Course bi5b chemistry: Chapter 23
lipids (vetten)

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Reference

Fundamentals of General, Organic, and Biological
Chemistry Seventh Edition

John McMurry
Cornell University

David S. Ballantine
Northern Illinois University

Carl A. Hoeger
University of California, San Diego

Virginia E. Peterson
University of Missouri, Columbia

(Reference: Chapter 23 from McMurry et al.)

Chapter goals

CHAPTER GOALS

1. **What are the major classes of fatty acids and lipids?**
   THE GOAL: Be able to describe the chemical structures and general properties of fatty acids, waxes, fats, sterols, and oils. (◀◀◀ B, C, D, E.)
2. **What reactions do triacylglycerols undergo?**
   THE GOAL: Be able to describe the results of hydrogenation and hydrolysis of triacylglycerols, and, given the reactants, predict the products. (◀◀◀ B, C.)
3. **What are sterols?**
   THE GOAL: Be able to identify sterols and their derivatives; describe their structures and roles.
4. **What are the membrane lipids?**
   THE GOAL: Be able to identify the membrane lipids; describe their structures and roles. (◀◀◀ A, C, D.)
5. **What is the nature of a cell membrane?**
   THE GOAL: Be able to describe the general structure of a cell membrane and its chemical composition. (◀◀◀ A, E.)
6. **How do substances cross cell membranes?**
   THE GOAL: Be able to distinguish between passive transport and active transport and between simple diffusion and facilitated diffusion. (◀◀◀ A.)
7. **What are eicosanoids?**
   THE GOAL: Be able to describe the general structure of prostaglandins and leukotrienes, and some of their functions. (◀◀◀ E.)

CONCEPTS TO REVIEW ◀◀◀

- **A. Intermolecular Forces** (Section 8.2)
- **B. Cis–Trans Isomerism** (Section 13.3)
- **C. Esters and Amides** (Sections 17.4, 17.6)
- **D. Phosphoric Acid Derivatives** (Section 17.8)
- **E. Carboxylic Acids** (Sections 17.1, 17.2)

(Reference: Chapter 23 from McMurry et al.)

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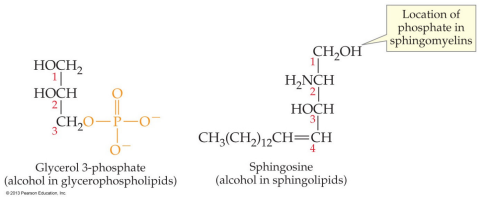
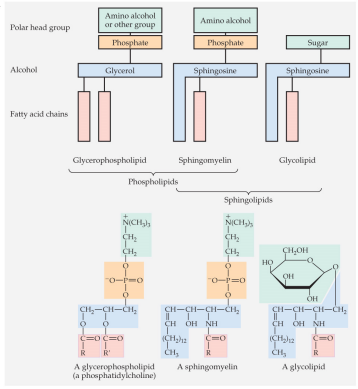
(Reference: Chapter 23 from McMurry et al.)

23.5 Phospholipids and Glycolipids



(Reference: Chapter 23 from McMurry et al.)

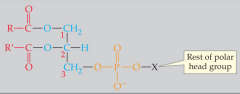
23.5 Phospholipids and Glycolipids

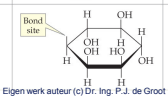


(Reference: Chapter 23 from McMurry et al.)

23.5 Phospholipids and Glycolipids

TABLE 23.3 Some Glycerophospholipids



PRECURSOR OF X (HO–X)	FORMULA OF X	NAME OF RESULTING GLYCEROPHOSPHOLIPID FAMILY	FUNCTION
Water	—H	Phosphatidate	Basic structure of glycerophospholipids
Choline	$-CH_2CH_2\overset{+}{N}(CH_3)_3$	Phosphatidylcholine	Basic structure of lecithins; most abundant membrane phospholipids
Ethanolamine	$-CH_2CH_2\overset{+}{N}H_3$	Phosphatidylethanolamine	Membrane lipids
Serine		Phosphatidylserine	Present in most tissues; abundant in brain
myo-Inositol		Phosphatidylinositol	Relays chemical signals across cell membranes

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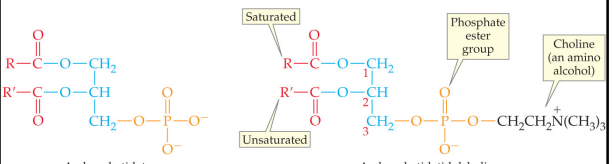
23.5 Phospholipids and Glycolipids



A phosphatidate

A phosphatidatidylcholine (a glycerophospholipid that is a lecithin)

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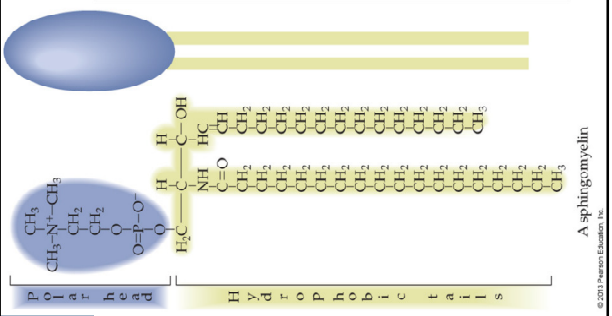
23.5 Phospholipids and Glycolipids



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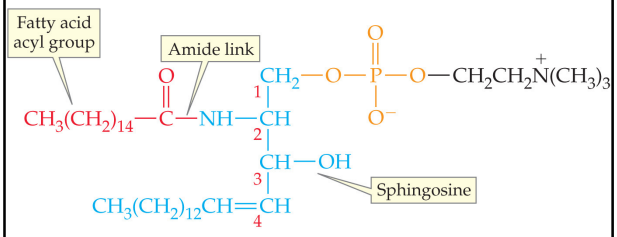
23.5 Phospholipids and Glycolipids



A sphingomyelin (a sphingolipid)

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Problem 23.12

PROBLEM 23.12
Lecithins are often used as food additives to provide emulsification. How do they accomplish this purpose?

23.12 Lecithins emulsify fats in the same way as soaps dissolve grease: The fats are coated by the nonpolar part of a lecithin, and the polar part of lecithins allows fats to be suspended in aqueous solution.

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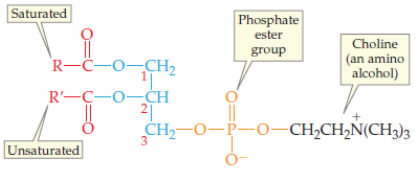
Problem 23.13

PROBLEM 23.13
Identify the products formed by complete hydrolysis of all ester bonds in (a) the phosphatidylcholine on p. 735 and (b) the sphingomyelin in Figure 23.5.



A phosphatidatidylcholine
(a glycerophospholipid that is a lecithin)

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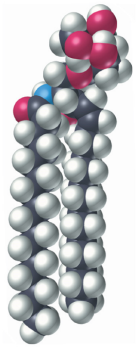
23.13 **(a)** glycerol, phosphate ion, choline, $RCOO^-Na^+$, $R'COO^-Na^+$

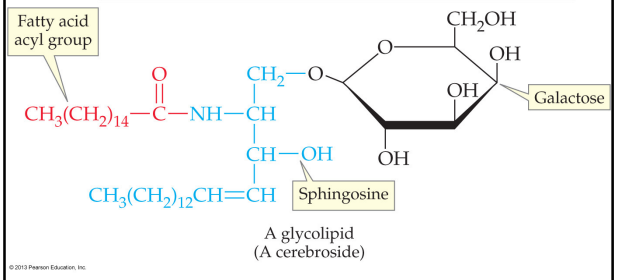
23.5 Phospholipids and Glycolipids



A glycolipid

(Reference: Chapter 23 from McMurry et al.)

23.5 Phospholipids and Glycolipids



A glycolipid
(A cerebroside)

(Reference: Chapter 23 from McMurry et al.)

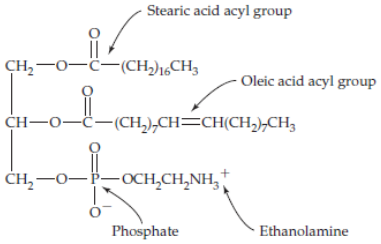
Problem 23.15

PROBLEM 23.15

Draw the structure of the glycerophospholipid that contains a stearic acid acyl group, an oleic acid acyl group, and a phosphate bonded to ethanolamine.

Stearic acid: HO-CO-$(CH_2)_{16}$-CH_3

Oleic acid: HO-$(CH_2)_7$-CH=CH-$(CH_2)_7$-CH_3



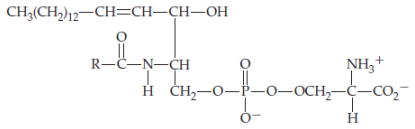
(Reference: Chapter 23 from McMurry et al.)

Problem 23.16

PROBLEM 23.16

Which of the following terms apply to the compound shown below? (Hint: Look at the functional groups and the bonds involved to begin analyzing the compound part by part in comparison to the lipids discussed in this chapter.)

(a) A phospholipid
(b) A steroid
(c) A sphingolipid
(d) A glycerophospholipid
(e) A lipid
(f) A phosphate ester
(g) A ketone

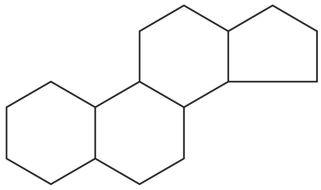


23.16 (a), (c), (e), (f)

(Reference: Chapter 23 from McMurry et al.)

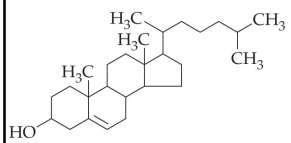
23.6 Sterolen

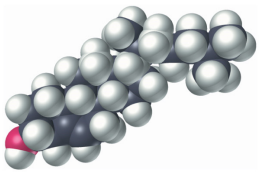
The steroid nucleus



(Reference: Chapter 23 from McMurry et al.)

23.6 Sterolen





(Reference: Chapter 23 from McMurry et al.)

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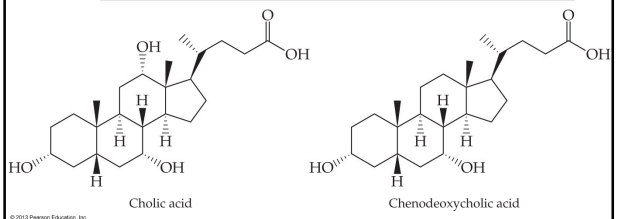

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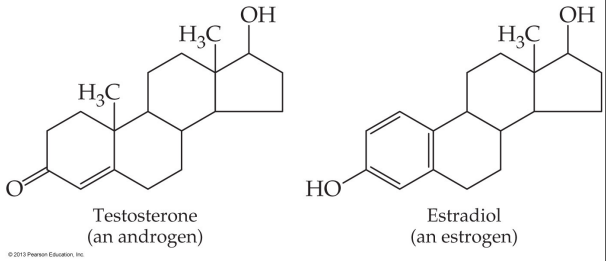
23.6 Sterolen



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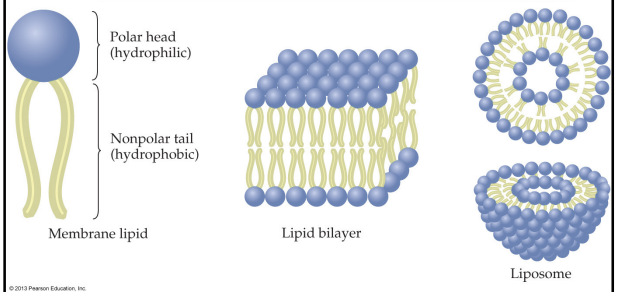
23.7 Structure of Cell Membranes



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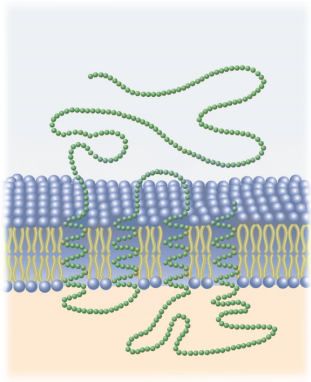

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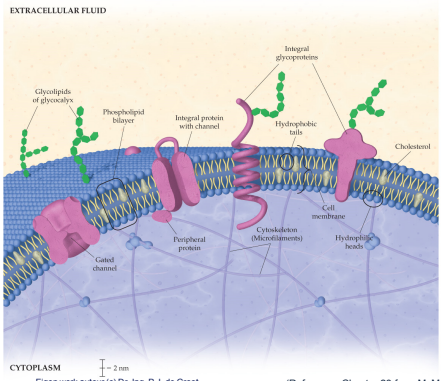
23.7 Structure of Cell Membranes



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Key Concept Problem 23.18

KEY CONCEPT PROBLEM 23.18

Integral membrane proteins are not water-soluble. Why? How must these proteins differ from globular proteins?

23.18 They must be hydrophobic, contain many amino acids with nonpolar side chains, and must be folded so that the hydrophilic regions face outward.

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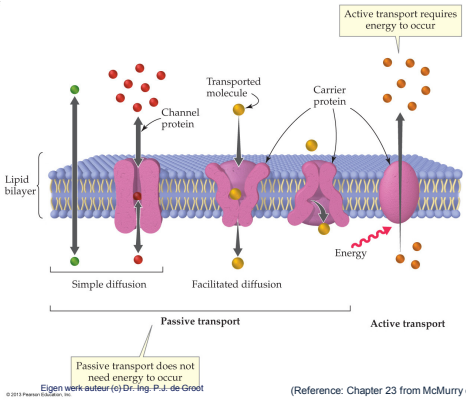
23.8 Transport Across Cell Membranes



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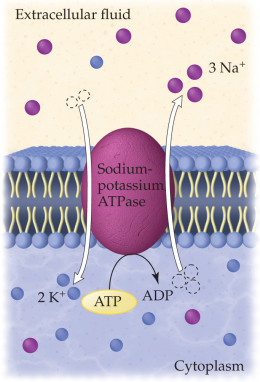
(Reference: Chapter 23 from McMurry et al.)

23.8 Transport Across Cell Membranes



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(Reference: Chapter 23 from McMurry et al.)

Problems 23.19 & 23.20

PROBLEM 23.19
Does an NO molecule cross a lipid bilayer by simple diffusion? Explain.

PROBLEM 23.20
As noted earlier (Section 22.3), the first step in glycolysis, which occurs within cells, is phosphorylation of glucose to glucose 6-phosphate. Why does this step prevent passive diffusion of glucose back out of the cell?

23.19 yes

23.20 Glucose 6-phosphate has a charged phosphate group and can't pass through the hydrophobic lipid bilayer.

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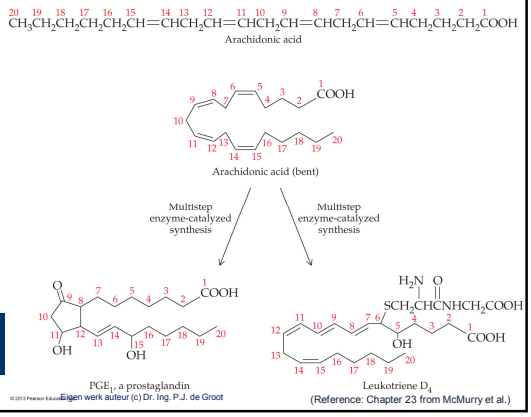
(Reference: Chapter 23 from McMurry et al.)

23.9 Eicosanoids: Prostaglandins and Leukotrienes



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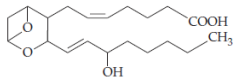
(Reference: Chapter 23 from McMurry et al.)

Key Concept Problem 23.22

KEY CONCEPT PROBLEM 23.22

In the eicosanoid shown here, identify all the functional groups. Which groups are capable of hydrogen bonding? Which are most acidic? Is this molecule primarily nonpolar, polar, or something in between?



23.22 carboxylic acid (most acidic), alcohol, C—C double bonds, ethers. The molecule has both polar and nonpolar regions. Form hydrogen bonds: —COOH, —OH.

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(Reference: Chapter 23 from McMurry et al.)