

Hogeschool van Amsterdam en Maastricht
Maastricht University of Applied Sciences

**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.)

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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. (A, 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)

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(Reference: Chapter 23 from McMurry et al.)

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Inhoud

- 23.1 Structure and Classification of Lipids
- 23.2 Fatty Acids and Their Esters
- 23.3 Properties of Fats and Oils
- 23.4 Chemical Reactions of Triacylglycerols
- 23.5 Phospholipids and Glycolipids
- 23.6 Sterols
- 23.7 Structure of Cell Membranes
- 23.8 Transport Across Cell Membranes
- 23.9 Eicosanoids: Prostaglandins and Leukotrienes

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23.1 Structure and Classification of Lipids

- energie-opslag in adipocyten
- deel van celmembraan (scheiding binnen/buiten cel)
- endocrien (hormonen) boodschappers

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23.1 Structure and Classification of Lipids

- Lipiden zijn oplosbaar in apolaire oplosmiddelen
 - zeer veel verschillende soorten stoffen
 - veel verschillende functies
- Grote koolwaterstof-gedeeltes en weinig polaire groepen

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23.1 Structure and Classification of Lipids

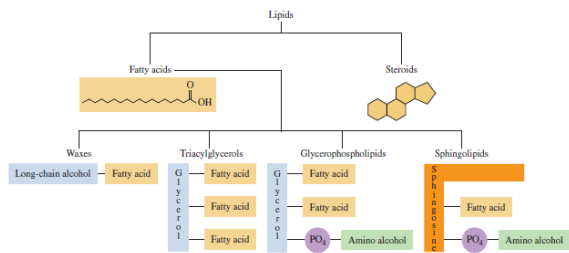
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FIGURE 15.1 ▶ Lipids are naturally occurring compounds in cells and tissues, which are soluble in organic solvents but not in water.

What chemical property do waxes, triacylglycerols, and steroids have in common?

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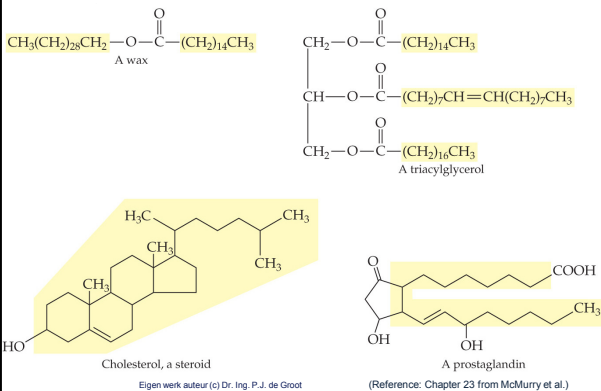
- was
 - bijenwas, cuticula
- tri-acyl-glycerol (tri-ester van glycerol)
 - voedsel en vetopslag (biochemische energie)
- glycerofosfolipiden (tri-ester met geladen fosfaat di-ester groepen)
 - celmembraan

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23.1 Structure and Classification of Lipids

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23.1 Structure and Classification of Lipids

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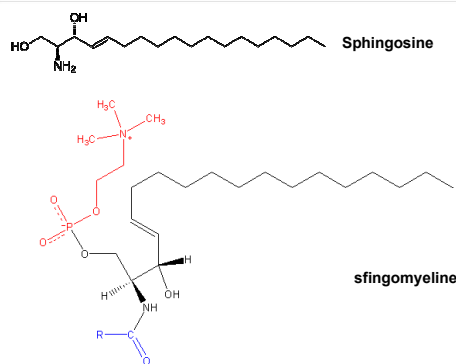
- sfingomyelines
 - amides afgeleid van een aminoalcohol (sfingosine)
 - geladen fosfaatgroepen
 - structuur celmembraan (zenuwcellen)
- glycolipiden
 - amides van sfingosine met polaire koolhydraatgroepen
 - op celoppervlak herkenning en interactie met intercellulaire boodschappers

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23.1 Structure and Classification of Lipids

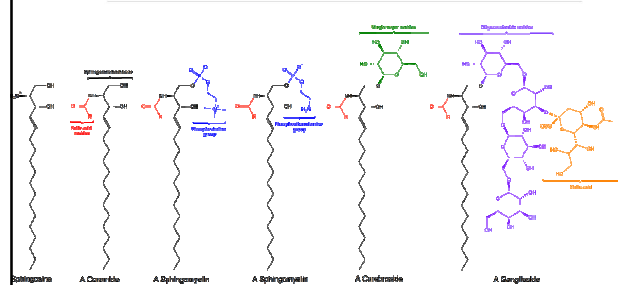
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23.1 Structure and Classification of Lipids

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23.1 Structure and Classification of Lipids

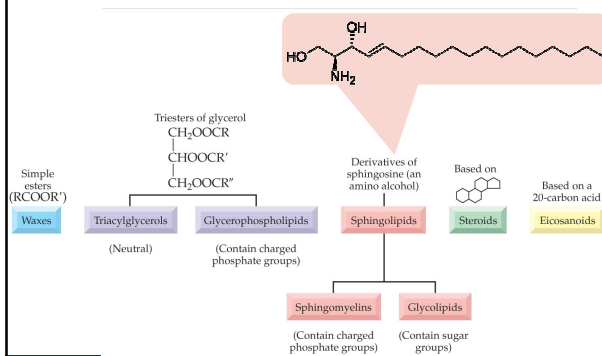
- **steroïden**
 - cholesterol (celmembraan, galzouten, sexhormonen)
- **eicosanoïden**
 - 20 C-atomen
 - ontstekingsprocessen
 - en immuunsysteem

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23.1 Structure and Classification of Lipids

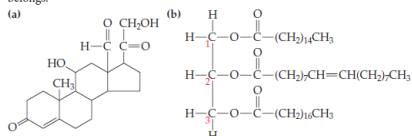


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Worked example 23.1

Use Figure 23.1 to identify the family of lipids to which each of these molecules belongs.



ANALYSIS Inspect the molecules and note their distinguishing characteristics. Molecule (a) has a four-member fused-ring system. Only sterols have this structure. Molecule (b) has three fatty acids esterified to a single backbone molecule—glycerol. Thus, (b) must be a member of the triacylglycerol family.

SOLUTION
Molecule (a) is a steroid, and molecule (b) is a triacylglycerol.

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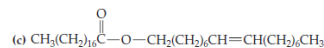
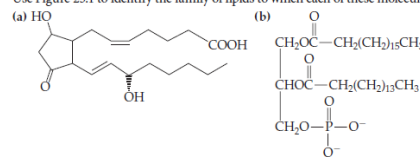
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Problem 23.1

PROBLEM 23.1

Use Figure 23.1 to identify the family of lipids to which each of these molecules belongs.



23.1 (a) eicosanoid (b) glycerophospholipid (c) wax

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23.2 Fatty Acids and Their Esters

TABLE 23.1 Structures of Some Common Fatty Acids

Name	Typical Source	Number of Carbons	Number of Double Bonds	Condensed Formula	Melting Point (°C)
Saturated					
Lauric	Coconut oil	12	0	CH ₃ (CH ₂) ₁₀ COOH	44
Myristic	Butter fat	14	0	CH ₃ (CH ₂) ₁₂ COOH	58
Palmitic	Most fats and oils	16	0	CH ₃ (CH ₂) ₁₄ COOH	63
Stearic	Most fats and oils	18	0	CH ₃ (CH ₂) ₁₆ COOH	70
Unsaturated					
Oleic	Olive oil	18	1	CH ₃ (CH ₂) ₇ CH=CH(CH ₂) ₇ COOH (cis)	4
Linoleic	Vegetable oils	18	2	CH ₃ (CH ₂) ₄ CH=CHCH ₂ CH=CH(CH ₂) ₇ COOH (all cis)	−5
Linolenic	Soybean and canola oils	18	3	CH ₃ CH ₂ CH=CHCH ₂ CH=CHCH ₂ CH=CH(CH ₂) ₇ COOH (all cis)	−11
Arachidonic	Animal fat	20	4	CH ₃ (CH ₂) ₄ (CH=CHCH ₂) ₄ CH ₂ COOH (all cis)	−50

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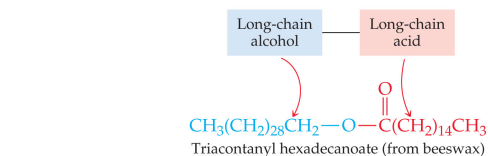
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23.2 Fatty Acids and Their Esters

Example of a wax



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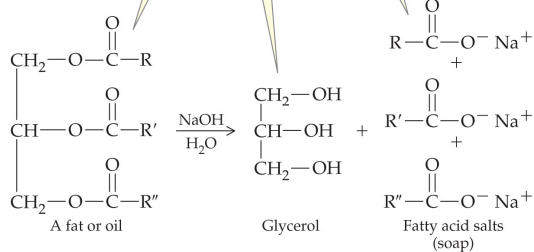
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23.4 Chemische reacties



Saponification

Strong aqueous base catalyzes fat hydrolysis

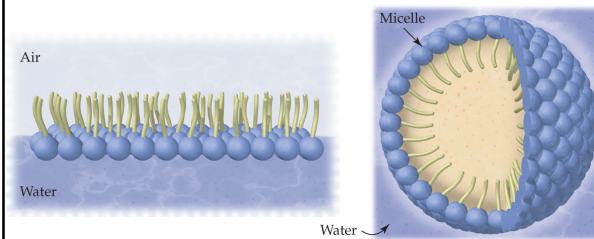


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23.4 Chemische reacties

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Problem 23.11



PROBLEM 23.11

Write the complete equation for the hydrolysis of a triacylglycerol in which the fatty acids are two molecules of stearic acid and one of oleic acid (see Table 23.1).

TABLE 23.1 Structures of Some Common Fatty Acids

Name	Typical Source	Number of Carbons	Number of Double Bonds	Condensed Formula	Melting Point (°C)
Saturated					
Lauric	Coconut oil	12	0	$\text{CH}_3(\text{CH}_2)_{10}\text{COOH}$	44
Myristic	Butter fat	14	0	$\text{CH}_3(\text{CH}_2)_{12}\text{COOH}$	58
Palmitic	Most fats and oils	16	0	$\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$	63
Stearic	Most fats and oils	18	0	$\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$	70
Unsaturated					
Oleic	Olive oil	18	1	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}(\text{cis})$	4
Linoleic	Vegetable oils	18	2	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}(\text{all cis})$	-5
Linolenic	Soybean and canola oils	18	3	$\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_4\text{COOH}(\text{all cis})$	-11
Arachidonic	Animal fat	20	4	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}_2\text{CH}_2\text{COOH}(\text{all cis})$	-50

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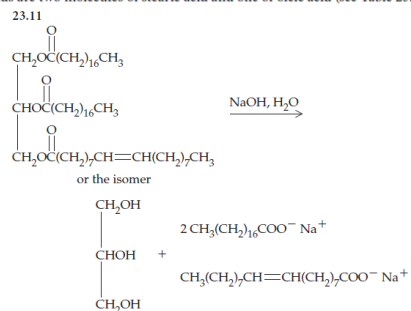
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