Carbohydrates (Slide 4)

§1. Giant Molecules from Smaller Building Blocks

1. Macromolecules (高分子)

1° Many of life's molecules are gigantic, earning the name macromolecules.

2° Three categories
- carbohydrates
- proteins
- nucleic acids

2. Polymers (聚合物)

1° Macromolecules are polymers

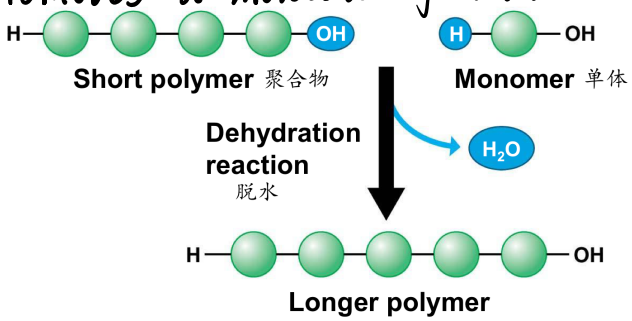
2° Polymers are made by stringing together many smaller molecules called monomers (单体)

3. Dehydration, Digestion and Hydrolysis

1° A dehydration (脱水) reaction

① link two monomers together

② removes a molecule of water



(a) Building a polymer chain

催化 聚合酶
Catalyzed by a polymerase enzyme

2° Digestion (消化作用)

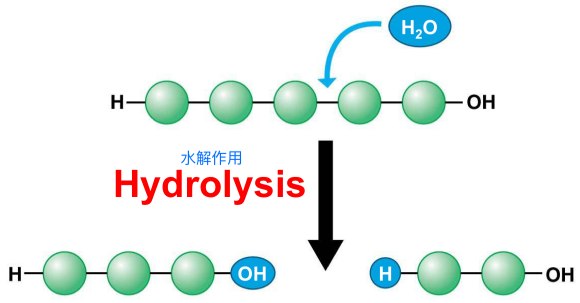
breaks down macromolecules to make monomers available to your cells.

3° Hydrolysis (水解作用)

① breaks bonds between monomers

② adds a molecule of water

③ reverses the dehydration reaction



(b) Breaking a polymer chain

Catalyzed by a hydrolase enzyme

水解酶

4. Large Biological Molecules

There're four categories:

- carbohydrates
- proteins
- nucleic acids
- lipids

§2. Carbohydrates (碳水化合物)

1. Basic Information

1° Carbohydrates includes sugars and polymers of sugar.

2° In animals, carbohydrates are

① a primary source of dietary energy

② raw material for manufacturing other kinds of organic compounds.

3° In plants, carbohydrates serve as a building material

for much of the plant body.

4° Sacchar = sugar

2. Monosaccharides (单糖)

1° Basic information

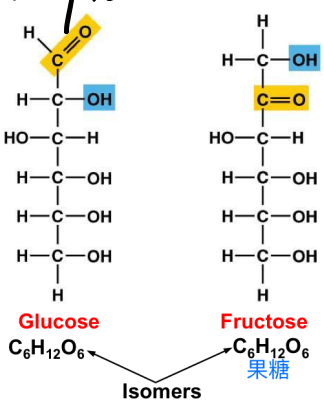
① are the monomers of carbohydrates

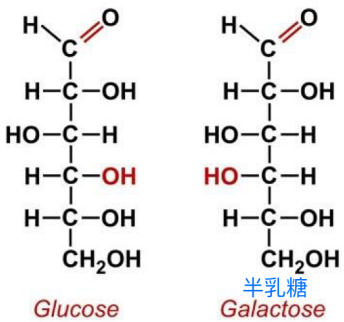
② cannot be broken down into smaller sugars.

③ with the general formula $(CH_2O)_n$, where n is usually 3, 4, 5, 6, 7 or 8

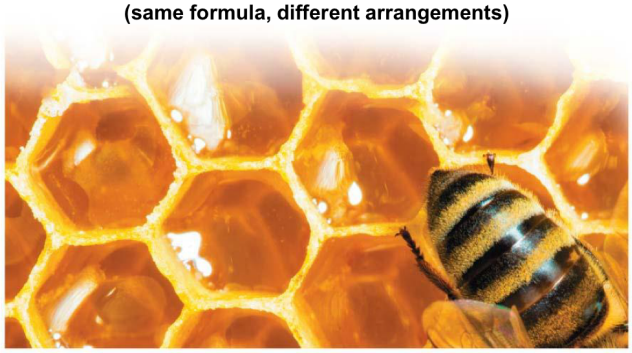
2° Common examples

Fructose tastes about 1.7 times sweeter than glucose.



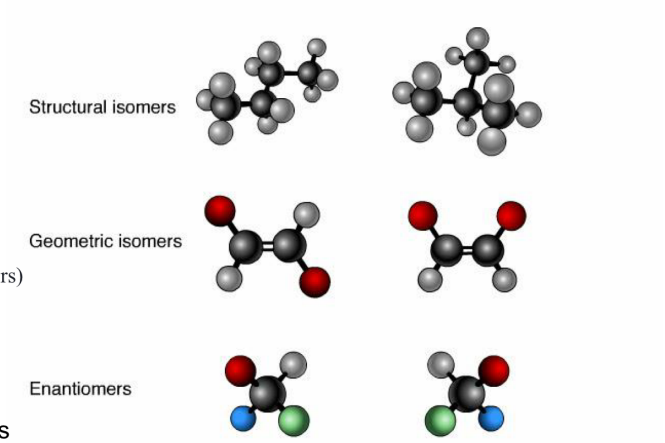


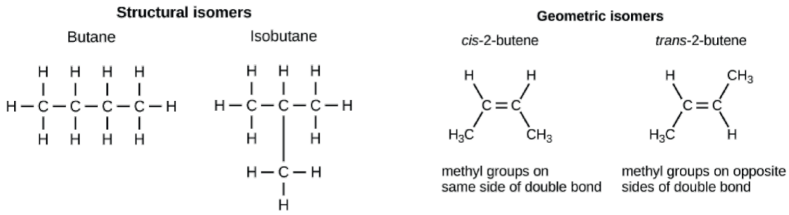
Galactose is only about half as sweet-tasting as glucose.

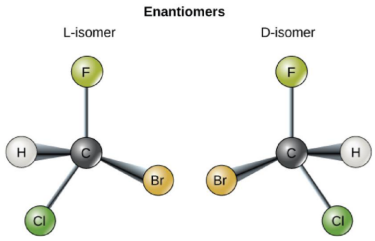


Celery

3° Isomers

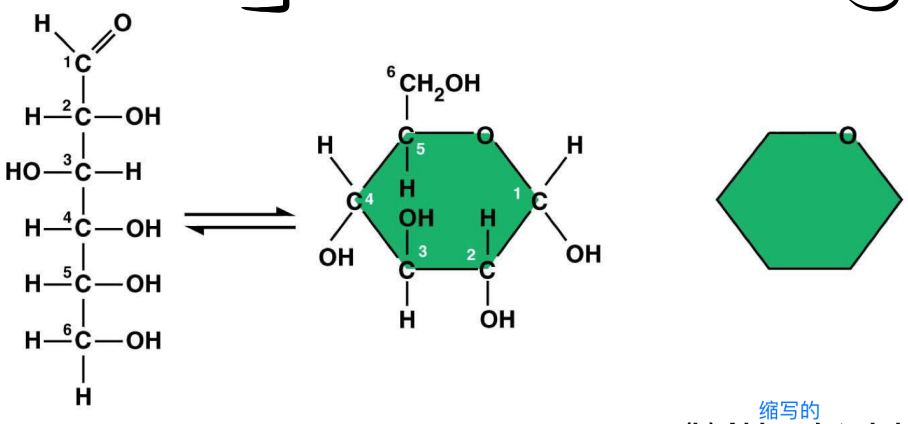






4° Structure

In water, many monosaccharides form a ring structure



(a) **Linear and ring structures**

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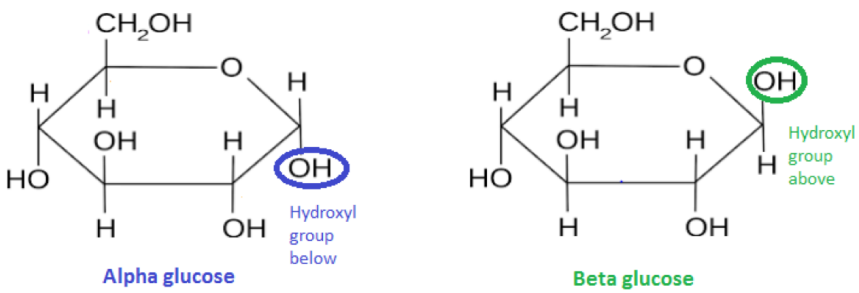
(b) **Abbreviated ring structure**

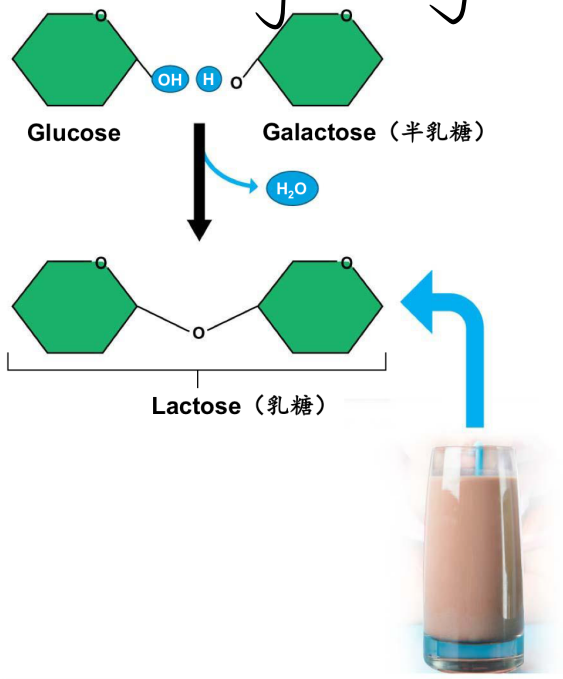
There are two forms of the cyclic glucose molecule: α-glucose and β-glucose.



3. Disaccharides (双糖)

1° The form of disaccharide

A disaccharide is a double sugar constructed from two monosaccharides by a dehydration reaction



2° Types of disaccharide

① lactose (乳糖)

in milk, made from glucose and galactose

② maltose (麦芽糖)

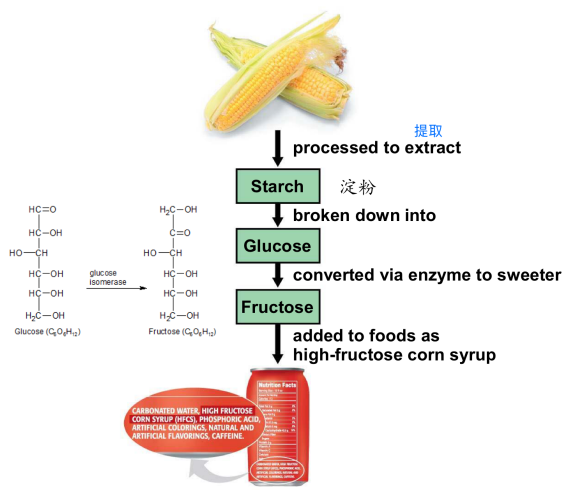
in beer, malted milk shakes.

③ Sucrose (蔗糖)

in table sugar, main carbohydrate in plant sap.

④ High-fructose corn syrup (HFCS) (高果葡糖浆)

made by a commercial process that converts natural glucose in corn syrup to much sweeter fructose.



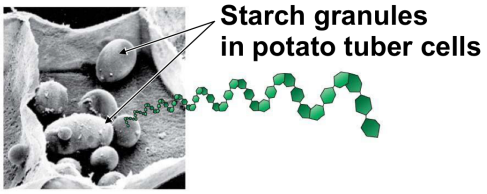
4. Polysaccharides (多糖)

1. Types of polysaccharides

① Starch (淀粉)

(1) consists of long string of glucose monomers

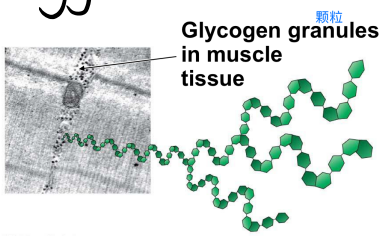
(2) is used by plant cells to store energy.



② Glycogen (糖原)

(1) is used by animal cells to store energy

(2) is broken down to release glucose when you need energy.

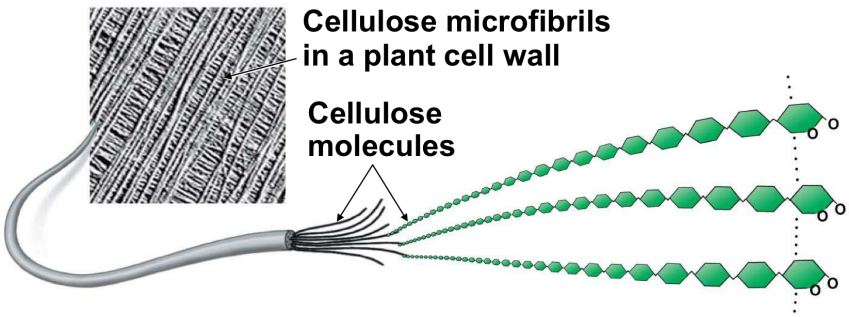


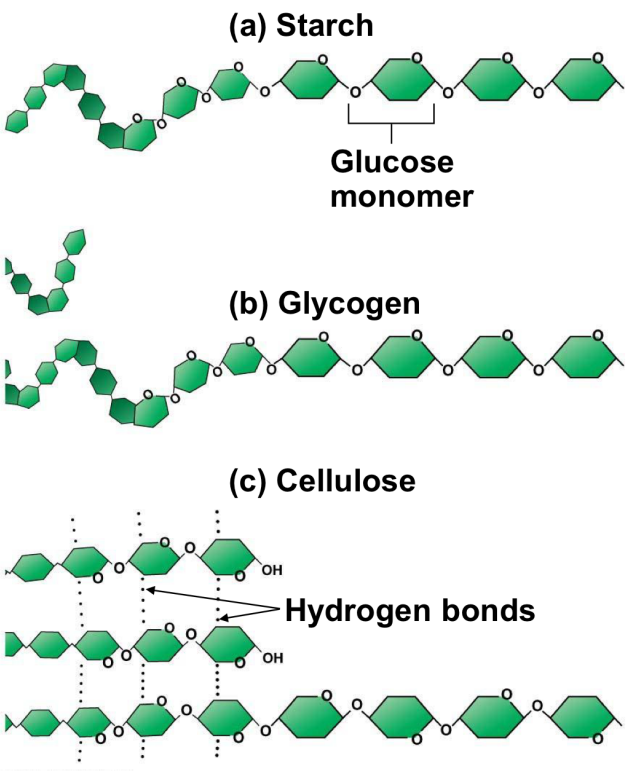
③ Cellulose (纤维素)

(1) is the most abundant organic compound on Earth

(2) forms cable-like fibrils (原纤维) in the walls that enclose plant cells

(3) cannot be broken by any enzyme produced by animals.





2. Structure

(a) **α and β glucose ring structures.** These two interconvertible forms of glucose differ in the placement of the hydroxyl group (highlighted in blue) attached to the number 1 carbon.

α Glucose ⇌ β Glucose

(b) **Starch: 1–4 linkage of α glucose monomers.** All monomers are in the same orientation. Compare the positions of the —OH groups highlighted in yellow with those in cellulose (c).

(c) **Cellulose: 1–4 linkage of β glucose monomers.** In cellulose, every β glucose monomer is upside down with respect to its neighbors. (See the highlighted —OH groups.)

▲ **Figure 5.7** Starch and cellulose structures.