Carbohydrates

General Information

1. **Carbohydrates** include **simple sugars and starches** and are made up of the elements, carbon, hydrogen, and oxygen.
2. Carbohydrates have several functions in living organisms:
    a. **immediate energy source**
    b. **make up many cell structures**
    c. **living organisms store excess glucose as starch.** This is because starch is harder to break down in water (remember the cell cytoplasm is about 90% water).
3. Simple sugars are also referred to as **monosaccharides**
    a. all monosaccharides have the molecular formula of **$C_6H_{12}O_6$**
    b. the only way to tell them apart is by their structures
    c. the **names of sugars end in "ose"**
    d. **examples of simple sugars** are ***glucose, fructose, and galactose***
4. The building blocks of carbohydrates are simple sugars
5. **Disaccharides are two simple sugars linked together by covalent bonds**
    a. **examples of disaccharides** include **maltose** (2 glucose molecules chemically bonded), **sucrose** (table sugar), and **lactose** (milk sugar)
6. **Polysaccharides are three or more simple sugars linked together by covalent bonds.**
    a. **examples of polysaccharides** include **glycogen** (animal starch), **cellulose** (makes up plant cell walls), and **chitin** (found in the exoskeletons of insects, lobster, shrimp, crabs)
    b. a polysaccharide is an example of a **polymer.**

Dehydration Synthesis

1. **Dehydration synthesis** is the **process of building up large complex molecules from smaller, simpler ones by removing a water molecule.**
2. In the case of carbohydrates, simple sugars are linked covalently to one another by the removal of a water molecule with the formation of each bond.

Example 1: We take two simple sugars (glucose) and chemically combine them with the help of enzymes (organic catalysts – in this case maltase), forming a disaccharide, maltose and one water

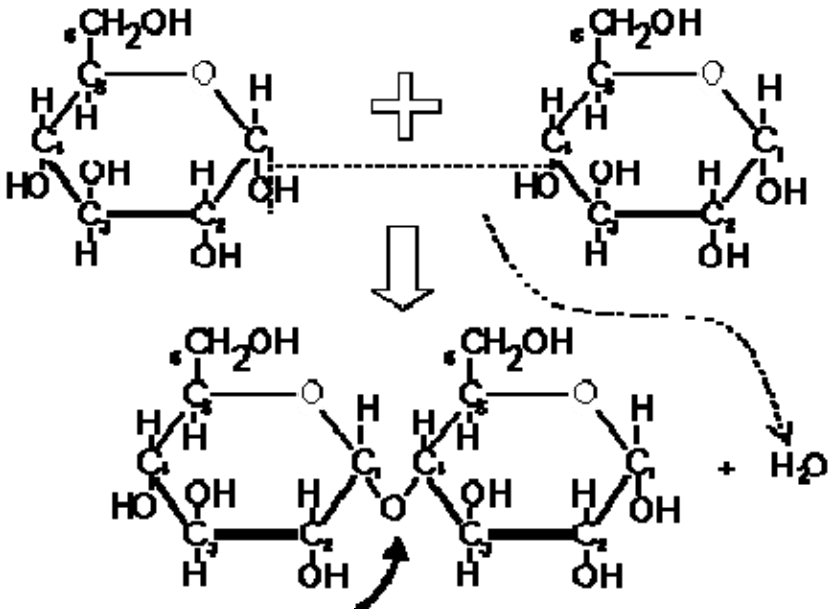
$$\text{GLUCOSE} + \text{GLUCOSE} \xrightarrow{\text{maltase}} \text{MALTOSE} + \text{WATER}$$

Now let's look at the same chemical equation using molecular formulas instead of words:

$$C_6H_{12}O_6 + C_6H_{12}O_6 \xrightarrow{\text{maltase}} C_{12}H_{22}O_{11} + H_2O$$

Important: The **glucose** molecules are the **reactants or raw materials**. Maltose is the **product** and **water** is considered a **metabolic waste or by-product** of this chemical reaction.

Now let's examine the structural formulas to see exactly how water is removed in forming a covalent bond between the two glucose molecules to form maltose:



Oxygen Bridge

Now don't get crazy with trying to memorize this diagram. This illustration is provided for you so that you can see exactly how dehydration synthesis takes place. **You must understand the concept that in living organisms, to synthesize larger compounds from smaller ones, a water is removed when a bond is formed between the two compounds being joined together.**

Hydrolysis: (hydro – water; lysis – to break down)

1. Hydrolysis is the **OPPOSITE** of dehydration synthesis.
2. **Large complex molecules are broken down into smaller simpler ones by the addition of water**.

Let's start with the same chemical compounds we used above in word form:

$$\text{MALTOSE} + \text{WATER} \xrightarrow{\text{maltase}} \text{GLUCOSE} + \text{GLUCOSE}$$

In molecular formulas, hydrolysis of maltose looks like this:

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{maltase}} C_6H_{12}O_6 + C_6H_{12}O_6$$

By adding water to maltose and with the help of the enzyme, maltase, the compound is split back into its building blocks, glucose.

Now, let's see what the hydrolysis of maltose looks like with structure formulas: