consume other organisms as an energy source. Plants store excess glucose as starch, a complex polysaccharide. Polysaccharides will be discussed in more detail later in this section. When organisms consume plants, they hydrolyze (verb form of hydrolysis reactions) the starch molecules into monosaccharides. These monosaccharides are then used to generate their ATP.

Galactose (part of lactose, or milk sugar) and fructose (found in fruit) are other common monosaccharides. Glucose, galactose, and fructose are all **isomers** meaning they have the same chemical formula ($C_6H_{12}O_6$) but differ structurally. Because of these structural differences, each molecule has different chemical properties. For example, the sugar fructose is sweeter than the sugar glucose.

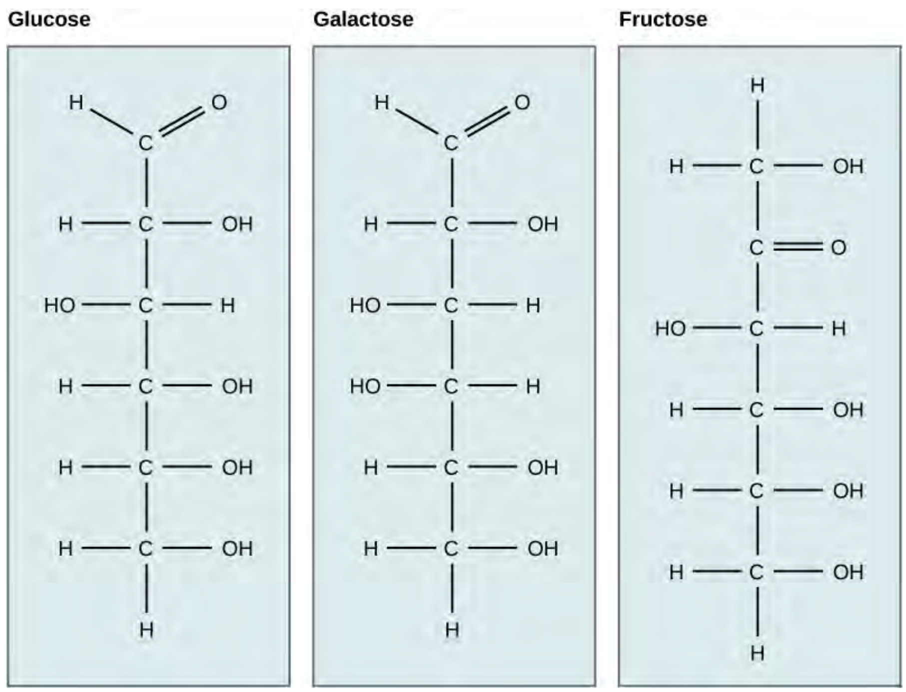

Figure 3.9 Glucose, galactose, and fructose are isomeric monosaccharides. (credit: Fowler et al. [/ Concepts of Biology OpenStax])

Disaccharides

Disaccharides (di- = "two") form when two monosaccharides undergo a dehydration synthesis. During this process, the hydroxyl group (–OH) of one monosaccharide combines with a hydrogen atom of another monosaccharide, releasing a water molecule (H_2O). A covalent bond forms between the atoms in the two sugar molecules (Figure 3.10).

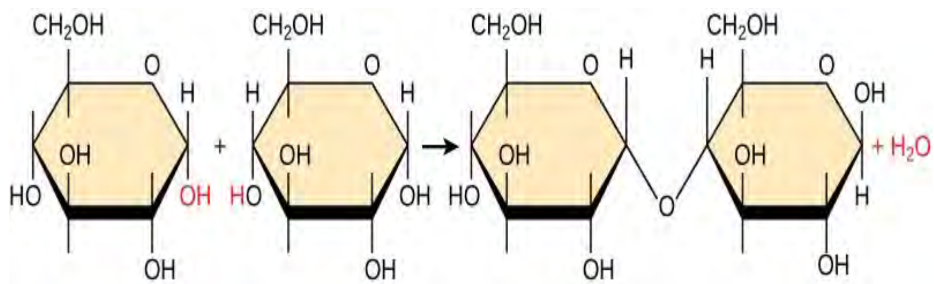

Figure 3.10 In the dehydration synthesis reaction above, two glucose molecules link to form the disaccharide maltose. In the process, a water molecule formed. (credit: Clark et al.[/ Biology 2E OpenStax])

Many disaccharide names also end with the suffix -ose. Lactose is a disaccharide made up of the monomers glucose and galactose. It is found naturally in milk. Maltose, or malt sugar, is a disaccharide formed from a dehydration synthesis between two glucose molecules. The most common disaccharide is sucrose, more commonly known as table sugar. Sucrose is composed of the monomers glucose and fructose (Figure 3.11).

Figure 3.11 A lump of sucrose, commonly called table sugar. (credit: Uwe Hermann/ Flickr)

Polysaccharides

A **polysaccharide** (poly- = "many") is a chain of three or more monosaccharides linked together by covalent bonds. The chain may be branched or unbranched and is typically very large (i.e. thousands of monosaccharides). Starch, glycogen, cellulose, and chitin are all examples of polysaccharides (Figure 3.12).

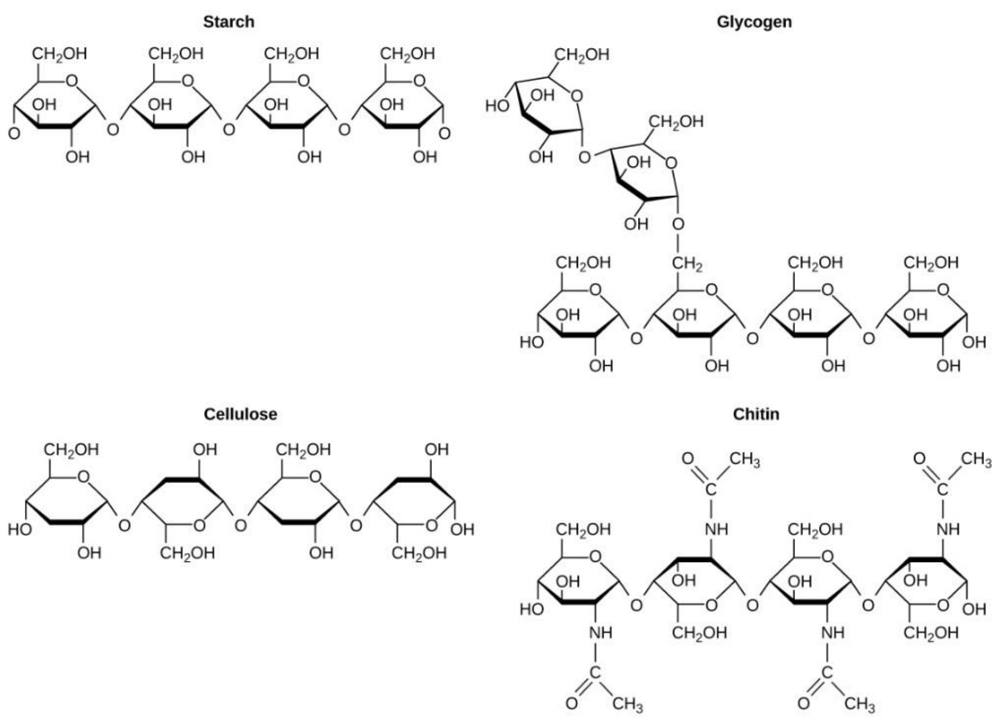

Figure 3.12 Although their structures and functions differ, all polysaccharide carbohydrates are made up of monosaccharides. (credit: Fowler et al. / Concepts of Biology OpenStax)

Starch

Plants can synthesize glucose through the process of photosynthesis. Any excess glucose that is not used to make ATP is stored as **starch** in different parts of the plant, including its roots and seeds. The potato in Figure 3.13 is an excellent example of a plant root that is rich in starch, storing glucose that was produced in the leaves of the potato plant. When animals consume potatoes, the starch is broken down through hydrolysis reactions into monomers of glucose. Cells can then absorb the glucose and use it to generate their form of energy, ATP.

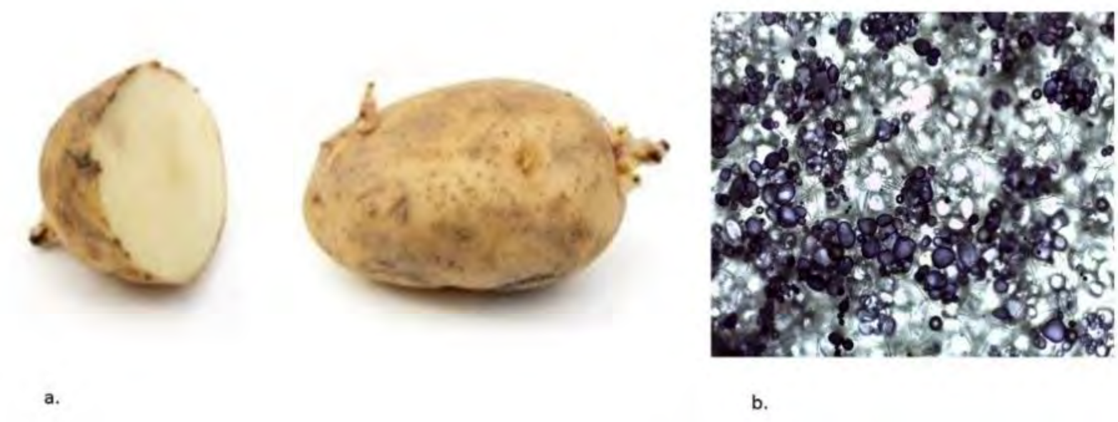

Figure 3.13 a. A potato represents the root of a plant that stores the plant's starch. b. Potato cells stained with iodine. Starch stains purple in specialized organelles called amyloplasts (10x magnification). (credit: a. ZooFari / Wikimedia b. Elizabeth O'Grady)

Glycogen

Humans and many other vertebrates store their excess glucose as **glycogen**. Glycogen is made up of glucose monomers and is the animal equivalent of starch. It is a highly branched molecule and most often stored in liver cells (Figure 3.14). Whenever glucose levels in the body decrease, glycogen in the liver can be broken down into glucose molecules with the help of enzymes. When glucose levels in the body are elevated, liver cells can take up excess glucose. Excess glucose is converted to glycogen in a dehydration synthesis reaction with the help of the enzyme, glycogen synthase. In humans, two important hormones, insulin and glucagon, govern these two processes of glycogen formation and glycogen breakdown.

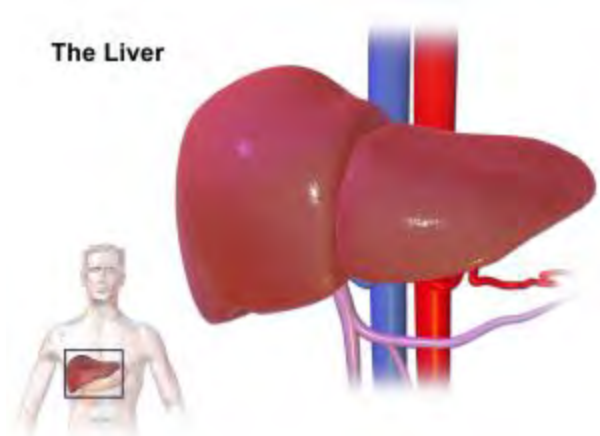

Figure 3.14 The human liver contains stored glycogen. (credit: BruceBlaus / Wikimedia)