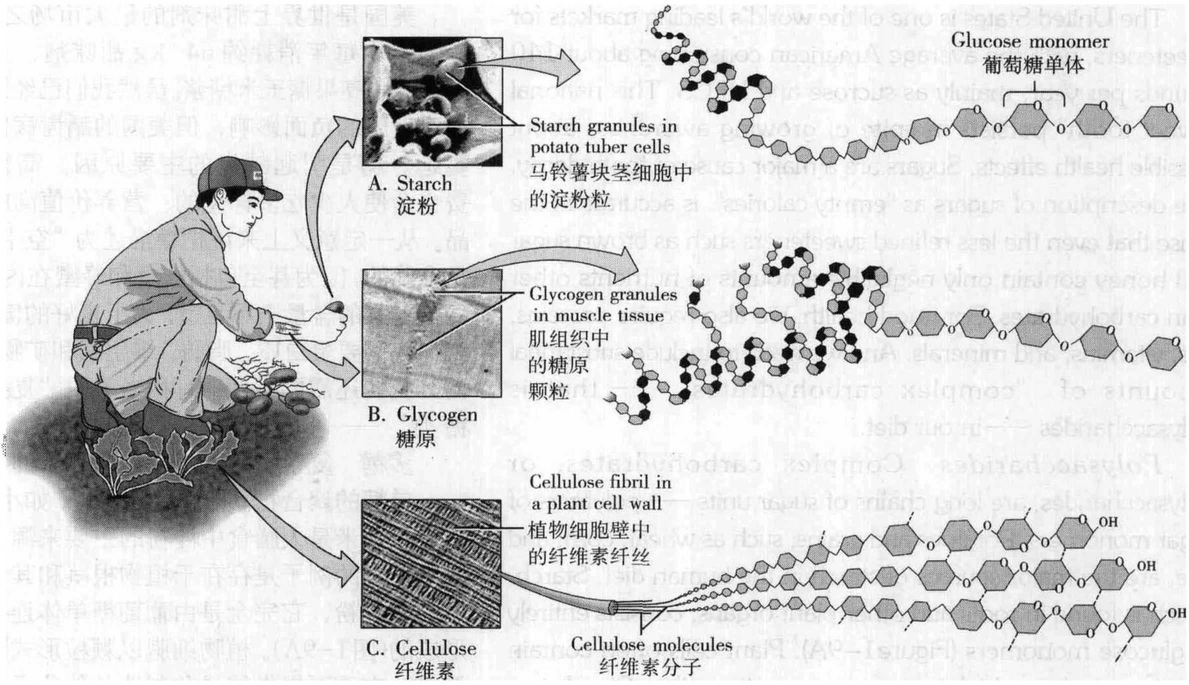


Figure 1-9 Polysaccharides

A. Plants store glucose by polymerizing it to form starch. B. Animals also store glucose, but in the form of glycogen, a polysaccharide more extensively branched than plant starch. C. The cellulose of plant cell walls is an example of a structural polysaccharide. The cellulose molecules are assembled into fibrils that make up the main fabric of the wall. Wood, cell wall material consisting of such cellulose fibrils along with other polymers, is strong enough to support trees hundreds of feet high. We take advantage of that structural strength in our use of lumber as a building material.

图1-9 多糖

A.植物贮存葡萄糖，将其多聚化形成淀粉；B.动物也贮存葡萄糖，但以糖原的形式贮存，糖原的分支比植物淀粉的多得多；C.植物细胞壁的纤维素是结构多糖的例子；纤维素分子聚集在一起形成纤丝，纤丝是组成细胞壁的主要构造物；木材是细胞壁物质，由纤维素和其他多聚物组成，其强度足以支持数百尺高的大树，人们就是利用这种结构性强度而把木材作为建筑材料来使用

including soft drinks. In spite of this difference, almost all carbohydrates, including cellulose and most other polysaccharides, are hydrophilic, which literally means "water-loving". Hydrophilic molecules adhere water to their surface. It is the hydrophilic quality of cellulose that makes a fluffy bath towel so water absorbent.

Lipids

In contrast to carbohydrates and most other biological molecules, lipids are hydrophobic, which means they do not mix with water (from the Greek *hydro*, water, and *phobos*, fearing). You have probably observed this chemical behavior in an unshaken bottle of salad dressing: the oil, which is a type of lipid, separates from the vinegar, which is mostly water. Shake the bottle and you can force a temporary mixture long enough to douse your salad with dressing, but what remains in the bottle

形成糖溶液，包括软饮料。纤维素和某些形式的淀粉分子太大，所以不溶于水。假若它们溶于水，那么大部分是纤维素成分的浴巾，只要一放进洗衣机里就要溶化了。虽然有这些差别，几乎所有的糖类都是亲水的。亲水的分子会让水分子吸附在它的表面。正是纤维素的亲水特性使得毛绒绒的浴巾能吸那么多水。

脂质

与糖类和大多数其他生物分子不同，脂质是疏水的，也就是说它们不与水相混合(希腊文 *hydro* 是水，*phobos* 是害怕)。你大概曾经看过一瓶未摇动过的沙拉调味酱的化学变化：油是一种脂质，它与醋分开，醋中含有大量水。假如你摇动瓶子，就可以强迫它们暂时混合在一起，可以将它们

will quickly separate again once you stop shaking. Beyond this distinction of being hydrophobic, the lipid category includes molecules of diverse structure and function. Just two examples are fats and steroids.

Fats The ingredients of a fat are an alcohol called glycerol joined to three molecules called fatty acids. Cells use dehydration synthesis to attach the three fatty acids to the glycerol (Figure 1–10A).

Perhaps the food industry prefers the word triglyceride on their product labels because the very word fat seems to bear negative connotations. However, fats actually perform essential functions. The major portion of a fatty acid is a long hydrocarbon, which, like the hydrocarbons of gasoline, store much energy. In fact, a pound of fat packs more than twice as much energy as a pound of carbohydrate such as starch. This compact energy storage enables a mobile animal such as a human to get around much better than if the animal had to lug its stored energy around in the bulkier form of carbohydrate. The downside to this energy efficiency, of course, is that it is very difficult for a person trying to lose weight to "burn off" excessive body fat. What's important to understand is that a reasonable amount of body fat is both normal and healthy as a fuel reserve. We stock these long–term food stores in specialized reservoirs called adipose cells that swell and shrink when we deposit and withdraw the fat from storage. In addition to storing energy, adipose tissue cushions such vital organs as the kidneys. A layer of fat beneath the skin also insulates us, helping us maintain a warm body temperature even when the outside air is cold.

"Saturated" versus "unsaturated" fats is a comparison you have probably encountered in advertisements for foods. What's that all about? Notice in Figure 1–10B that one of the fatty acids bends where there is a double bond in the carbon skeleton. Less hydrogen is attached to the carbon skeleton at that location, and so the fatty acid is said to be unsaturated because it has less than the maximum number of hydrogens. The other two fatty acids in the fat molecule of Figure 1–10B lack double bonds in their hydrocarbon portion. Those fatty acids are saturated, meaning that they are bonded to the maximum number of hydrogen atoms. A saturated fat is one with all three of its fatty acids saturated. If one or more of the fatty acids is unsaturated, then we have an unsaturated fat, such as the one in Figure 1–10B. And if the fatty acids have several double bonds, further reducing the number of hydrogens, then that's a polyunsaturated fat.

Most animal fats, such as lard and butter, are saturated. They are solid at room temperature. In contrast, the fats of plants and fishes are generally unsaturated. These unsaturated fats are

倒在沙拉上，但只要你停止摇动瓶子，留在瓶中的沙拉调味酱立即就分成两层。除了都具有疏水的特性之外，脂类含有不同结构和功能的分子。这里仅举脂肪和类固醇两个例子。

脂肪 膳食中的脂肪由三酰甘油分子组成，是由 1 个甘油分子和 3 个脂肪酸分子通过脱水合成而连接起来的(图 1–10A)。

尽管大多数人不喜欢脂肪，但这些脂肪分子在人体内具有重要的功能。其中主要的部分是脂肪酸，是一个烃的长链，就像汽油中的烃一样，贮存着许多能量。事实上，1 kg 脂肪中的能量是 1 kg 淀粉中能量的 2 倍以上。这种密集的能量贮存使得像人这样的动物活动起来比携带大量糖类时容易得多。在能量效率方面的不利影响是想要“减肥”的人要“燃烧”掉体内多余的脂肪很困难。重要的是要了解体内有适量的脂肪作为贮存的燃料是正常的，也是健康的。我们将这些长期的食物储备贮存在被称作脂肪细胞的特殊贮存库中。当我们向这些细胞存贮或从中取用脂肪时，它们就会膨大或缩小。除了贮存能量外，脂肪组织可以保护重要器官如肾脏免受碰撞，皮下脂肪层也可以隔热，即使外面的气温很低也能使我们保持温暖的体温。

在有关食品的广告中，你大概已经遇到过对“饱和”和“不饱和”脂肪的比较。这是什么意思呢？注意图 1–10B 中，有一个脂肪酸是弯的，其碳骨架中有 1 个双键。这就是不饱和的脂肪酸，因为在双键处氢的数目没有达到最大。其他脂肪酸都是饱和的，意思是其中的碳都与最大数目的氢形成了键。饱和脂肪就是指其中3个脂肪酸都是饱和的。如果有 1 个或多个脂肪酸是不饱和的，那么它就是不饱和脂肪，图 1–10B 中的就是。多不饱和脂肪则是指在其脂肪中有几个双键。

大多数动物脂肪，例如猪油或黄油，含有较高比例的饱和脂肪酸。饱和脂肪酸的直线形状使得它们容易摞在一起，所以室温下脂肪呈固态。饱和脂肪多的膳食促进动脉粥样硬化，会引起心血管疾病。在这种情况下，称为斑块的含脂质的沉积物存在于血管内壁上，使血流减慢并使心脏病发作的危险增多。反之，植物油和兔的脂肪通常是不饱

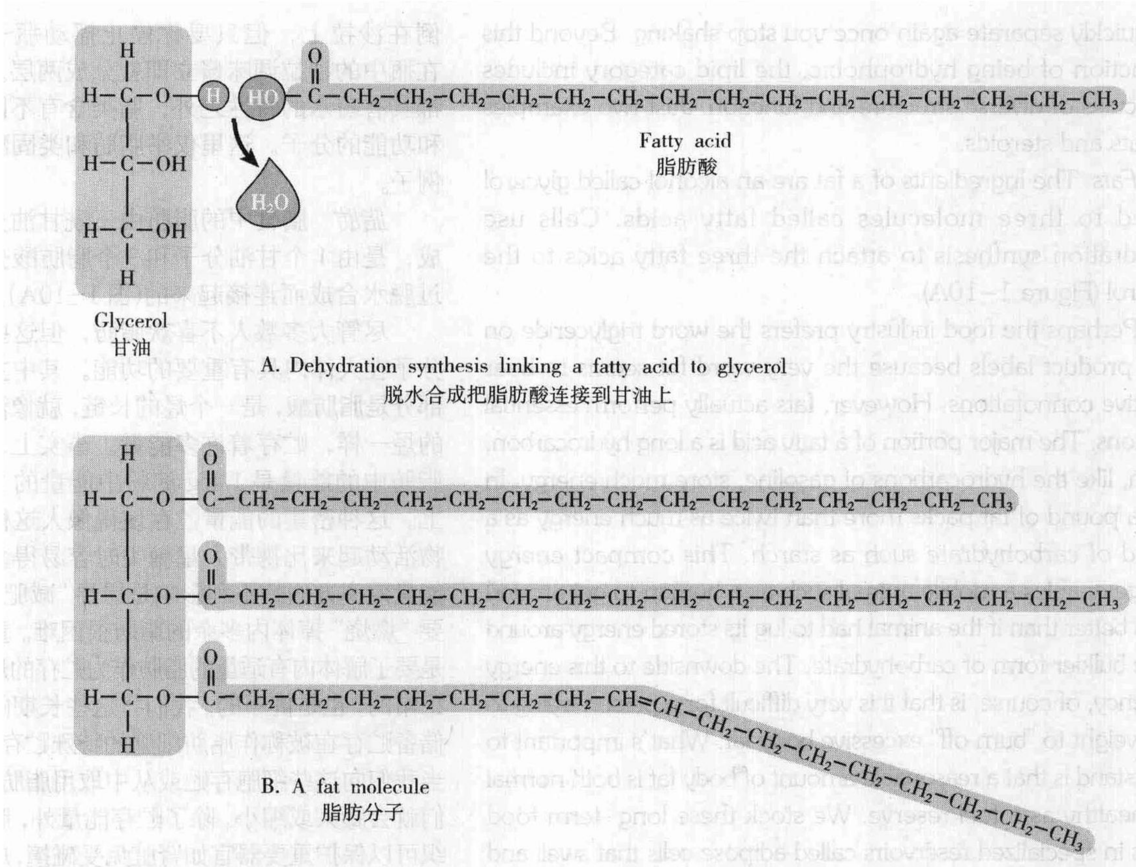


Figure 1–10 Synthesis and structure of a fat or triglyceride

A. This diagram shows the first of three fatty acids that will attach to glycerol by dehydration synthesis. B. The finished fat has a glycerol "head" and three fatty acid "tails". The fatty acids consist mainly of energy-rich hydrocarbon.

图 1–10　脂肪或三酰甘油的合成和结构

A．此图显示了 3 个脂肪酸中的第 1 个，它将通过脱水合成连接到甘油上；B．已合成的脂肪，有 1 个甘油的"头"和 3 个脂肪酸的"尾"；脂肪酸主要由高能的碳氢链组成

referred to as oils because they are liquid at room temperature. Corn oil, olive oil, and other vegetable oils are examples. When you see "hydrogenated vegetable oils" on the label of a product such as margarine, it means that unsaturated fats have been converted to saturated fats by adding hydrogen. This chemical processing gives the lipids the solid consistency of margarine.

Steroids Classified as lipids because they are hydrophobic, steroids arevery different from fats in structure and function. The carbon skeleton of a steroid is bent to form four fused rings. Perhaps the best known steroid is cholesterol, which gets a lot of bad press because of its association with cardiovascular disease. But cholesterol is also an essential molecule in your body. It is present in the membranes that surround your cells, and cholesterol is also the "base steroid" from which your body produces other steroids that includes estrogen and testosterone,

和的。不饱和脂肪酸的弯曲的形状使它们不易形成固态，所以不饱和脂肪在室温下通常呈液态。玉米油、橄榄油及其他植物油都是例子。当你看到一种产品如人造奶油的标鉴上写着还原性植物油时，这意味着不饱和脂肪通过加入了氢而转化成饱和脂肪。这种化学过程就是人造奶油具有固体硬度的原因。

类固醇　类固醇分类上属于脂质，因为它们是疏水的。但类固醇在结构和功能上都与脂肪相差甚大。类固醇的碳骨架是弯曲的，形成了 4 个稠合的环。胆固醇就是一种类固醇(图 1–11)，因为它与心血管疾病有关，所以给人很坏的印象。但是胆固醇是体内必需的分子。胆固醇和称为磷脂的另一种脂类存在于包围细胞的膜中。胆固醇是体

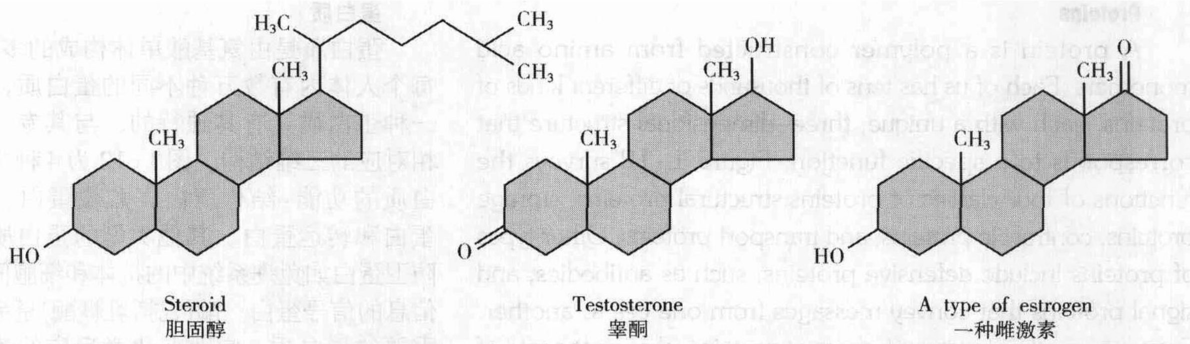


Figure 1-11 Sex hormones

Examples of steroids. All steroids have a carbon skeleton consisting of four fused rings, abbreviated here with all the atoms of the rings omitted. Different steroids vary in the functional groups attached to this core set of rings. For example, the subtle contrast between testosterone and estrogen influences the development of the anatomical and physiological differences between male and female mammals, including humans.

图 1-11　性激素

类固醇中的一种。所有的类固醇的碳骨架都由4个稠合的环组成，图中的简式略去了环中所有的碳原子；不同类固醇的区别在于连在核心环系统上的功能团不同，例如睾酮和雌激素的细微差异就影响了它们在雄性和雌性哺乳动物，包括人，在解剖和生理上发育的不同

the steroids that function as sex hormones (Figure 1-11).

The controversial drugs called synthetic anabolic steroids are variants of testosterone, the male hormone. Testosterone causes a general buildup in muscle and bone mass during puberty in males and maintains masculine traits throughout life. Because anabolic steroids structurally resemble testosterone, they also mimic some of its effects. some athletes began using anabolic steroids to build up their muscles quickly and enhance their performance. Today, anabolic steroids, along with many other drugs, are banned by most athletic organizations.

Using anabolic steroids is indeed a fast way to increase body size. With these drugs, an athlete who is willing to cheat at a sport can increase body mass beyond what hard work alone can produce. But at what cost? Although medical researchers still debate the extent of health risks from steroid abuse, there is evidence that these substances can cause serious physical and mental problems. Overdosing can bloat the face and produce violent mood swings and deep depression. Internally, there may be liver damage leading to cancer. Anabolic steroids can also make blood cholesterol levels rise, perhaps increasing a user's chances of developing serious cardiovascular problems. Heavy users may also experience a reduced sex drive and become infertile, just the opposite of what one might expect from using a mimic of a sex hormone. The reason is that anabolic steroids often make the body reduce its normal output of sex hormones. The many potential health hazards of anabolic steroids coupled with the unfairness of an artificial advantage strongly support the argument for banning their use in athletics.

内的“基础类固醇”，是体内产生其他类固醇的母体，这些类固醇包括雌激素和睾酮，是两种性激素(图 1-11)。

有争议的药物，人工合成的促蛋白质合成的类固醇是睾酮的一种，睾酮是一种雄激素。睾酮在男性的青春期引起肌肉和骨质的生长，并且终生维持着男性特征。因为促蛋白质合成的类固醇在结构上与睾酮相似，它也有睾酮的某些效应。有些运动员就利用这种人工合成的类固醇使其肌肉迅速增长而提高运动成绩。大多数体育组织都禁用这种类固醇和其他药物。

使用促蛋白质合成的类固醇确实是一种迅速增加身体肌肉和体能的方法，是任何重体力活动都不能比拟的。但是代价如何？虽然医学研究者对于滥用类固醇药物危害健康的程度仍有争论，但有证据表明，这些物质能引起严重的体力和智力的问题。过量服用可导致脸肿、激烈的情绪波动、深度的精神压抑、肝的损害、高胆固醇、性欲减退和不育。为什么利用性激素的仿制品能减少性欲呢？原因是促蛋白质合成的类固醇常会使身体中正常的性激素水平降低。此类药物对健康有潜在性危害，加上人为的优势造成不公平竞争，致使世界各国都强烈支持禁止运动员使用这些药物。