General Biology I (101-NYA)
Carbohydrates Key Concepts & Learning Outcomes

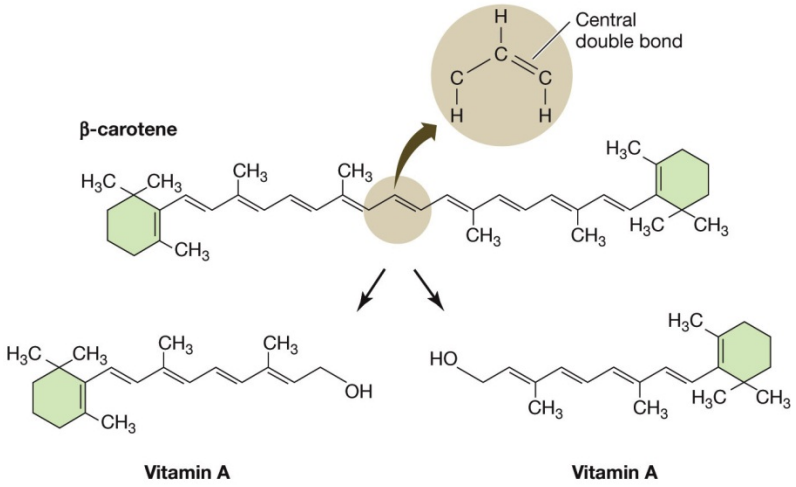
Topic	Chapters 5-6 pages*	Concept	Learning Outcomes
Biologically important carbohydrates	p. 75	1. General chemical formula of carbohydrates: $(CH_2O)_n$, a ratio of 1 C: 2 H:1 O. 2. Carbohydrates contain a carbonyl, several hydroxyl functional groups, and many C–H bonds. 3. There are 4 major categories of carbohydrates: a. Monosaccharides b. Disaccharides (2 monosaccharides) c. Oligosaccharides (3–20 monosaccharides) d. Polysaccharides (100 to >100,000 monosaccharides)	1. Define carbohydrates and identify the 4 major categories of biologically important carbohydrates
Monosaccharides (simple sugars)	p. 76-77	4. Monosaccharides vary in the placement of the carbonyl group: aldose (aldose at end of the molecule) and ketose (carbonyl in the middle of the carbon chain). 5. Monosaccharides also vary in the arrangement of their OH groups, so that many sugars have the same chemical formula but different structures. 6. The C atoms in a monosaccharide are numbered starting at the end closest to the carbonyl group. 7. The number of C atoms in monosaccharides varies between: 3 (triose); 5 (pentose: $C_5H_{10}O_5$; eg, ribose and deoxyribose in RNA and DNA); 6 (hexose: $C_6H_{12}O_6$; eg, glucose, fructose, mannose, and galactose) 8. Glucose is a main monosaccharide and is found in all living organisms. It exists as a straight chain and a ring (predominant conformation). 9. In the ring conformation, glucose has 2 forms: α-glucose and β-glucose.	2. Describe and recognize the basic structure of monosaccharides 3. Assign appropriate numbers to the carbons inside the ring of a monosaccharide molecule 4. Recognize and differentiate between the straight chain and the α and the β ring forms of glucose
Disaccharides &	p. 77	10. Disaccharides and oligosaccharides form from 2 or more	5. Describe how monosaccharides link

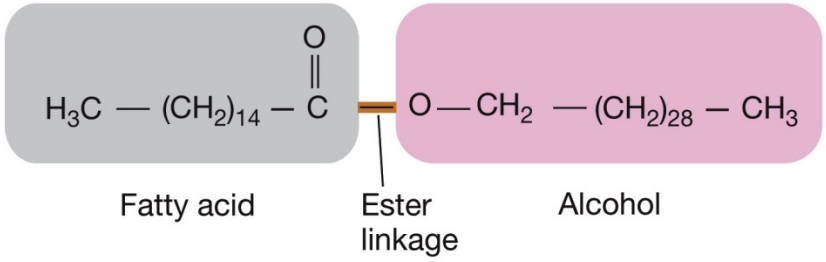
oligosaccharides		monosaccharides through a condensation reaction between OH groups to create a glycosidic linkage. For example, sucrose consists of glucose and fructose bonded together via an α-1,2 glycosidic linkage.	together to form a glycosidic linkage 6. Describe and recognize the structure of disaccharides and oligosaccharides
Polysaccharides	p. 77-80	11. Polysaccharides are large polymers of monosaccharides connected by glycosidic linkages. Polysaccharides can take the form of linear or branched chains of monosaccharides. 12. Biologically important polysaccharides include: a. Starch: branched chains with α-1,4 and α-1,6 glycosidic linkages; found in plants. b. Glycogen: similar to starch but with higher degree of branching; found in animals. c. Cellulose: Polymer of β-glucose linked by β-1,4-glycosidic bonds; alternate flipping of glucose monomers allows extensive H bonding between adjacent parallel strands; found in plant cell walls. d. Chitin: polymer of N-acetylglucosamine (modified sugar); found in exoskeleton of insects and crustaceans and in the cell walls of fungi.	7. Define polysaccharides and give examples of biologically important polysaccharides 8. Recognize and differentiate between α and β glycosidic linkages 9. Compare the structures of energy storage polysaccharides and structural polysaccharides
Functions of carbohydrates	p. 80-83	13. Main functions of carbohydrates include: a. **Building blocks** in the synthesis of other molecules (eg, amino acids and pentoses). b. Indicate **cell identity (oligosaccharides)** c. Storage of **chemical energy (starch and glycogen)**. d. Support and protection (cellulose and chitin)	10. List and describe the biological roles of carbohydrates

* Textbook: Biological Science, Freeman, S. *et al.,* 2nd Canadian ed., 2014

General Biology I (101-NYA)
Lipids Key Concepts & Learning Outcomes

Topic	Chapters 5-6 pages*	Concept	Learning Outcomes
Biologically important lipids	p. 87-88	1. Lipids consist mostly of hydrocarbon skeleton that make then nonpolar and hydrophobic. 2. Lipids are not polymers and vary greatly in structure. Most lipids are built from isoprene units and fatty acids. 3. There are 5 major categories of biologically important lipids: triglycerides, phospholipids, carotenoids, steroids and modified fatty acids, and waxes.	1. Define lipids and identify the 5 major categories of biologically important lipids
Triglycerides	p. 88-898	4. Triglycerides (simple lipids) consist of glycerol that is bonded via ester linkages to 3 fatty acid molecules. Ester linkages form by condensation reactions. 5. There are 2 general types of triglycerides: a. Fats: solid at room temperature; high in saturated fatty acids and low in unsaturated fatty acids; found mostly in animals b. Oils: liquid at room temperature; high in unsaturated fatty acids and low in saturated fatty acids; found mostly in plants	2. Describe the structure of a triglyceride, including the compounds that make it up, and describe how these components are linked together in a triglyceride molecule 3. Differentiate between saturated and unsaturated fatty acids in terms of structure, where they can be found, cellular importance, and molecular characteristics
Phospholipids	p. 89-90	6. Phospholipids consist of glycerol linked to a phosphate-containing compound and 2 fatty acid chains (bacteria and eukarya) or 2 isoprene chains(Archaea). 7. Phospholipids are amphipathic molecules, ie, they have a hydrophobic component (fatty acid chains, aka tails) and a hydrophilic component (phosphate-containing compound, aka head). 8. Biological membranes (plasma membrane and membranes surrounding organelles) consist of a double layer (bilayer) of phospholipids.	4. Define the term amphipathic and use this term to describe the structure of a phospholipid molecule, the basic structure of phospholipid bilayer, and explain why phospholipid are able to form bilayers
Carotenoids		9. Carotenoids are highly hydrophobic light-absorbing pigments found in plants and animals. Example: β-carotene (orange pigment).	5. Define and give an example of carotenoids



Steroids and modified fatty acids	p. 89	10. All steroids share the same 4-ring structure that is made from isoprene subunits. A common example of steroid is cholesterol. 11. Example of modified fatty acids include many lipid vitamins such as vitamin A and K.	6. Define steroids and modified fatty acids and explain how they differ from other lipids
Waxes		12. Waxes are highly nonpolar molecules consisting of long saturated fatty acids linked via ester linkage to long fatty alcohol.  	7. Define waxes and explain how they differ from other lipids
Functions of lipids		13. Biologically important roles of lipids include: energy storage (triglycerides); structural functions (phospholipid bilayers and cholesterol in biological membranes); hormonal (sex hormones); metabolic (lipid vitamins), and protection (waxes).	8. List and describe the various biological roles of lipids

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