

CARBON AND MOLECULAR DIVERSITY

The structure and function of
macromolecules:

Carbohydrates and Lipids

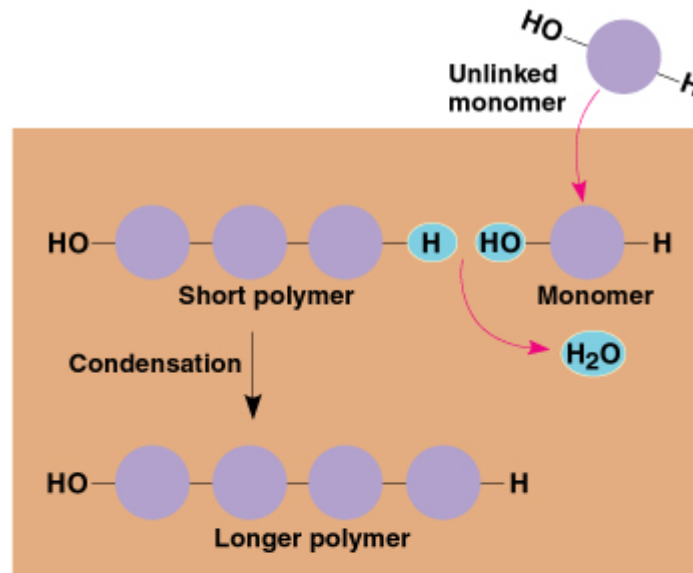
Chapter 5

Objectives

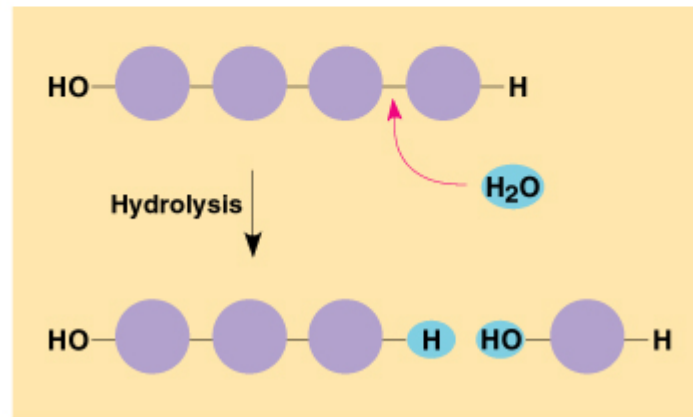
- Be familiar with how polymers are assembled and dismantled
- Understand that most organic macromolecules are polymers of smaller units
- Describe the properties of a carbohydrate
- Be able to distinguish between a monosaccharide, disaccharide and a polysaccharide.
- Be able to give examples of each kind of carbohydrate
- Know that the energy of a carbohydrate comes from its ability to donate electrons
- Describe the properties of a lipid
- Understand the 3 categories of lipids and the significance of each kind of lipid

POLYMER PRINCIPLES.

- Most macromolecules are polymers built from smaller units called monomers.
- Polymerization reactions are carried out through the elimination of water (condensation or dehydration synthesis) or the addition of water (hydrolysis).
- An immense variety of polymers can be built from a small set of monomers.



(a) Condensation (dehydration) synthesis of a polymer



(b) Hydrolysis of a polymer

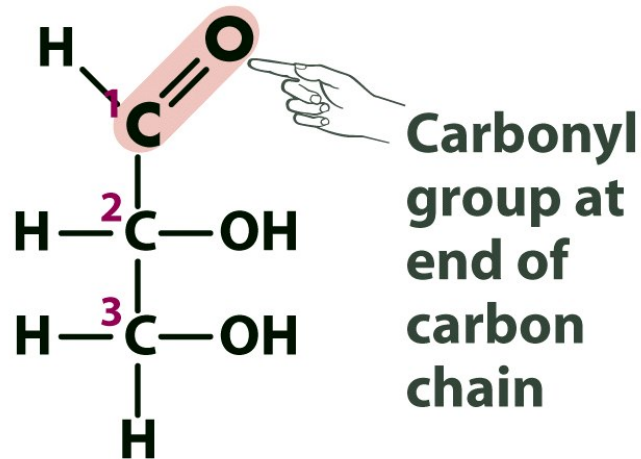
CARBOHYDRATES: FUEL AND BUILDING MATERIAL

- Carbohydrates are molecules built from monomer units with a chemical formulation of CH_2O
- Depending on their size and configuration, carbohydrates serve as energy molecules or structural “building blocks”
- Three “size categories” of carbohydrates are recognized: Monosaccharide, Disaccharide, and Polysaccharide

Monosaccharides: Fuel and Building Material

- Monosaccharides, the smallest carbohydrates, serve as fuel and carbon sources

An aldose



A ketose

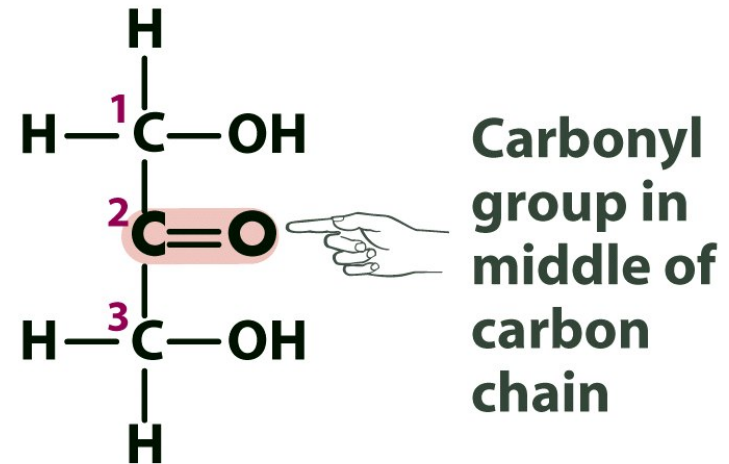
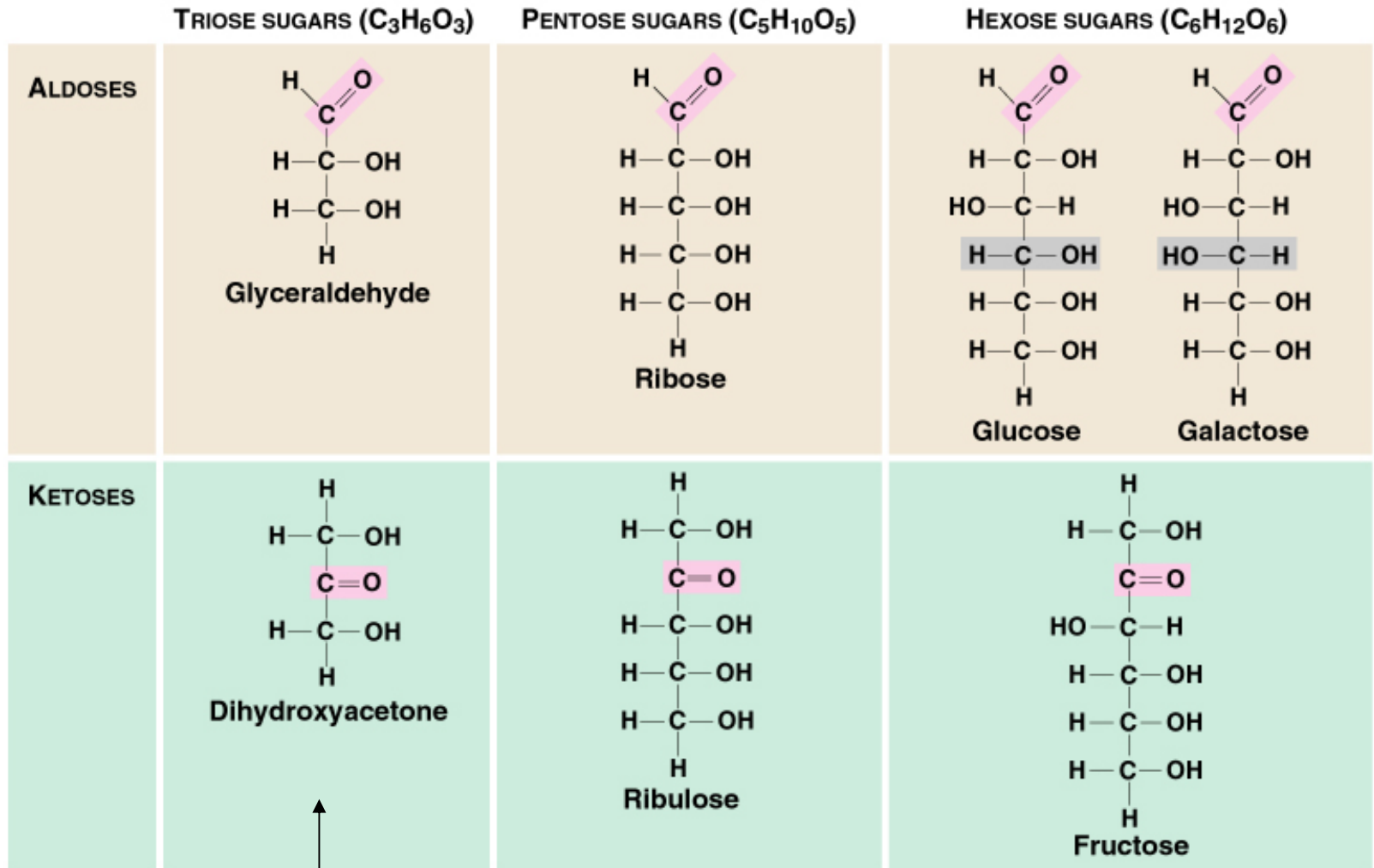


Figure 5-1 Biological Science, 2/e

Examples of linear (chain) form structures for several monosaccharides

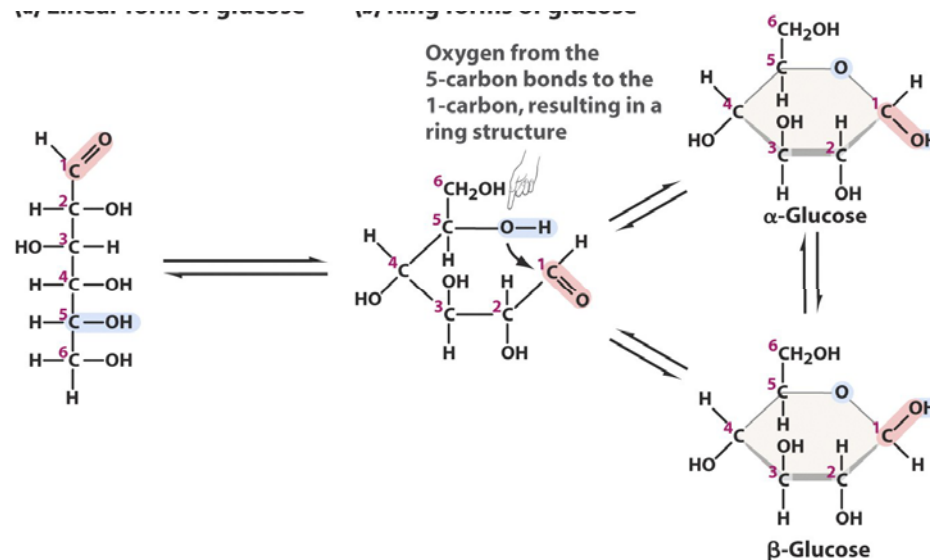


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What are these? Answer: Isomers of each other

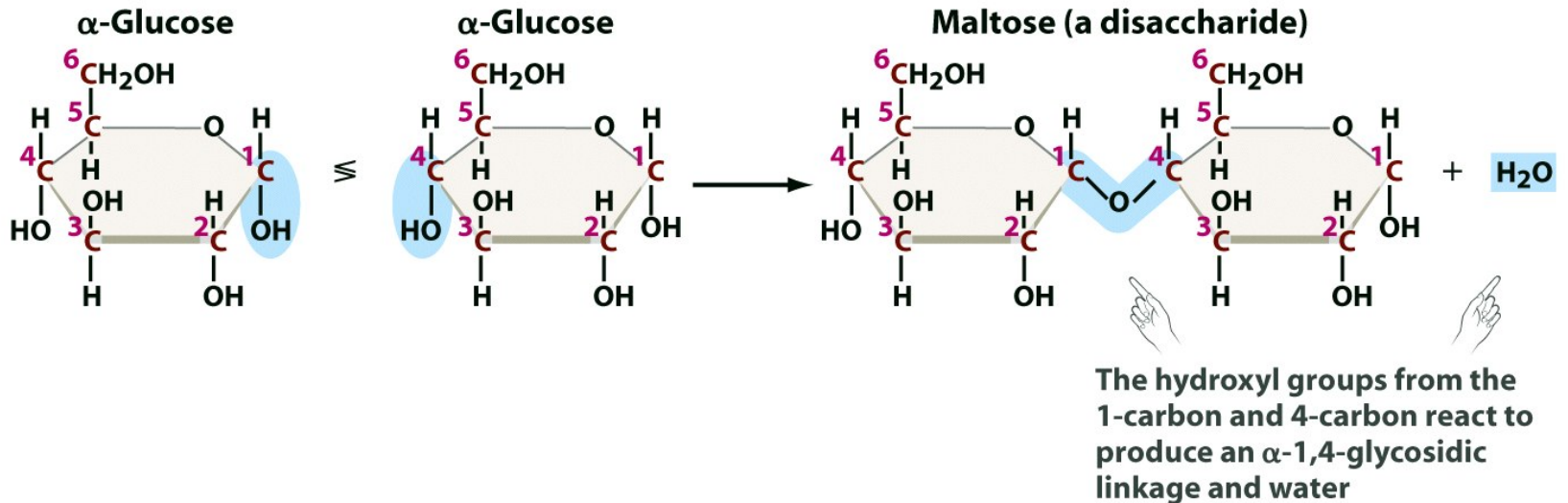
Disaccharides

- When two monosaccharides are hooked together via dehydration synthesis, a disaccharide is formed.
- The monosaccharide must first be in ring form:



Glycosidic Linkage Formation

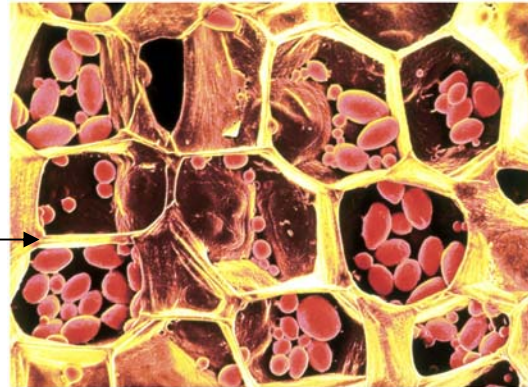
Polymerization reaction



- The junction between two monosaccharides is called a glycosidic linkage
- The structure of the disaccharide (types of monosaccharides used and glycosidic linkage position) is important in determining how the disaccharide functions

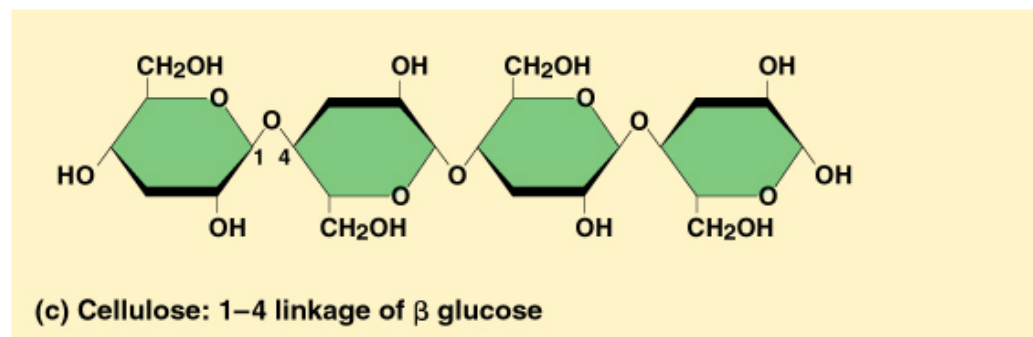
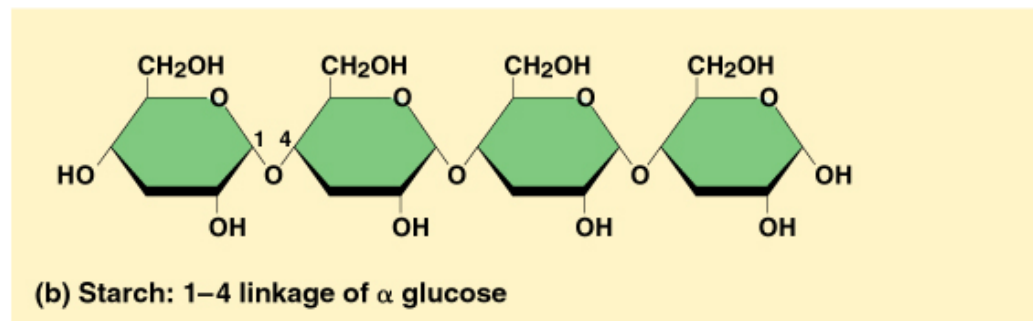
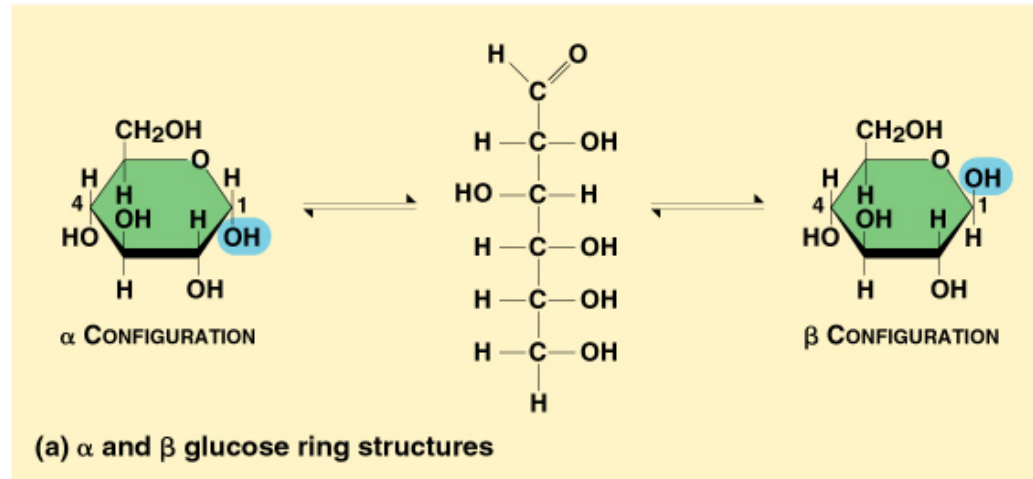
Polysaccharide

- Polysaccharides result from many monosaccharides being linked together
 - Energy Storage
 - Glycogen, Starch
 - Structural Support
 - Chitin, Cellulose



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- Again, type of monosaccharide and glycosidic linkage structure are important



Importance of Carbohydrates

- Energy (electron donors)
- Building materials
- Used for cell-cell recognition (important to the immune system)

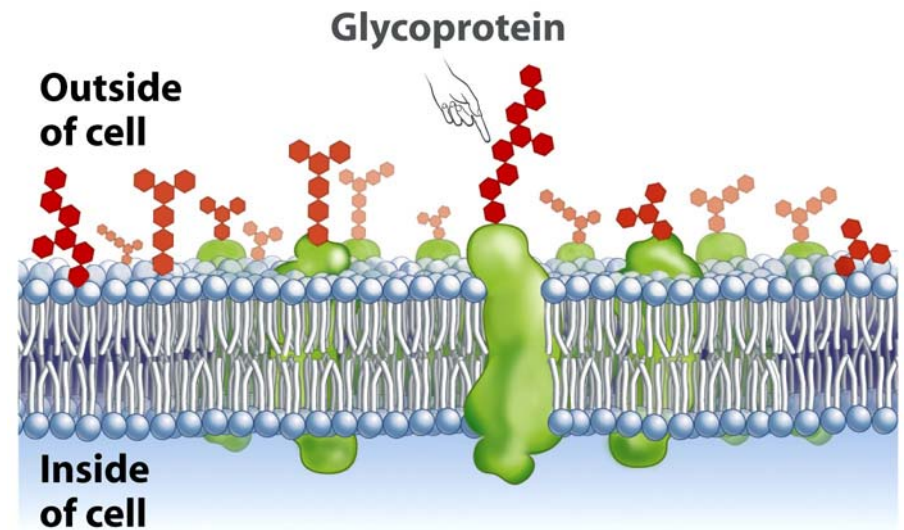


Figure 5-5 Biological Science, 2/e

LIPIDS: DIVERSE HYDROPHOBIC MOLECULES

- Lipids store large amounts of energy
 - 9 kcal/gram due to energy rich fatty acid chain
- Characteristics of fat
 - Hydrophobic because of nonpolar FA chain
- Saturated versus unsaturated fats.
 - Saturated FA chains form no more bonds, unsaturated FA chains can form more bonds

General Role of Lipids

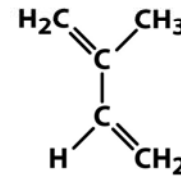
- Functions of fat
 - energy storage, cushioning, insulation
- Lipids store large amounts of energy
 - 9 kcal/gram due to energy rich fatty acid chain
- Their fluid (pliable) nature makes them a good cushion as “Shockwaves” are dispersed
- Molecules can be close together making some fats good insulators

What are Lipids?

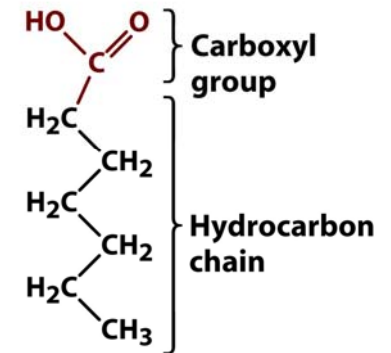
- Characteristics

- Tend to be Hydrophobic (water fearing) because of nonpolar components (lots of hydrocarbons (C-H))
- Made from isoprene units combined to make chains
- Chains are made polar through the addition of a carboxyl group forming a Fatty acid

(a) Isoprene



(b) Fatty acid



- Saturated versus unsaturated fats.

- Saturated FA chains form no more bonds, unsaturated FA chains can form more bonds

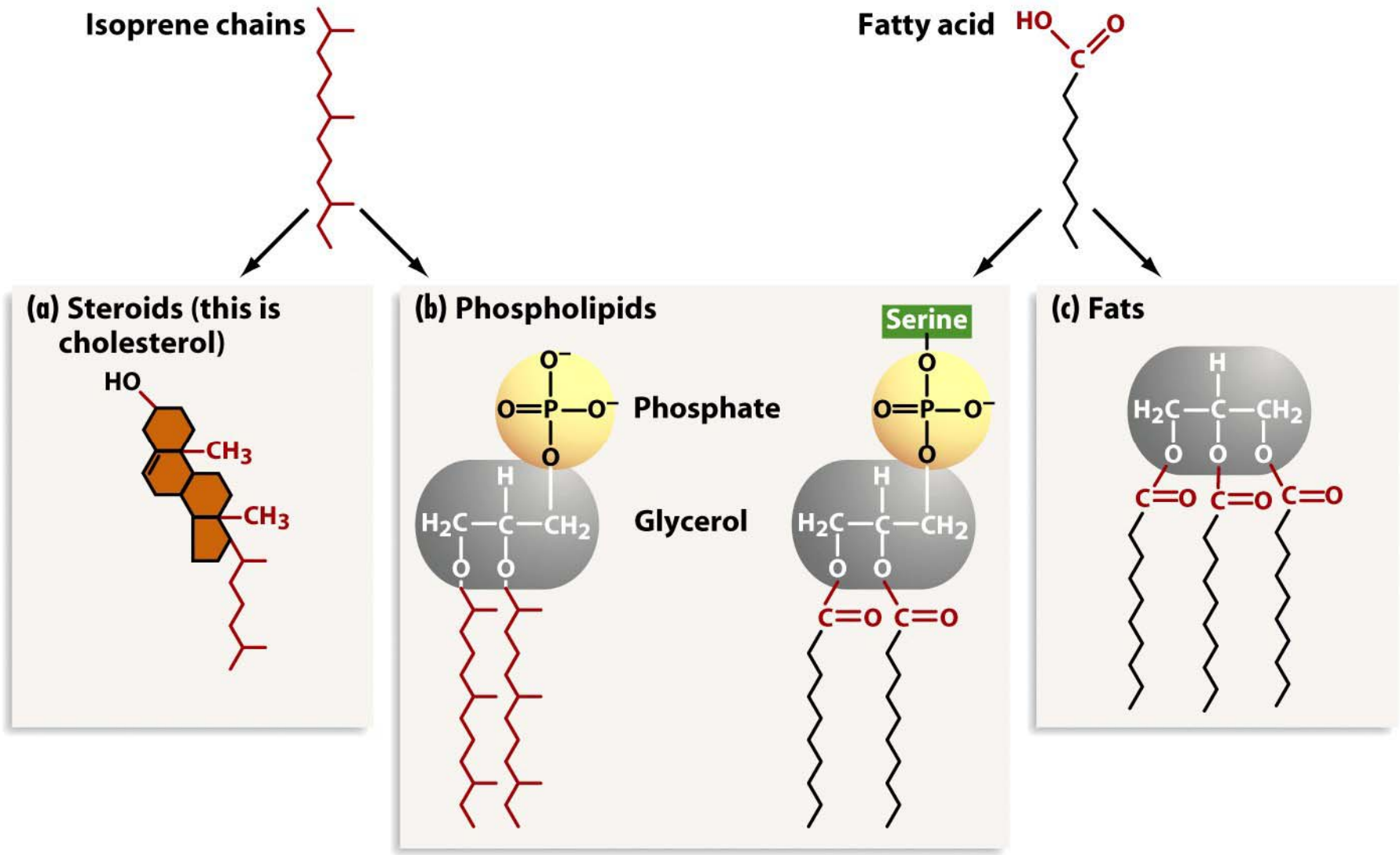


Figure 6-4 Biological Science, 2/e

Kinds of Lipids

- **Triglyceride**
(triacylglycerol)
- Comprise many of the dietary oils and fats
- Functional differences arise from differences in hydrophobic chain type and position

Dehydration reactions join fatty acids to glycerol.

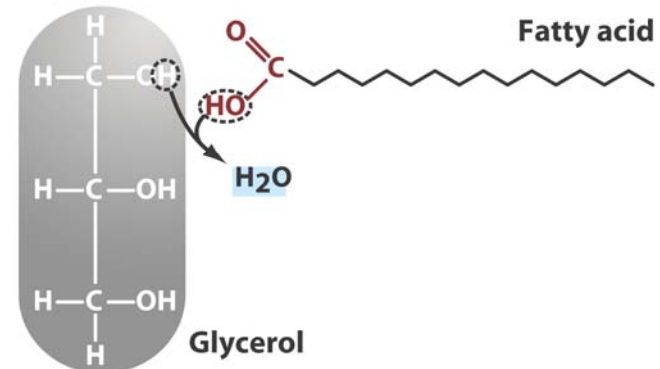


Figure 6-5a Biological Science, 2/e

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Fats consist of glycerol linked to three fatty acids.

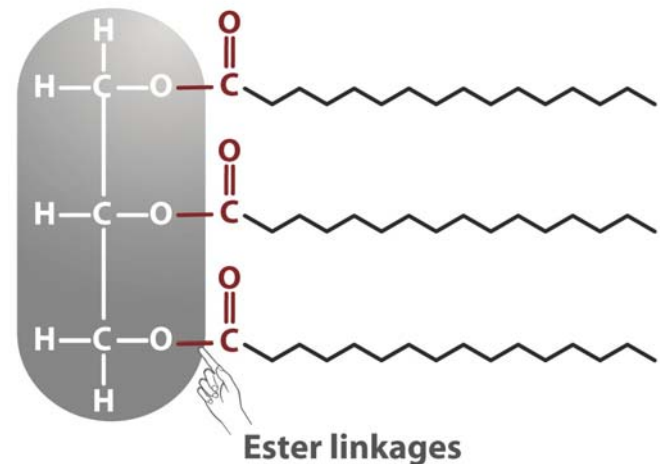


Figure 6-5b Biological Science, 2/e

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Kinds of Lipids

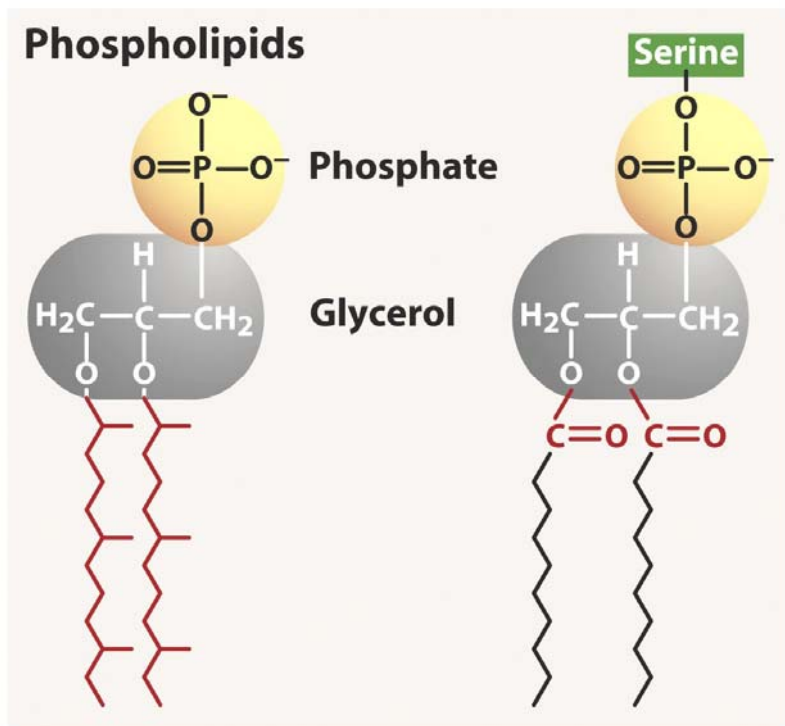
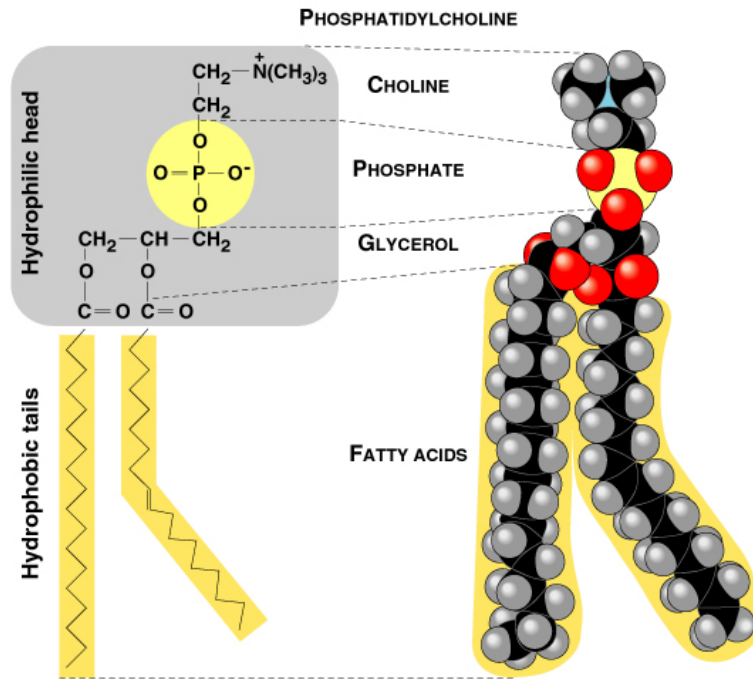


Figure 6-4b Biological Science, 2/e

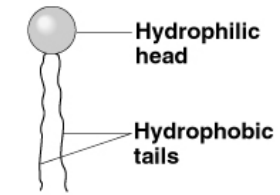
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- **Phospholipid**
- Comprises much of the Plasma Membrane (border around cell)
- Polar phosphate group coupled with nonpolar hydrocarbon chains make this molecule **amphipathic**



(a) Structural formula

(b) Space-filling model



(c) Phospholipid symbol

Kinds of Lipids

- **Steroids**
- Isoprene chains form a 17 carbon ring system as core structure
- Steroid types vary depending on position and type of groups attached to ring system
- Comprise some hormones such as Testosterone, Estradiol, Cortisol, and Aldosterone

