Cellulose

Cellulose is one of the most abundant natural polysaccharides. The cell walls of plants are mostly made of cellulose, which provides structural support for the cell (Figure 3.15). Wood and paper are also mostly cellulose in nature. Glucose monomers in cellulose are held together by covalent bonds and pack tightly into long extended chains. Tightly packed chains of glucose give cellulose its rigidity and high tensile strength, which is very important to plant cells.

Figure 3.15 Plants, which are composed of plant cells, have rigid cell walls that contain cellulose. (credit: Yash Deshpande / Wikimedia)

Cellulose passing through the human digestive system is called dietary fiber. The glucose-glucose bonds in cellulose cannot be broken down by human digestive enzymes. Humans rely on dietary fiber to help maintain the consistency of their stools rather than providing a source of energy. Diets that lack dietary fiber may result in stools becoming hard and difficult to pass, a condition referred to as constipation. Herbivores such as cows, buffalos, and horses can digest cellulose found in plant matter and use it as a food source. These animals and certain species of bacteria that reside in their rumen, part of the digestive system of herbivores, secrete the enzyme cellulase. Cellulase can break cellulose down into glucose monomers that are then used to synthesize ATP.

Chitin

Insects, spiders, and crabs are arthropods that protect their internal organs with hard outer shells, called the exoskeletons (Figure 3.16). Exoskeletons are made of a polysaccharide called **chitin**. Chitin is also found in the scales of fish and the cell walls of fungi.

Figure 3.16 Stag Beetle (*Lucanus capreolus*) with its hard exoskeleton made of chitin. (credit: Dr. Bob Remedi)

CONCEPTS IN ACTION - For an additional perspective on carbohydrates, explore "Biomolecules: the Carbohydrates" through this interactive animation.

CAREER CONNECTION - Registered Dietitian

Obesity is a worldwide health concern. It has been linked with diseases such as diabetes, atherosclerosis, and hypertension. As a result, registered dietitians are increasingly sought after for advice. Registered dietitians help plan food and nutrition programs for individuals in various settings. They often work with patients in health-care facilities, designing nutrition plans to prevent and treat diseases. For example, dietitians may teach a patient with diabetes how to manage blood sugar levels by eating the correct types and amounts of carbohydrates. Dietitians may also work in nursing homes, schools, and private practices.

Section Summary

Carbohydrates are classified as monosaccharides, disaccharides, and polysaccharides. The classification depends on the number of monomers in the molecule. Carbohydrates are a group of macromolecules that are a vital energy source for cells and provide structural support to many organisms.

Exercises

1. An example of a monosaccharide is _____.
    a. fructose
    b. maltose
    c. starch
    d. glycogen

2. Glycogen and chitin are examples of _____.
    a. monosaccharides
    b. disaccharides
    c. lipids
    d. polysaccharides

3. Plant cell walls contain which of the following in abundance _____.
    a. starch
    b. cellulose
    c. glycogen
    d. lactose

4. Compare and contrast starch and glycogen.

Answers

1. (a)
2. (d)
3. (b)
4. Starch and glycogen are both polysaccharides used by organisms to store sugar. Starch is the major polysaccharide that is used by plants to store their sugar, whereas most animals store their complex sugars as glycogen in their livers.

Glossary

carbohydrate: a biological macromolecule in which the ratio of carbon to hydrogen to oxygen is 1:2:1; carbohydrates serve as energy sources and structural support in cells

cellulose: a polysaccharide that makes up the cell walls of plants and provides structural support to the cell

chitin: a type of carbohydrate that forms the outer skeleton of arthropods, such as insects and crustaceans, and the cell walls of fungi

dehydration synthesis: a reaction where monomers combine with the help of water (and often an enzyme) to form polymers

disaccharide: two sugar monomers that are linked together by a peptide bond

glycogen: a storage carbohydrate in animals

monosaccharide: a single unit or monomer of carbohydrates

polysaccharide: a long chain of monosaccharides; may be branched or unbranched

starch: a storage carbohydrate in plants