

# Structure of lipids

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# Lipids

= group of biological molecules that are  
**insoluble in aqueous solutions**  
and soluble in organic solvents

- **structural** components of biological membranes
- **energy** reserves, predominantly in the form of triacylglycerols (TAG)
- excellent mechanical and thermal **insulators**
- **biologically active** compounds  
(vitamins, hormones, bile acids, visual pigment)

# Classification of lipids

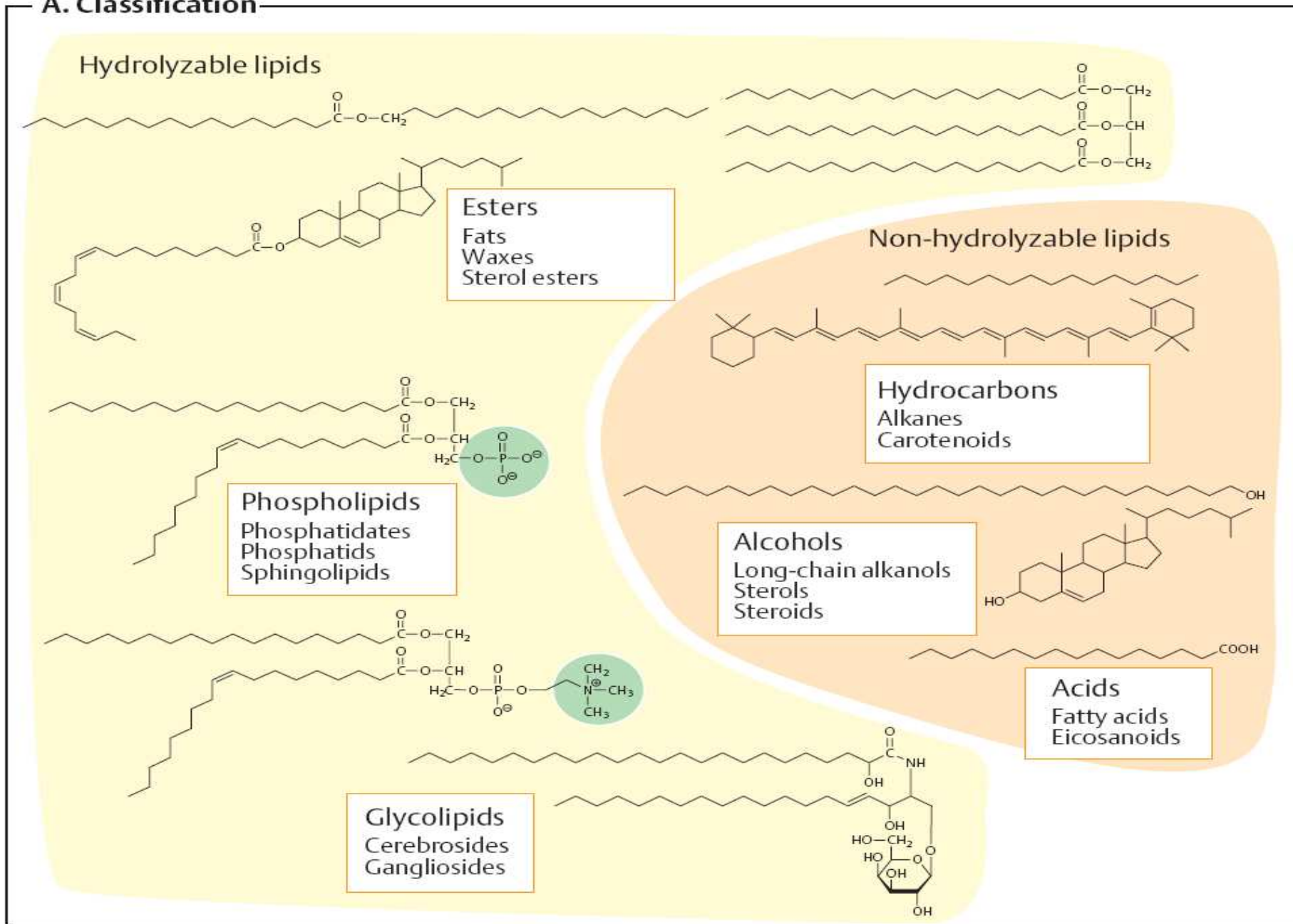
## 1. by composition

- simple lipids
- complex lipids (lipid + other compound)

## 2. by structure

- hydrolyzable lipids
- nonhydrolyzable lipids

## A. Classification

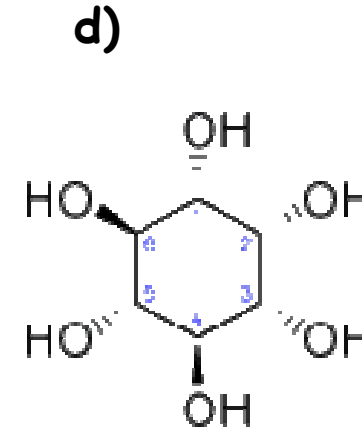
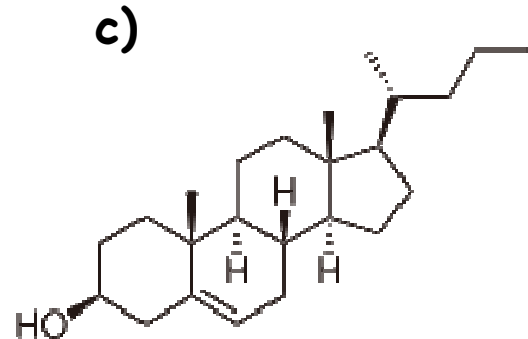
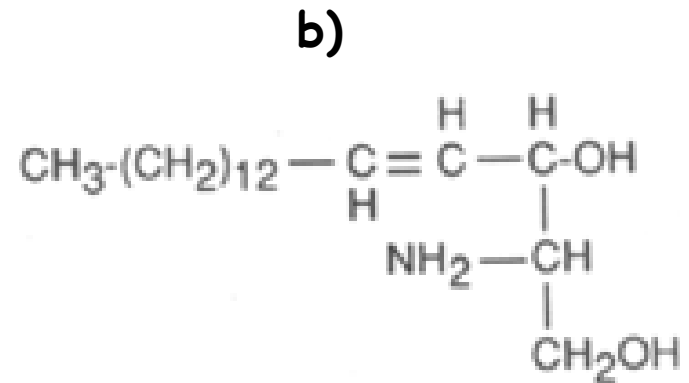
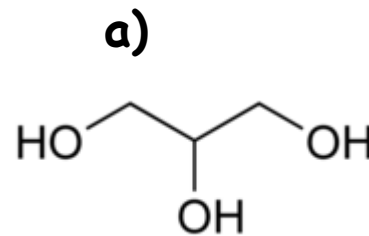


The figure was adopted from: J.Koolman, K.H.Röhm / Color Atlas of Biochemistry, 2<sup>nd</sup> edition, Thieme 2005

# Structural components of lipids

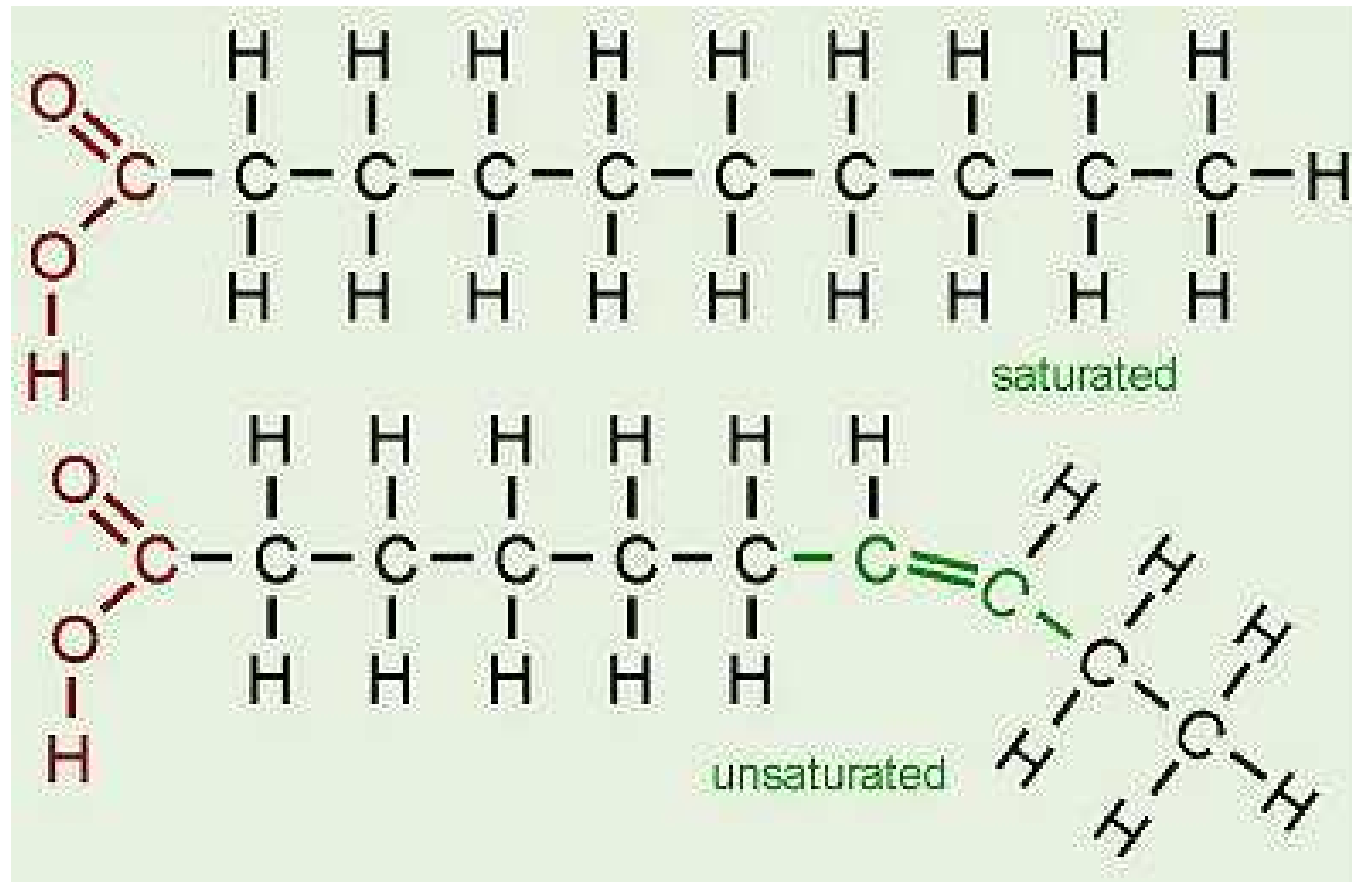
- **alcohols**

- glycerol (a)
- sfingosine (b)
- cholesterol (c)
- inositol (d)



- long chain carboxylic acids acids  
(= **fatty acids**)

# Free Fatty Acids (FFA)



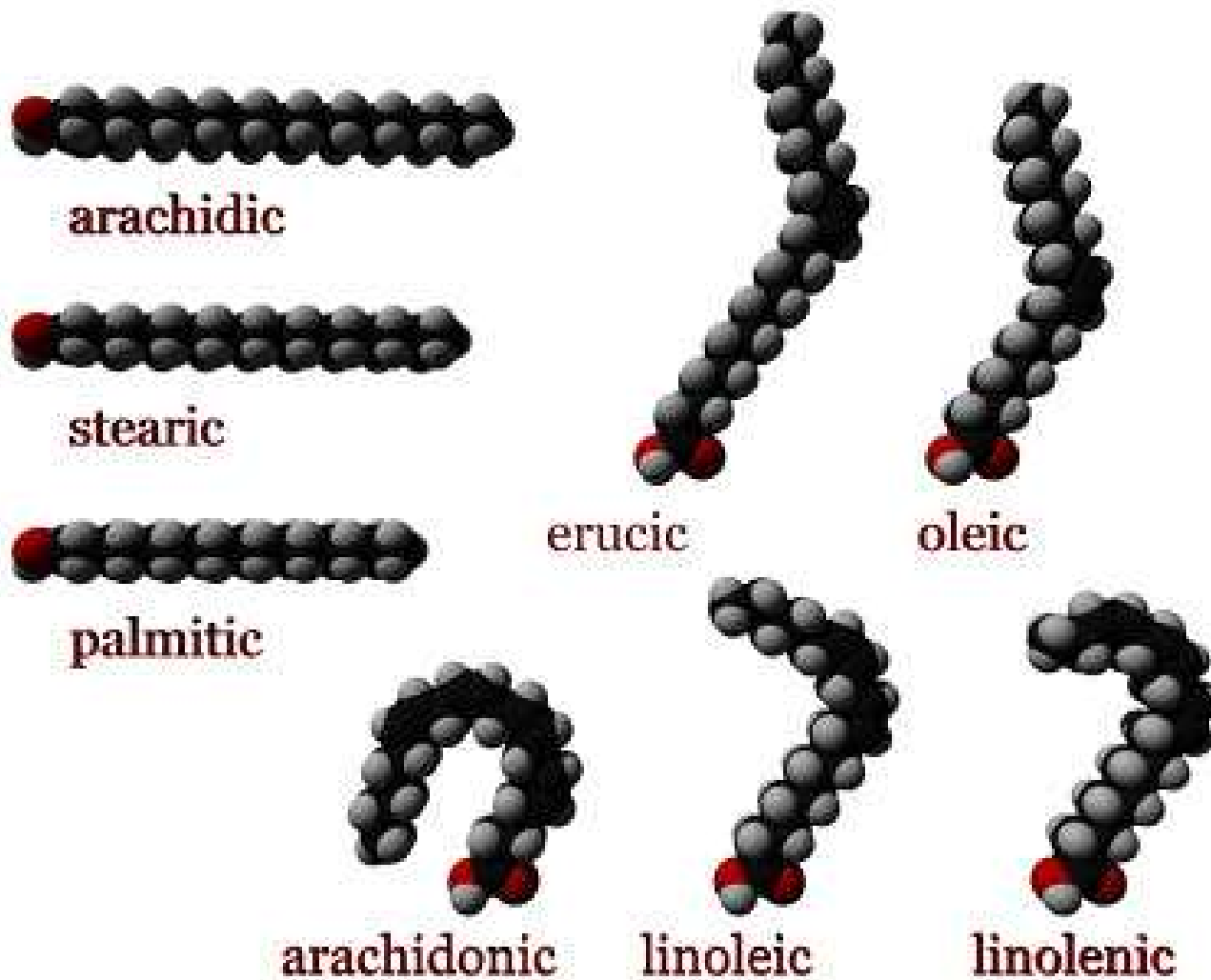
The figure is found at <http://www.tvdsb.on.ca/saunders/courses/online/SBI3C/Cells/Lipids.htm> (Jan 2007)

### A. Carboxylic acids

Name	Number of carbons	Number of double bonds		Position of double bonds
Formic acid	1 : 0			Not contained in lipids
Acetic acid	2 : 0			
Propionic acid	3 : 0			
Butyric acid	4 : 0			
Valerianic acid	5 : 0			
Caproic acid	6 : 0			HOOC—CH <sub>2</sub> —CH <sub>2</sub> —CH <sub>2</sub> —CH <sub>2</sub> —CH <sub>3</sub>
Caprylic acid	8 : 0			Caproic acid
Capric acid	10 : 0			
Lauric acid	12 : 0			
Myristic acid	14 : 0			
Palmitic acid	16 : 0			
Stearic acid	18 : 0			
Oleic acid	18 : 1; 9			
★ Linoleic acid	18 : 2; 9,12			
★ Linolenic acid	18 : 3; 9,12,15			
Arachidic acid	20 : 0			
★ Arachidonic acid	20 : 4; 5,8,11,14			
Behenic acid	22 : 0			
Erucic acid	22 : 1; 13			
Lignoceric acid	24 : 0			
Nervonic acid	24 : 1; 15			

★ Essential in human nutrition

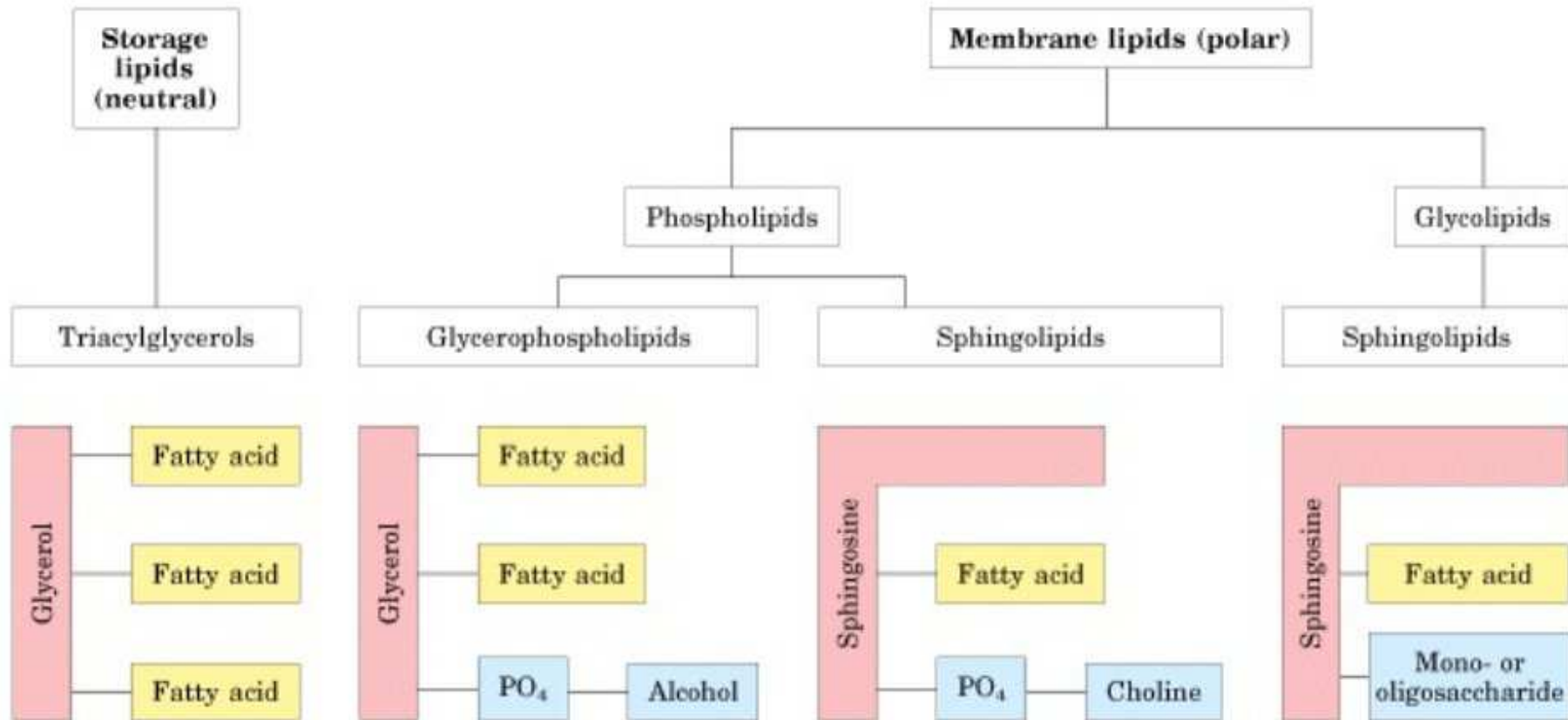
The figure was adopted from: J.Koolman, K.H.Röhm / Color Atlas of Biochemistry, 2<sup>nd</sup> edition, Thieme 2005



The figure was adopted from [http://en.wikipedia.org/wiki/Fatty\\_acid](http://en.wikipedia.org/wiki/Fatty_acid) (April 2007)

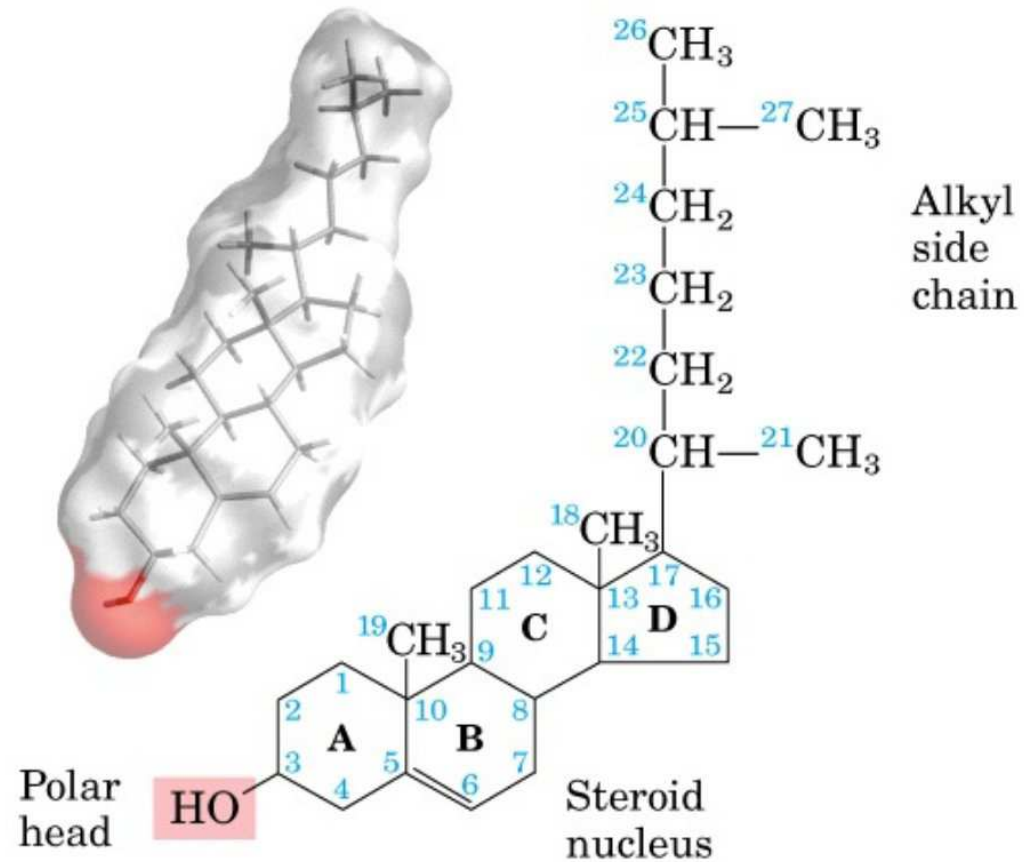


# Structure of lipids



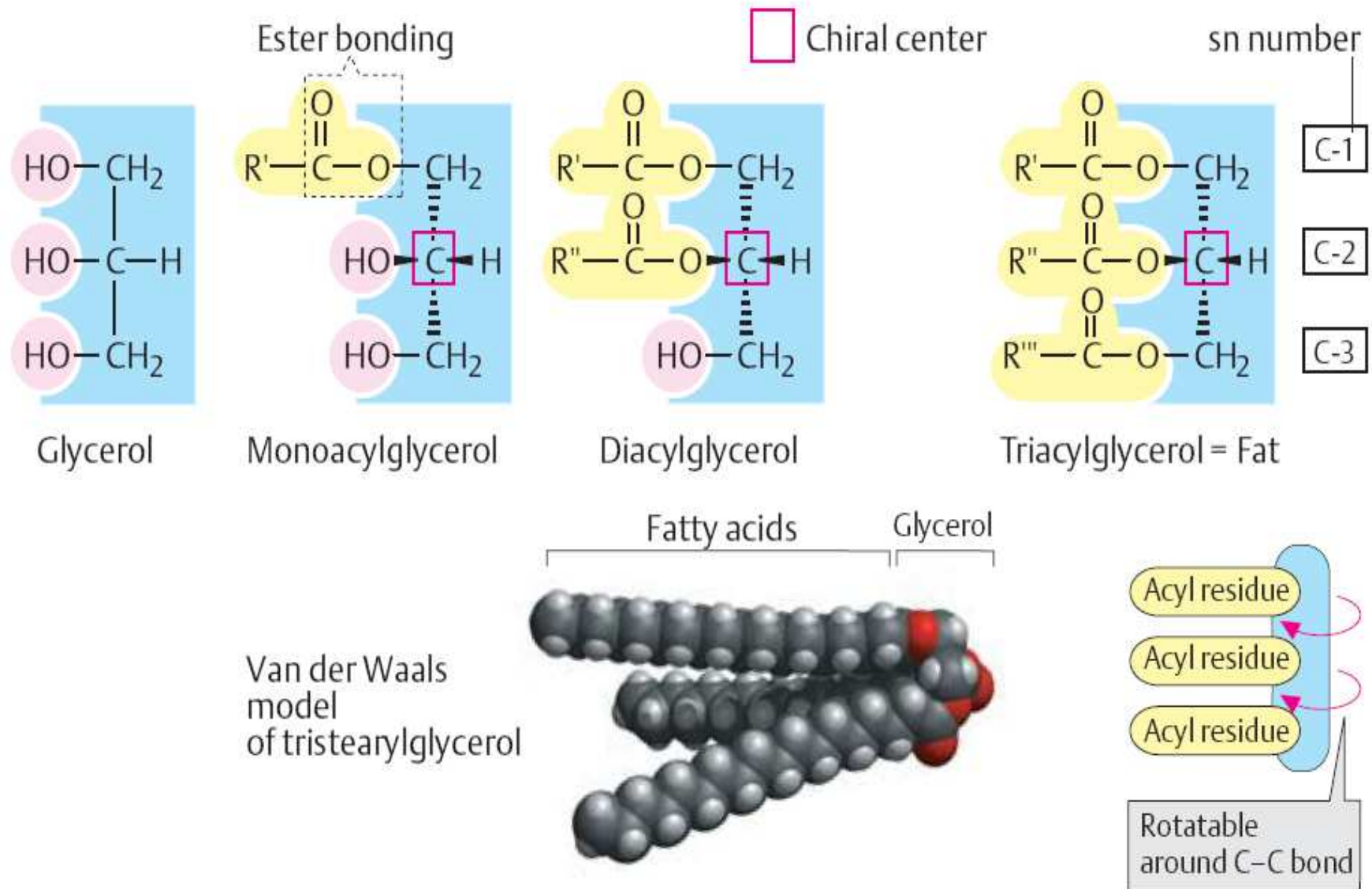
The figure is found at [http://courses.cm.utexas.edu/archive/Spring2002/CH339K/Robertus/overheads-2/ch11\\_lipid-struct.jpg](http://courses.cm.utexas.edu/archive/Spring2002/CH339K/Robertus/overheads-2/ch11_lipid-struct.jpg)  
(Jan 2007)

# Cholesterol



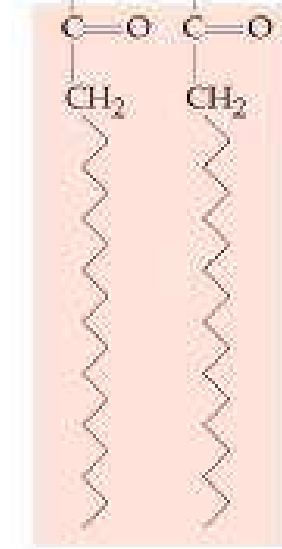
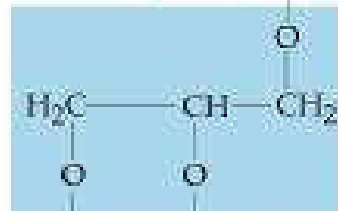
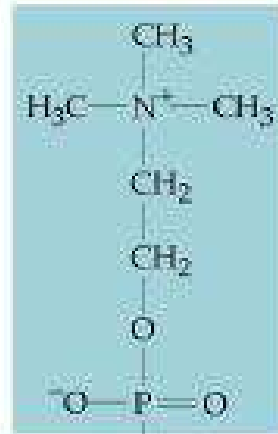
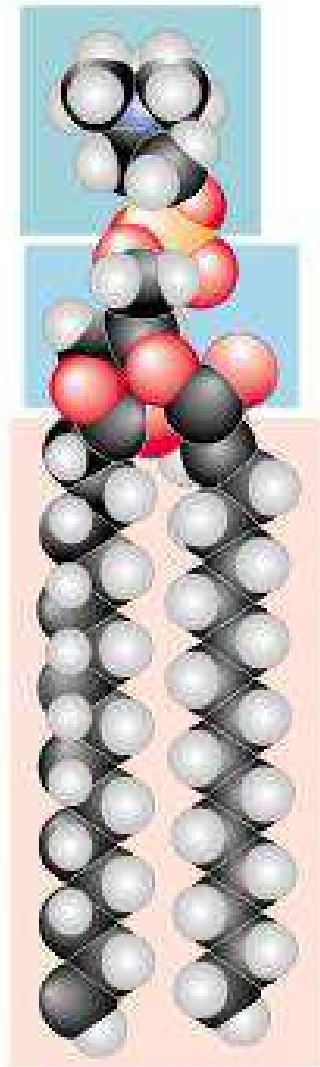
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## B. Structure of fats



The figure was adopted from: J.Koolman, K.H.Röhm / Color Atlas of Biochemistry, 2<sup>nd</sup> edition, Thieme 2005

Phosphatidyl choline



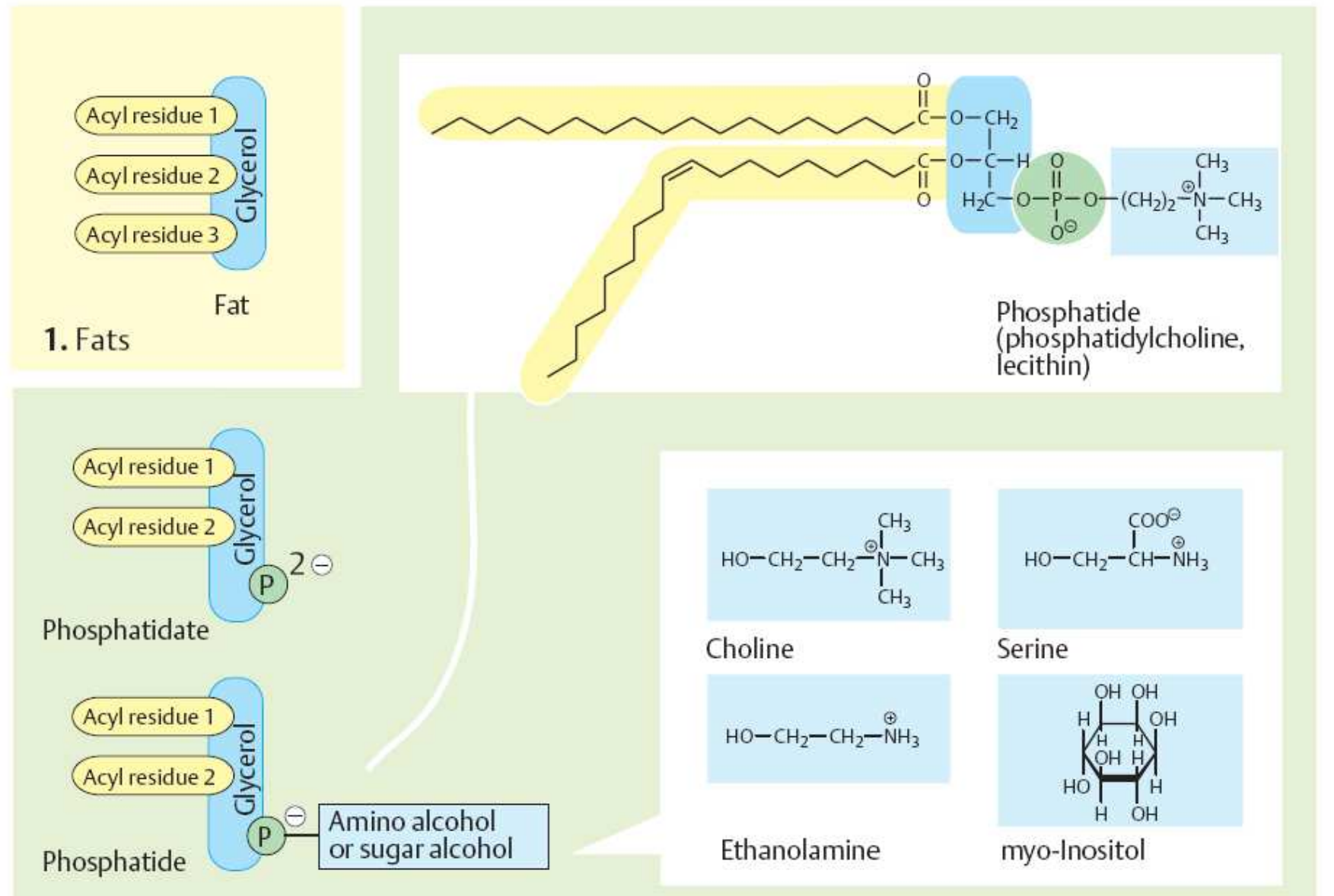
Hydrophilic head  
Hydrophobic tails

Structure of phospholipid

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The figure is found at <http://www.mie.utoronto.ca/labs/lcdlab/biopic/fig/3.21.jpg> (Jan 2007)

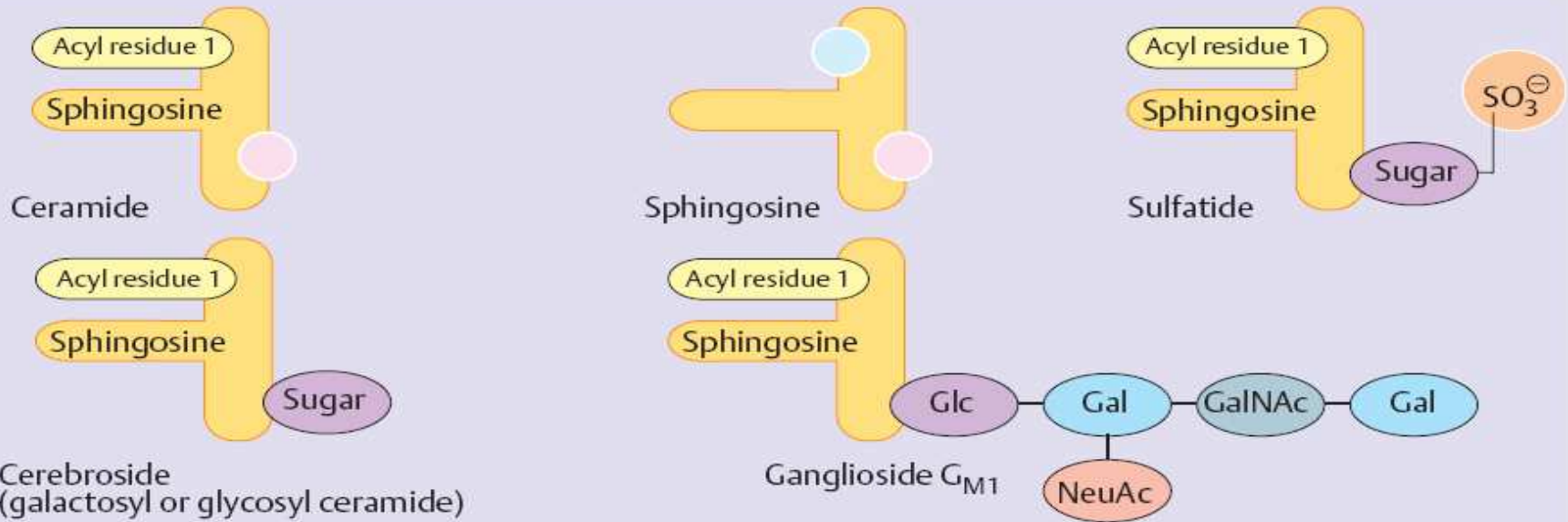
# A. Structure of fats, phospholipids, and glycolipids



The figure was adopted from: J.Koolman, K.H.Röhm / Color Atlas of Biochemistry, 2<sup>nd</sup> edition, Thieme 2005

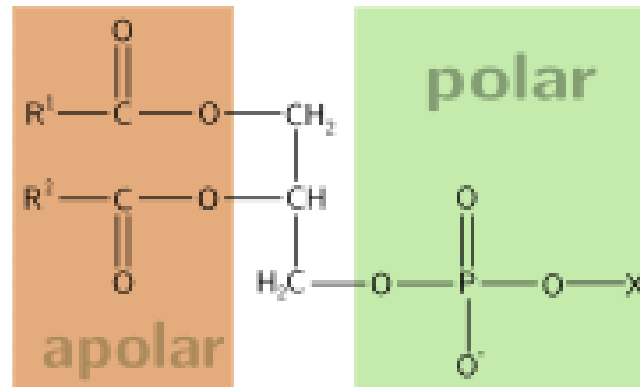


**2. Phospholipids**

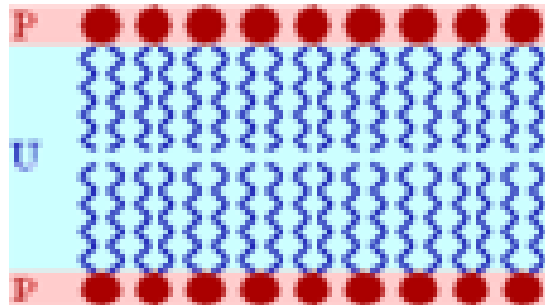


**3. Sphingolipids**

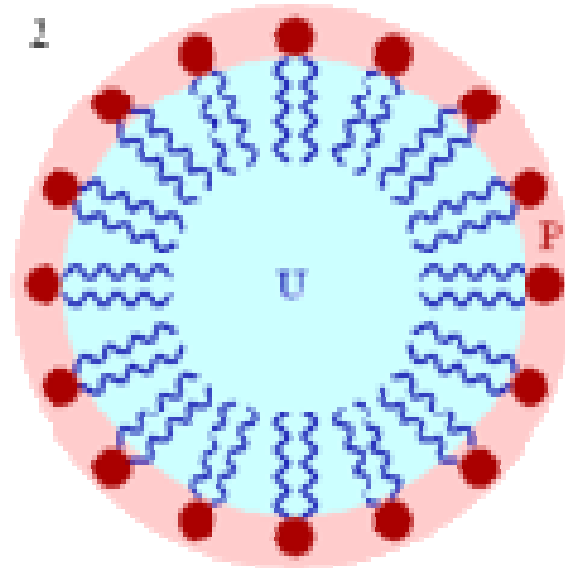
The figure was adopted from: J.Koolman, K.H.Röhm / Color Atlas of Biochemistry, 2<sup>nd</sup> edition, Thieme 2005



1



2

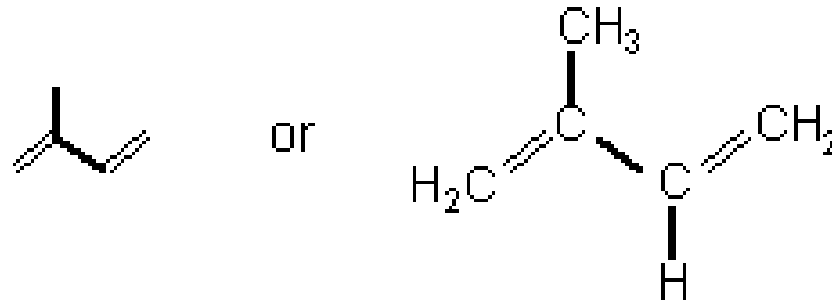


Self-organization of phospholipids. A lipid bilayer is shown on the left and a micelle on the right.

The figures are adopted from <http://en.wikipedia.org/wiki/Lipids> (April 2007)

# Terpenes

- derivatives of **isoprene** (= 2-methylbuta-1,3-diene)



- found in oils of plants and flowers
- characteristic odour (geraniol, menthol,...)
- **steroids** are derived from triterpenes

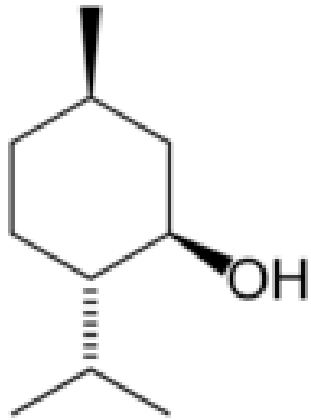


## Terpenes - classification:

- monoterpenes ( $C_{10}$ )      2 x isoprene
- sesquiterpenes ( $C_{15}$ )      3 x isoprene
- diterpenes ( $C_{20}$ )      4 x isoprene
- triterpenes ( $C_{30}$ )      6 x isoprene
- tetraterpenes ( $C_{40}$ )      8 x isoprene

- formed by bonding „head to tail“ or „tail to tail“
- different degree of unsaturation
- variety of functional groups

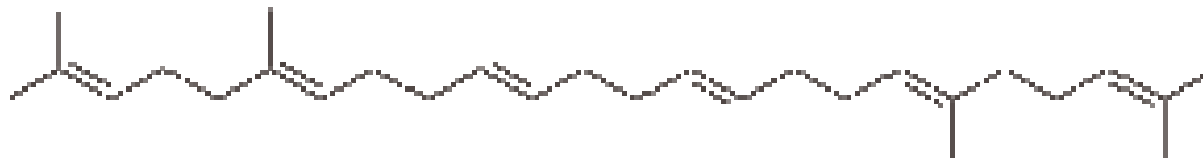
## Examples of terpenes



menthol (C10)

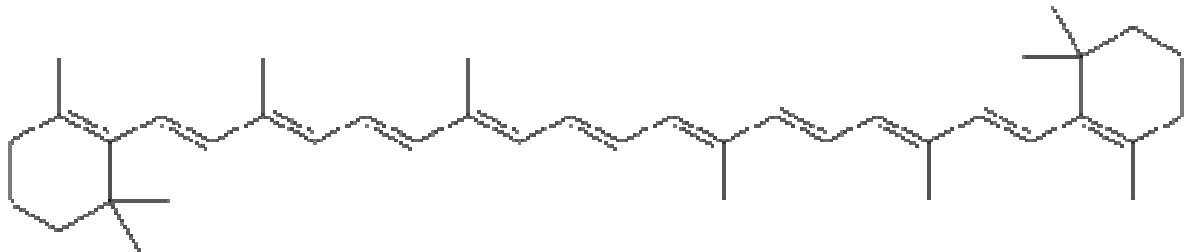


phytol (C 20)

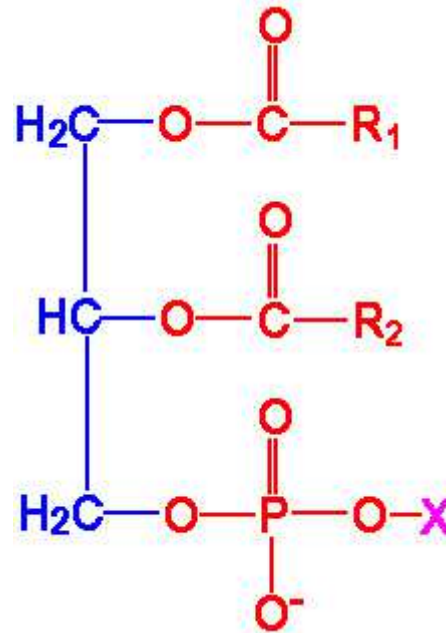
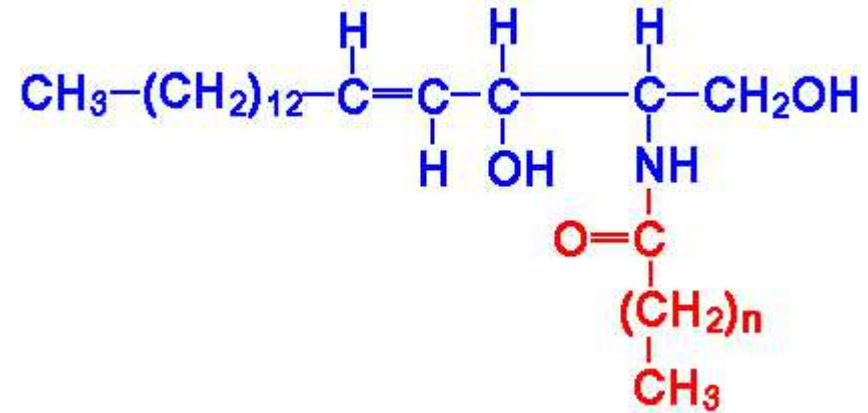
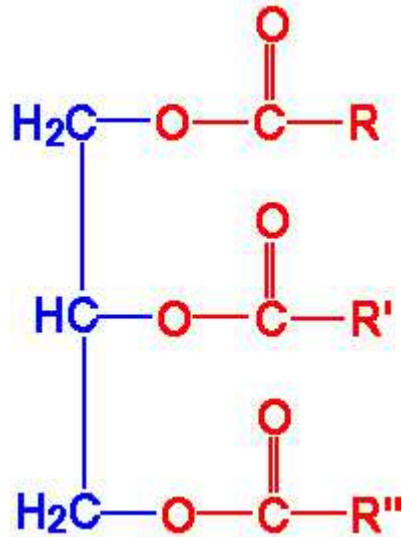


squalene (C 30)

$\beta$ -carotene (C40)



# EXERCISE



The figures are adopted from <http://web.indstate.edu/thcme/mwking/lipids.html> (April 2007)

