Chem 352 - Lecture 6
Part I: Lipids

Question for the Day: Why do phospholipids, when placed in water, spontaneously assemble to form membranes?

Introduction to Lipids

- Lipids are defined by a physical property instead of a chemical one.
  - Lipids are the non-polar components of a cell which can be extracted with organic solvents
  - While all lipids contain a large non-polar moiety, not all are entirely non-polar.
- Lipids come in many different flavors (structures and functions)

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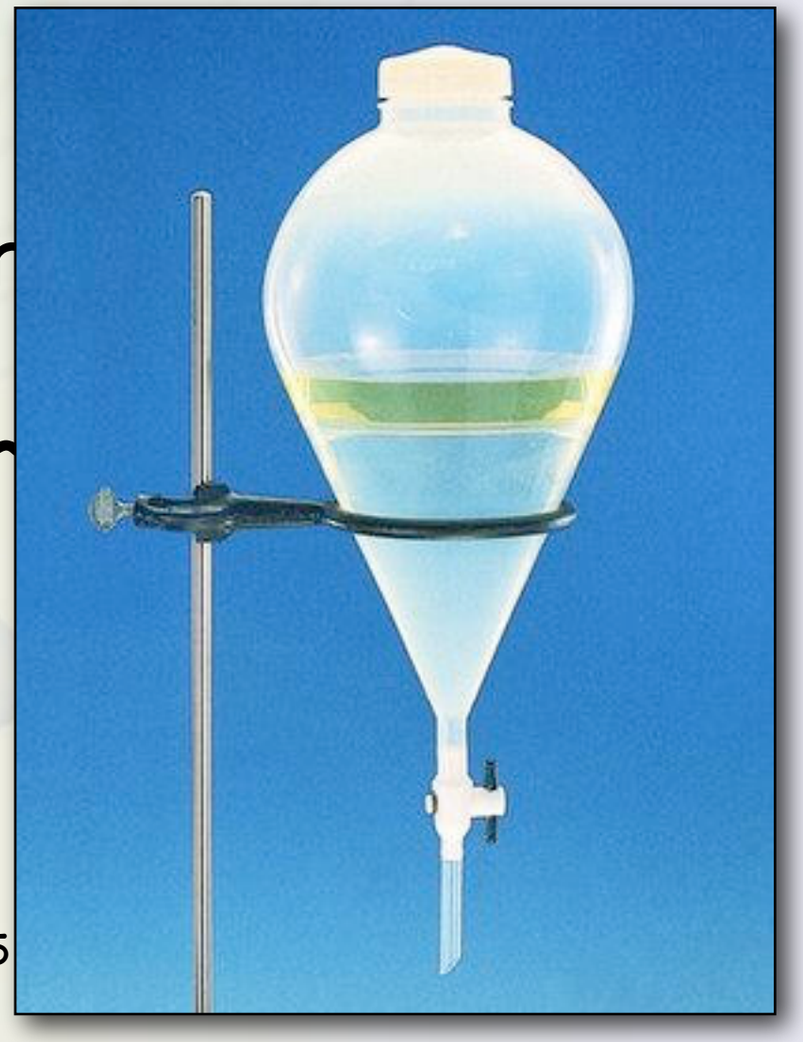

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Dictionary

moi•e•ty | ˈmoiətē | noun or
each of two parts into which a thing is or can be divided.

Wikipedia

Moiety

Moiety may refer to:

- Moiety (chemistry), a part or functional group of a molecule …

many different flavors functions)

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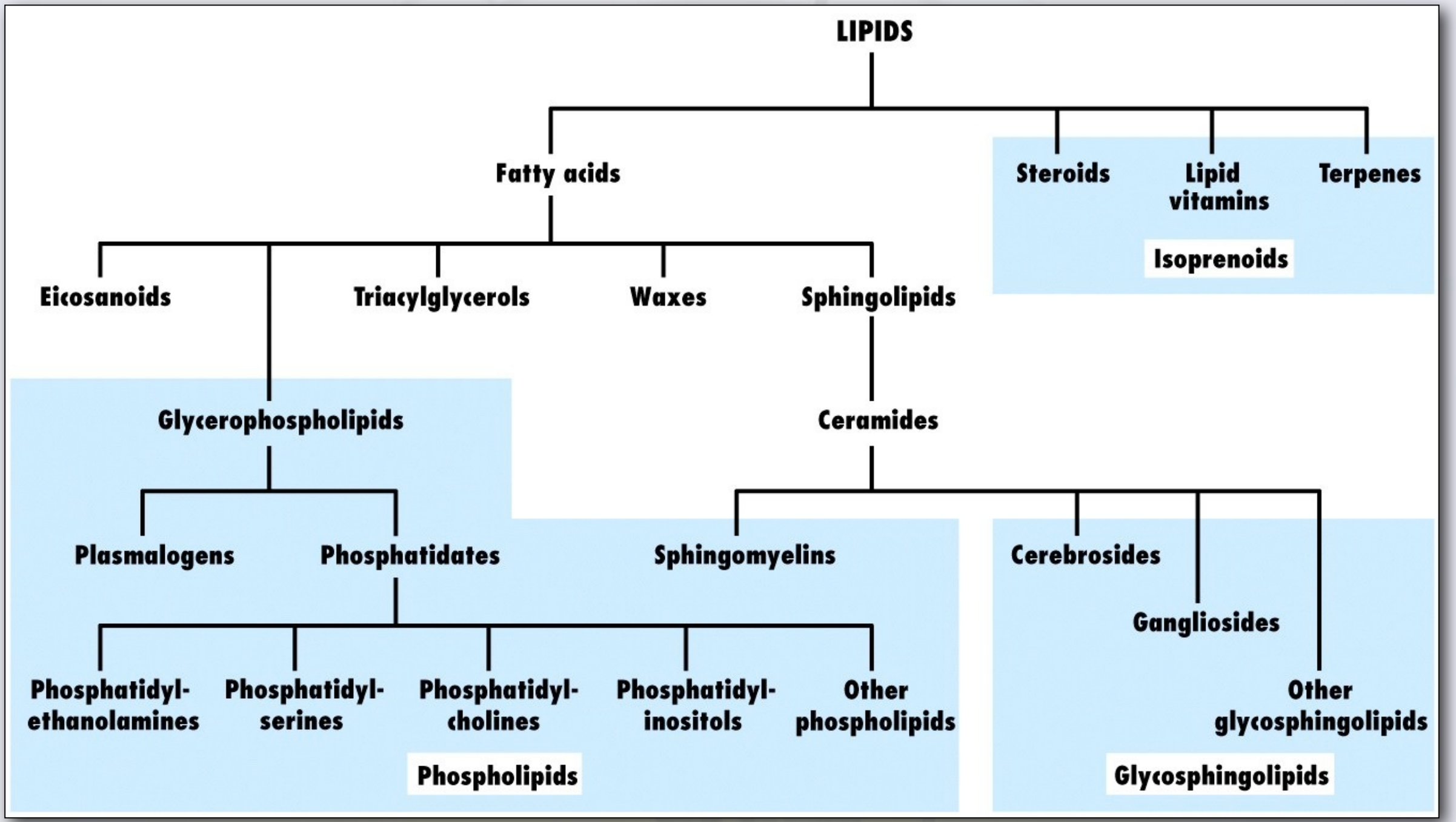

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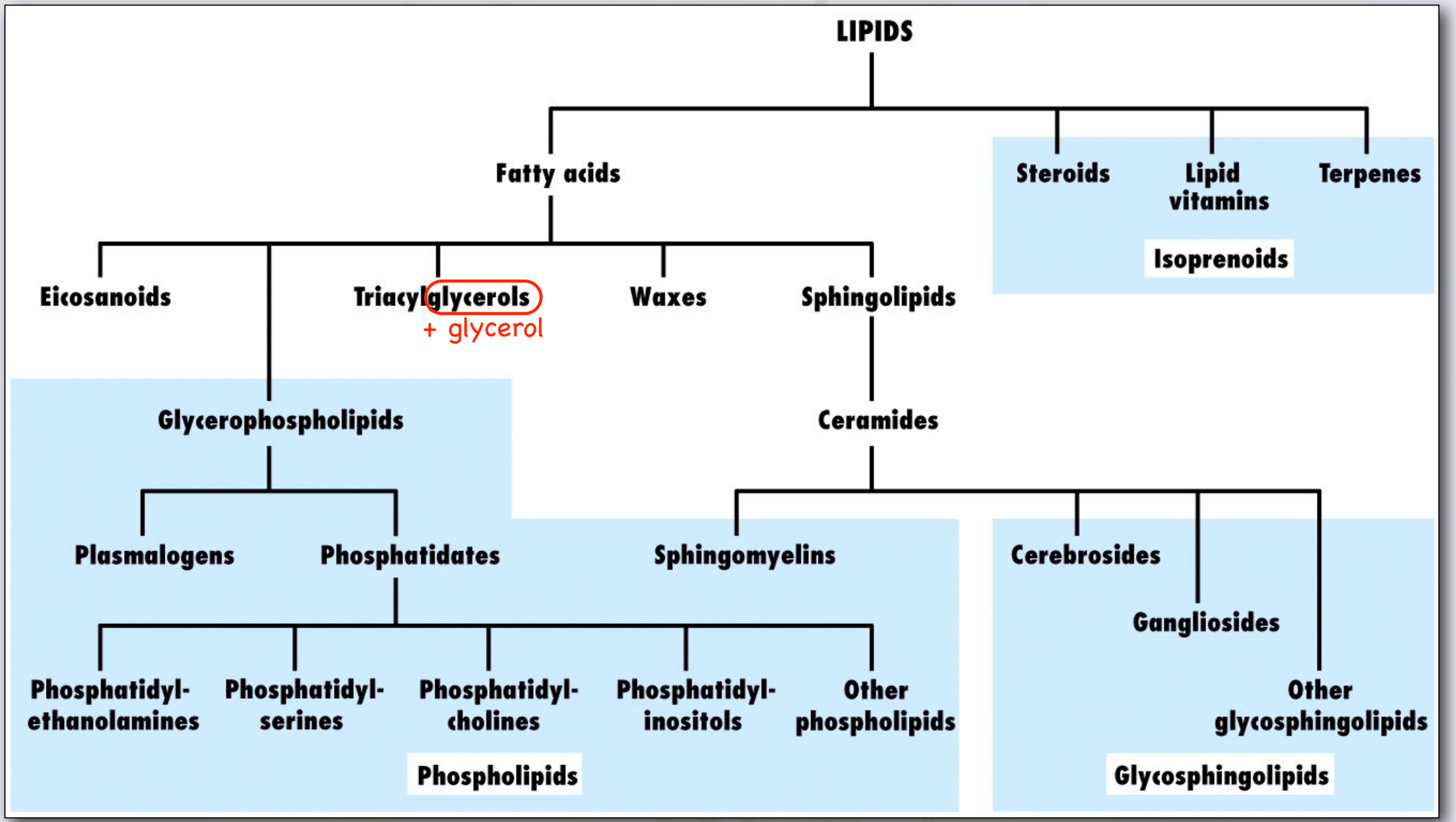

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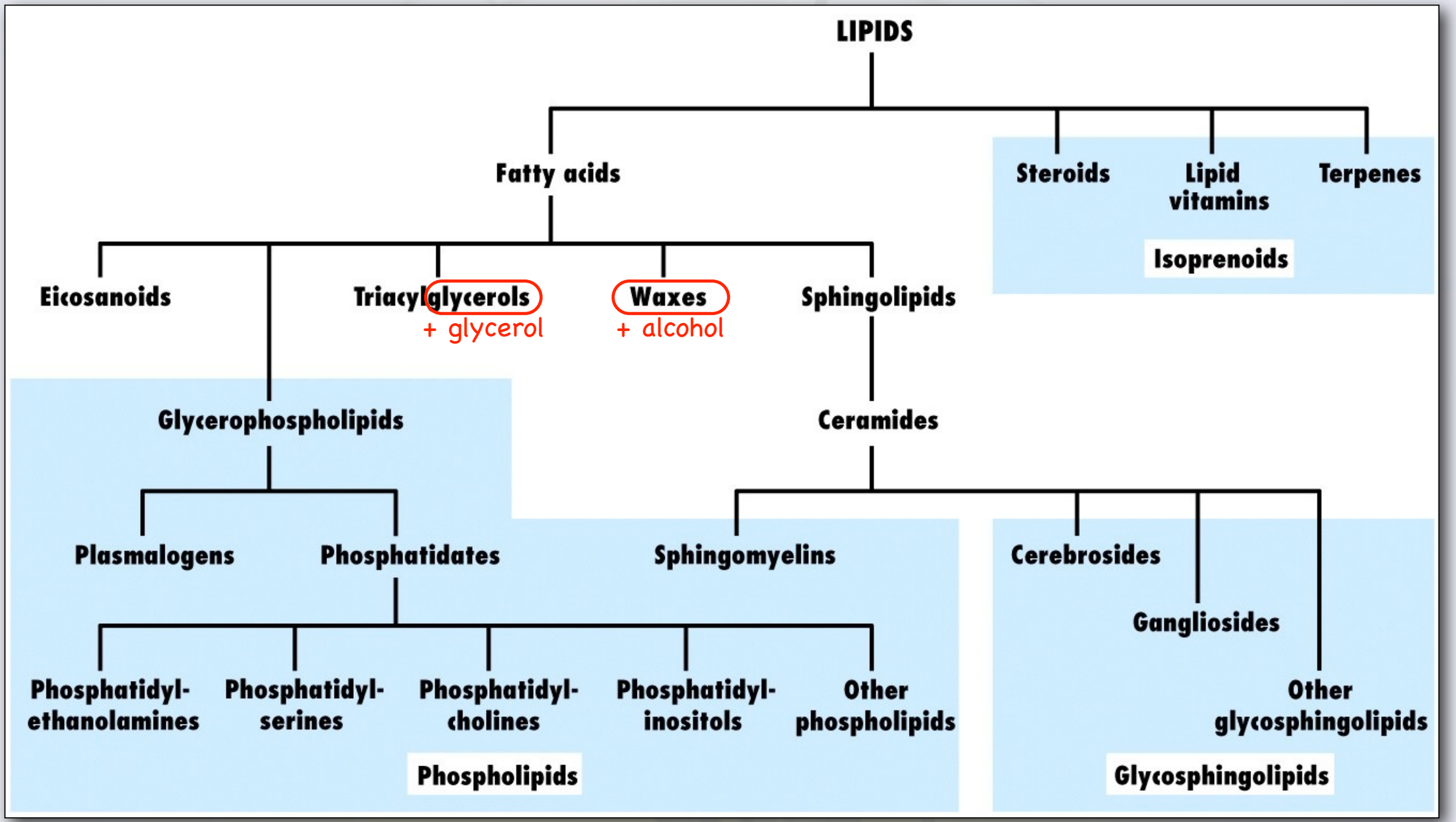

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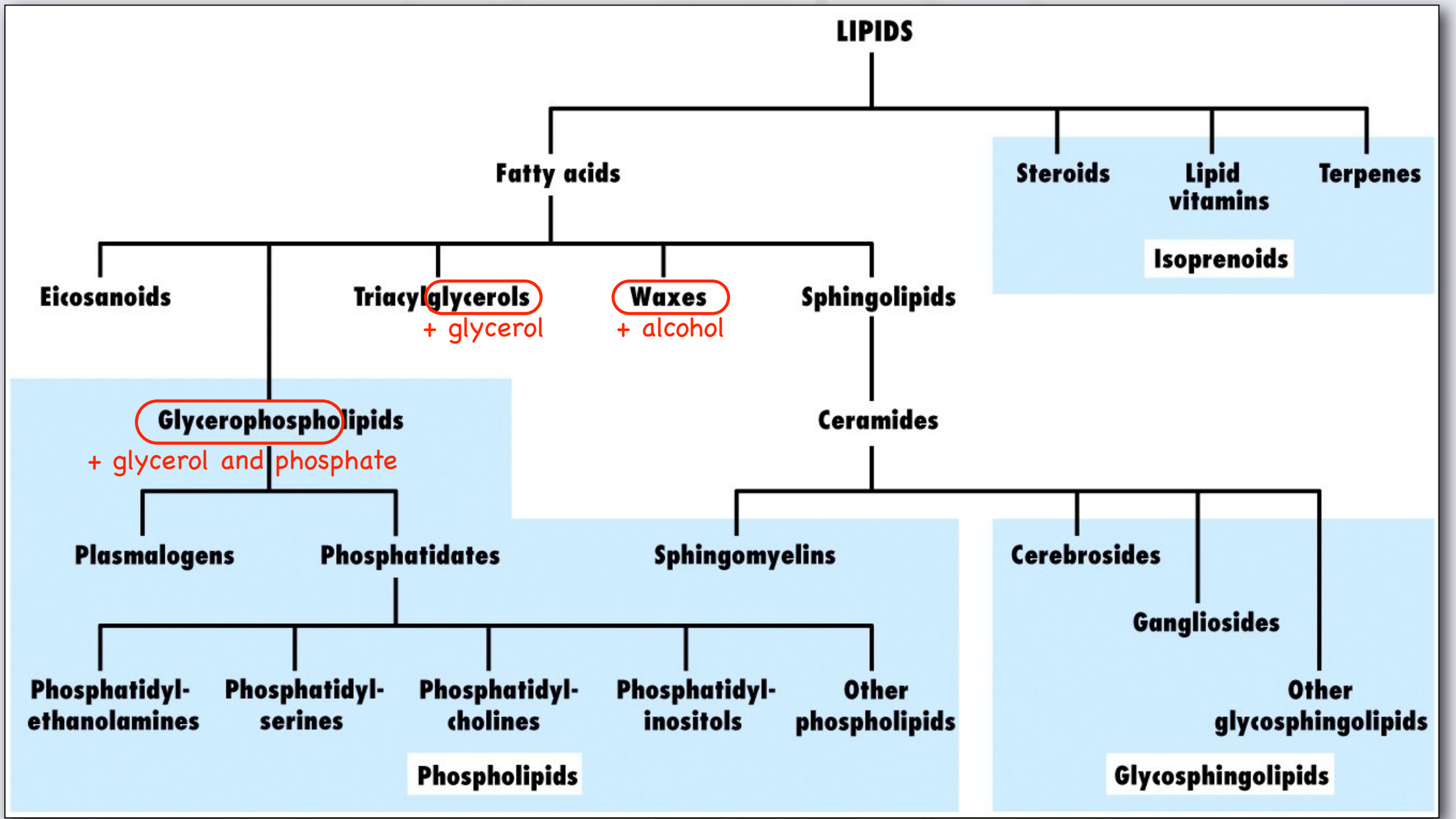

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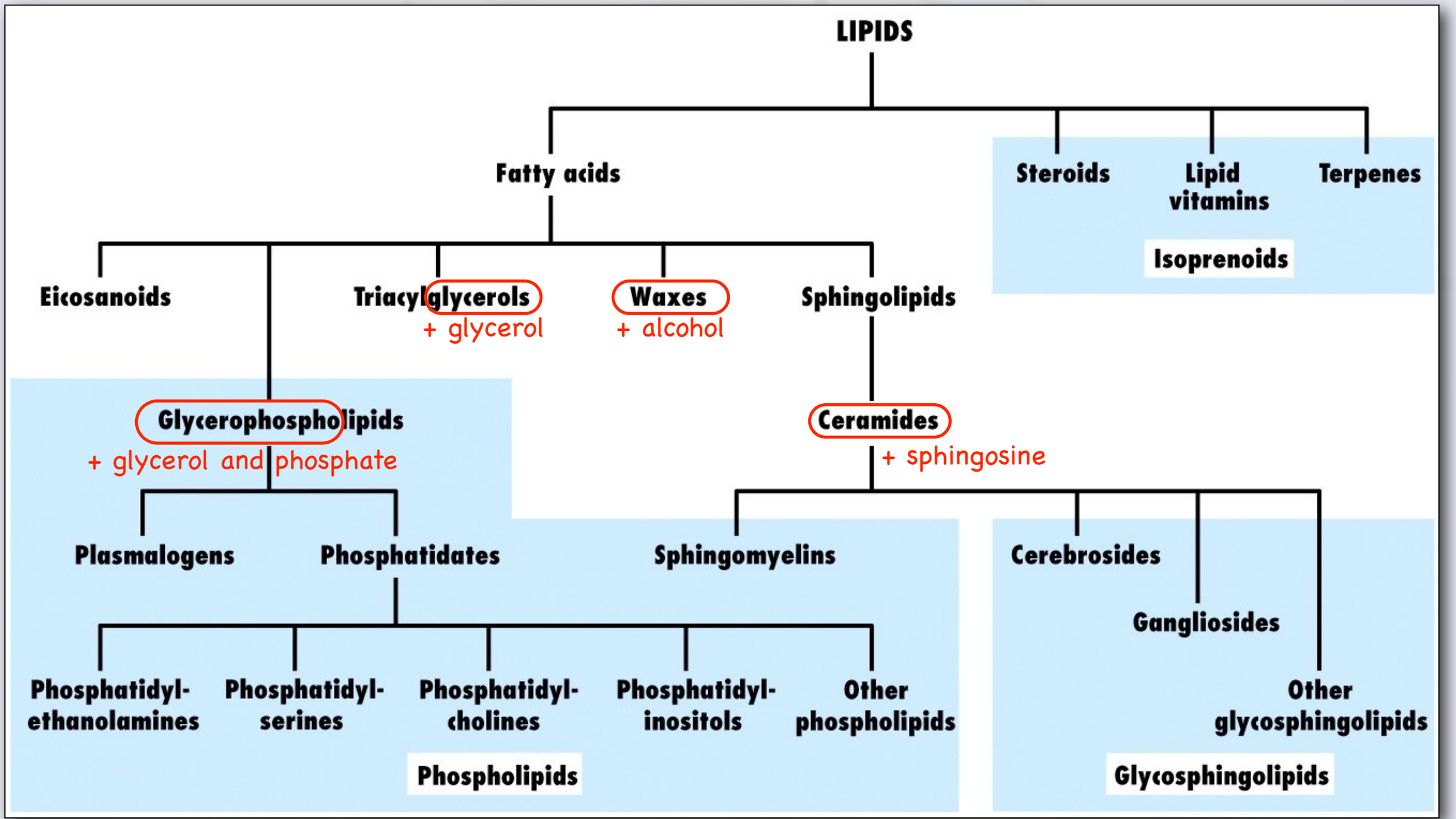

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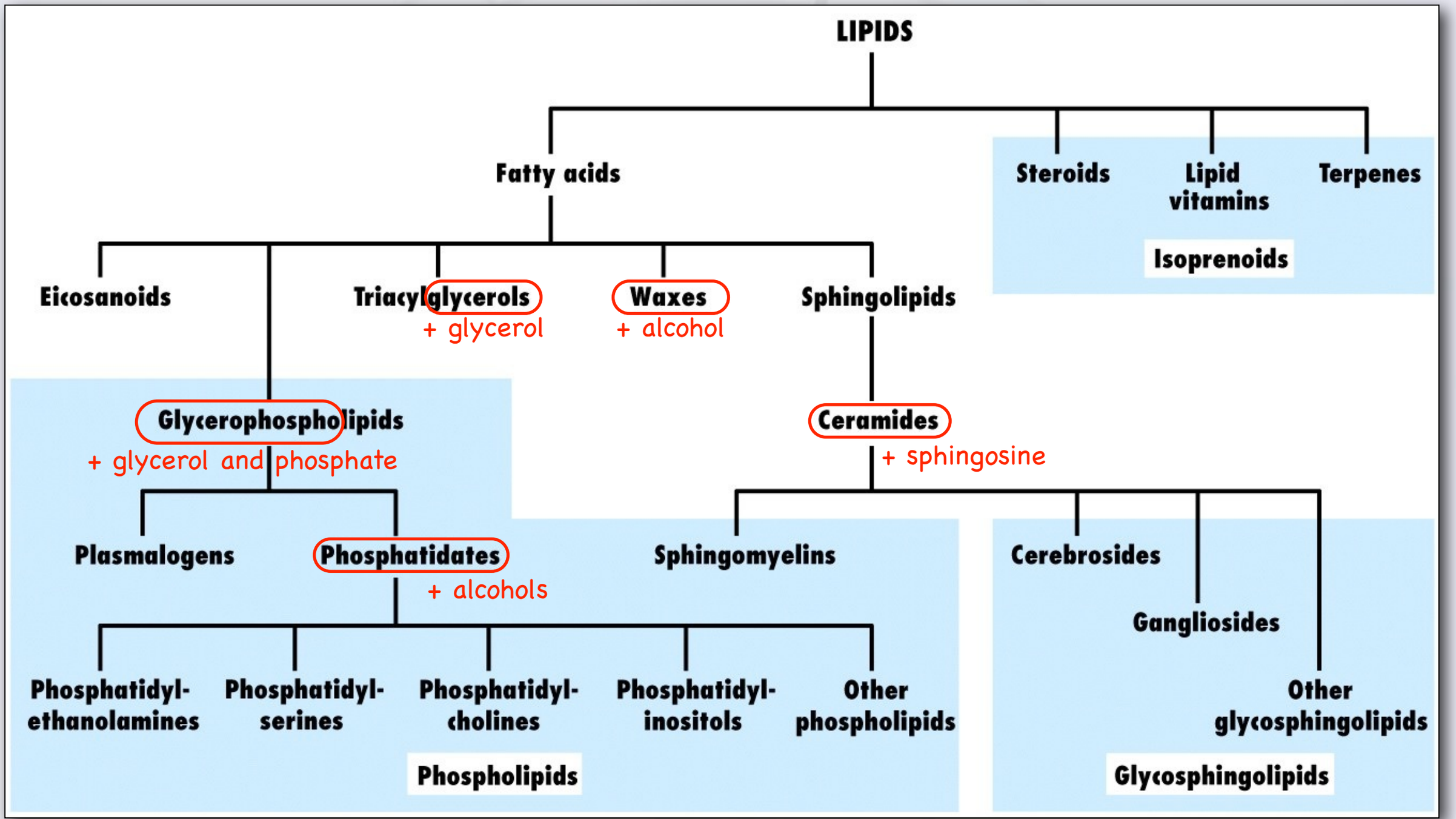

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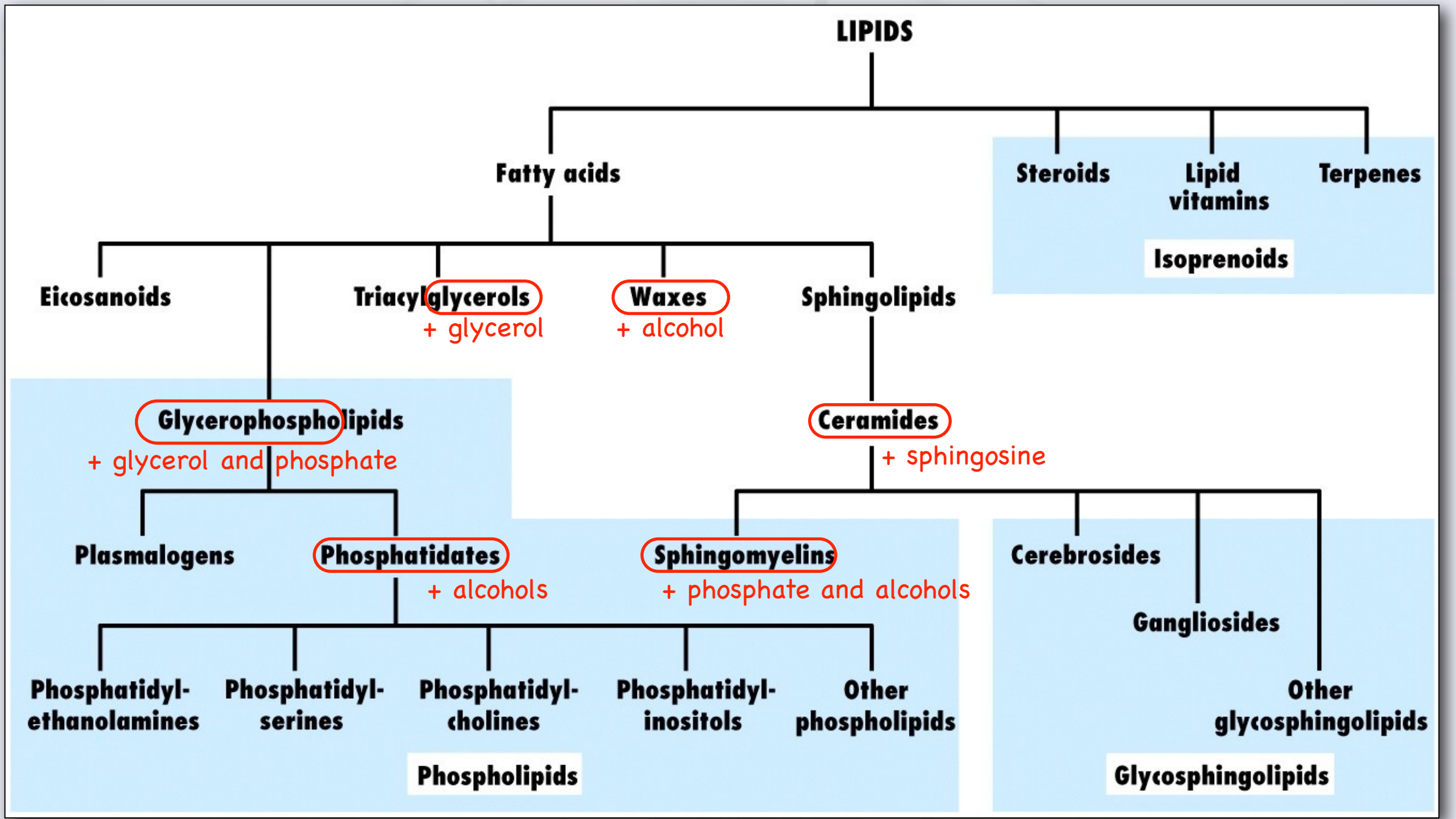

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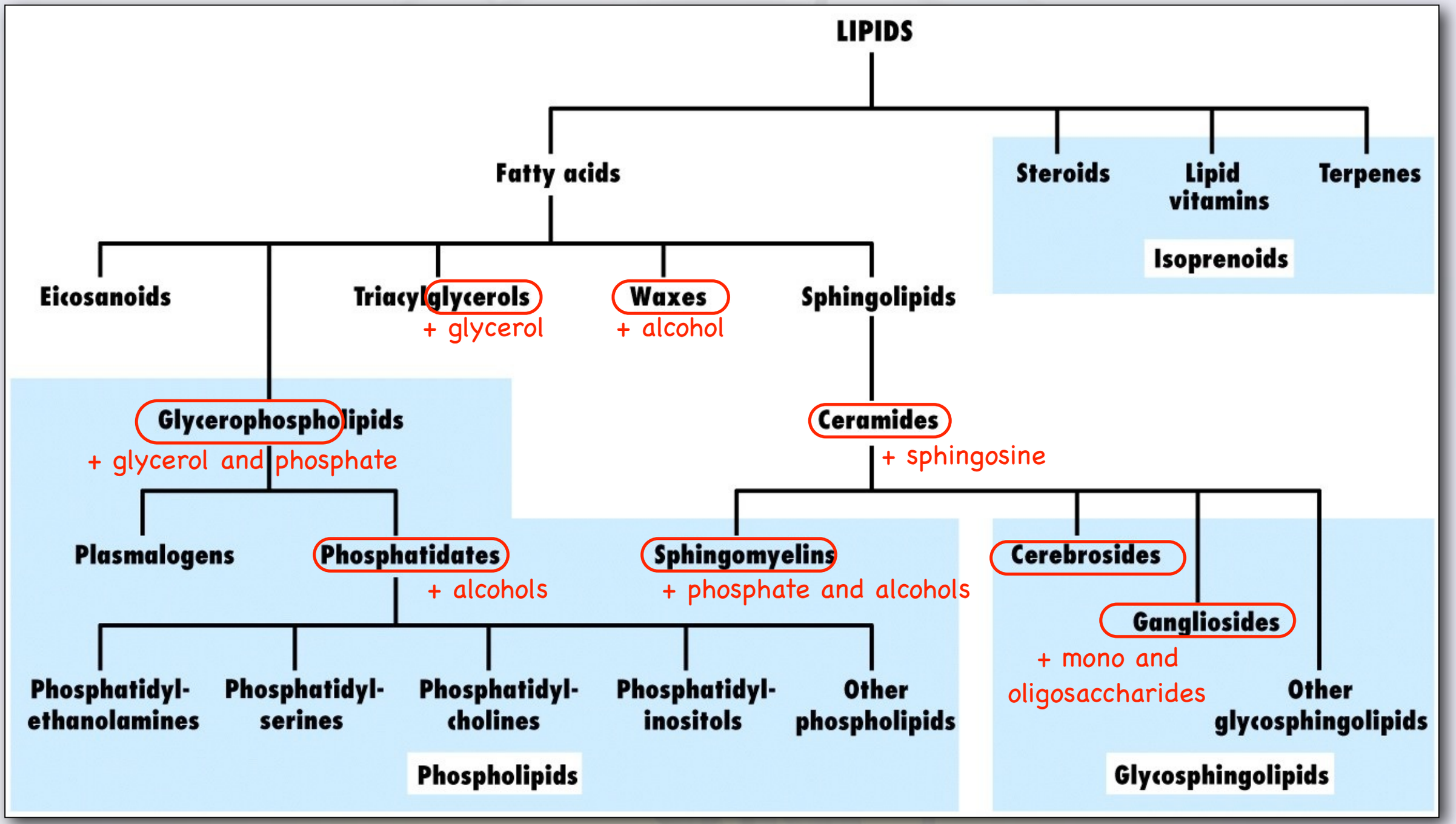
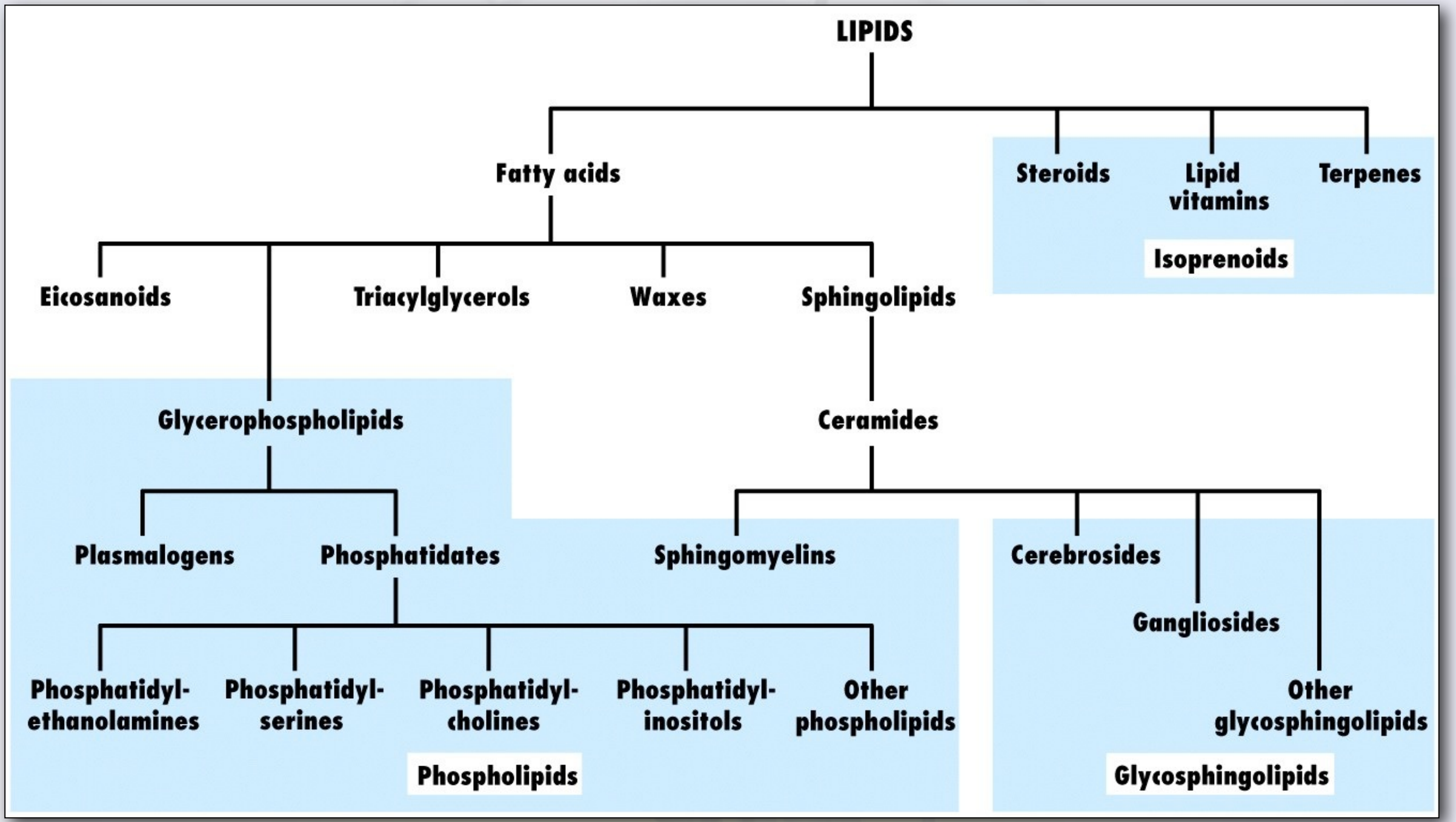


Fatty Acids


LIPIDS
Fatty acids
Steroids
Lipid vitamins
Terpenes
Isoprenoids
Eicosanoids
Triacylglycerols
Waxes
Sphingolipids
Glycerophospholipids
Ceramides
Plasmalogens
Phosphatidates
Sphingomyelins
Cerebrosides
Gangliosides
Other glycosphingolipids
Phosphatidyl-ethanolamines
Phosphatidyl-serines
Phosphatidyl-cholines
Phosphatidyl-inositols
Other phospholipids
Phospholipids
Glycosphingolipids

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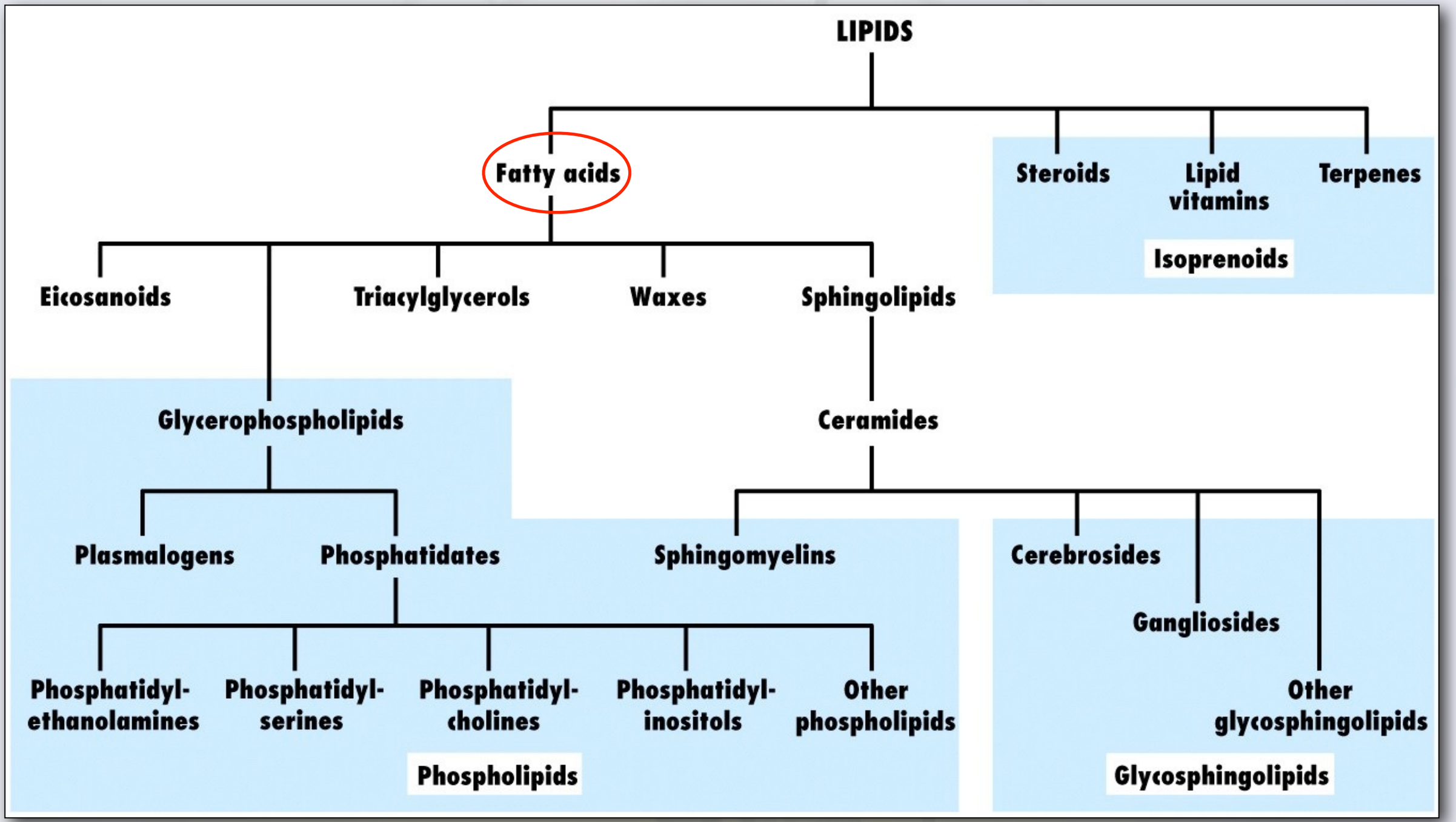
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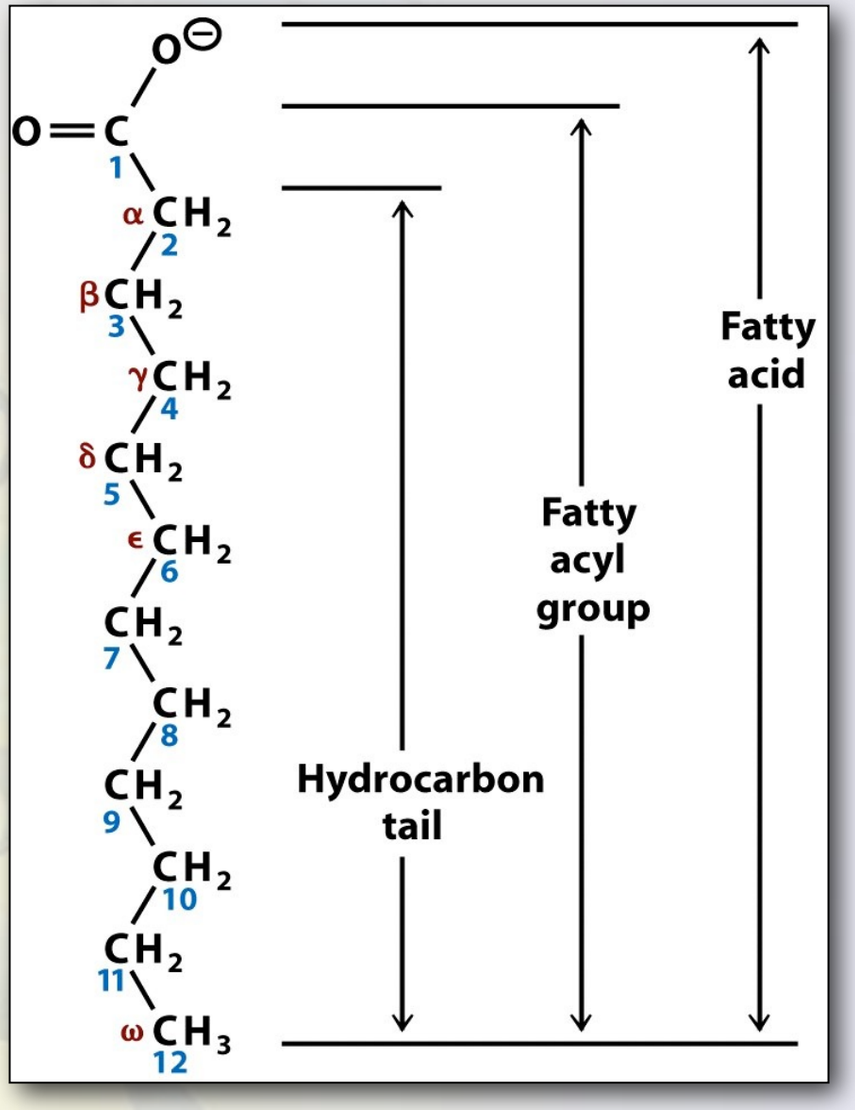
Fatty Acids

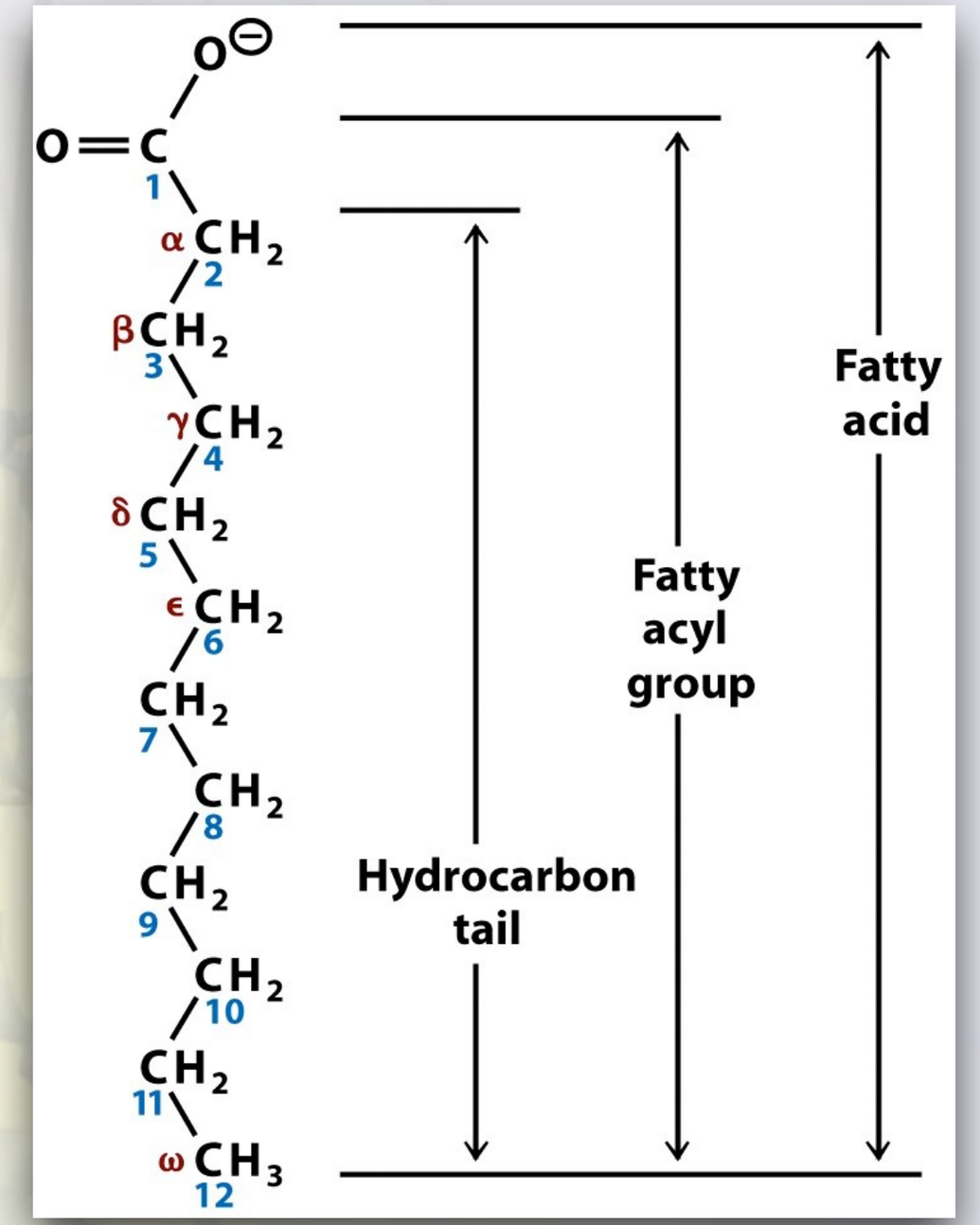
- Fatty acids contain
  - A carboxylic acid group
  - A long aliphatic chain



Fatty Acids

The carboxyl group has a pKa of 4-5

- Is charged at neutral pH values
- The salts of fatty acids are "soaps"



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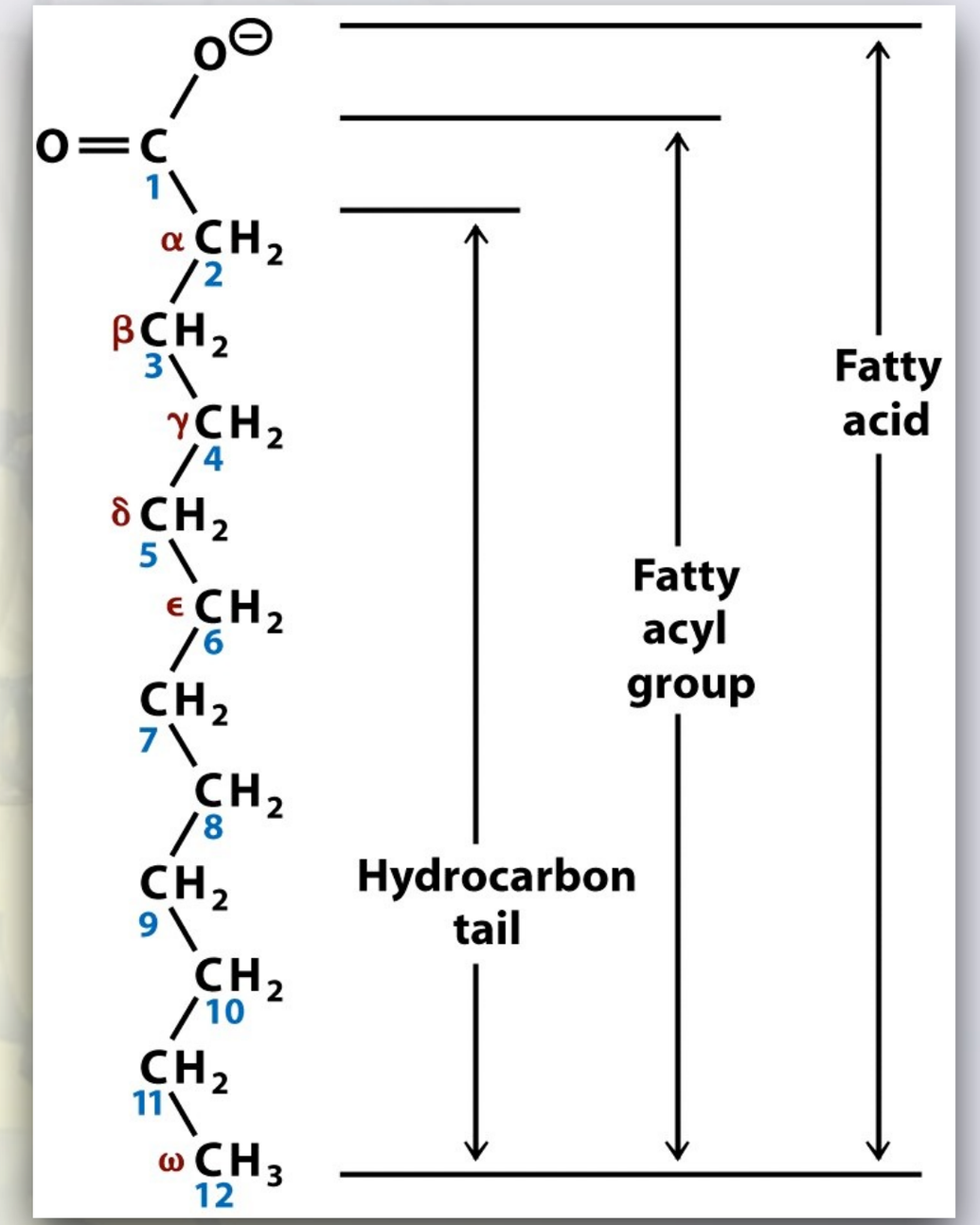

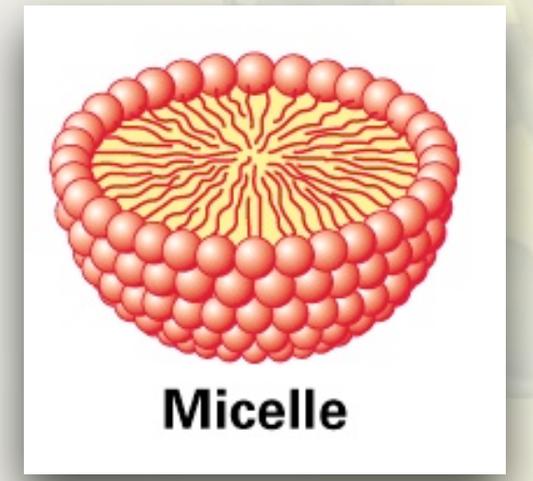

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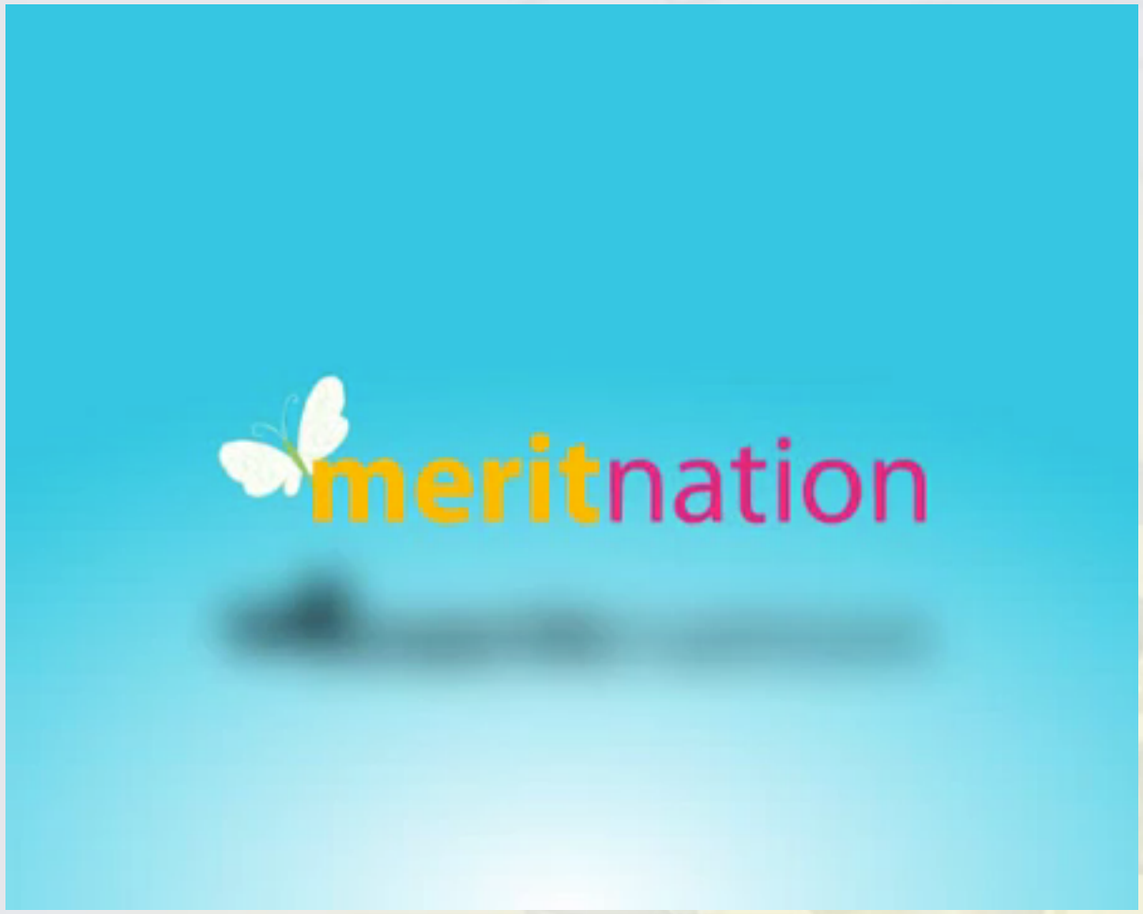
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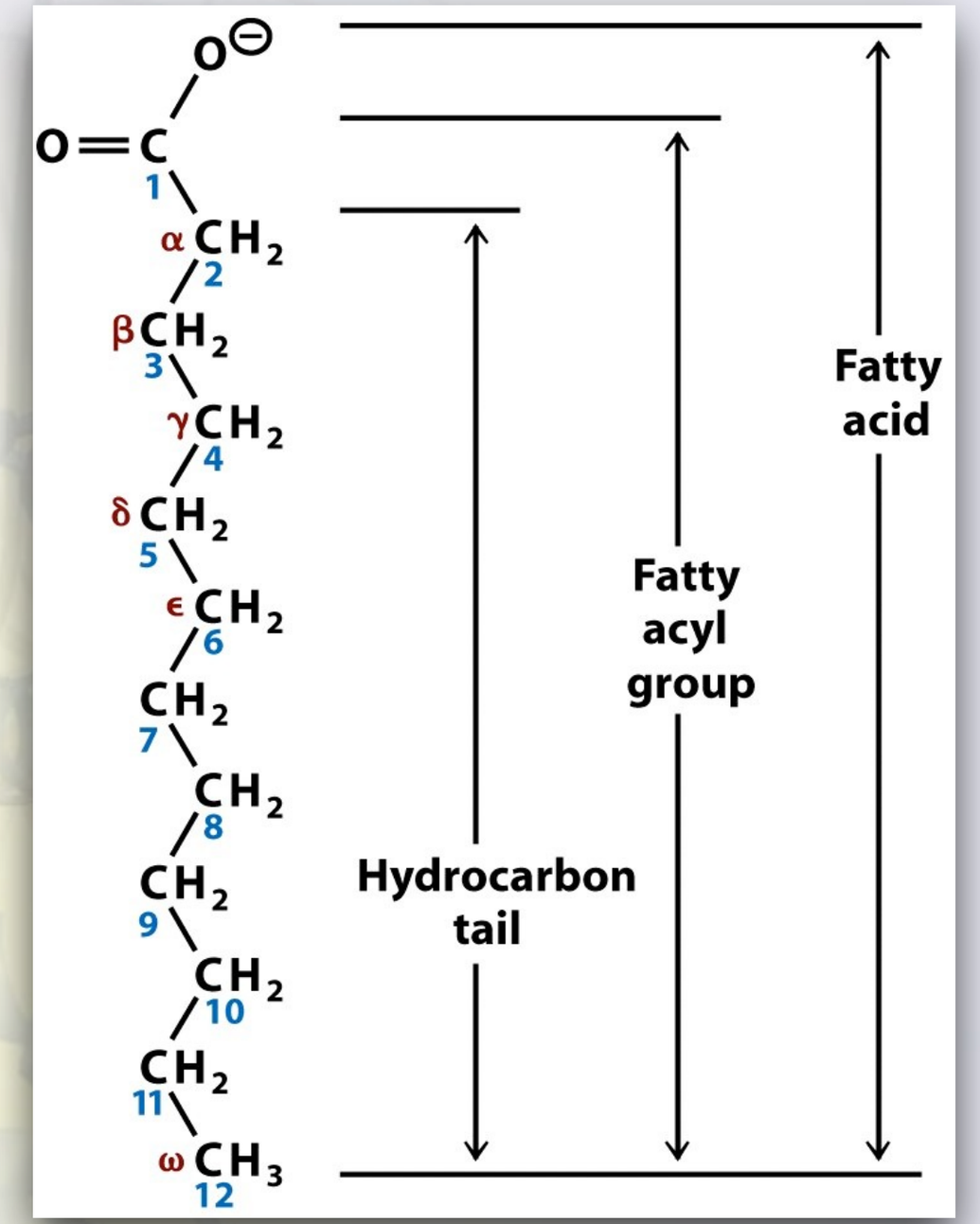
O⊖
O
C
1
α CH2
2
β CH2
3
γ CH2
4
δ CH2
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ϵ CH2
6
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7
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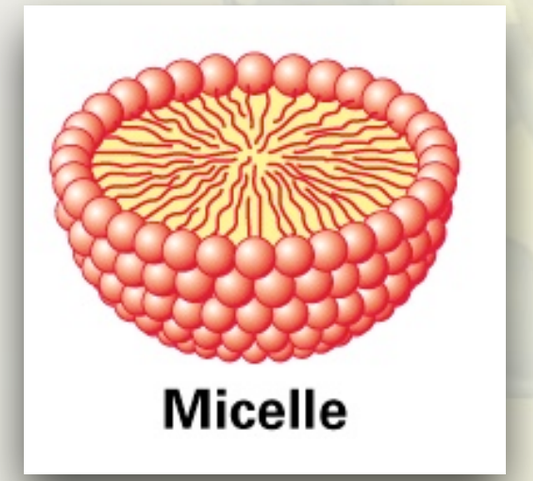
8
CH2
9
CH2
10
CH2
11
ω CH3
12
Fatty acid
Fatty acyl group
Hydrocarbon tail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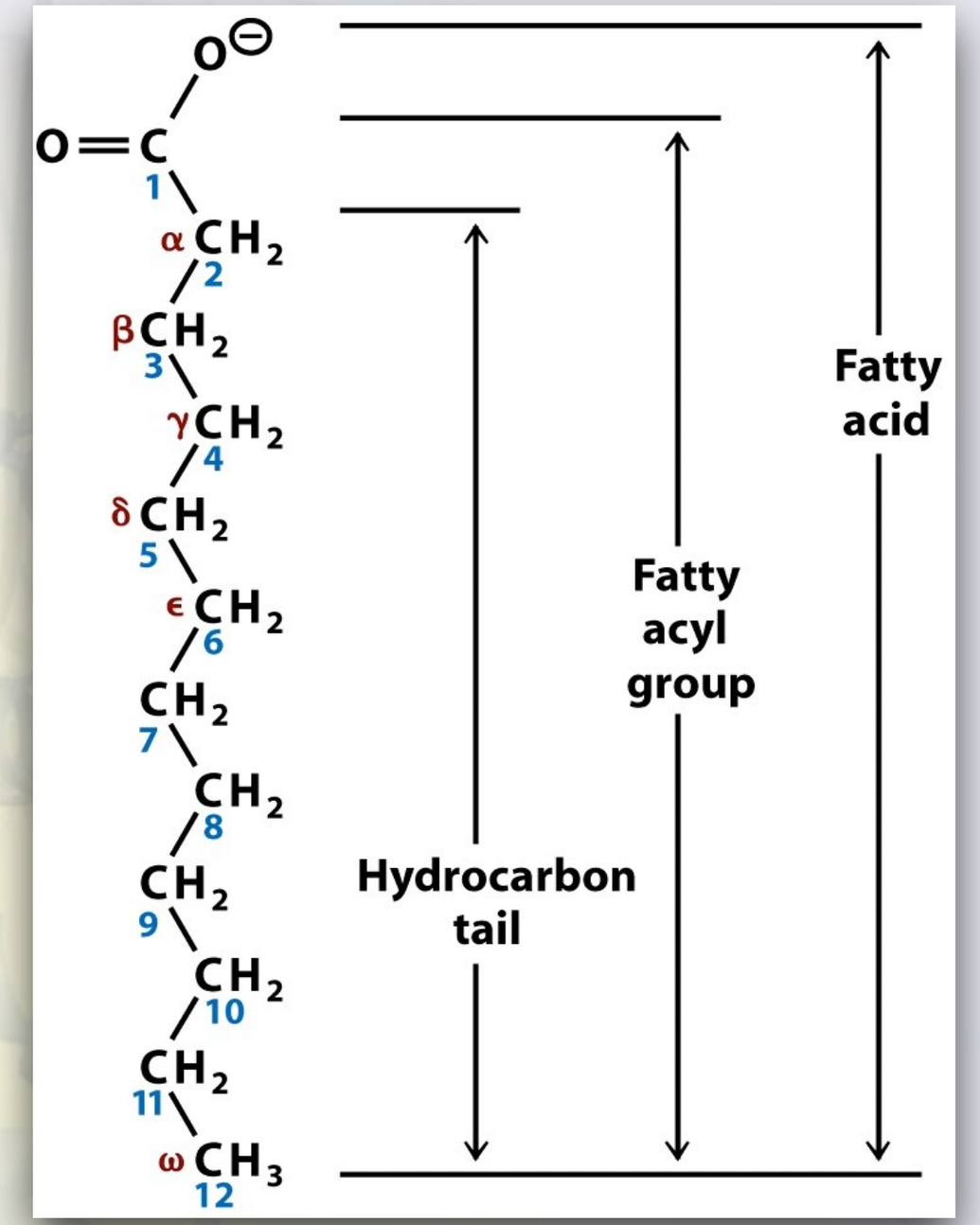

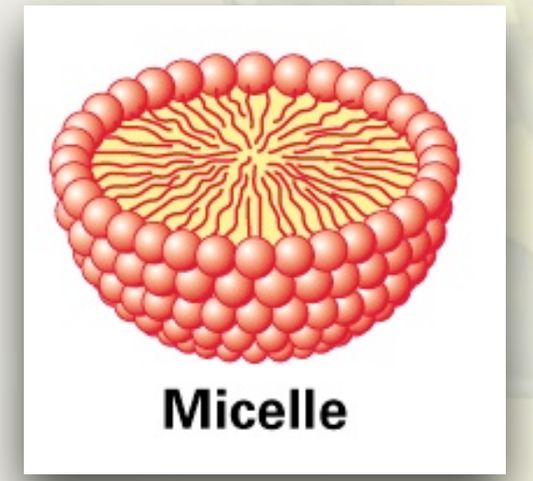

Fatty Acids

TABLE 9.1 Some common fatty acids (anionic forms)

Number of carbons	Number of double bonds	Common name	IUPAC name	Melting point, °C	Molecular formula
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14	0	Myristate	Tetradecanoate	52	$CH_3(CH_2)_{12}COO^{\ominus}$
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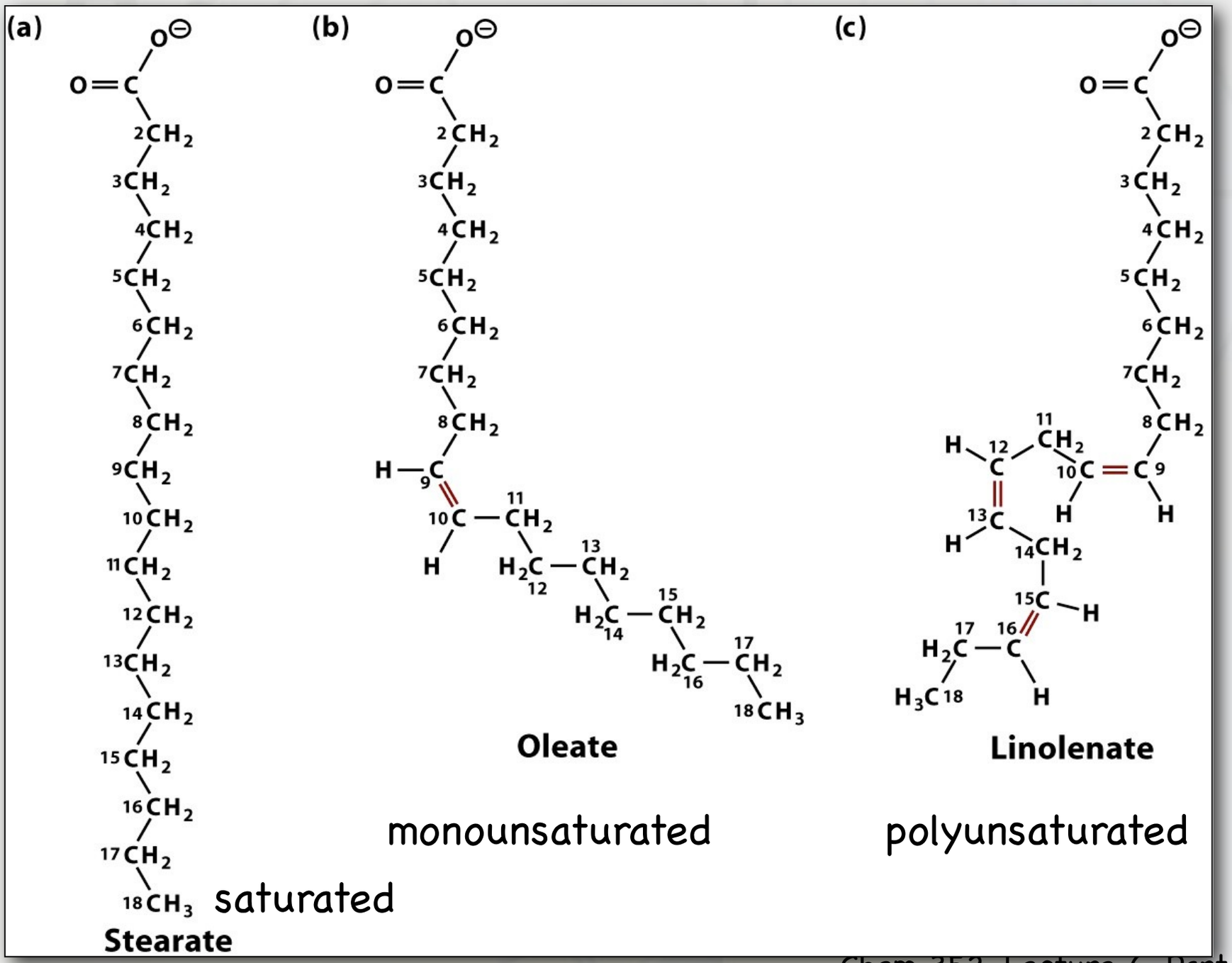

saturated

monounsaturated

polyunsaturated

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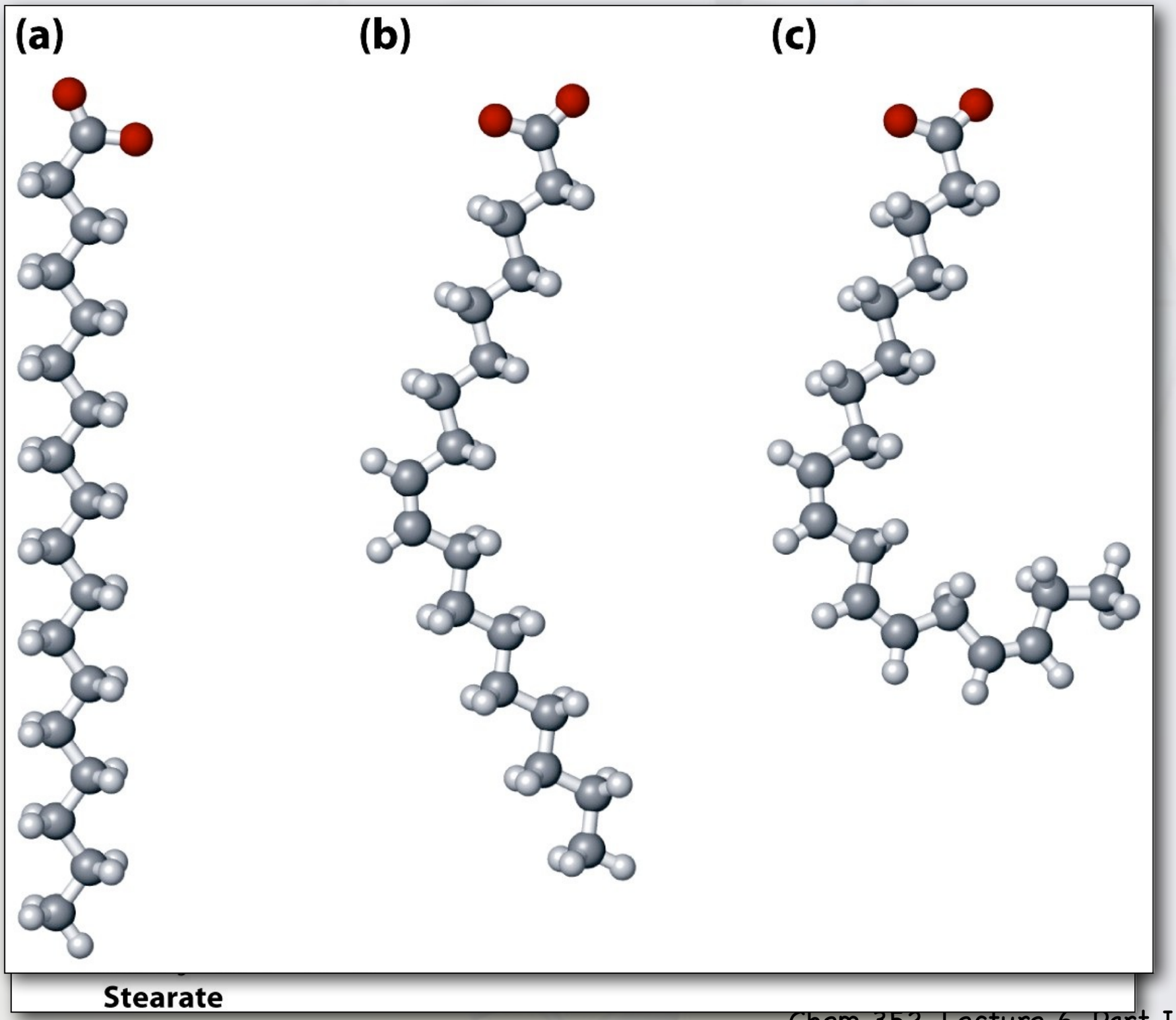

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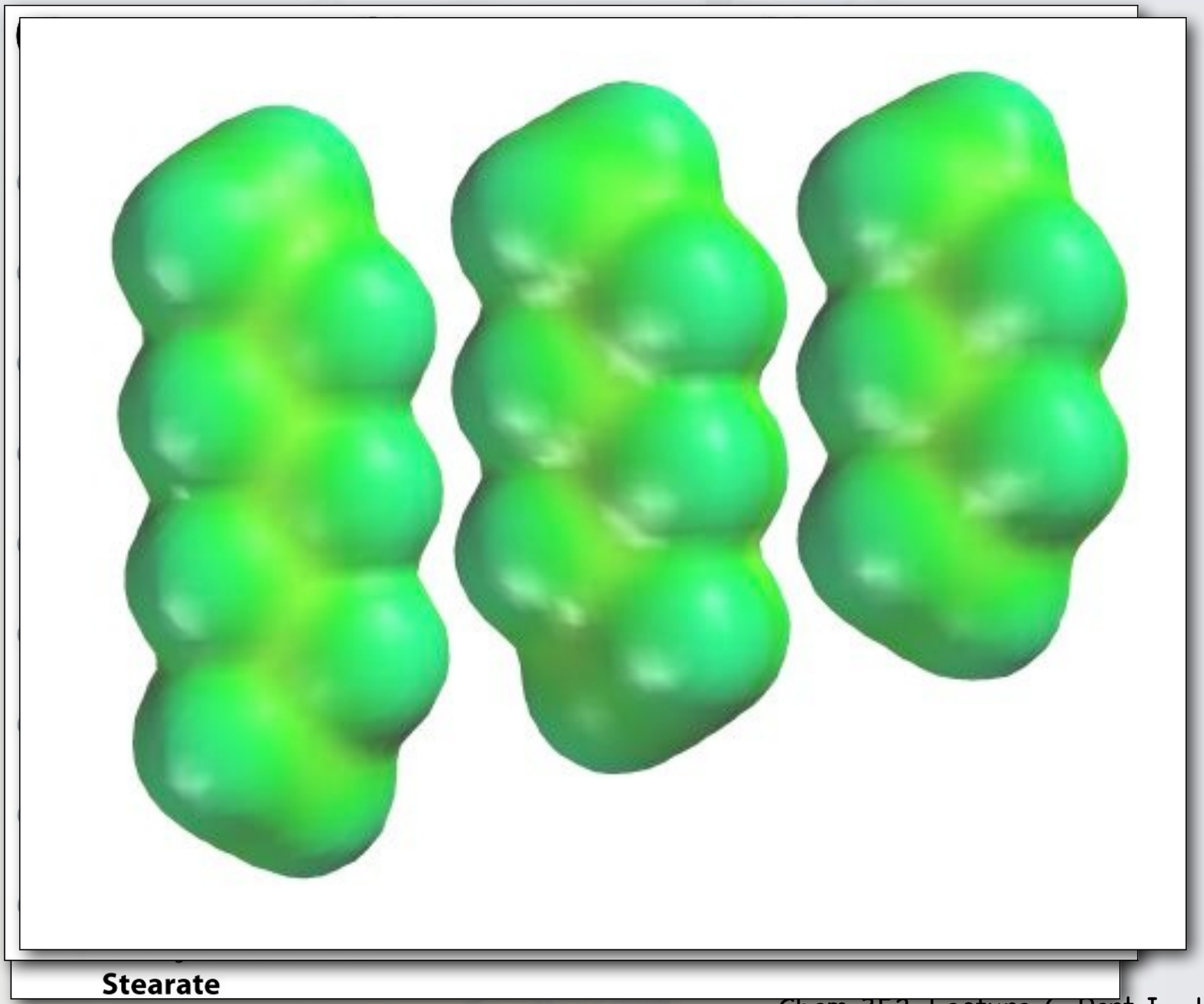

Stearate

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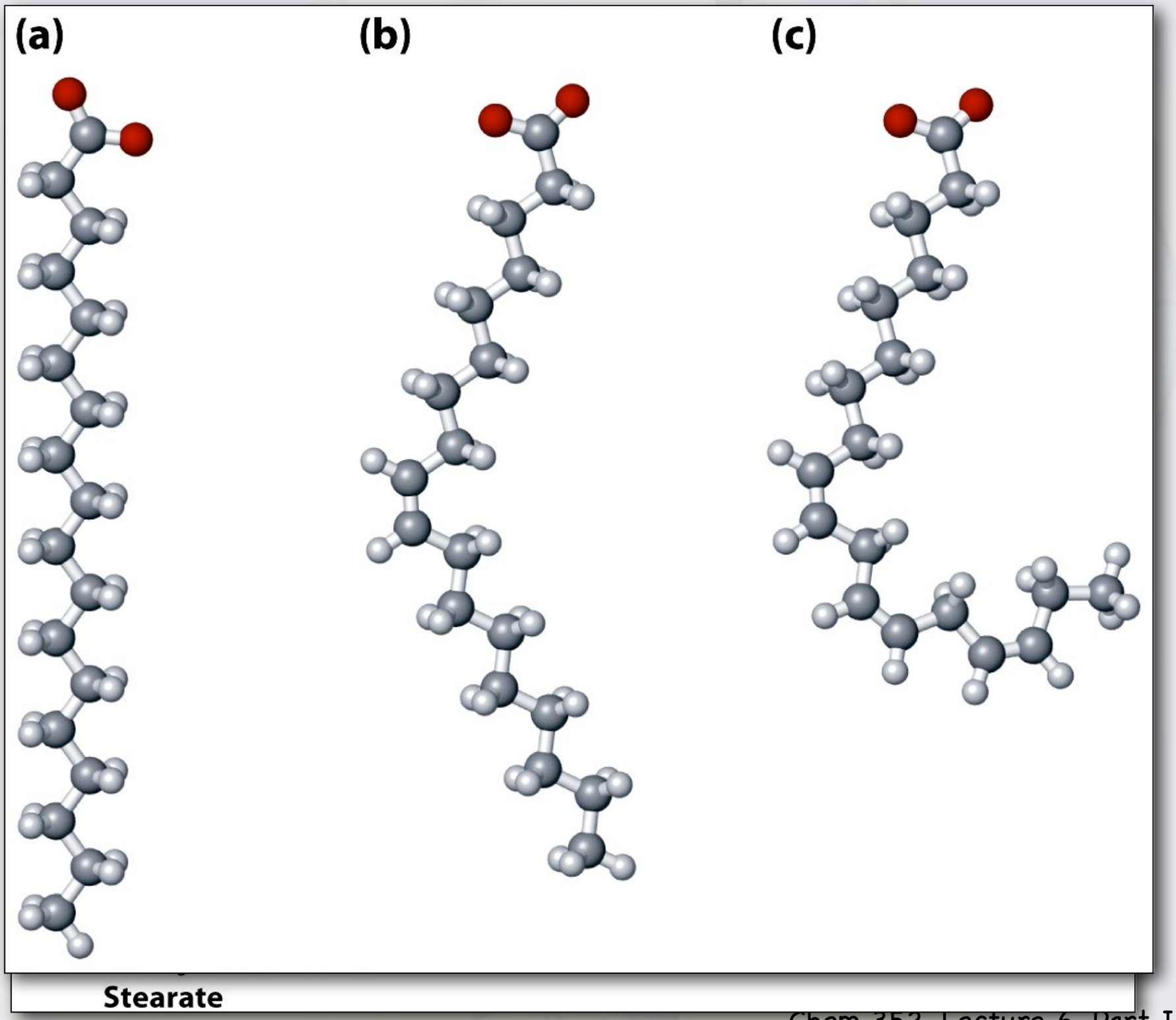

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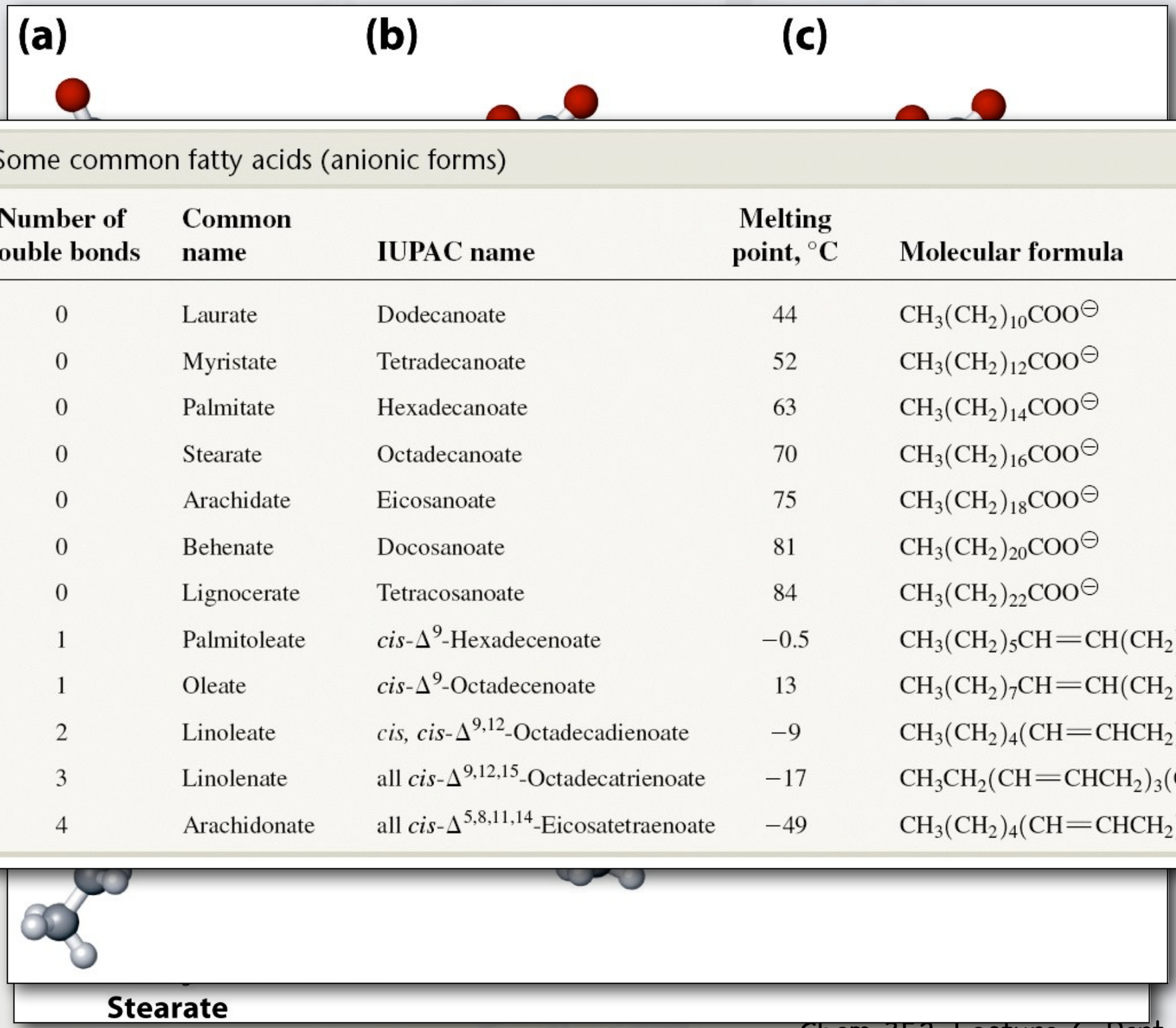

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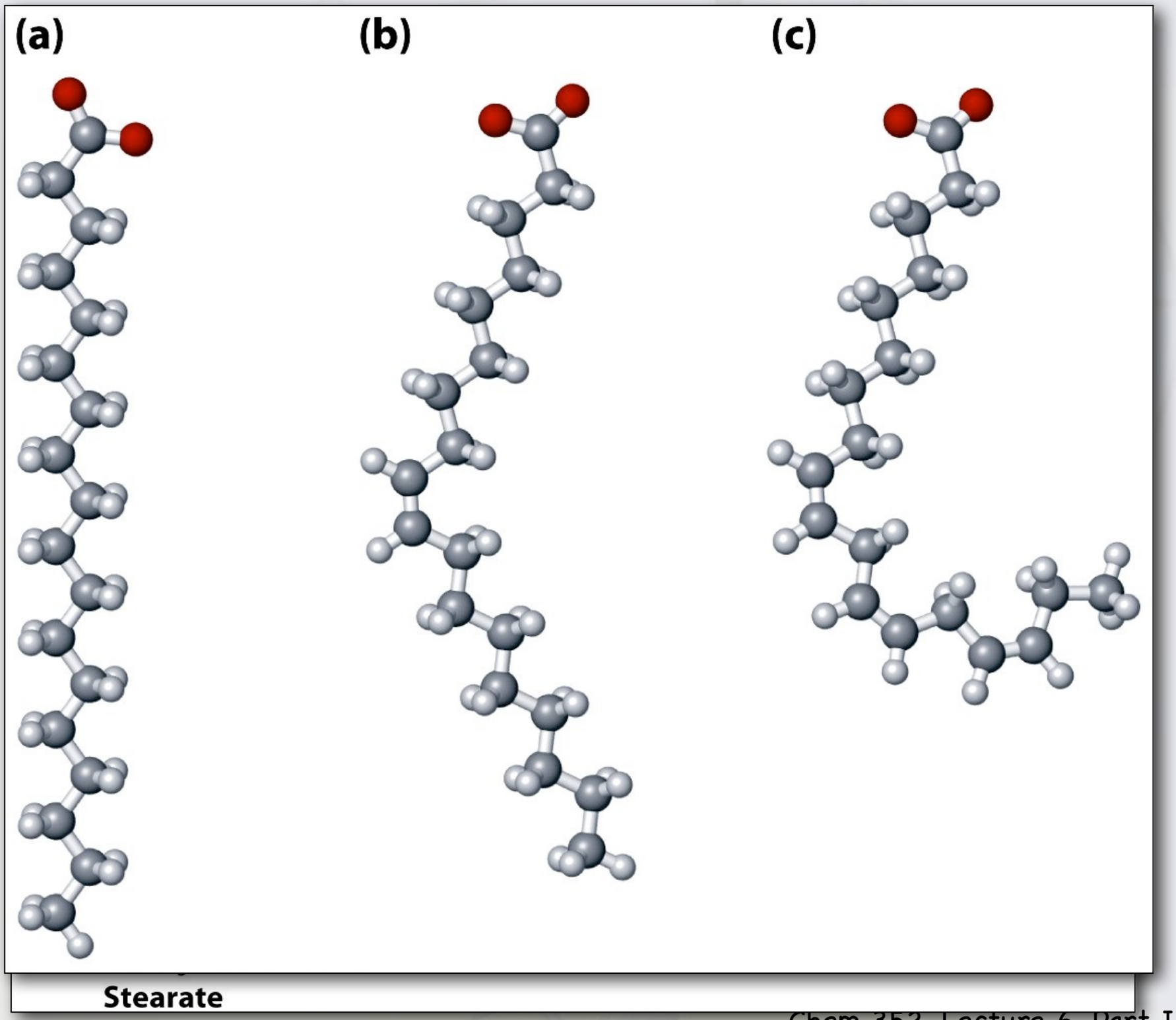
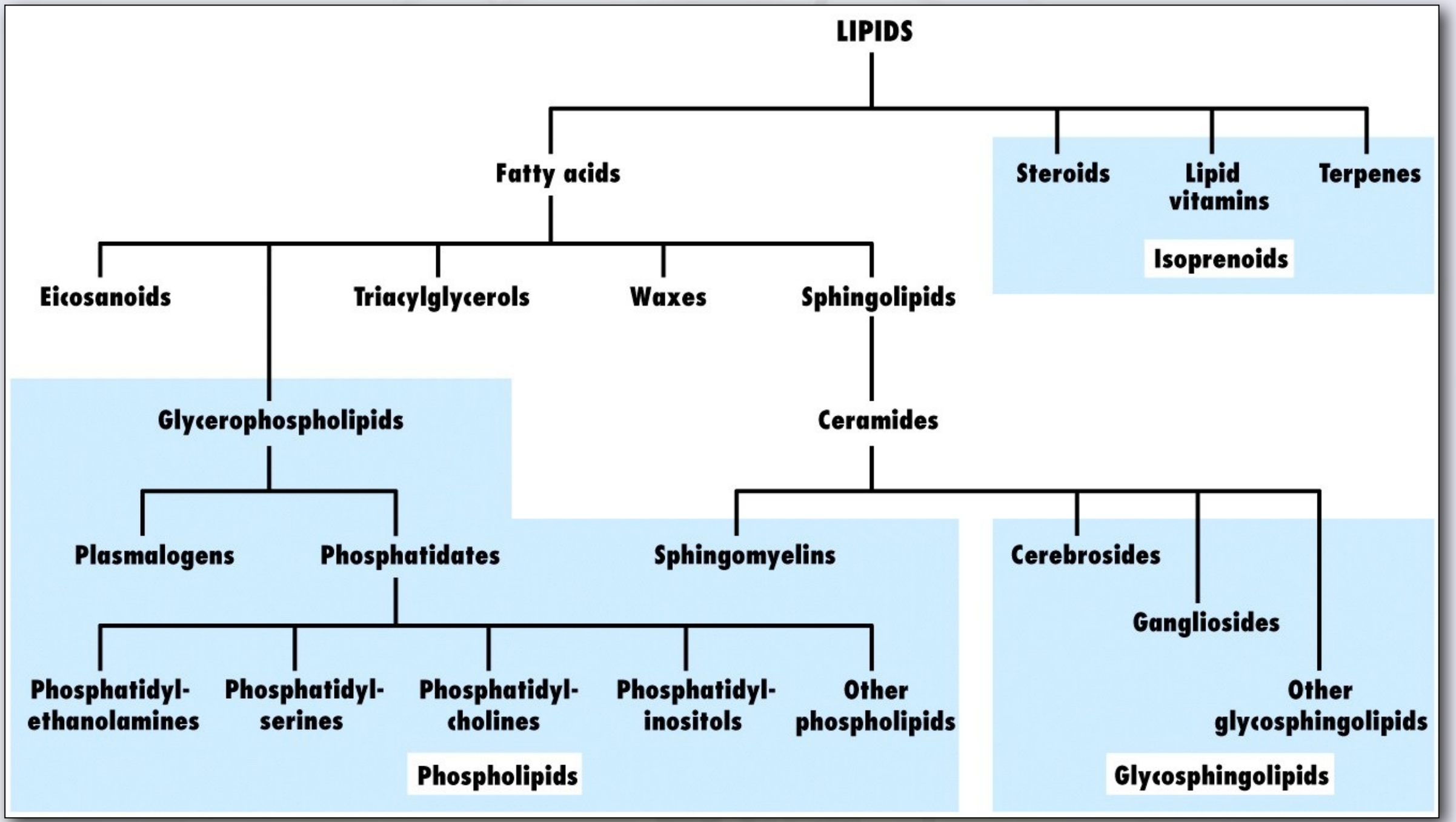


Triacylglycerols



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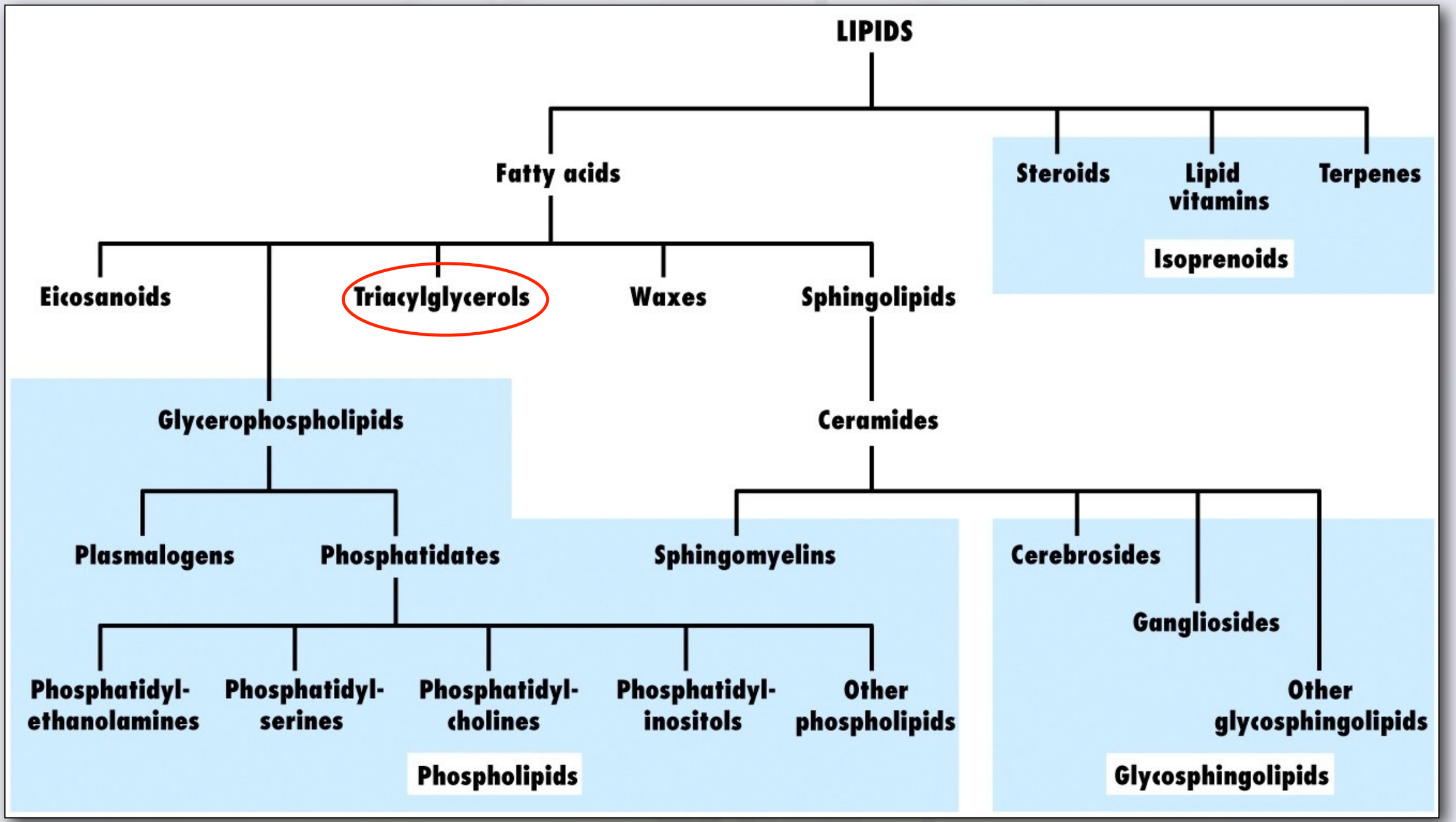

Triacylglycerols

- Triacylglycerols are also called
  - Fat
  - Oil
  - Triglycerides

- They are a chemical combination of glycerol and three fatty acids.

- They represent a storage form of fatty acids.

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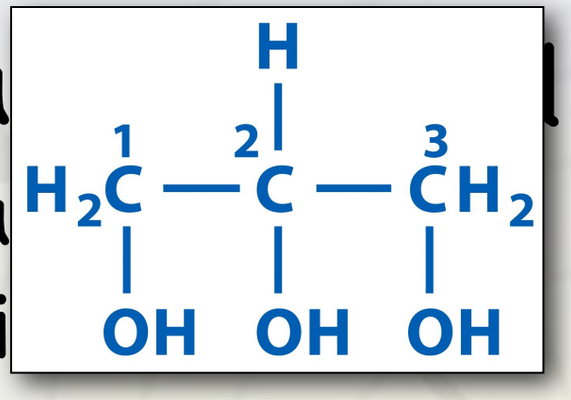

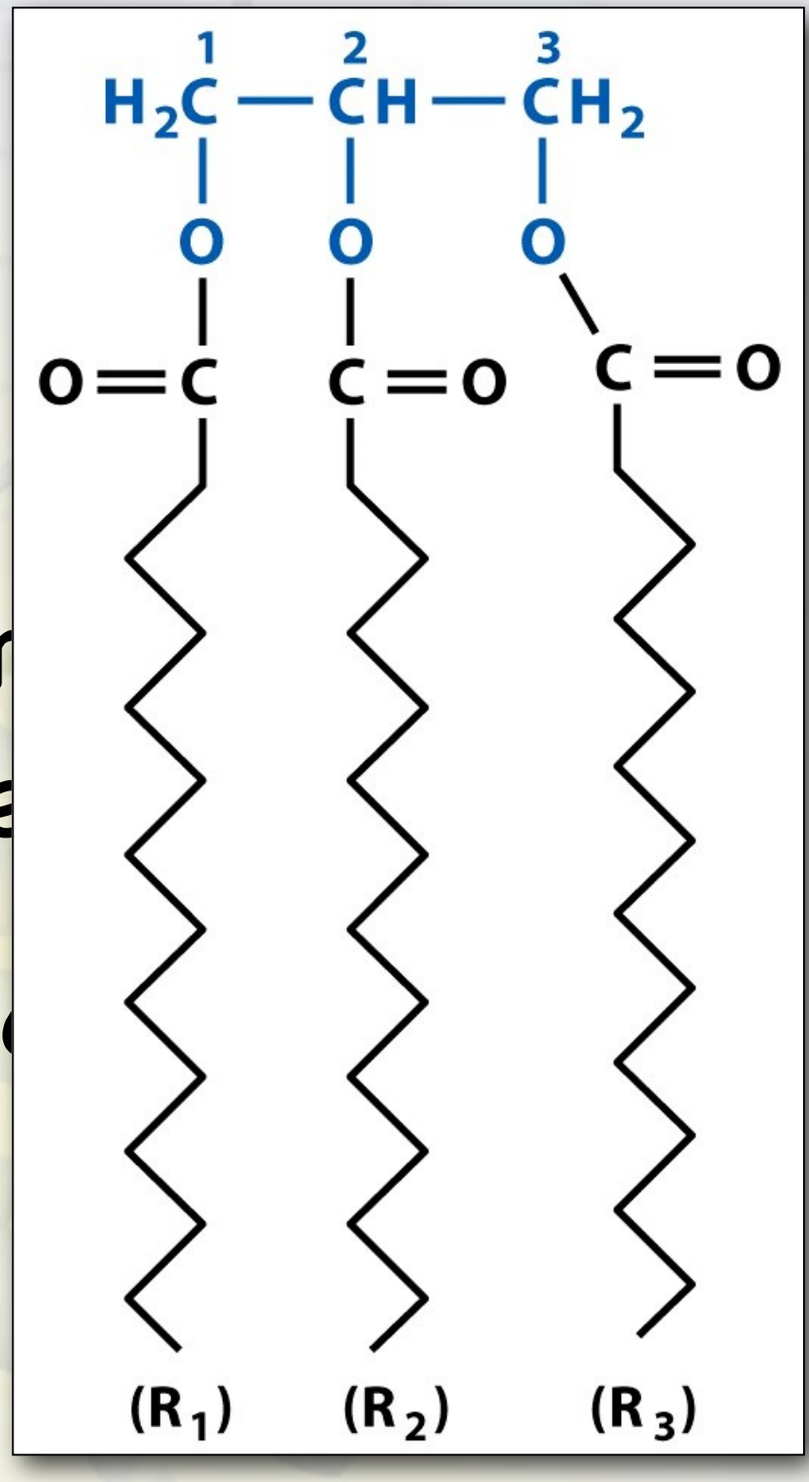

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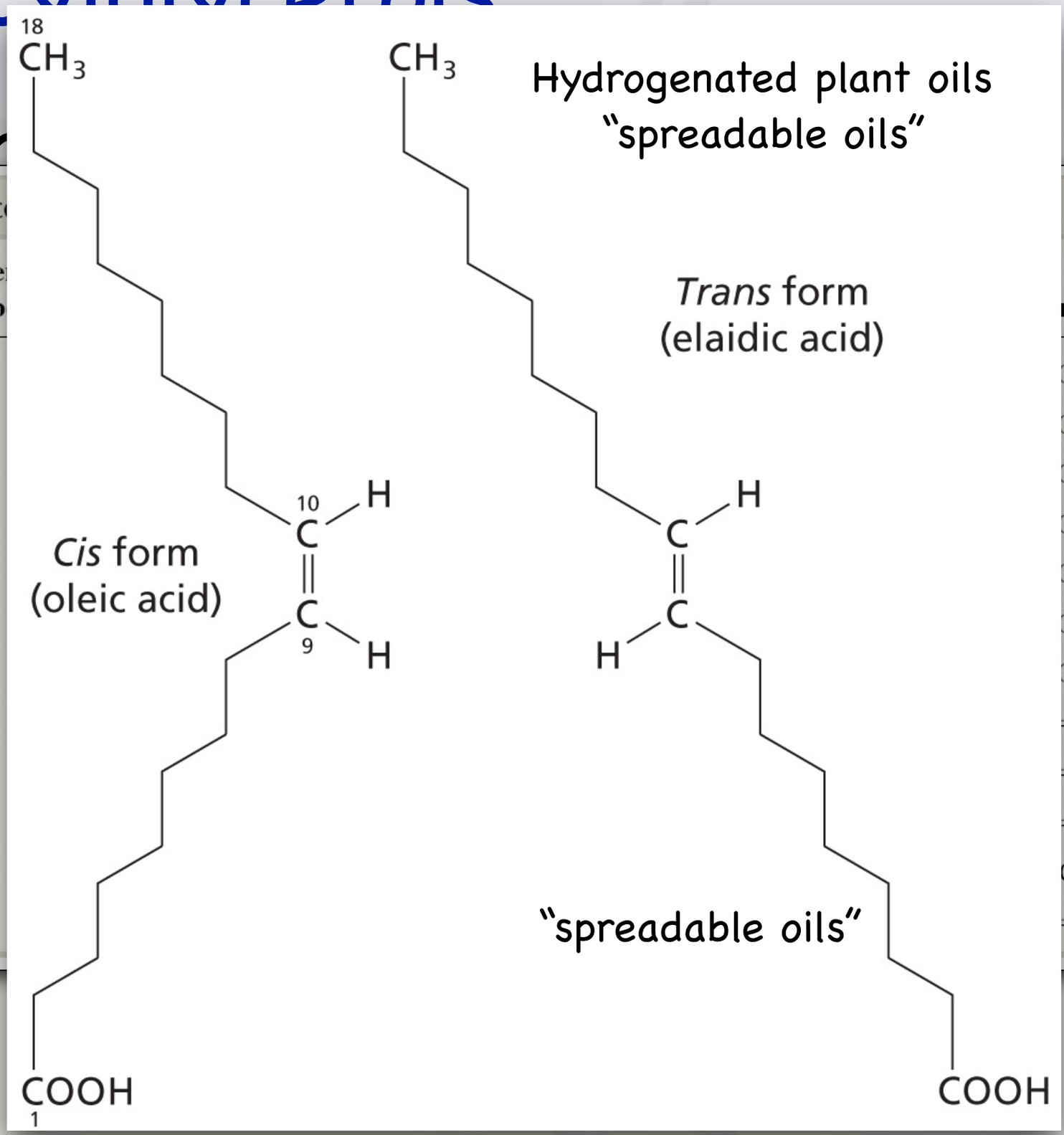

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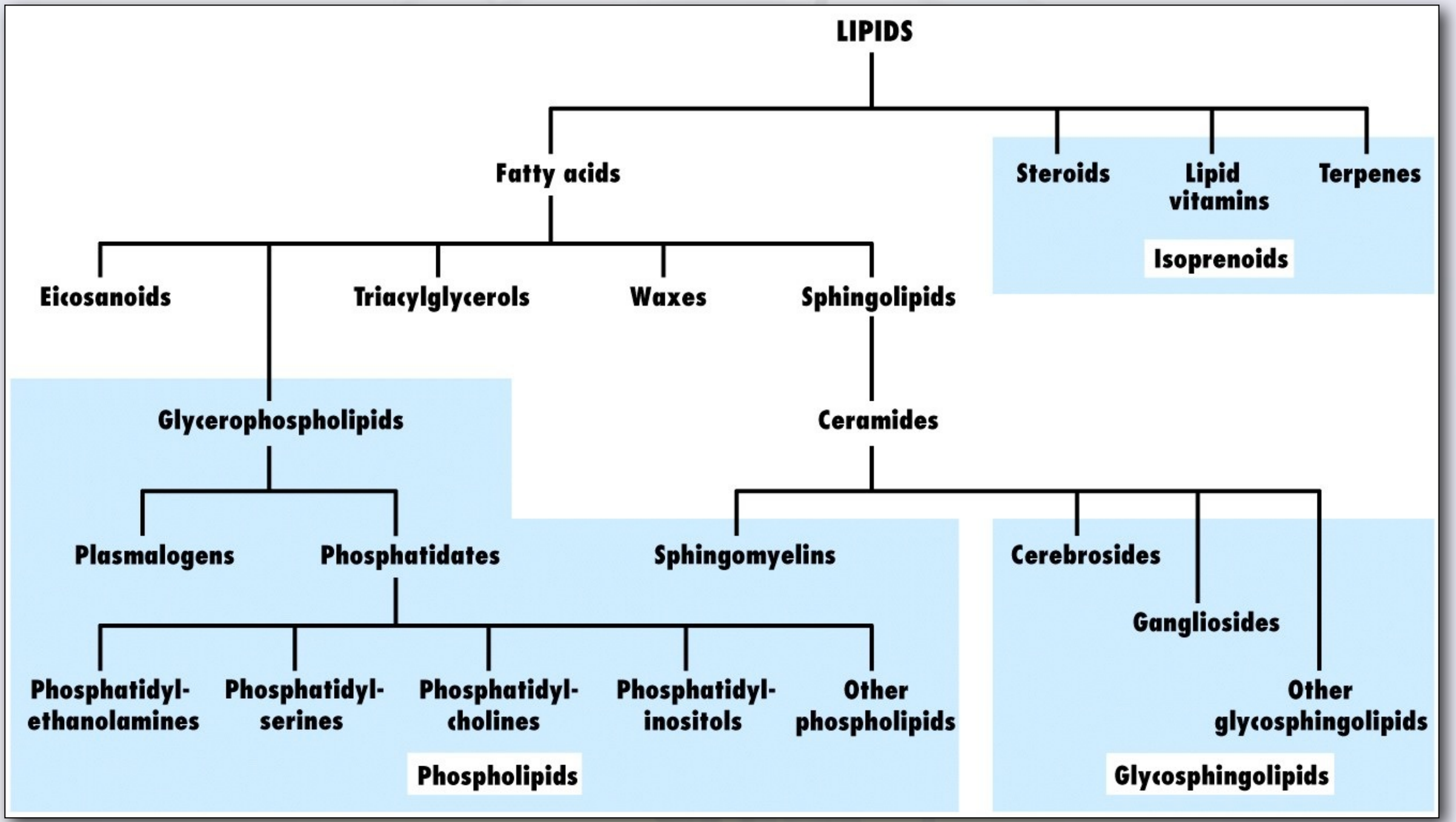
Glycerophospholipids



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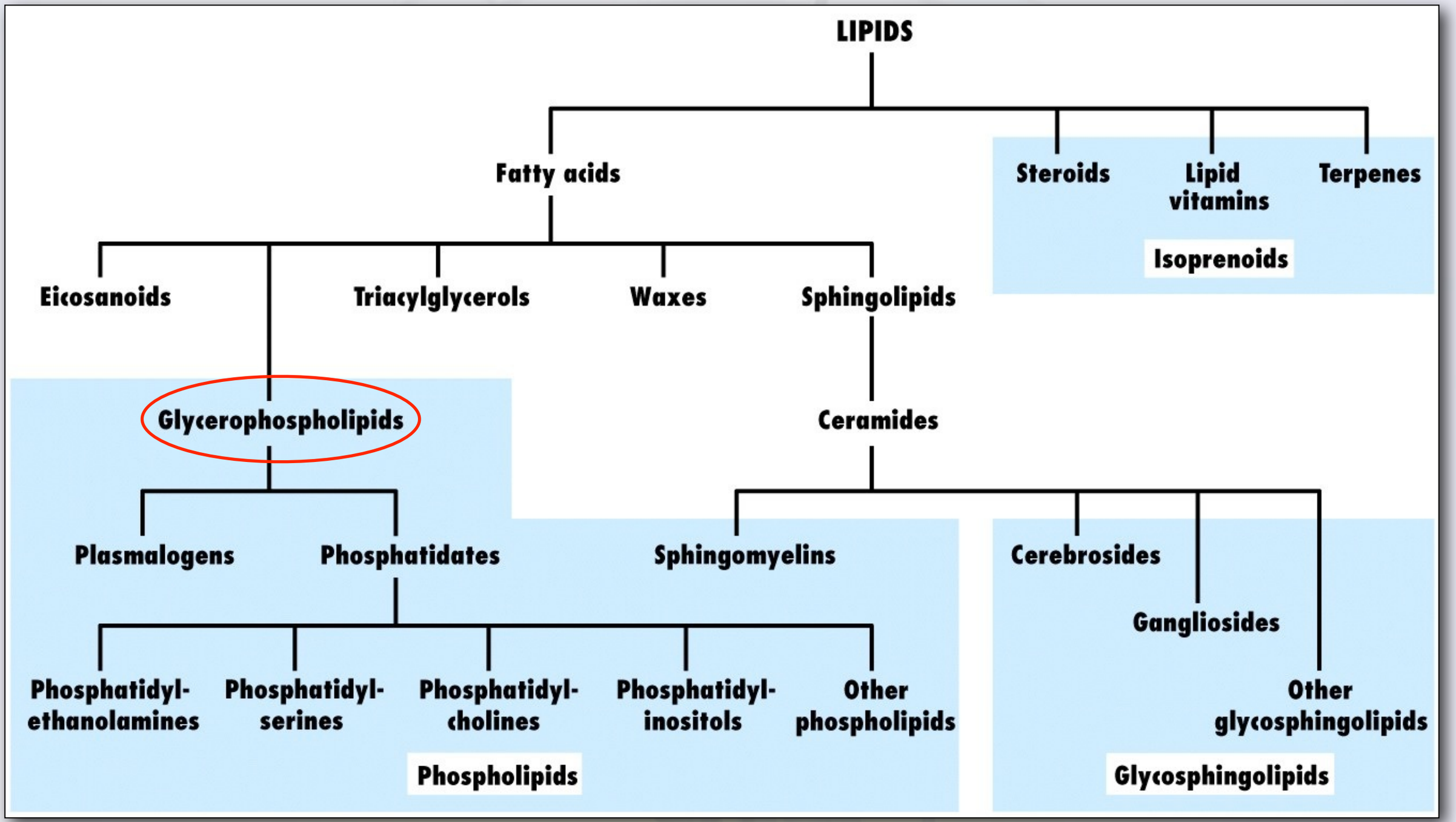


Glycerophospholipids

Glycerophospholipids are also called

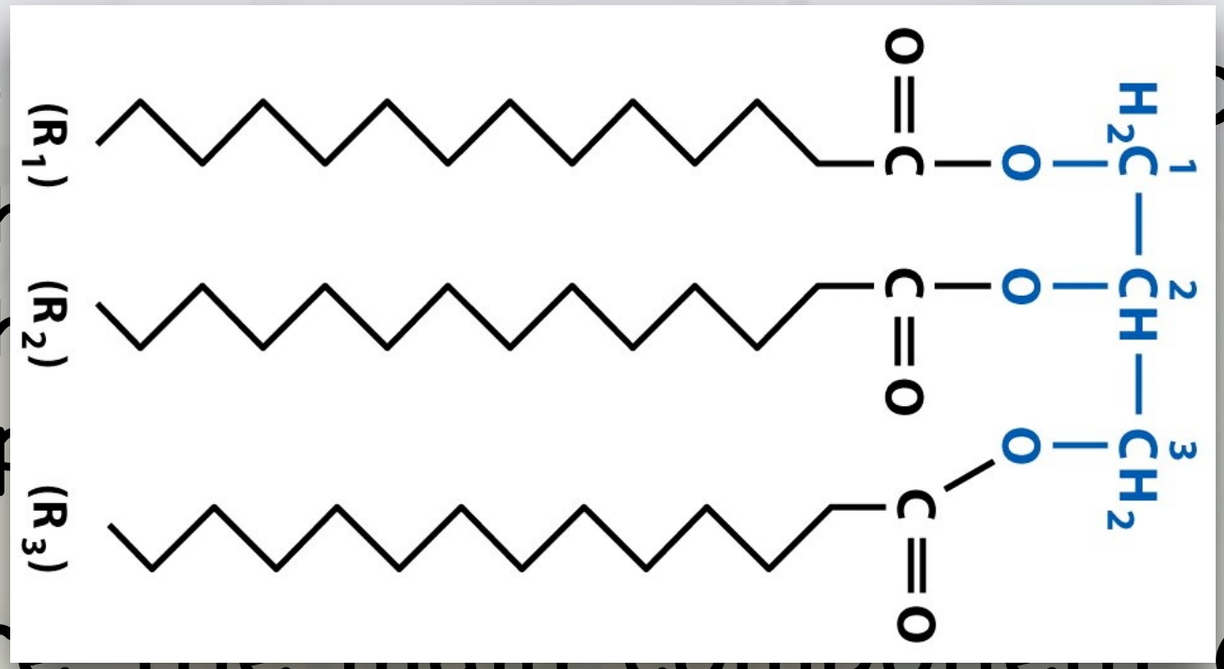
- phosphoglycerides
- phospholipids
- diacylphosphoglycerol

They are the main component of biological membranes.

Glycerophospholipids

Glycero called

- phosph
- phosph
- diacylp



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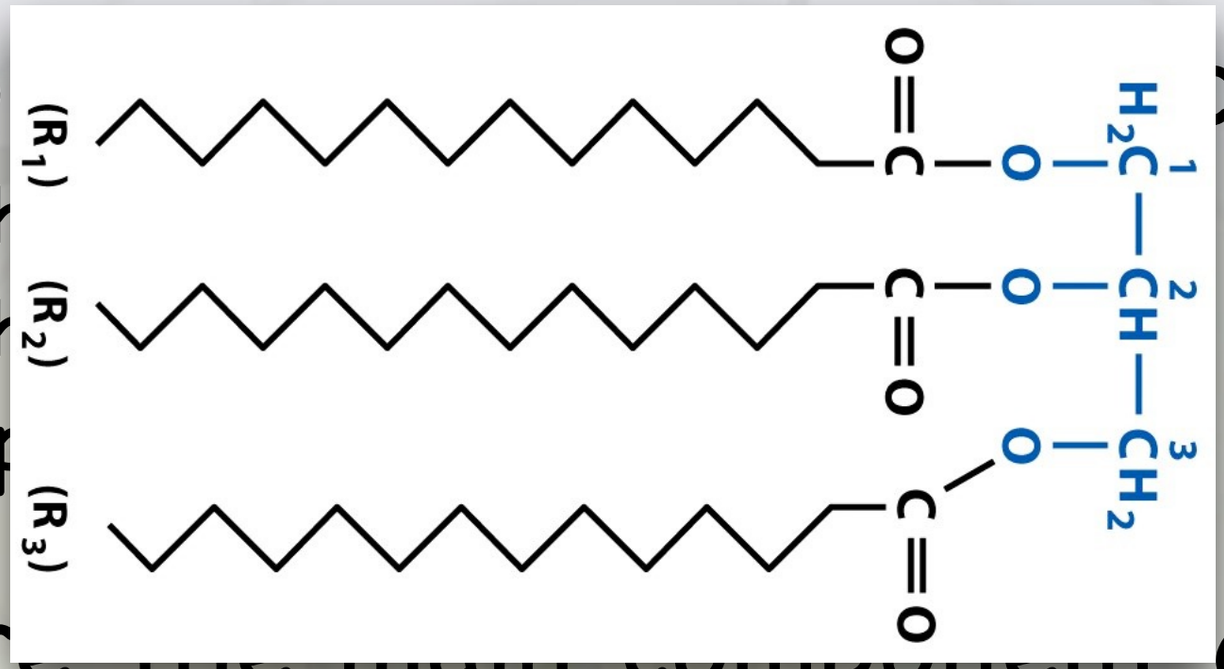
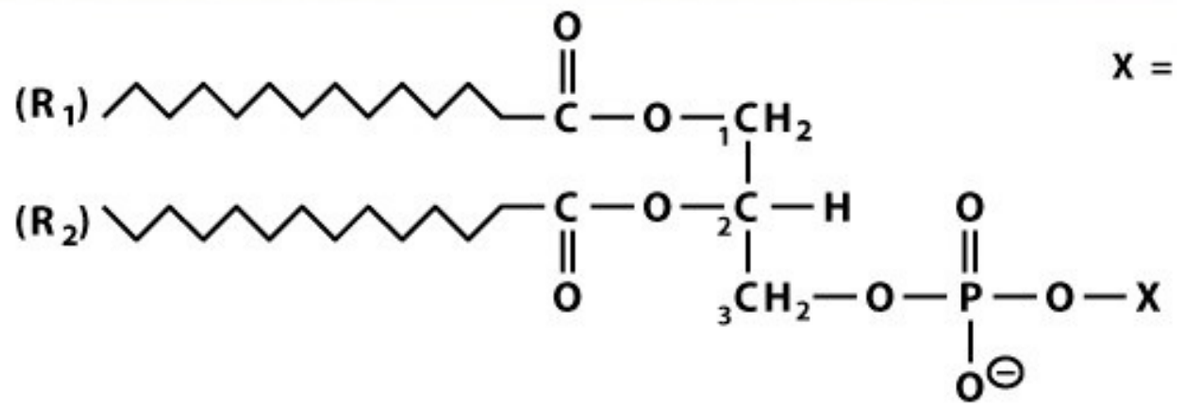


They ar of

b

TABLE 9.2 Some common types of glycerophospholipids



X = rest of polar head

Glycerophospholipids

Gly
- p
- p
- c

The

b

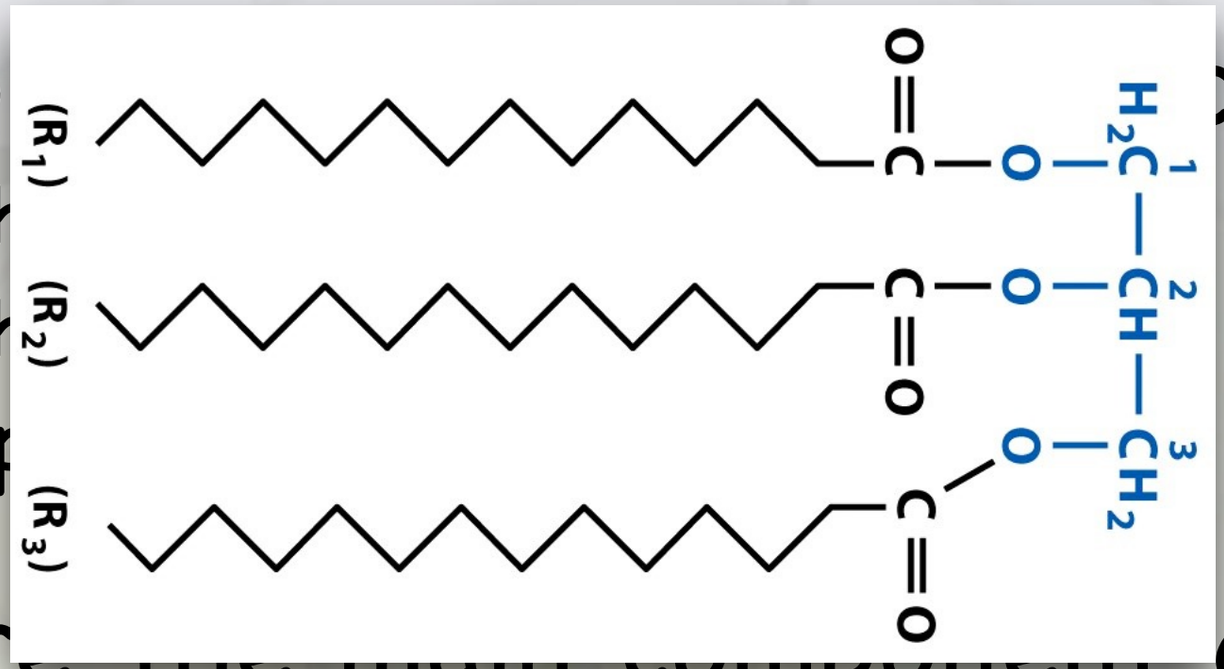
TAB

Precursor of X (HO—X)	Formulas of —O—X	Name of resulting glycerophospholipid
Water	—O—H	Phosphatidate
Choline	—O—$CH_2CH_2\overset{\oplus}{N}(CH_3)_3$	Phosphatidylcholine
Ethanolamine	—O—$CH_2CH_2\overset{\oplus}{N}H_3$	Phosphatidylethanolam
Serine	—O—CH_2—$CH(\overset{\oplus}{N}H_3)(COO^{\ominus})$	Phosphatidylserine
Glycerol	—O—$CH_2CH(OH)$—CH_2OH	Phosphatidylglycerol
Phosphatidyl-glycerol	—O—$CH_2CH(OH)$—CH_2—O—P(=O)($O^{\ominus}$)—O—CH_2—$CH(OCOR_4)$—CH_2OCOR_3	Diphosphatidylglycerol (Cardiolipin)
myo-Inositol	—O—$C_6H_5(OH)_5$	Phosphatidylinositol

Glycerophospholipids

Glycero called

- phosph
- phosph
- diacylp



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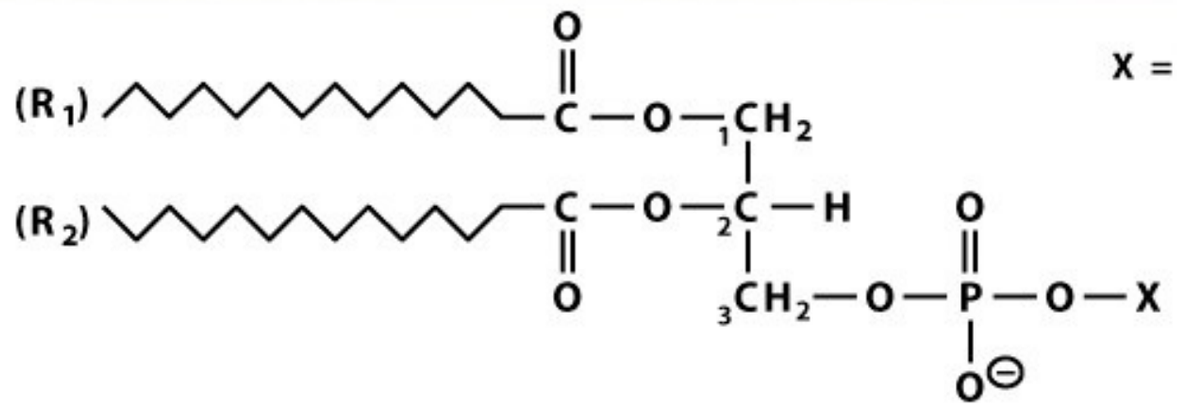

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Glycerophospholipids

Glycerophospholipids are also called

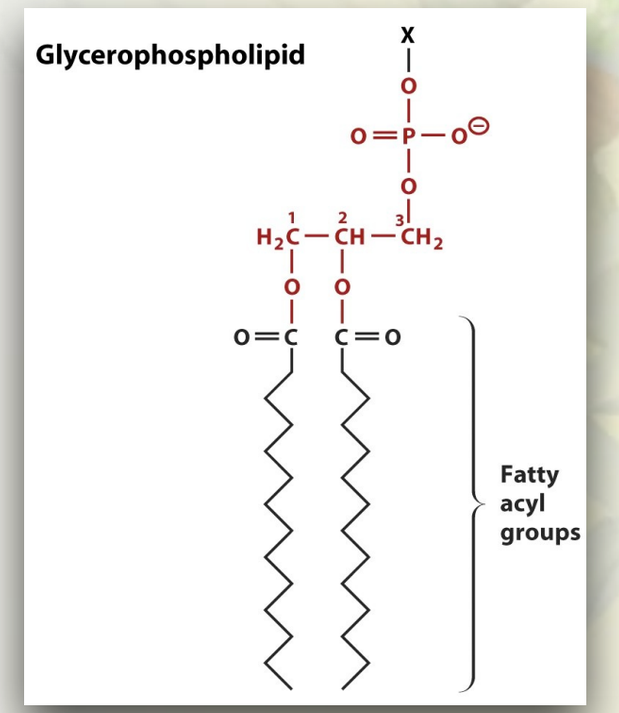
- phosphoglycerides
- phospholipids
- diacylphosphoglycerol

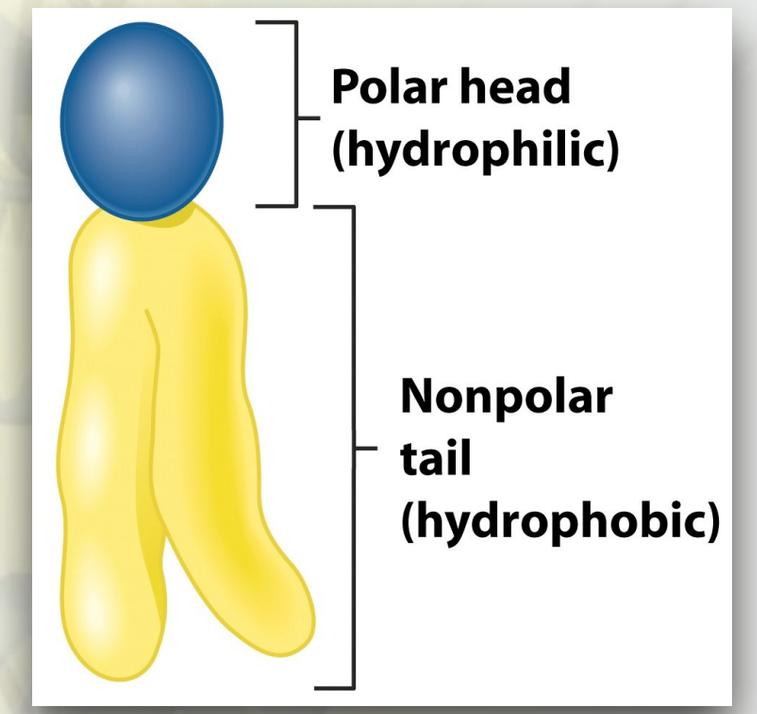
They are the main component of biological membranes.

Other Biological Molecules

An important group of lipids are the phospholipids

- Phospholipids are not polymers, but they do aggregate in the presence of water to form membranes.





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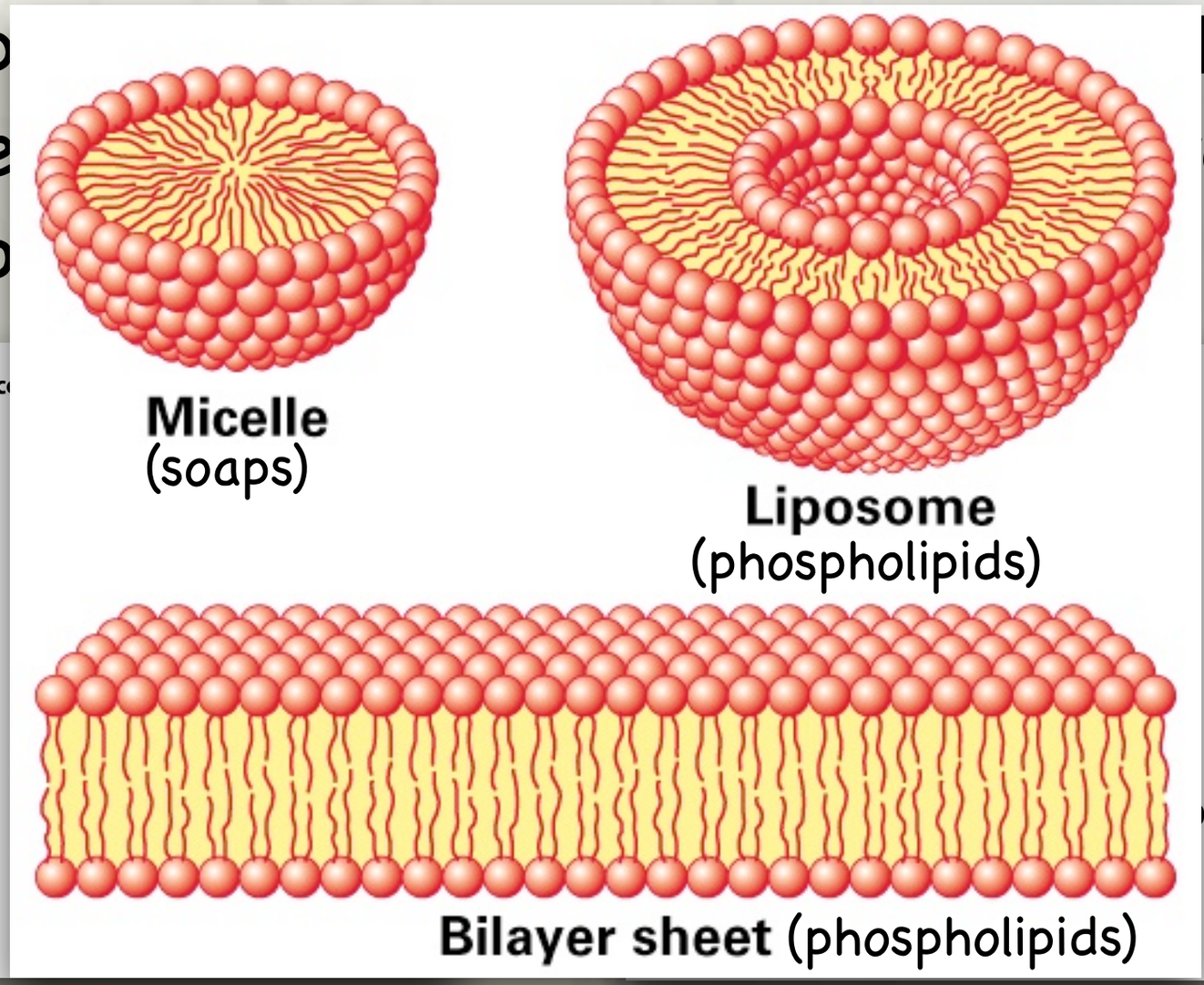
An important group of lipids are the phospholipids

- Phosp hey do aggre o form memb



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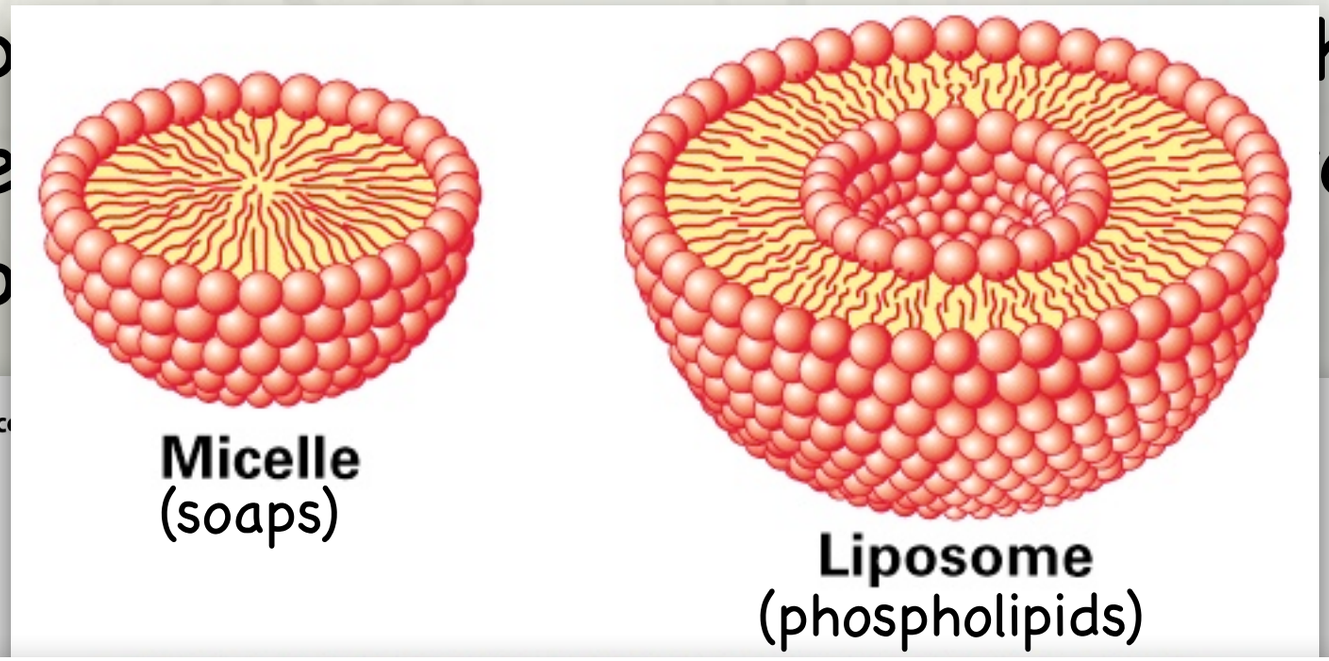

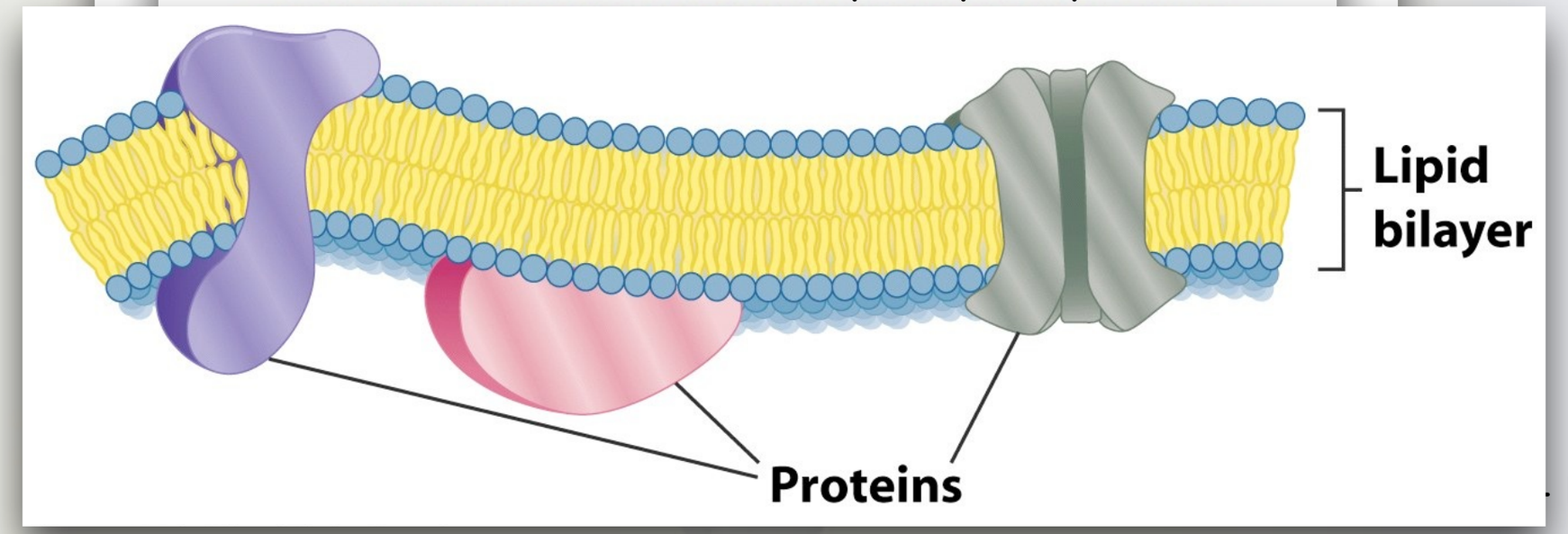

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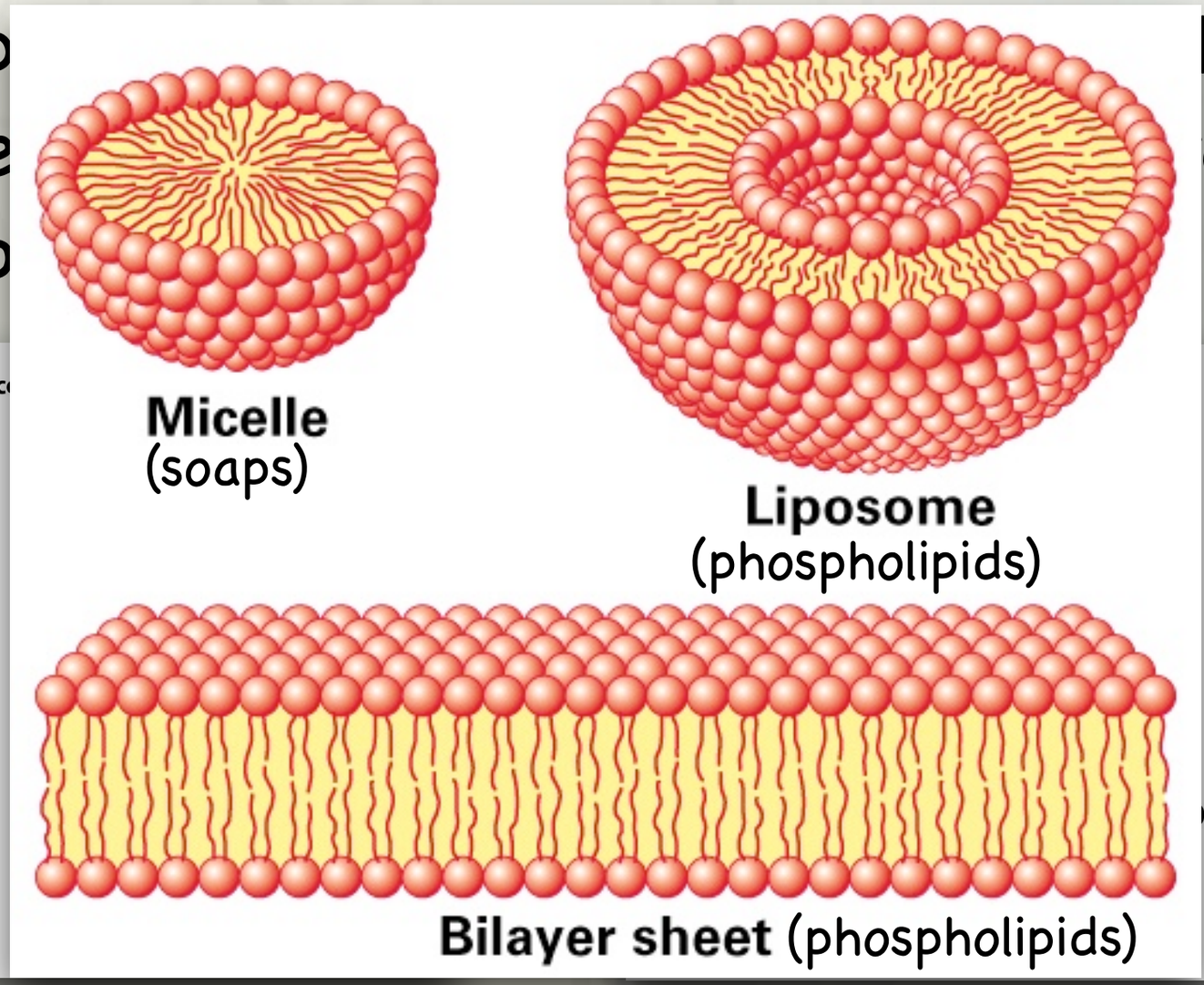

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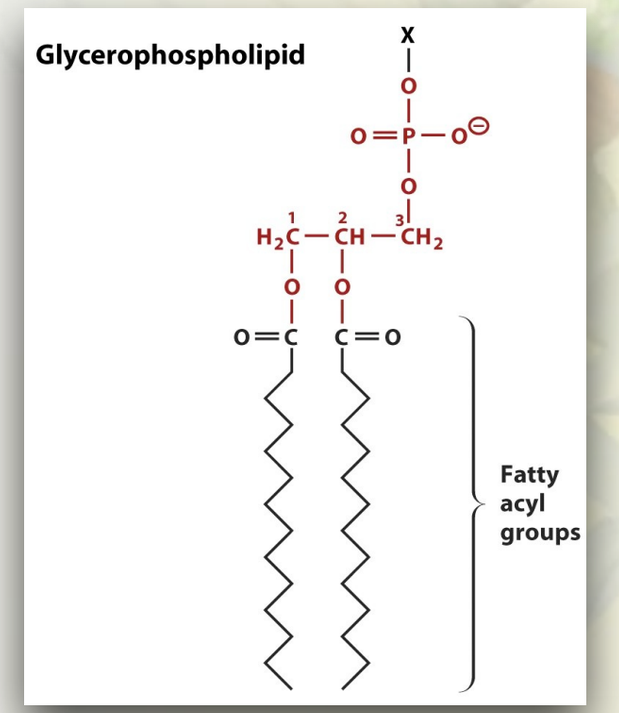
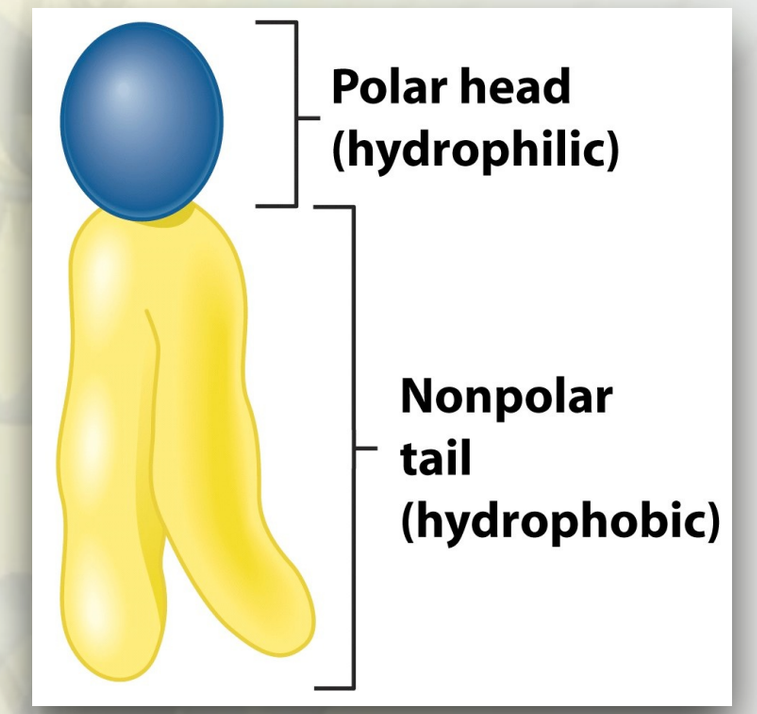
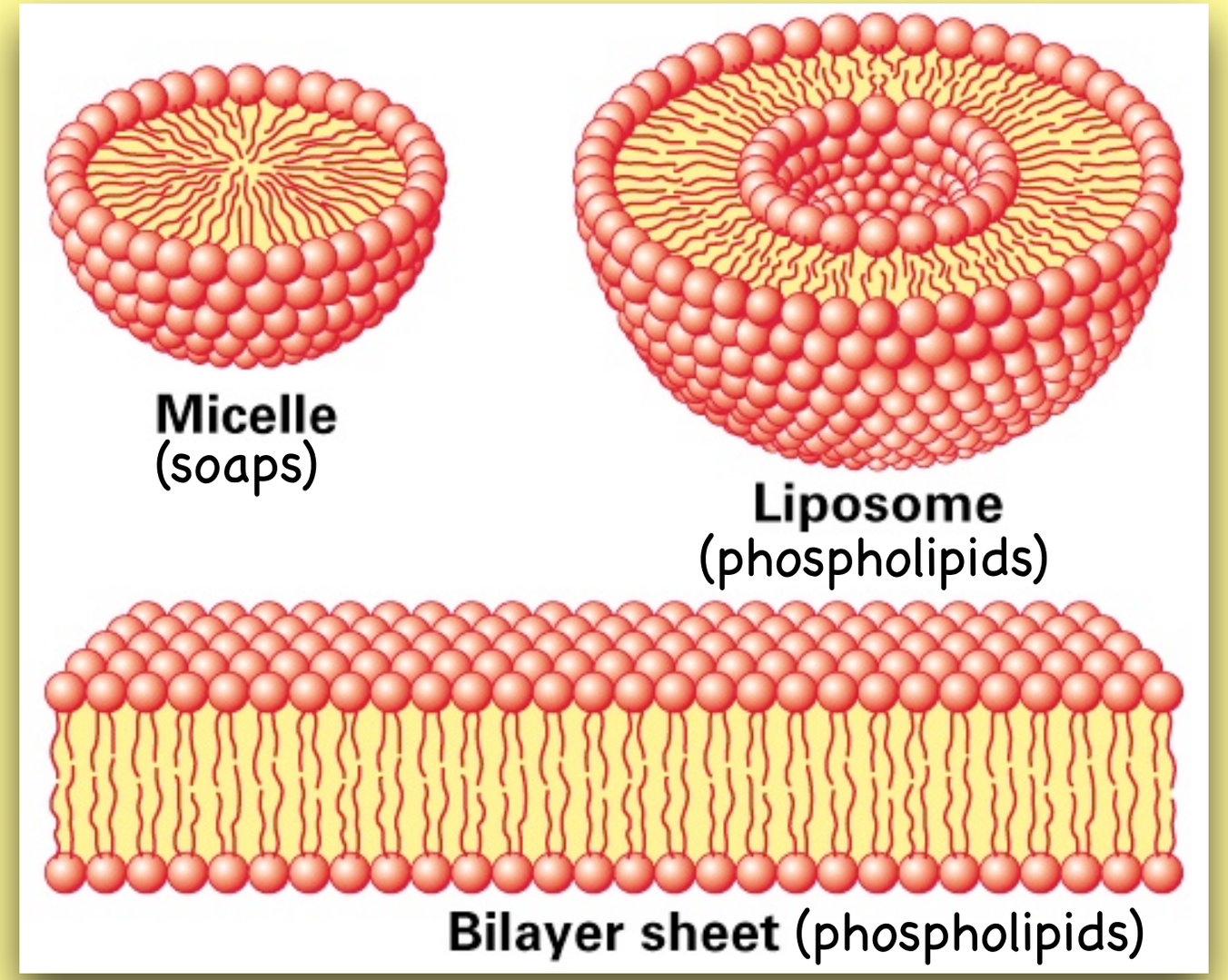




Other Biological Molecules

Question:

Why do phospholipids form lipid bilayers instead of micelles when placed in water?



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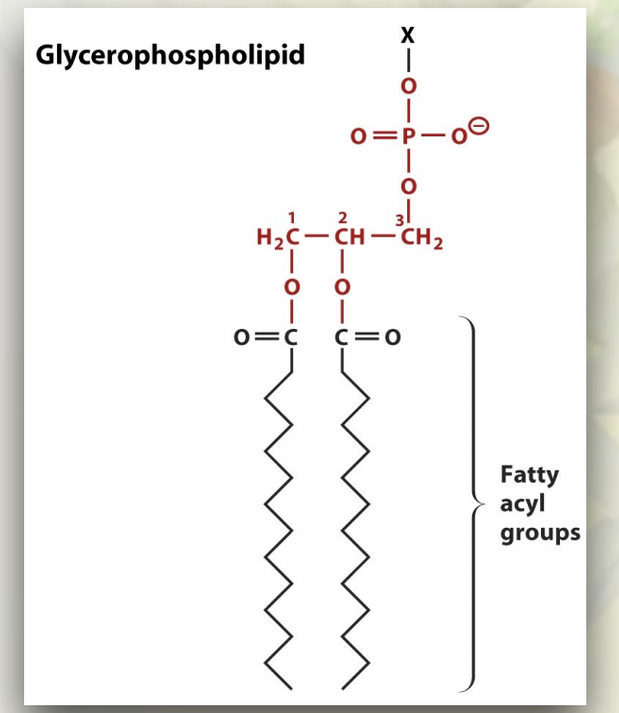
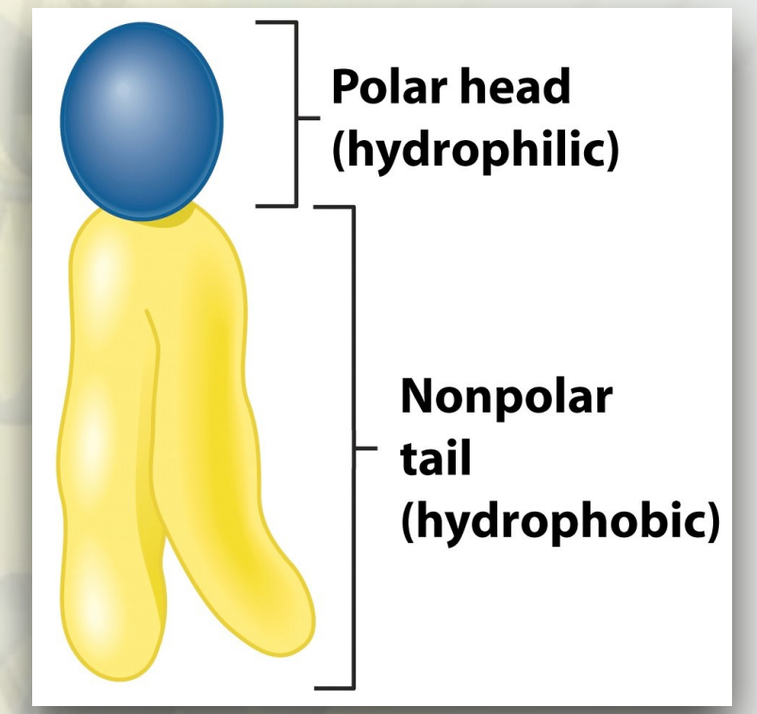
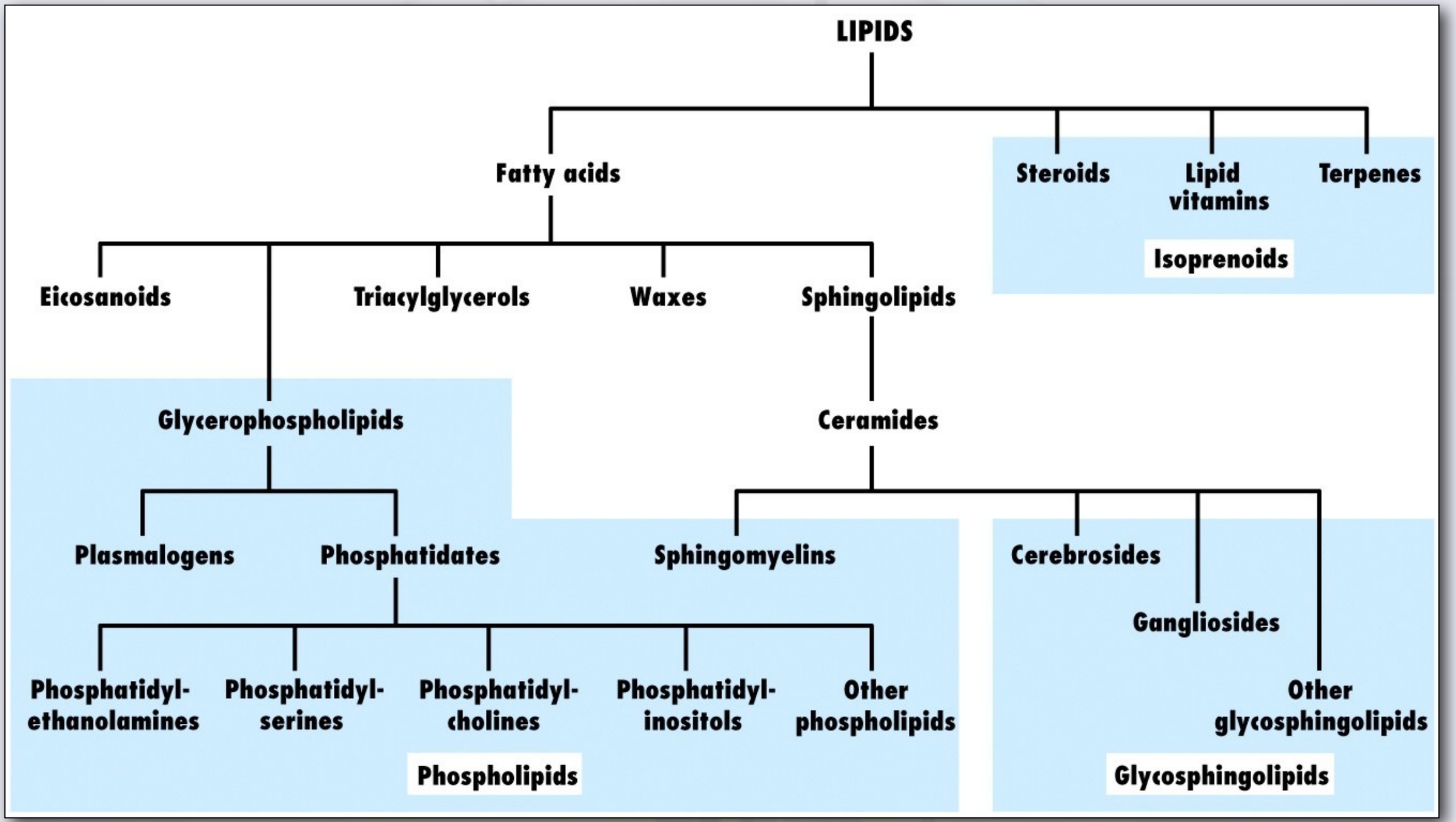




Other Membrane Lipids



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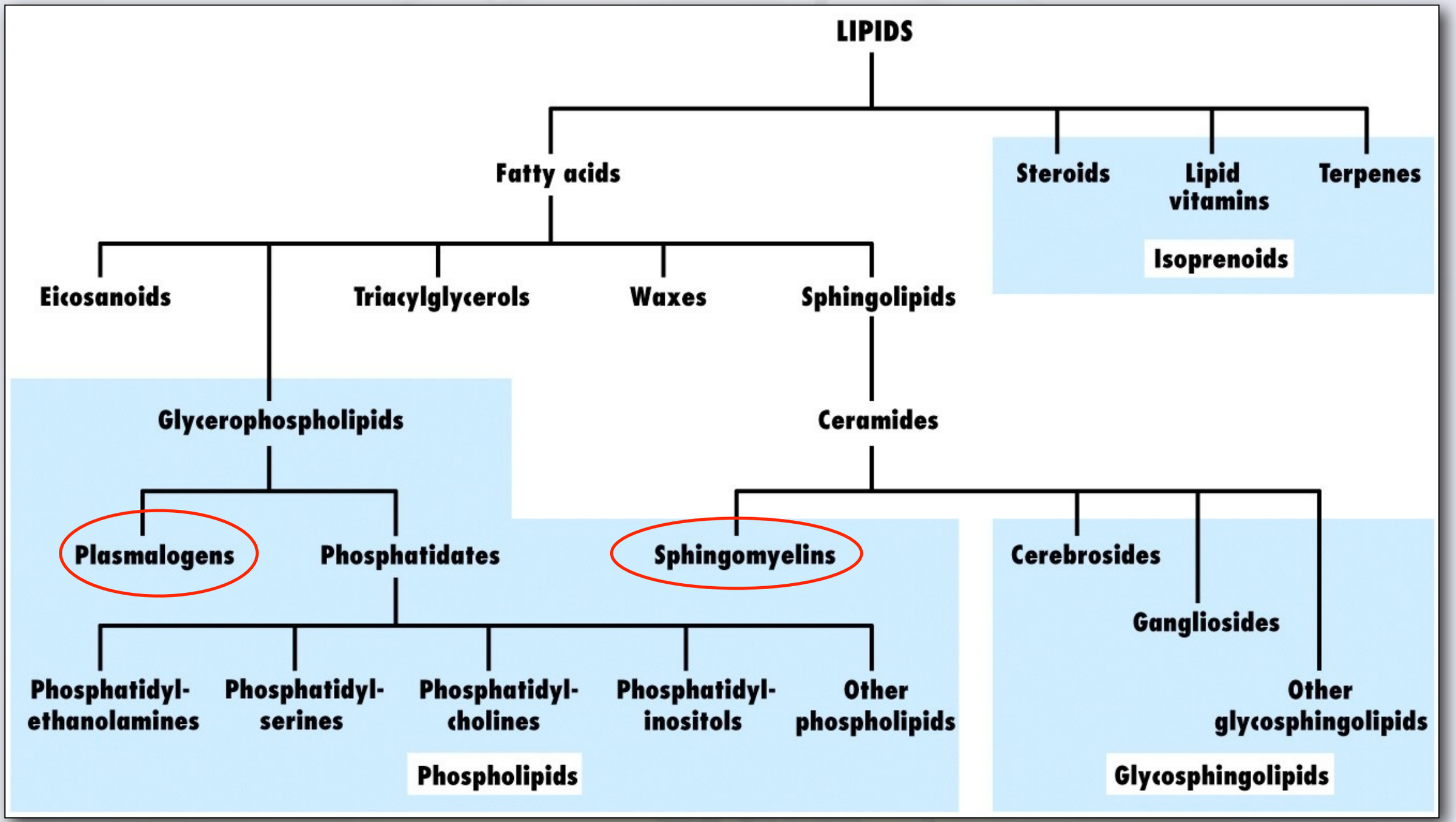
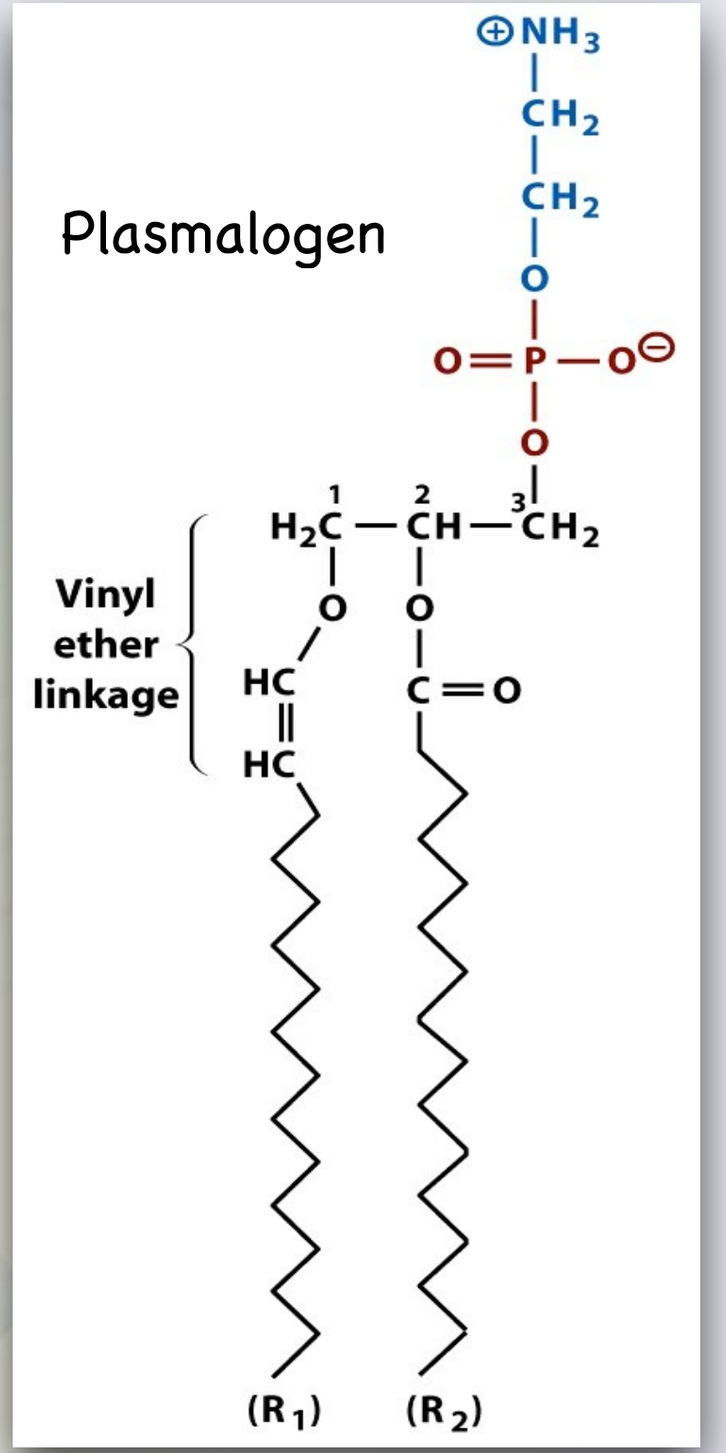


Other Membrane Lipids

Plasmalogens

- Derived from glycerophospholids
- Found in nerve tissue.



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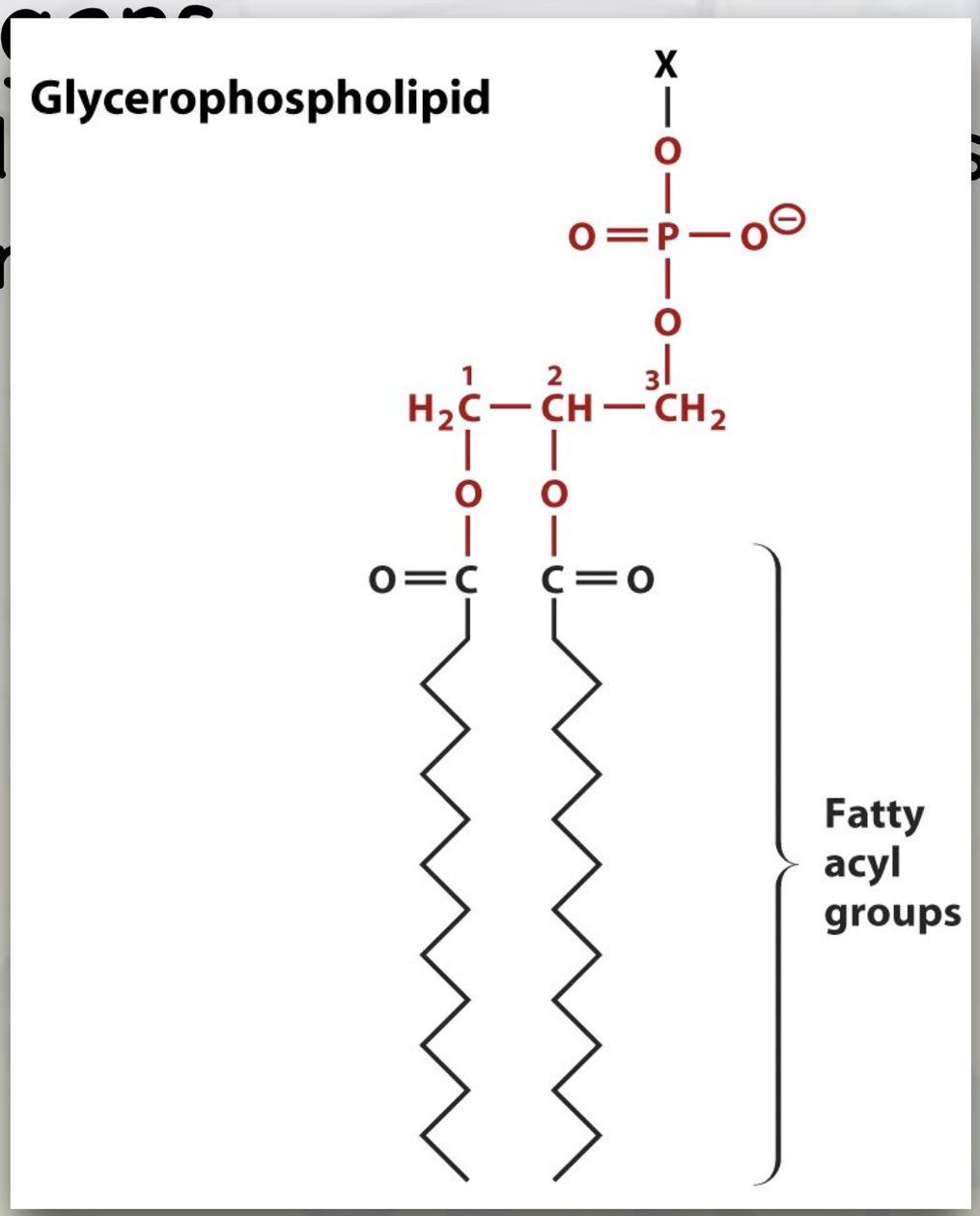
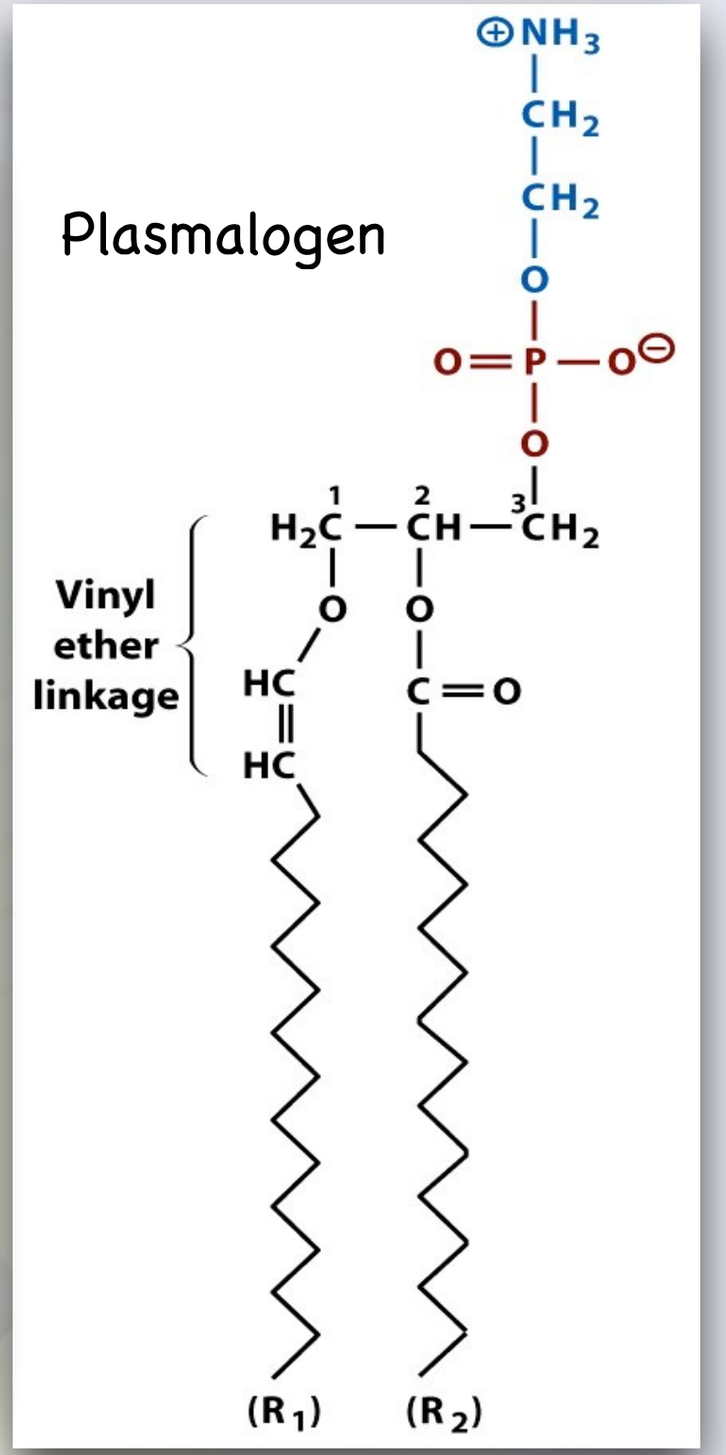
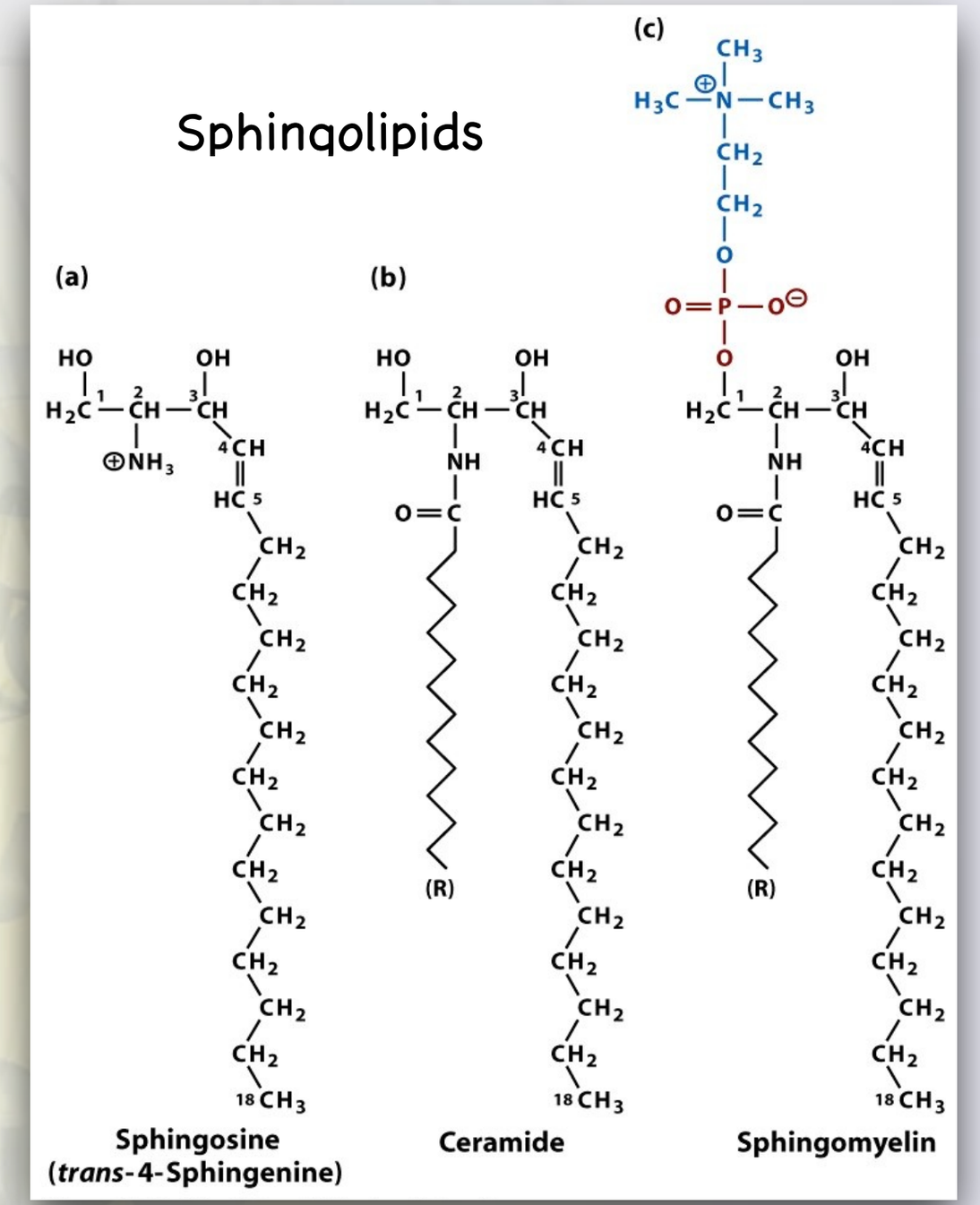




Other Membrane Lipids

Sphingolipids

- Derived from Sphingosine
- Also found in nerve tissue.



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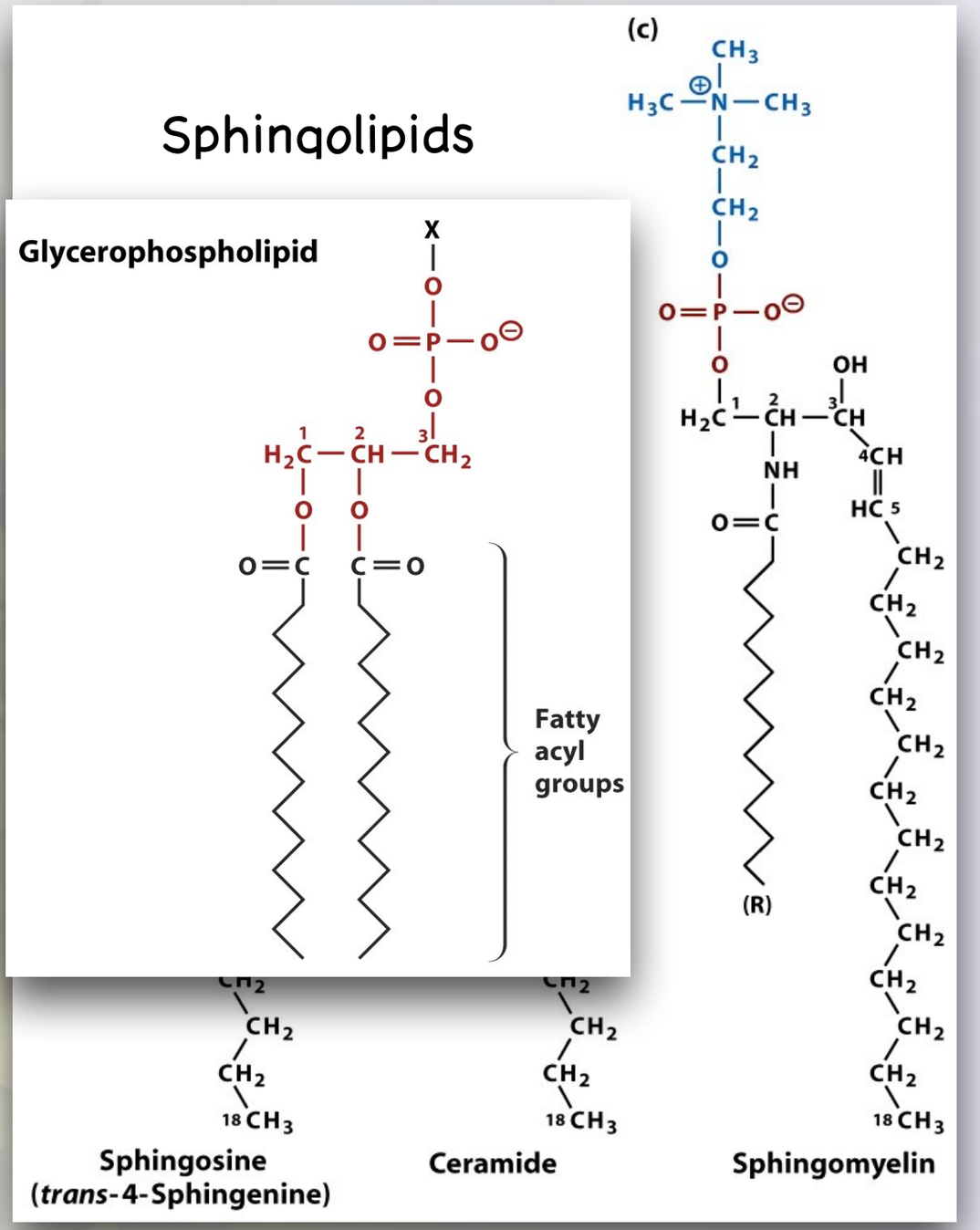

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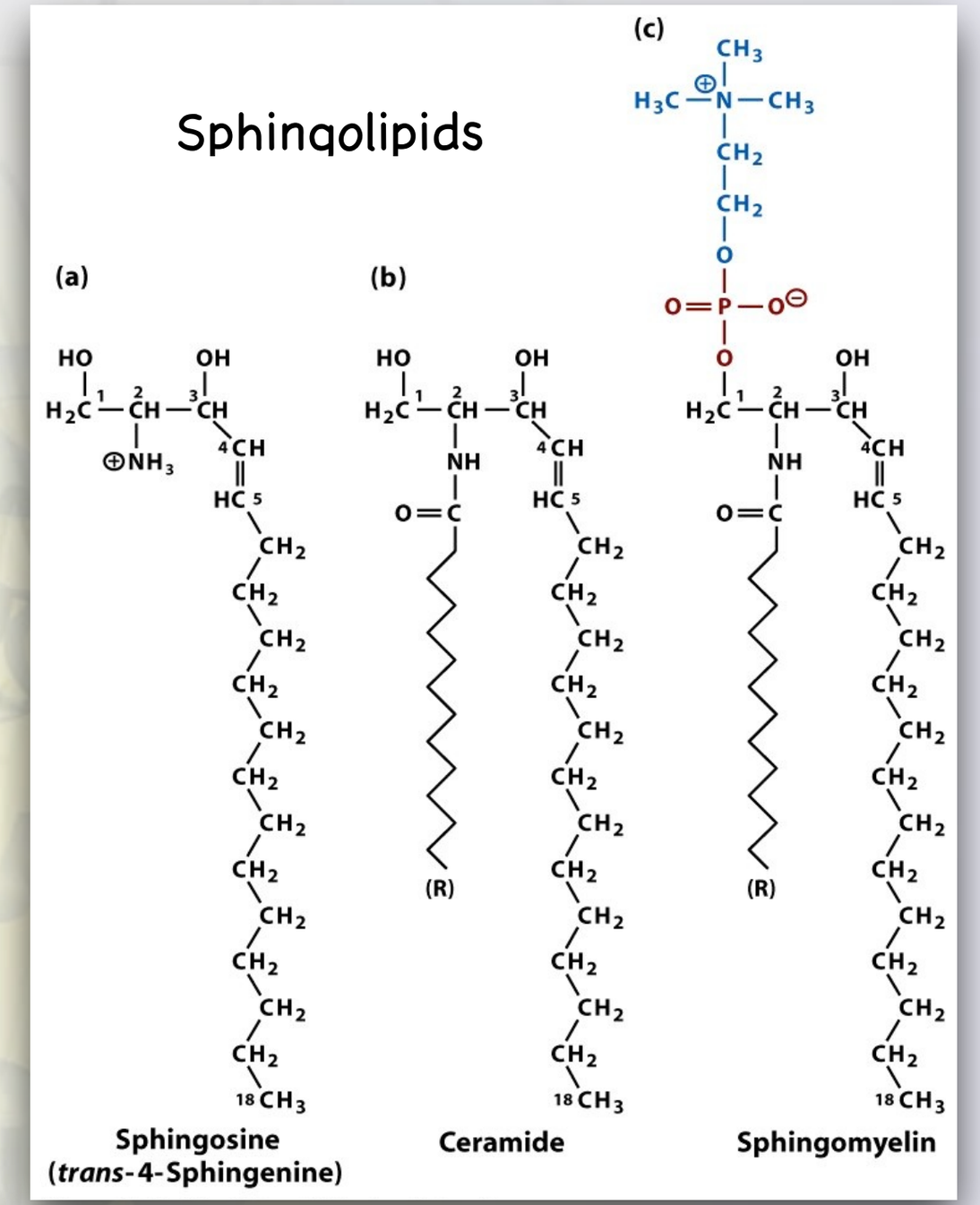

Other Membrane Lipids

- Sphingolipids
  - Are used to make glycolipids

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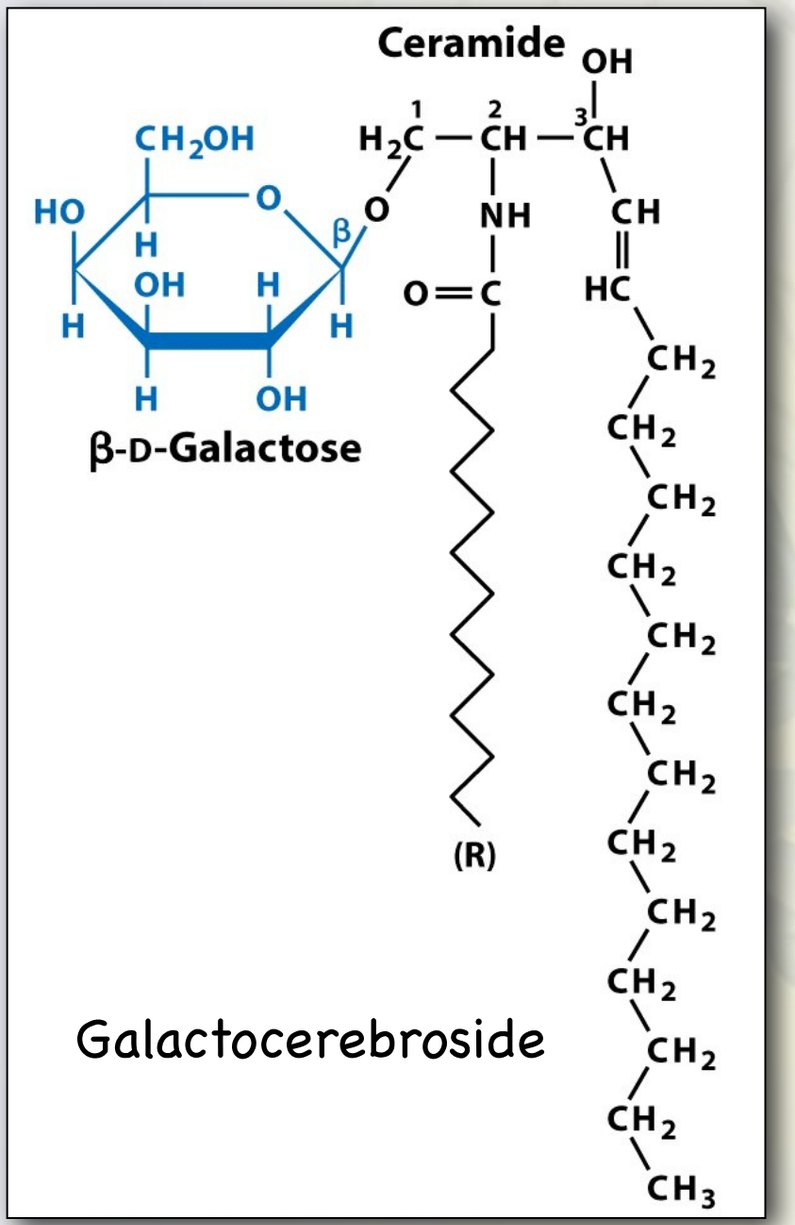

Galactocerebroside

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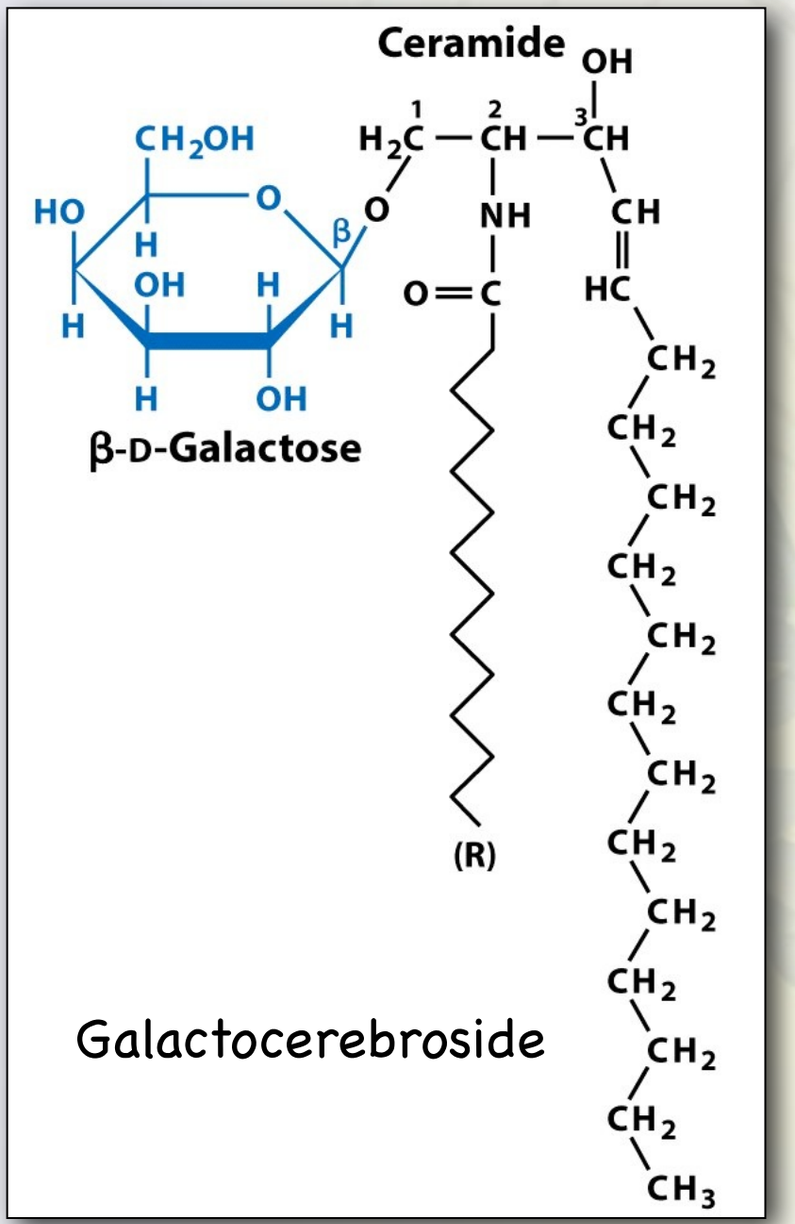

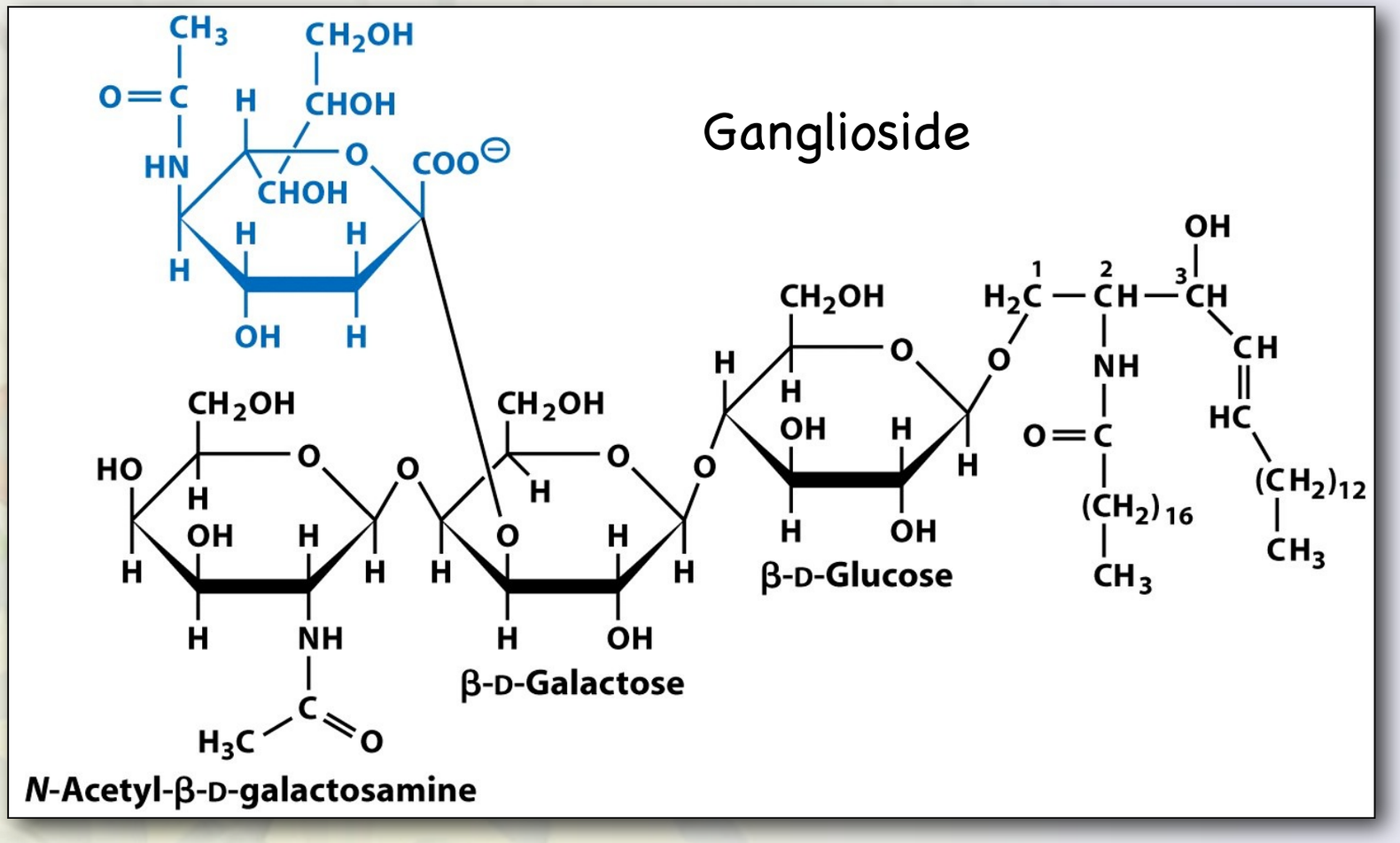

Other Membrane Lipids

Sphingolipids

- Gangliosides are used as cell surface markers and serve in cellular regogition and cell-to-cell communication.
- The ABO blood group antigens are an example.

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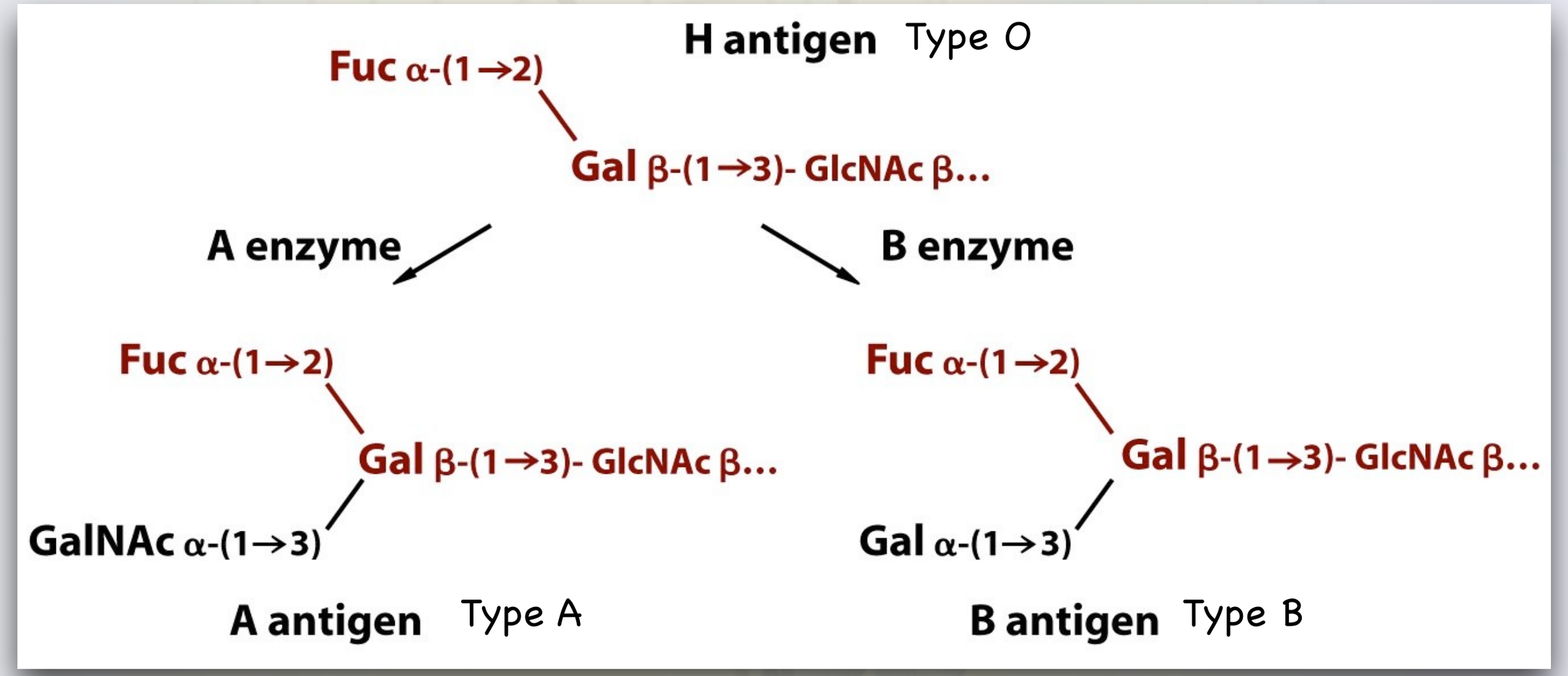
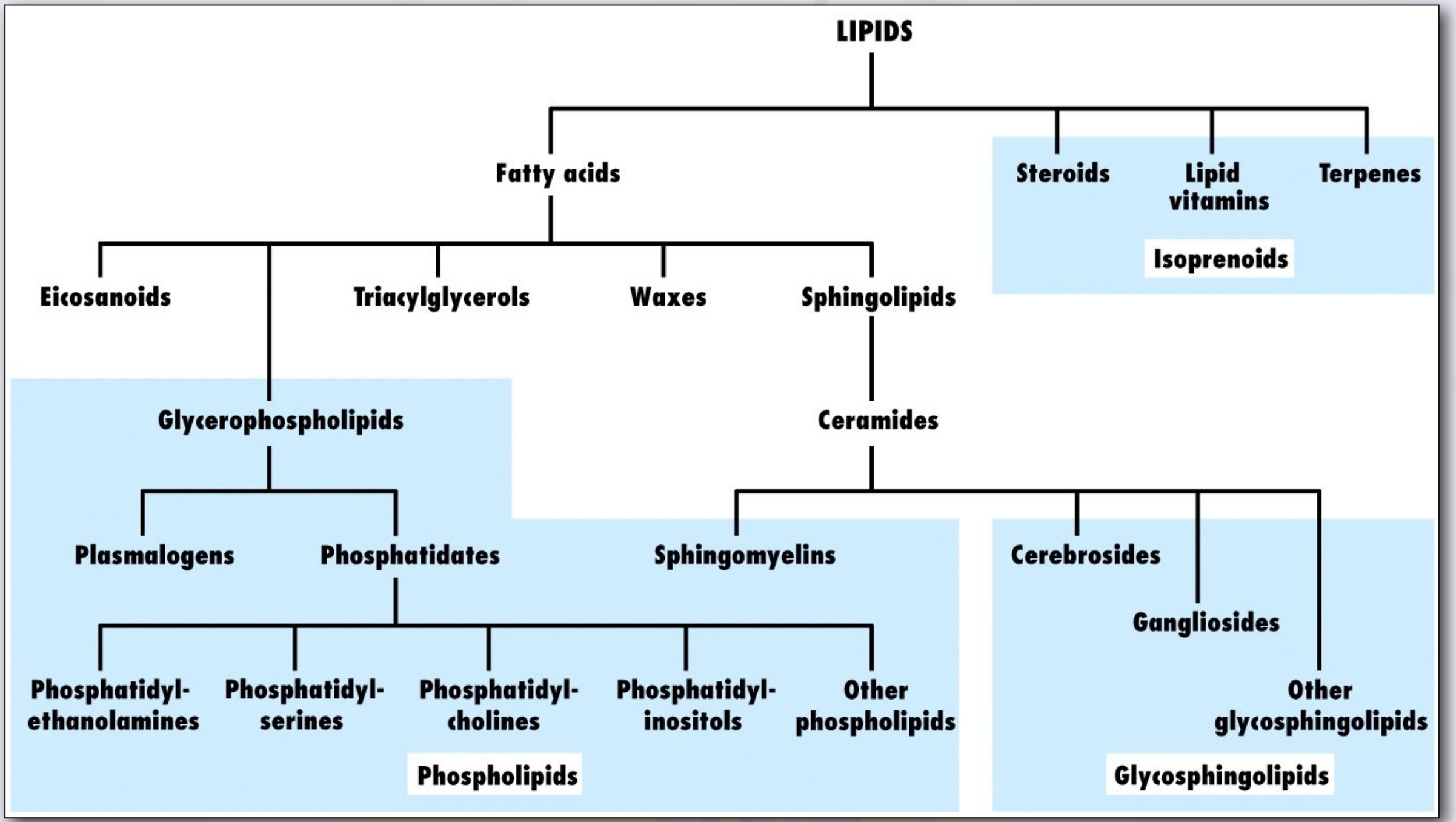


Isoprenoids



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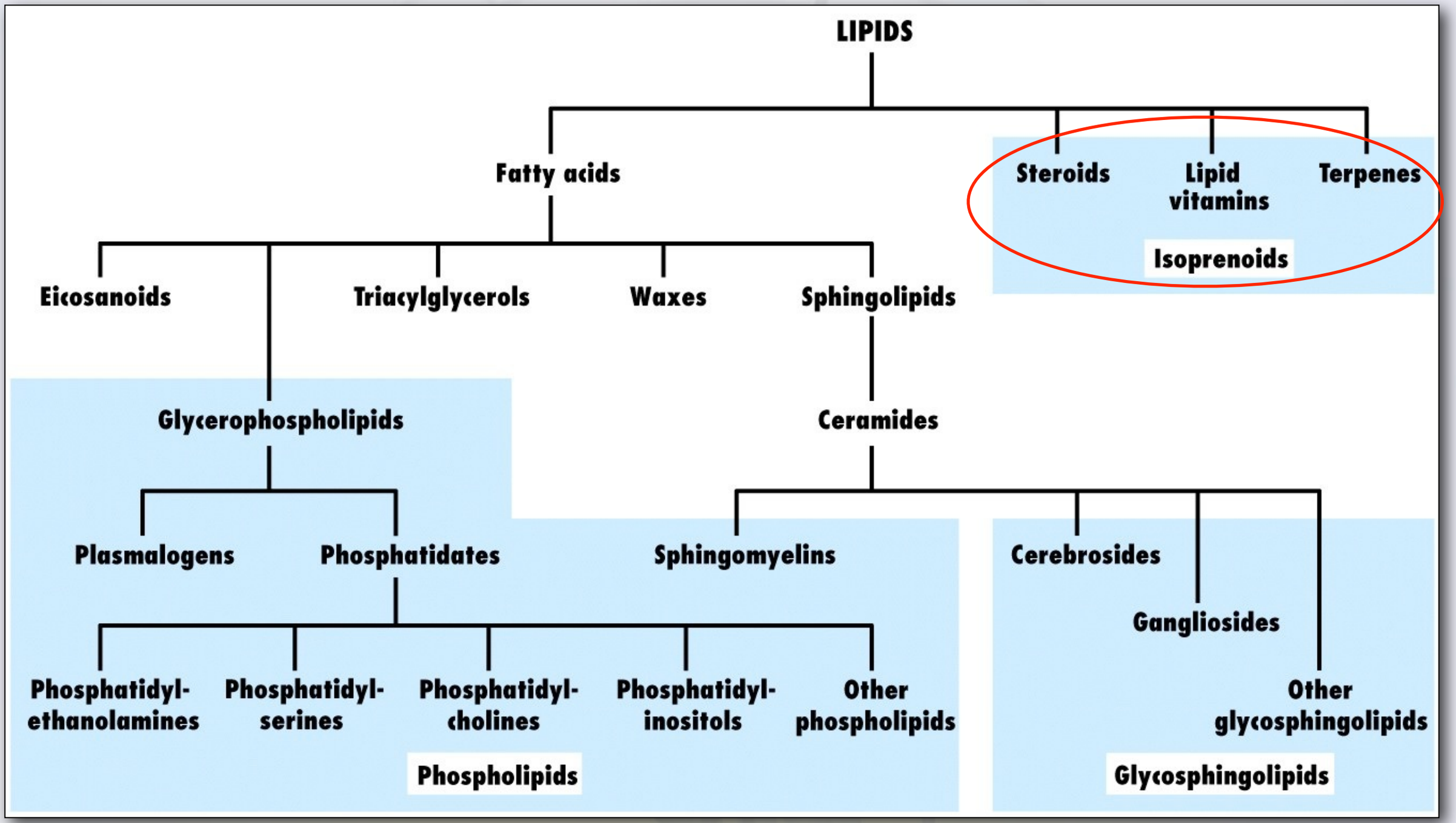
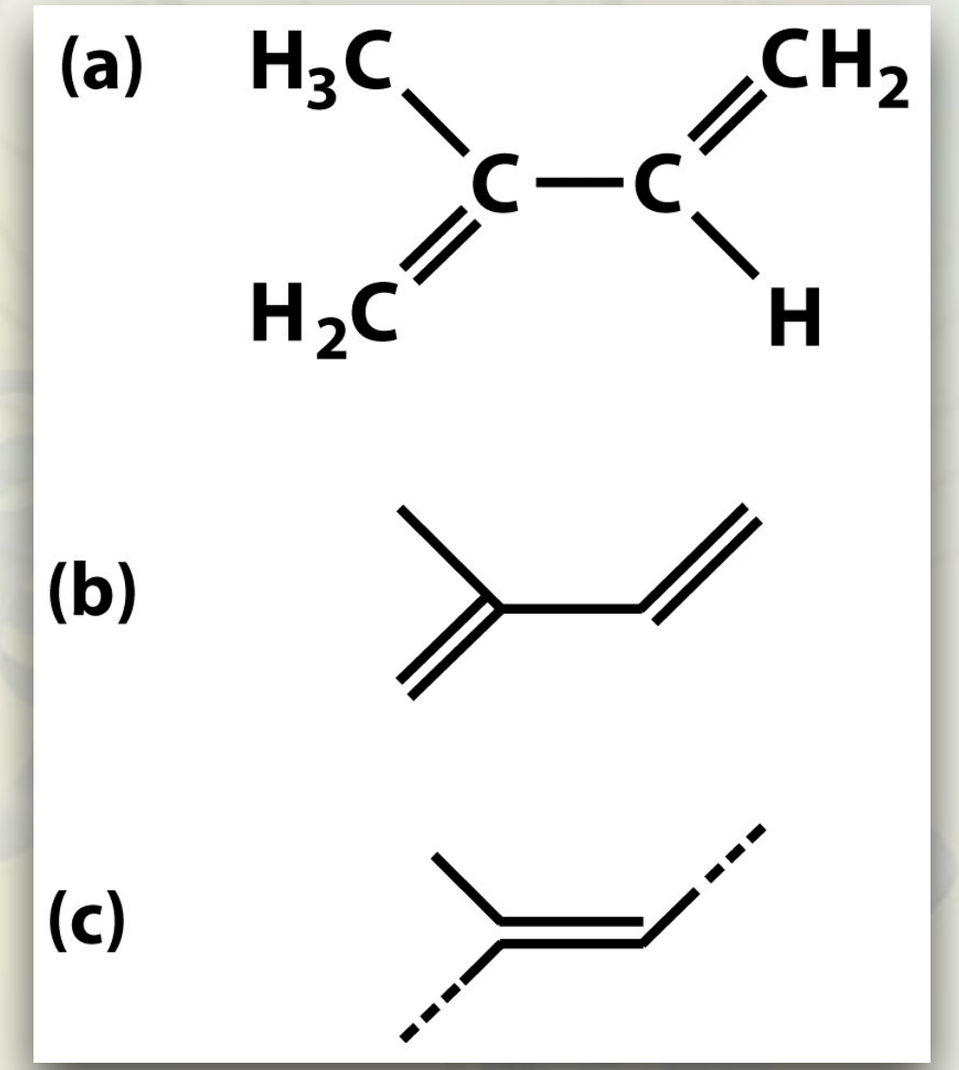


Isoprenoids

Isoprenoids are based on the isoprene unit (2-methyl-1,3-butadiene).



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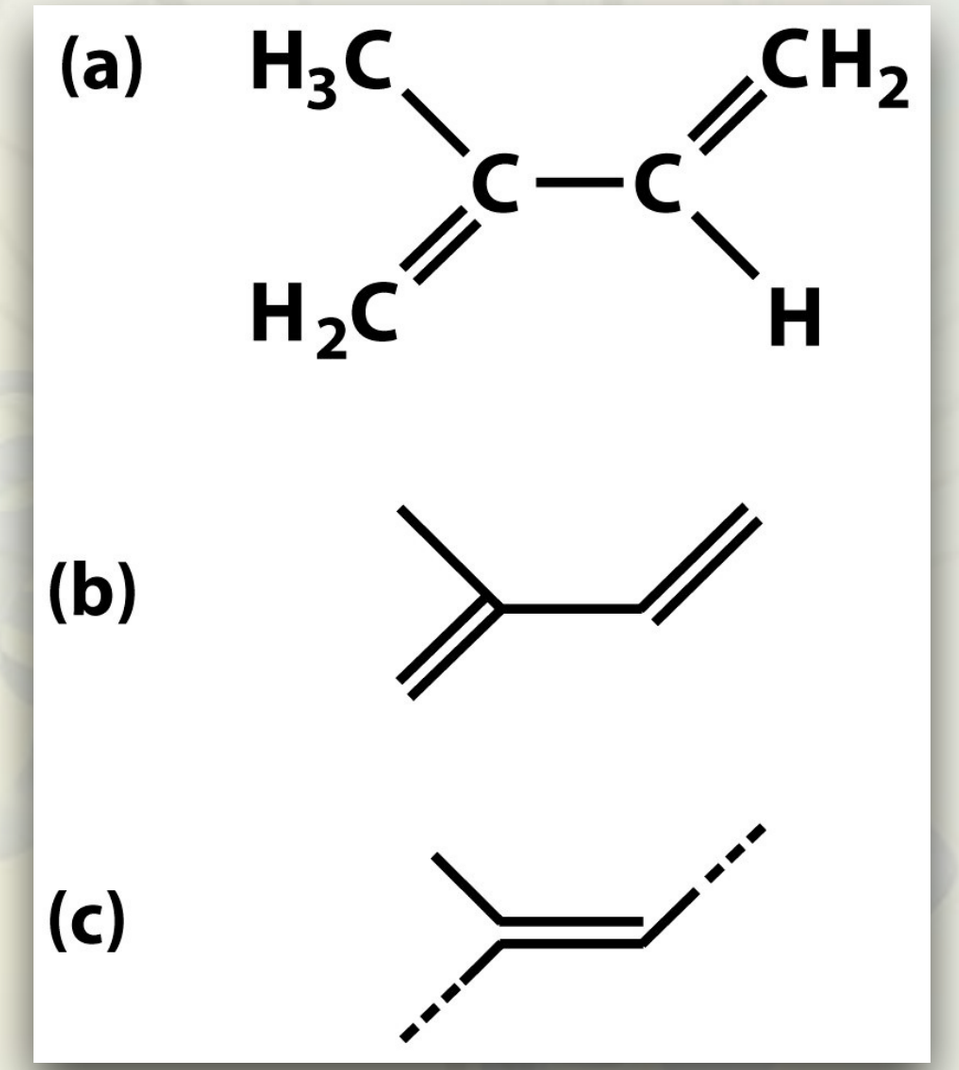

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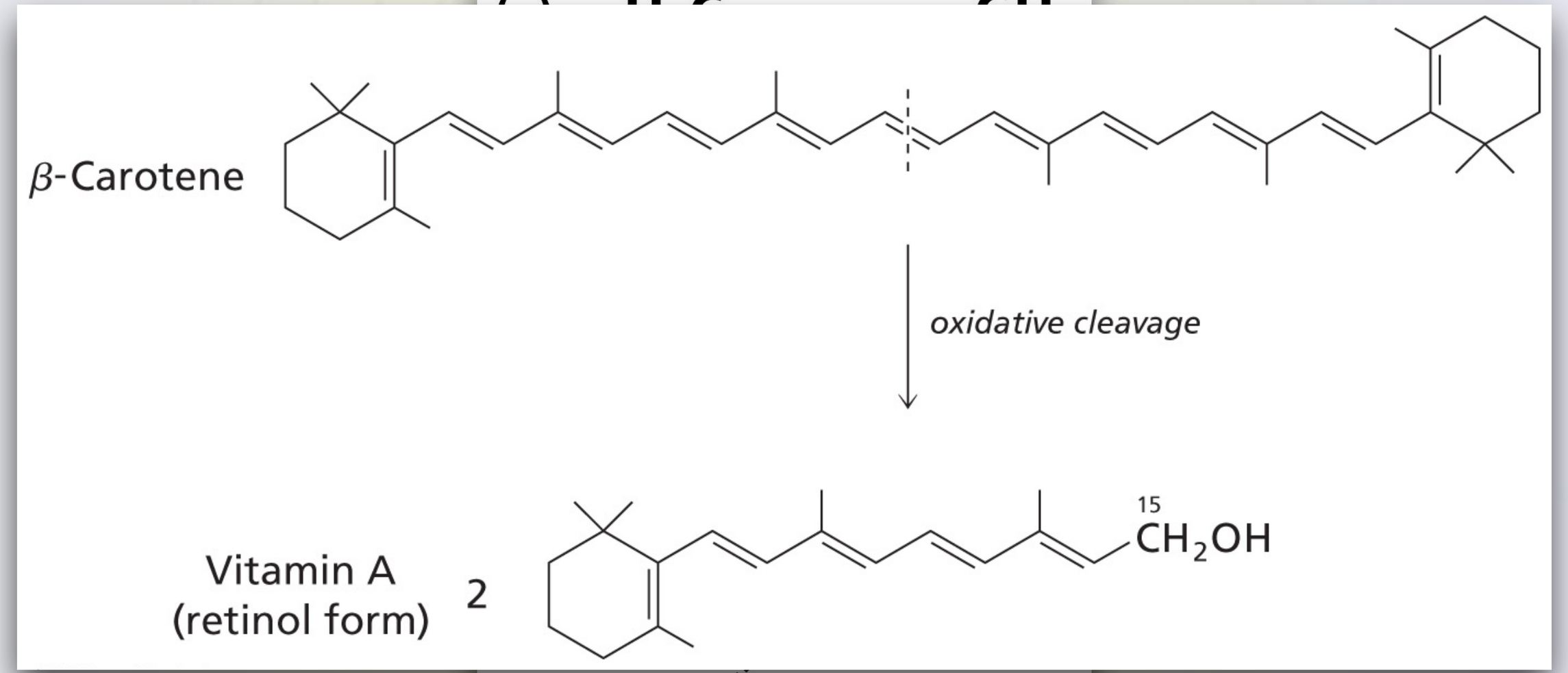

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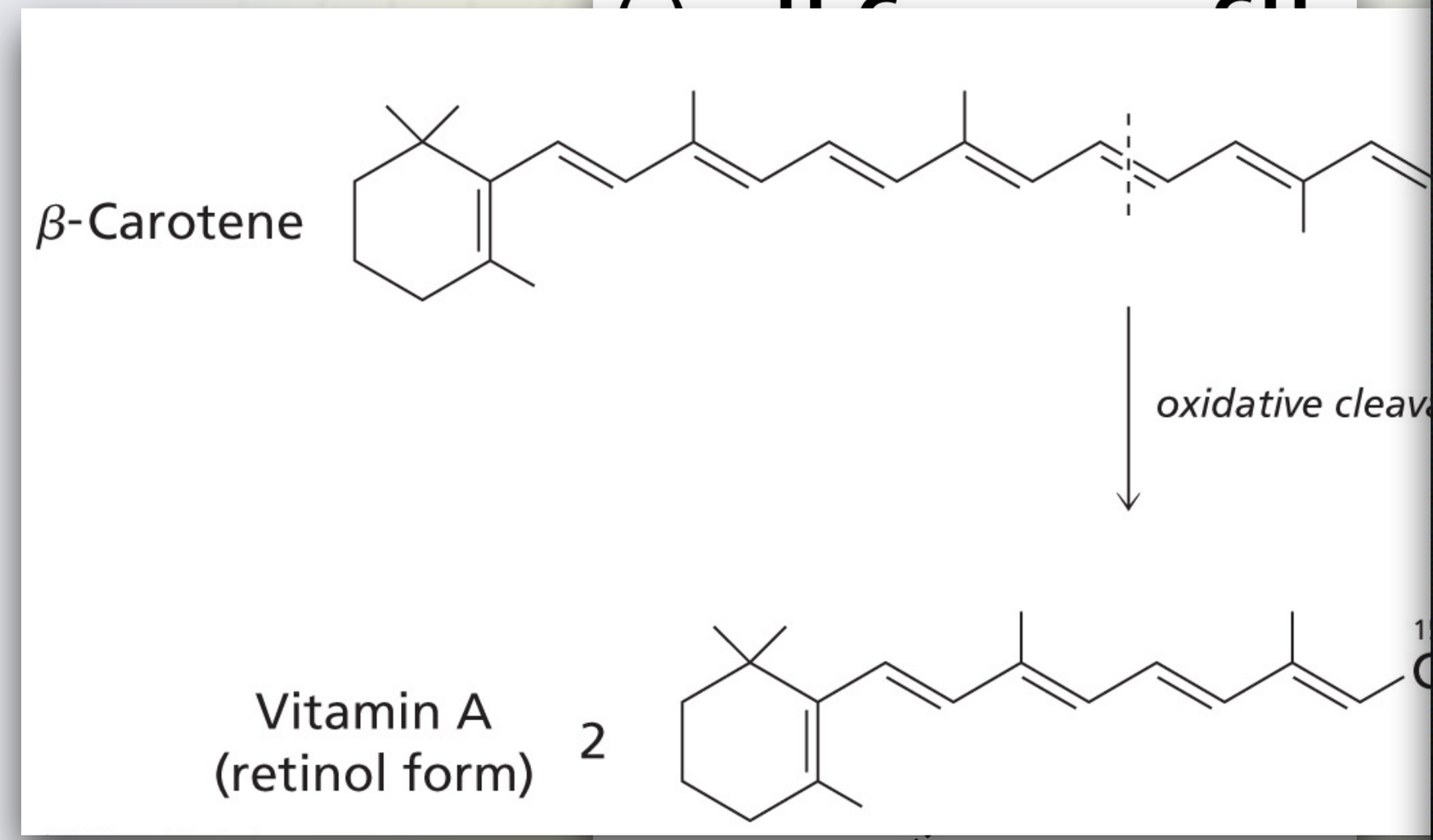

Paper chromatography of spinach leaf extract

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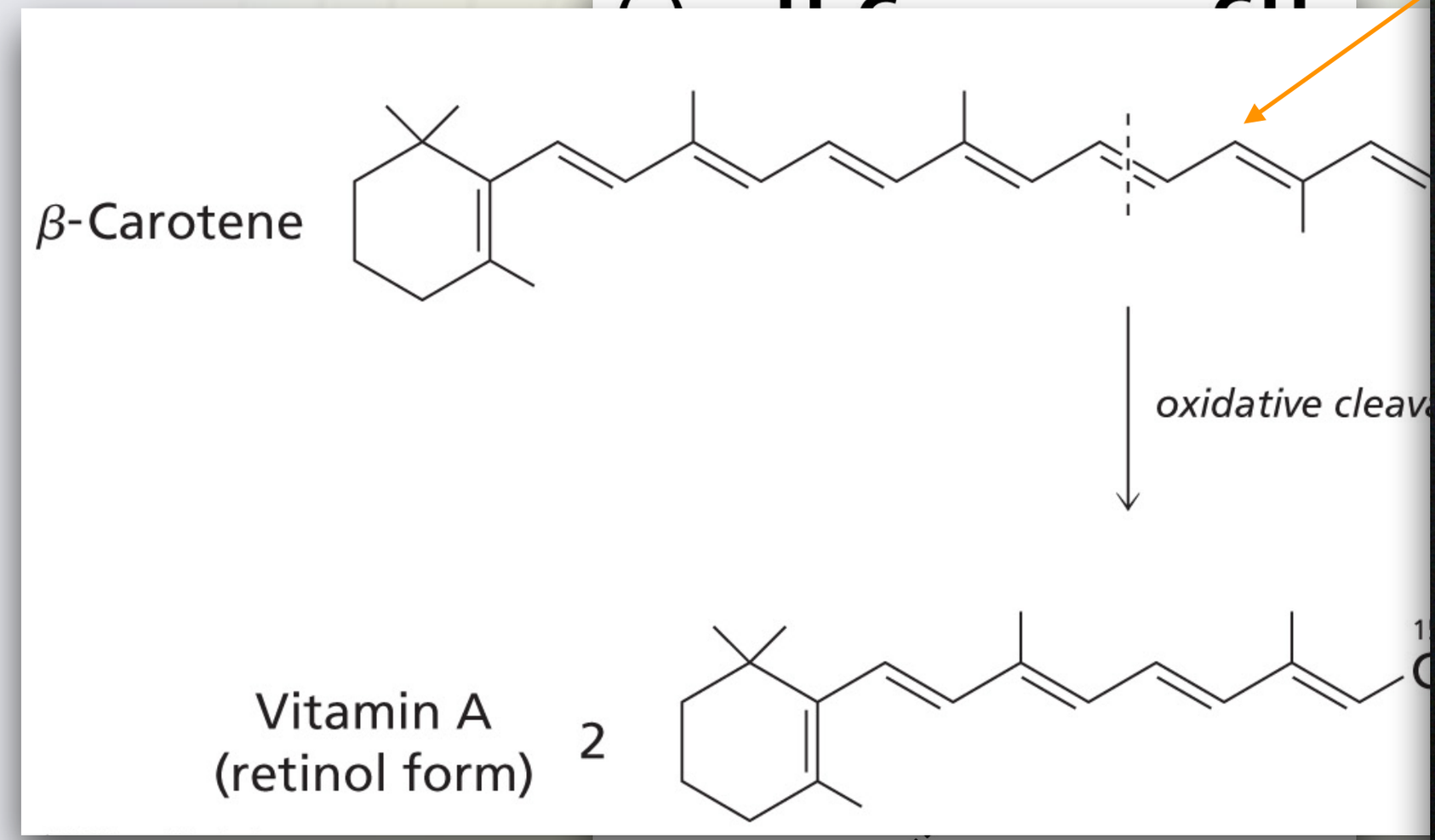

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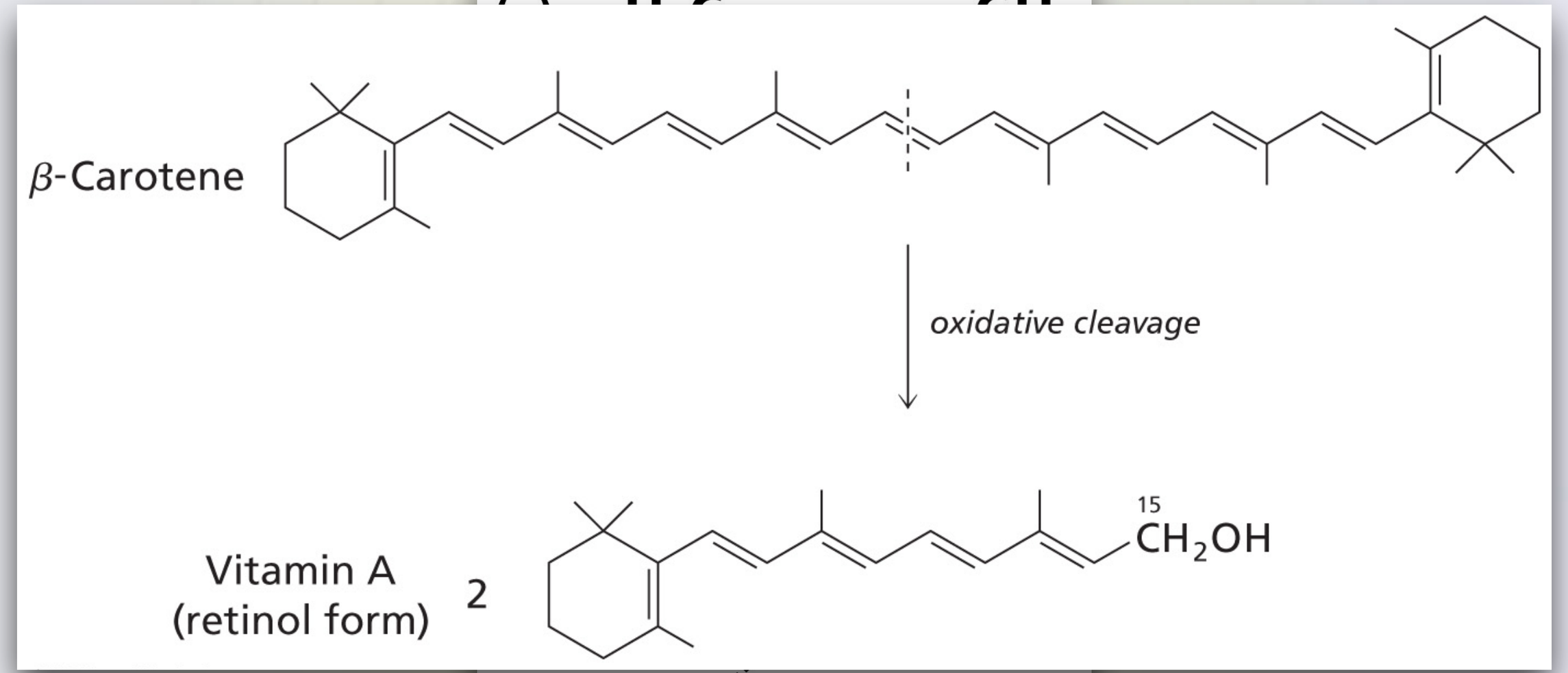

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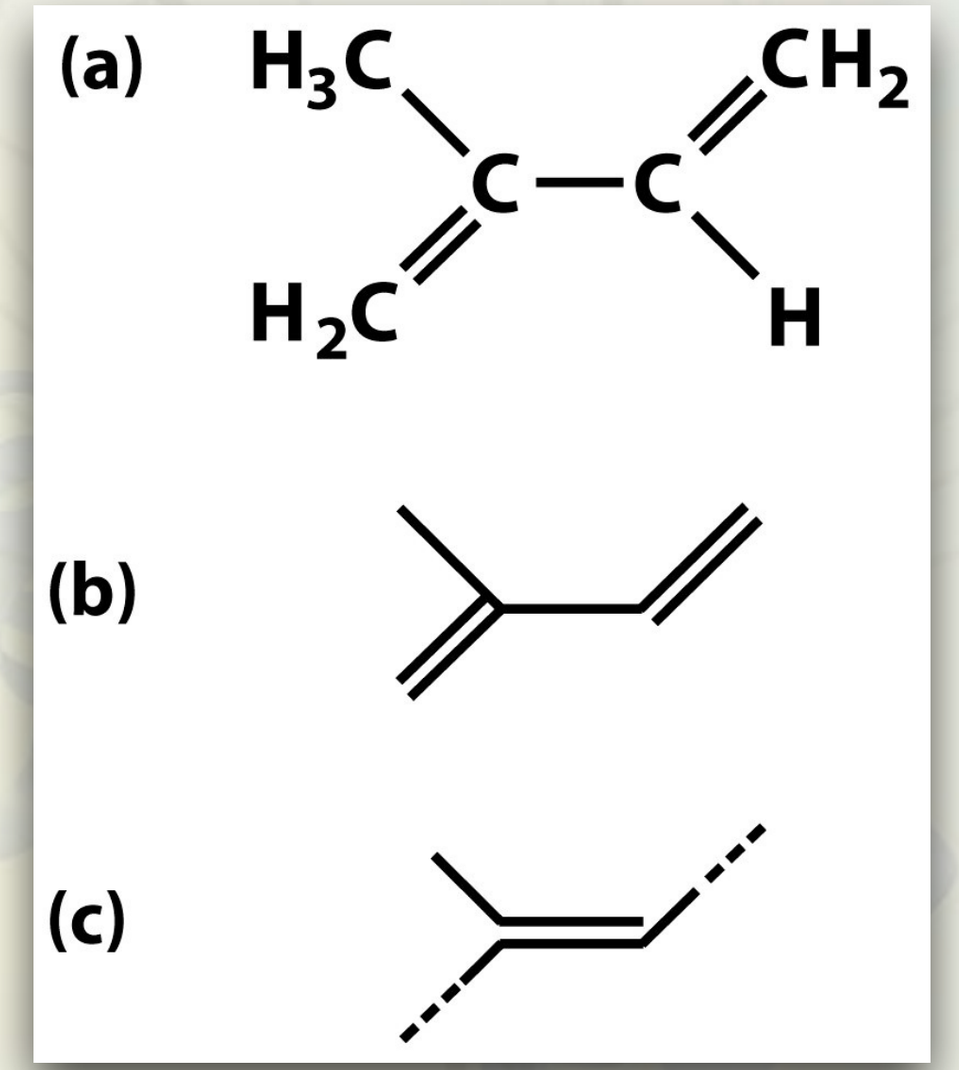

Isoprenoids

- The **steroids** are an important member of this group
  - Steroids are derived from the isoprenoid **squalene**, which forms **cholesterol**.

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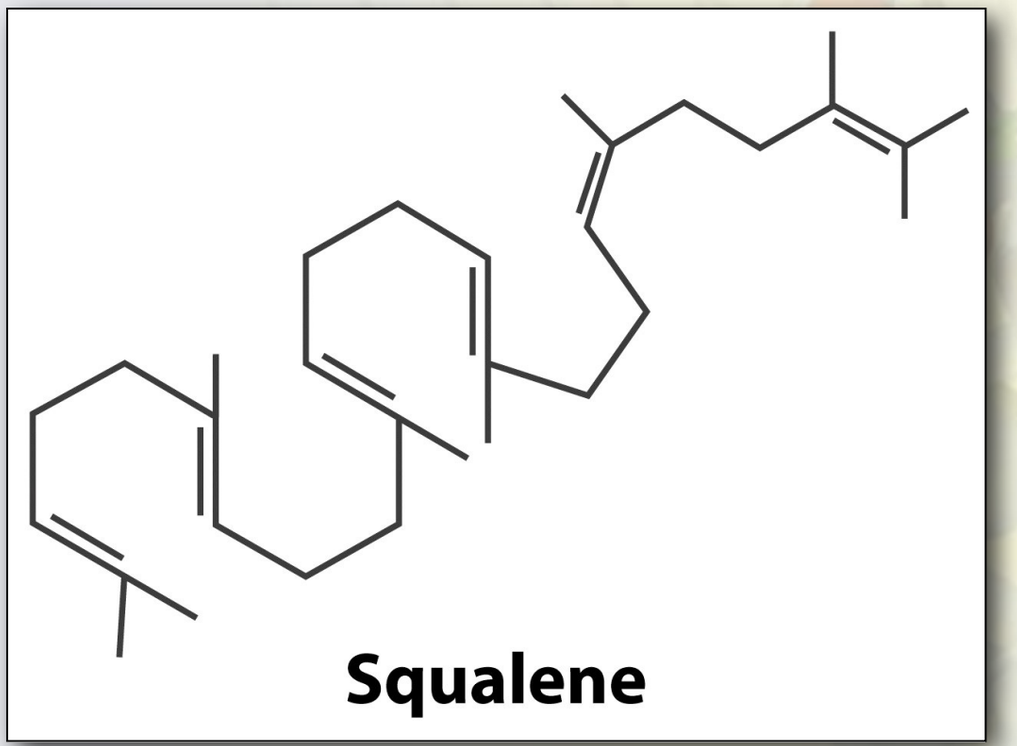

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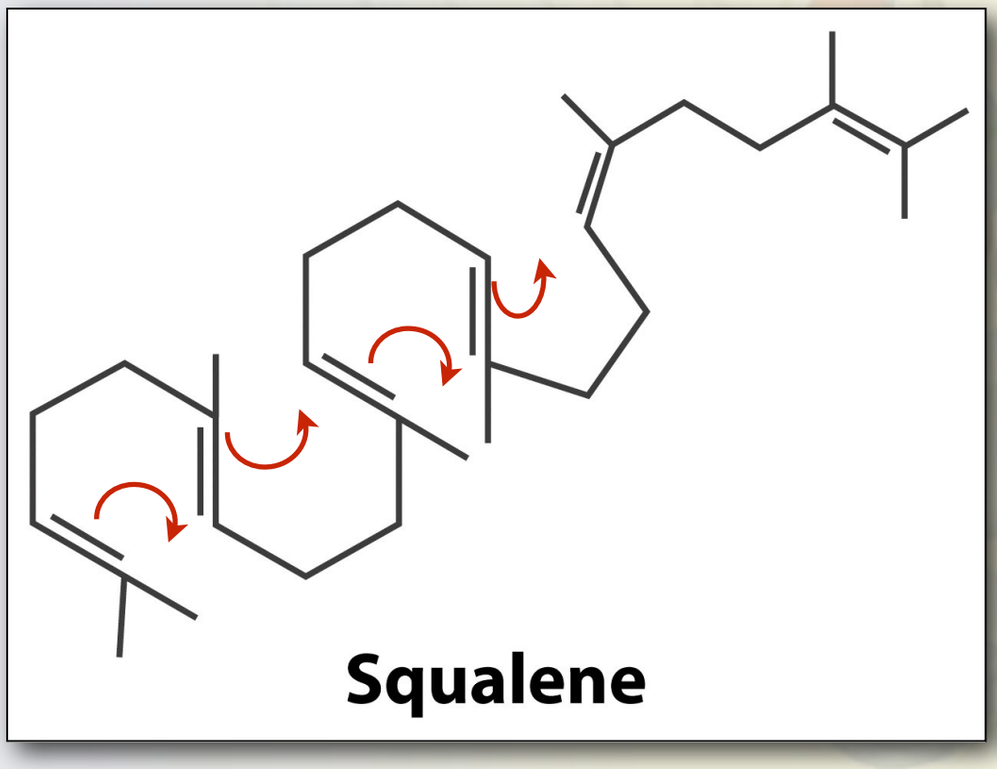

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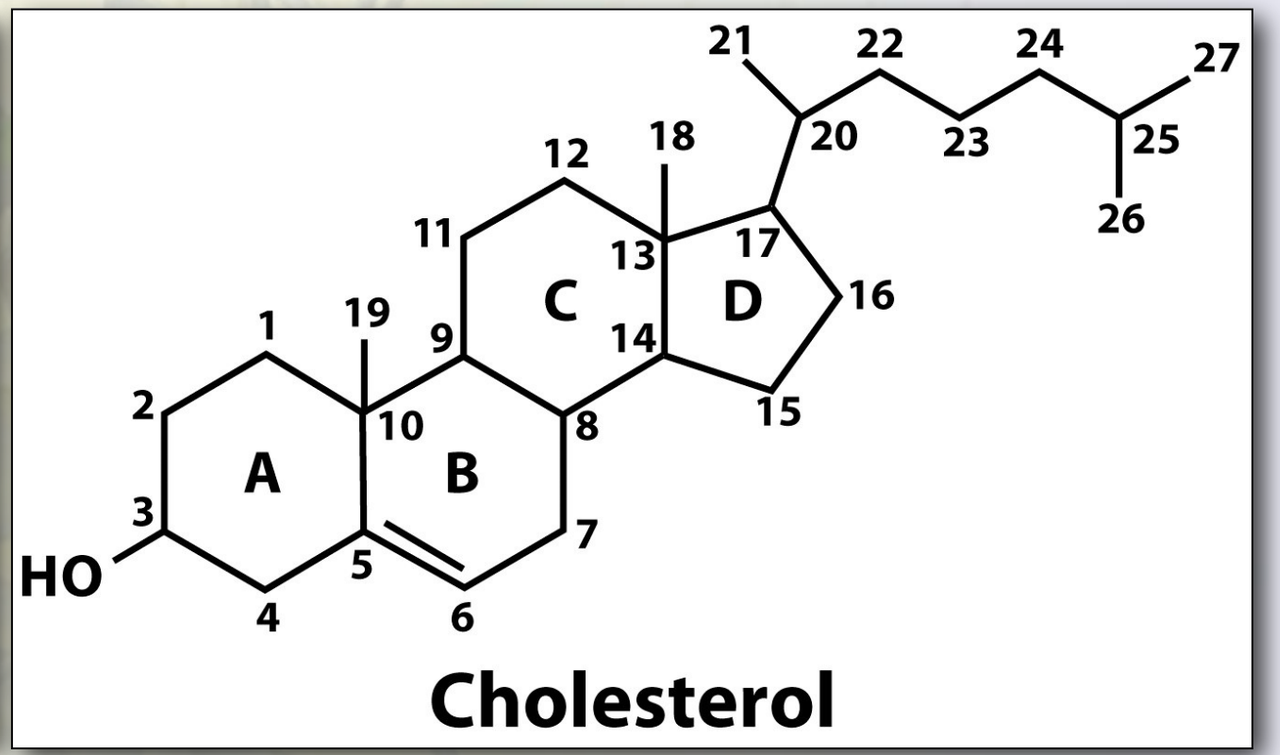

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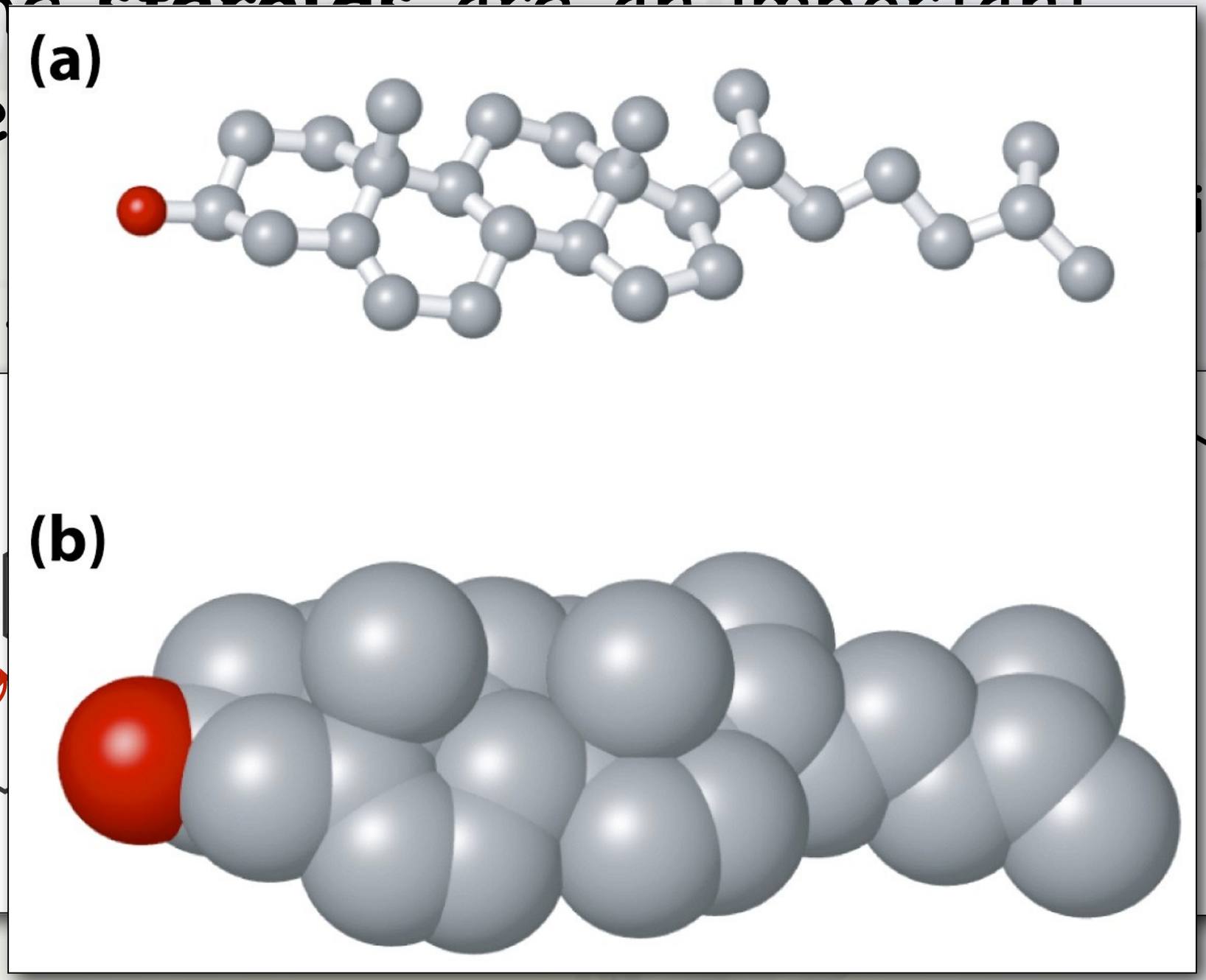

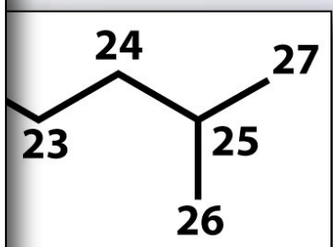

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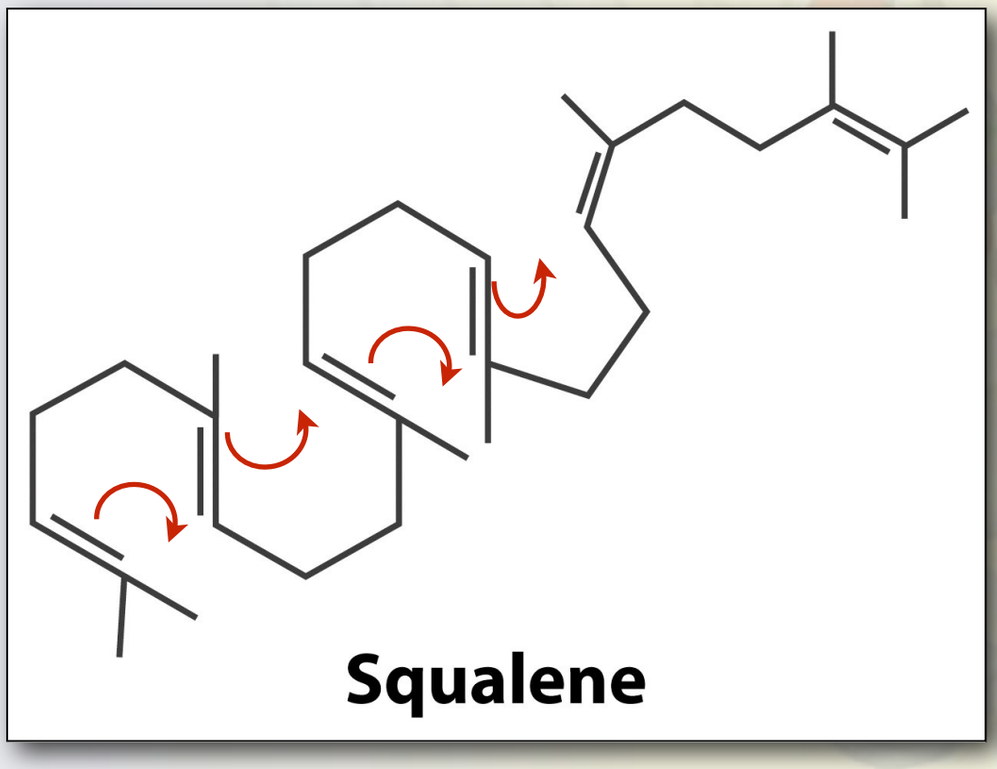

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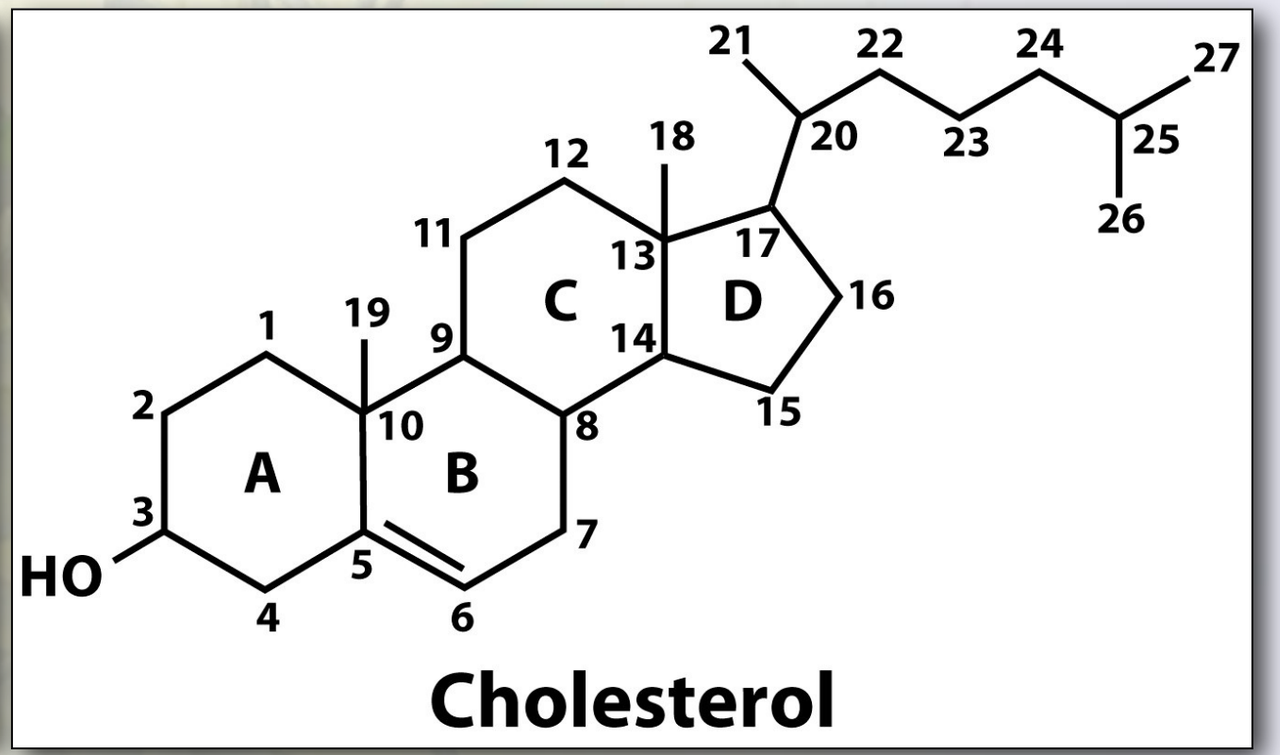

Cholesterol

Isoprenoids

- Cholesterol is a component of animal cell membranes.
  - It is dissolved in the lipid bilayer and used to keep them in a liquid state.
  - It is also the precursor to a number of other steroids having an array of different functions.

Isoprenoids

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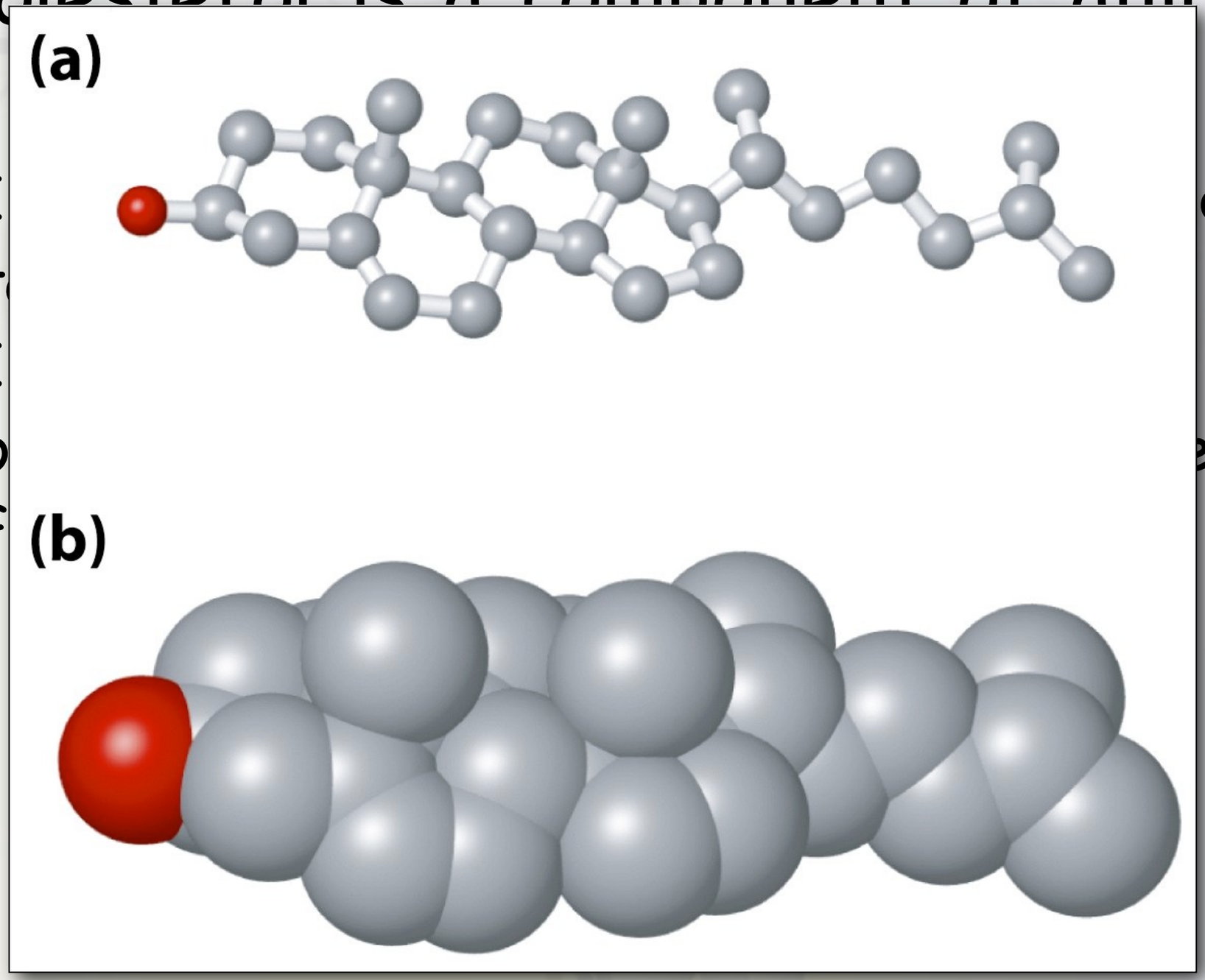
  - I
  - I



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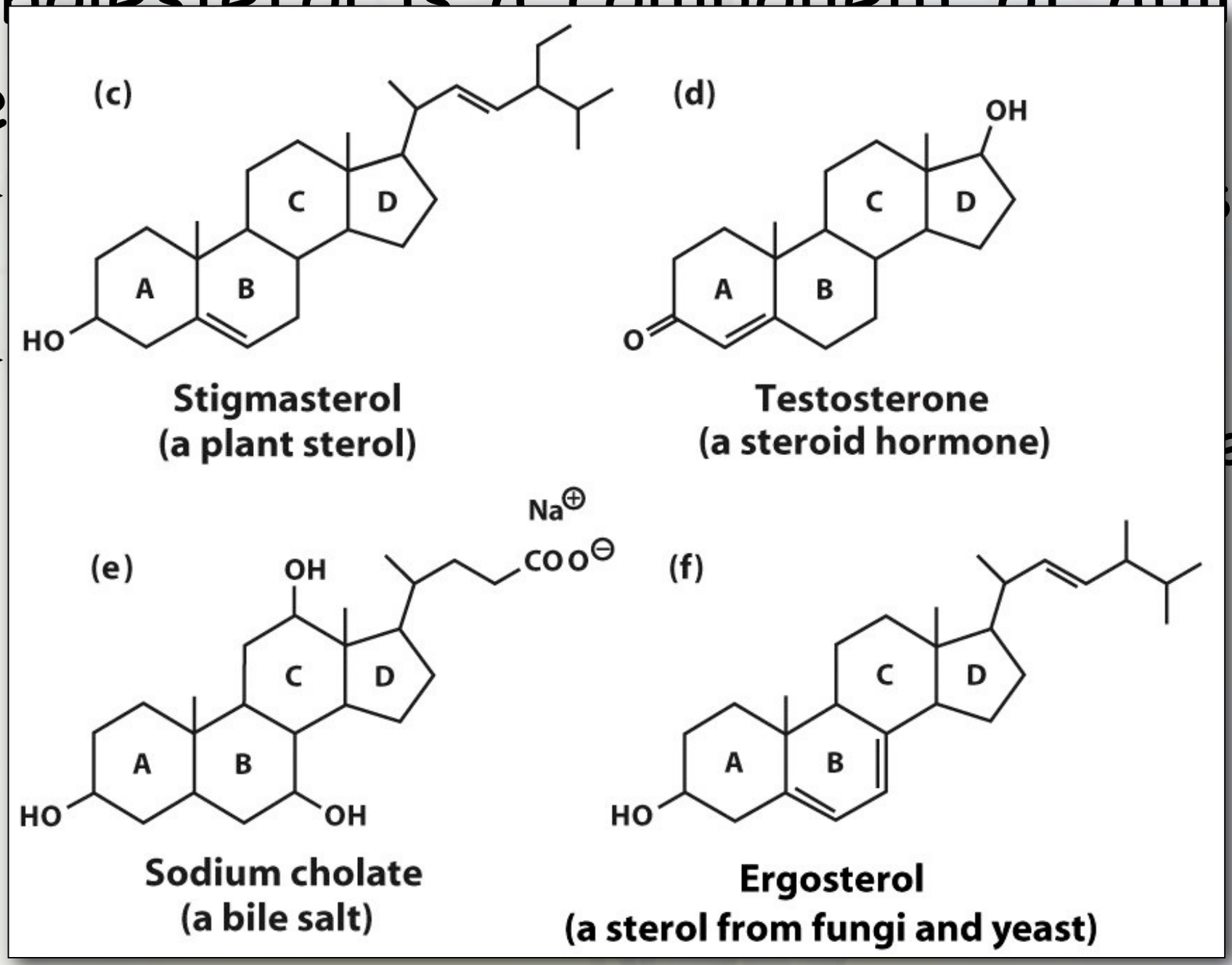
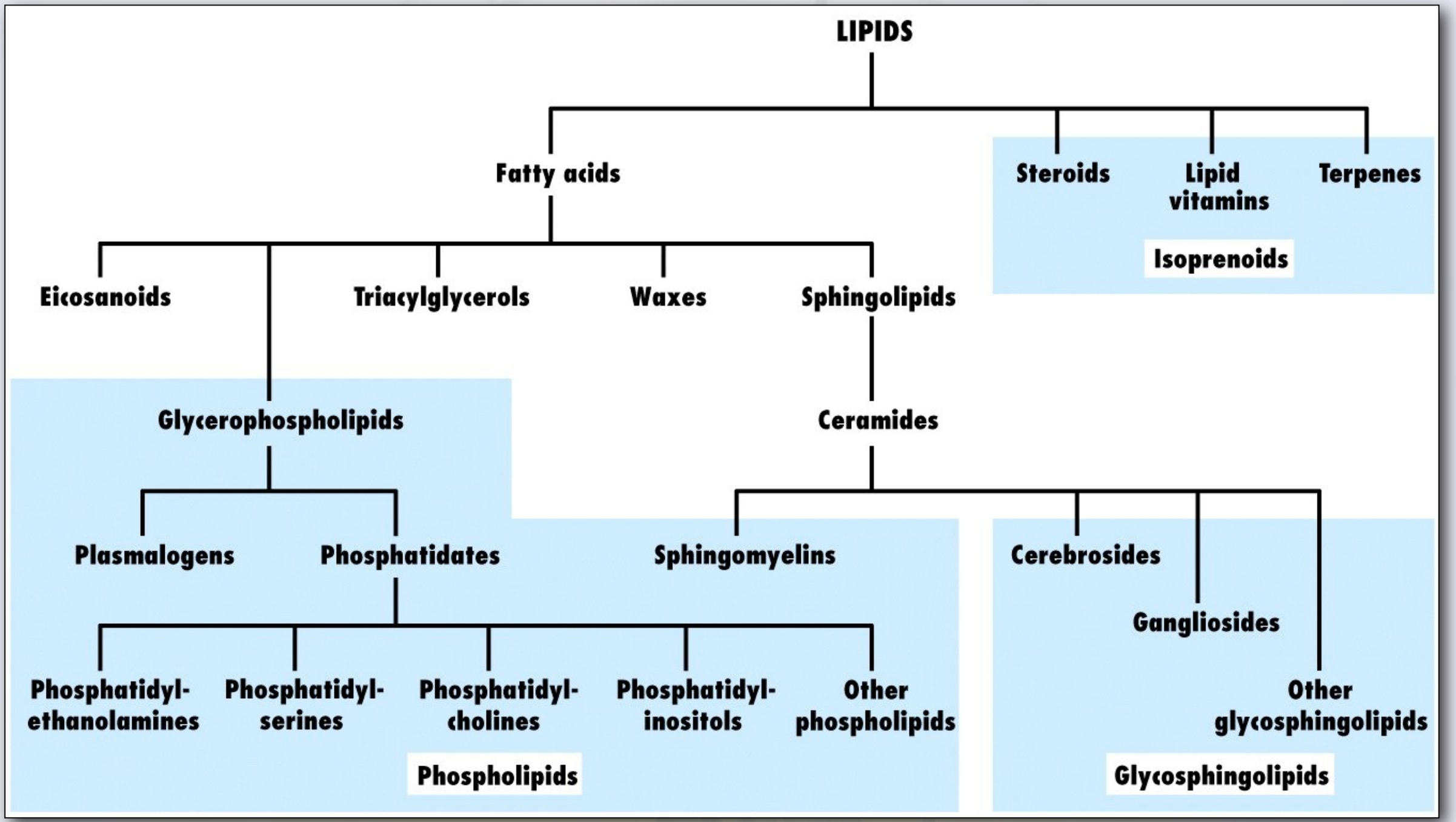


Eicosanoids



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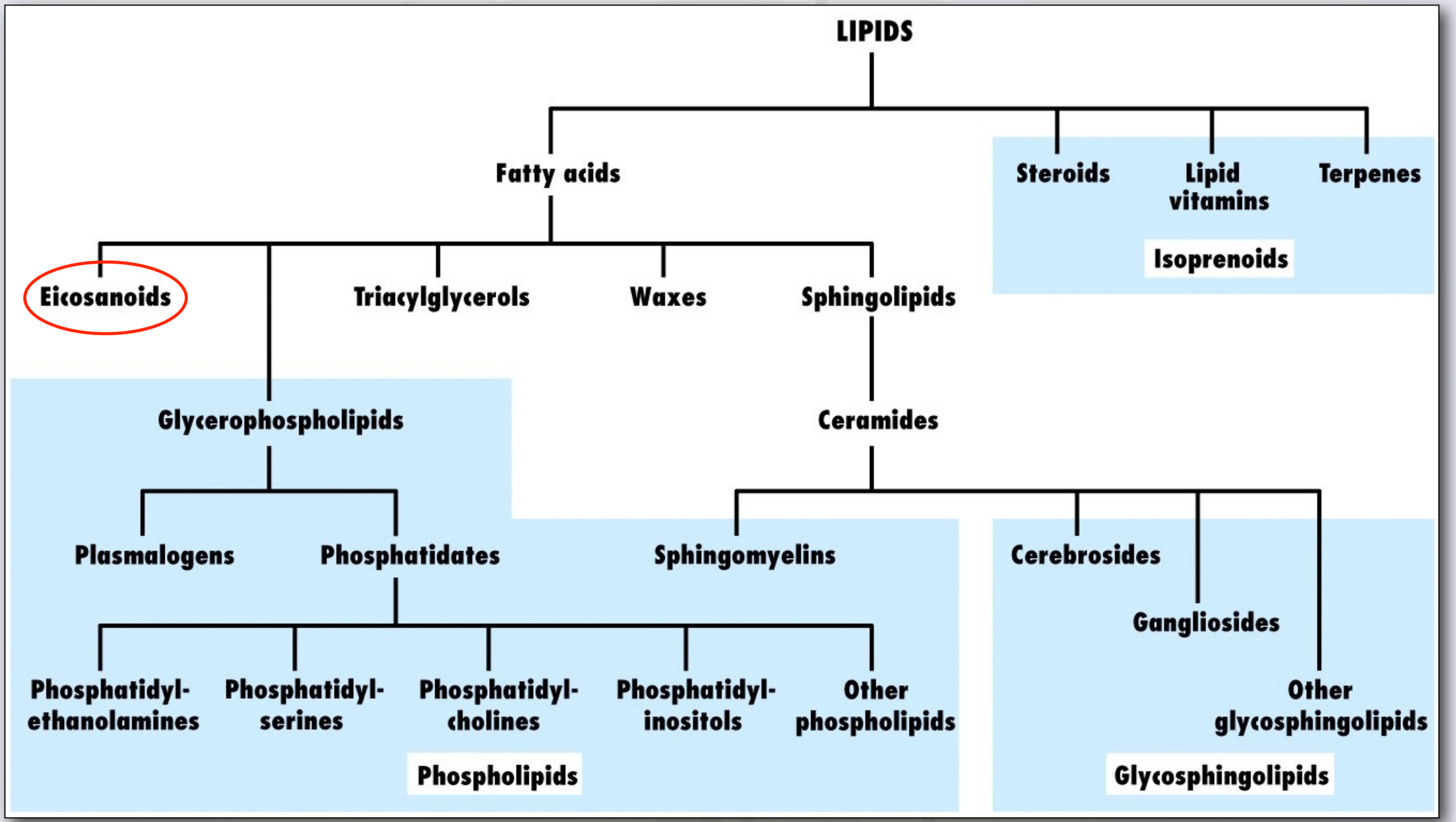


Eicosanoids

- Eicosanoids are derived from the fatty acid arachinoic acid (20:4-$\Delta^{5,8,11,14}$).
  - They are used as signaling molecules.
  - **Prostaglandins** are an example
    - They mediate smooth-muscle contraction and are associated with triggering fever, swelling and inflammation.

Eicosanoids

- Eicosanoids are derived from the fatty acid arachinoic acid (20:4-

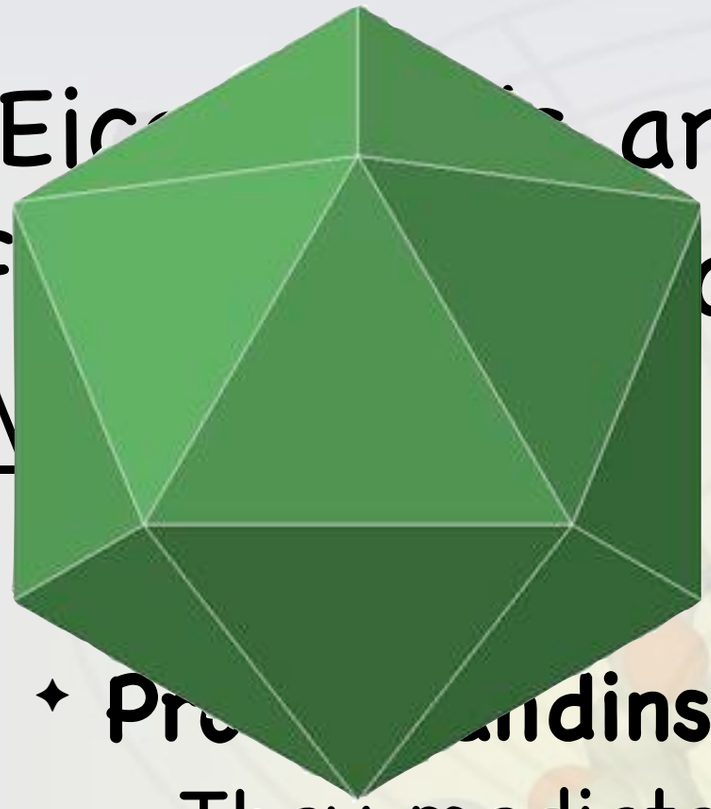
TABLE 9.1 Some common fatty acids (anionic forms)

Number of carbons	Number of double bonds	Common name	IUPAC name	Melting point, °C	Molecular formula
12	0	Laurate	Dodecanoate	44	$CH_3(CH_2)_{10}COO^{\ominus}$
14	0	Myristate	Tetradecanoate	52	$CH_3(CH_2)_{12}COO^{\ominus}$
16	0	Palmitate	Hexadecanoate	63	$CH_3(CH_2)_{14}COO^{\ominus}$
18	0	Stearate	Octadecanoate	70	$CH_3(CH_2)_{16}COO^{\ominus}$
20	0	Arachidate	Eicosanoate	75	$CH_3(CH_2)_{18}COO^{\ominus}$
22	0	Behenate	Docosanoate	81	$CH_3(CH_2)_{20}COO^{\ominus}$
24	0	Lignocerate	Tetracosanoate	84	$CH_3(CH_2)_{22}COO^{\ominus}$
16	1	Palmitoleate	*cis*-Δ^9-Hexadecenoate	−0.5	$CH_3(CH_2)_5CH{=}CH(CH_2)_7COO^{\ominus}$
18	1	Oleate	*cis*-Δ^9-Octadecenoate	13	$CH_3(CH_2)_7CH{=}CH(CH_2)_7COO^{\ominus}$
18	2	Linoleate	*cis, cis*-$\Delta^{9,12}$-Octadecadienoate	−9	$CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_6COO^{\ominus}$
18	3	Linolenate	all *cis*-$\Delta^{9,12,15}$-Octadecatrienoate	−17	$CH_3CH_2(CH{=}CHCH_2)_3(CH_2)_6COO^{\ominus}$
20	4	Arachidonate	all *cis*-$\Delta^{5,8,11,14}$-Eicosatetraenoate	−49	$CH_3(CH_2)_4(CH{=}CHCH_2)_4(CH_2)_2COO^{\ominus}$

Eicosanoids

- Eicosanoids are derived from the fatty acid arachinoic acid (20:4-$\Delta^{5,8,11,14}$).
  - They are used as signaling molecules.
  - **Prostaglandins** are an example
    - They mediate smooth-muscle contraction and are associated with triggering fever, swelling and inflammation.

Eicosanoids



- Eic[illegible] are derived from the f[illegible]chinoic acid (20:4-Δ[illegible]
  - [illegible] as signaling molecules.
    - **Pro[illegible]ndins** are an example
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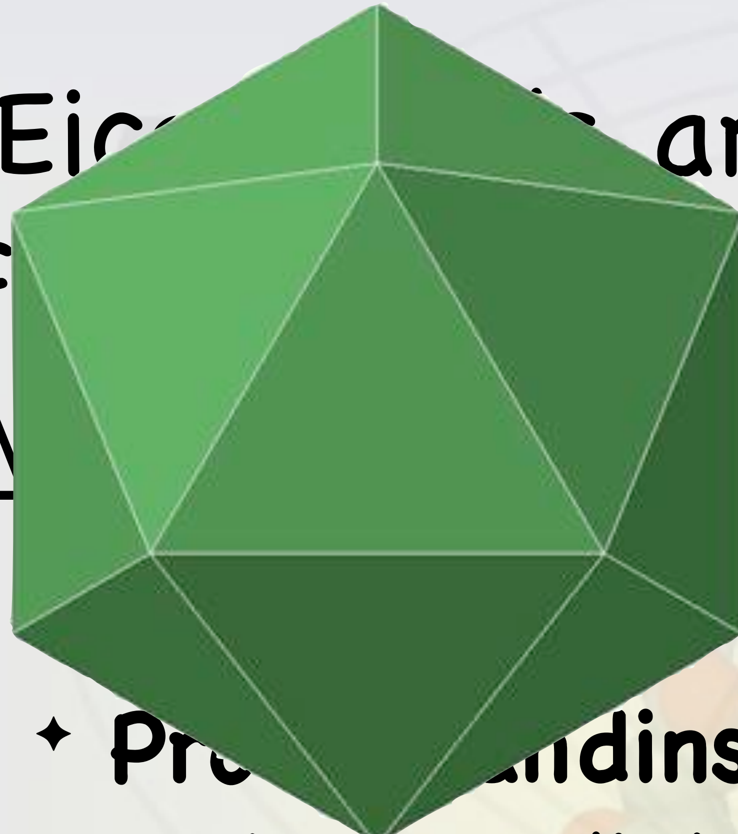
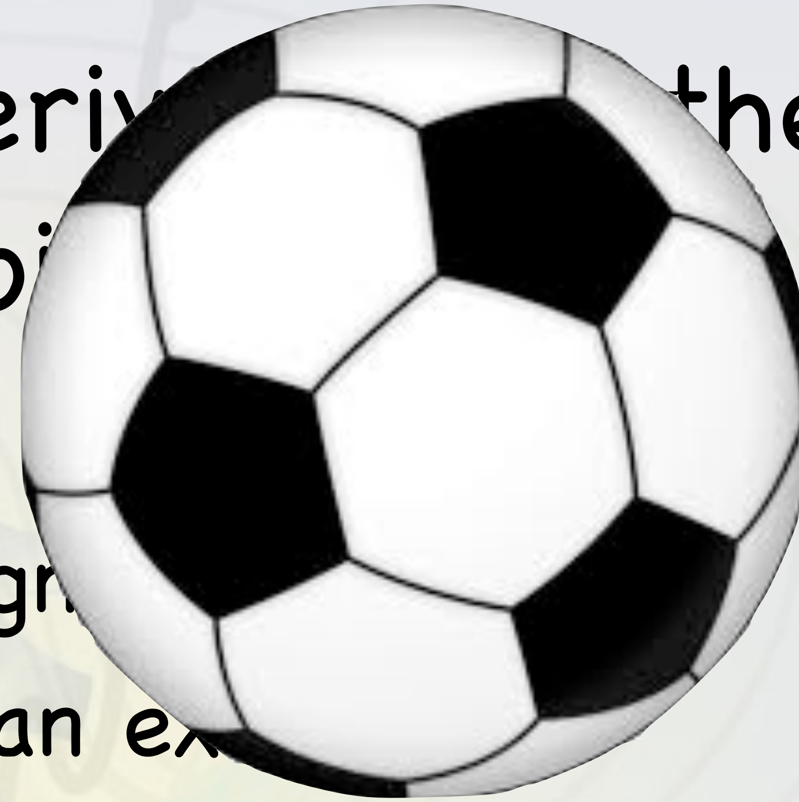
Eicosanoids





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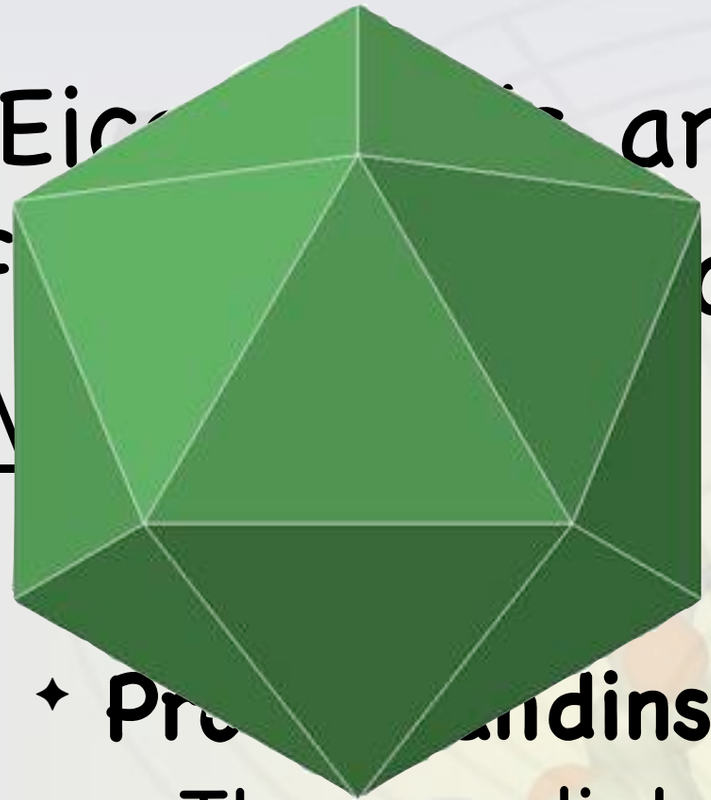
Eicosanoids



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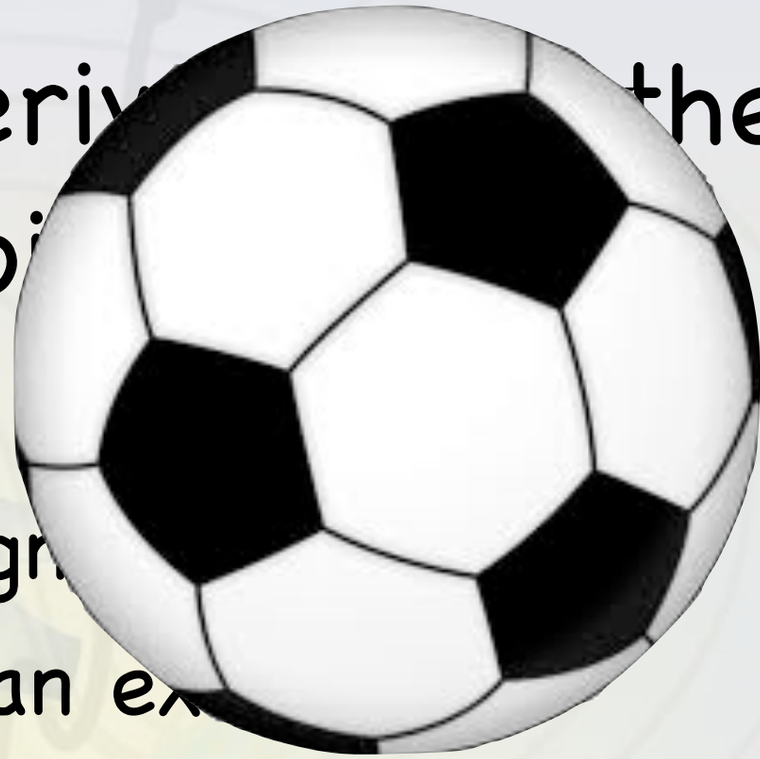
- Δ[illegible]



[illegible] as sign[illegible]

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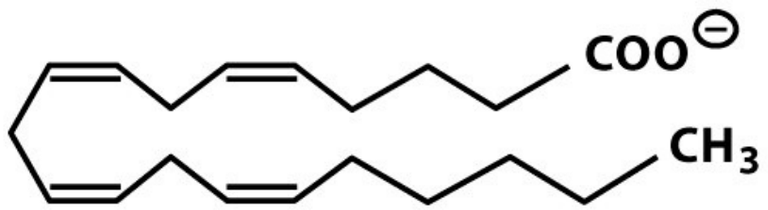
  - They mediate smooth-muscle contraction an[illegible]gering fever, sw[illegible]

Eicosanoids

- Eicosanoids are derived from the

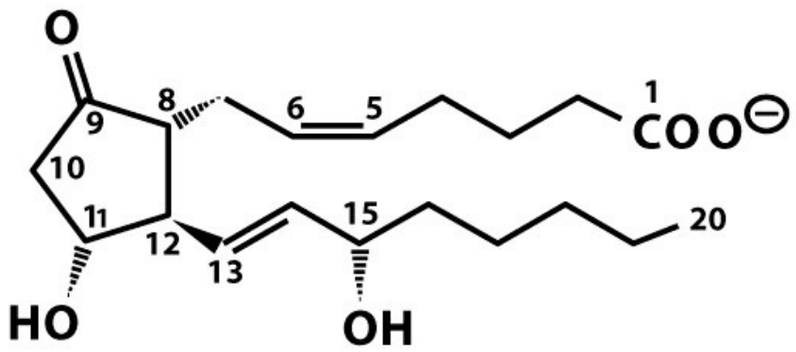
(a)

Arachidonic acid



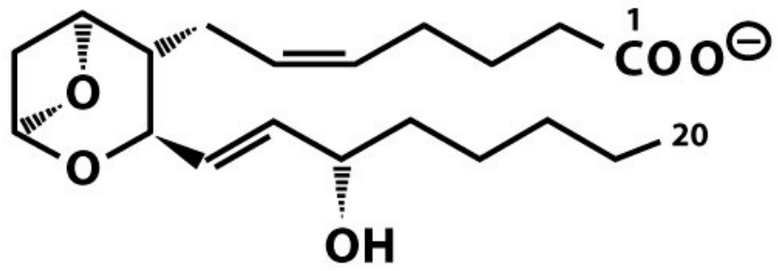
(b)

Prostaglandin E_2



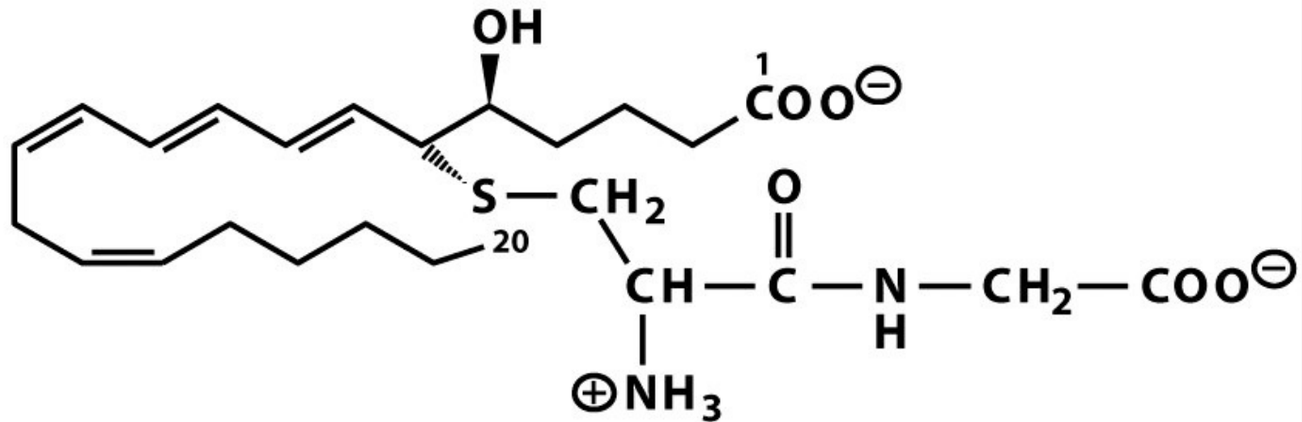
(c)

Thromboxane A_2



(d)

Leukotriene D_4



Eicosanoids

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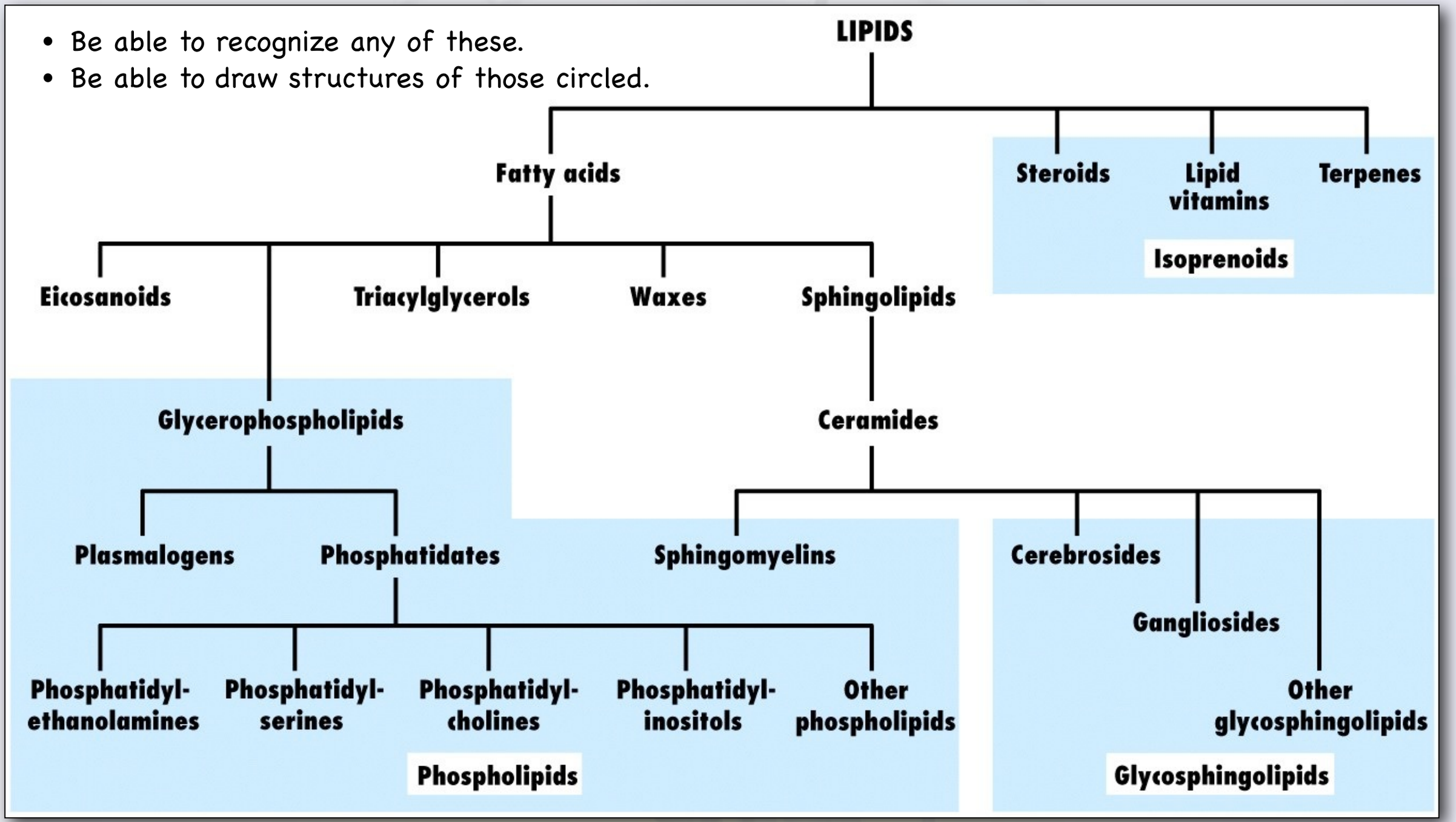
Eicosanoids

- The conversion of arachidonic acid to protaglandin E_2 is carried out by and enzyme call cyclooxygenase (COX).
  - Asprin, and other **nonsteroidal antiinflammatory drugs (NSAID's)**, such as ibruprofen, are inhibitors of the COX enzyme.

Introduction to Lipids

- Be able to recognize any of these.
- Be able to draw structures of those circled.



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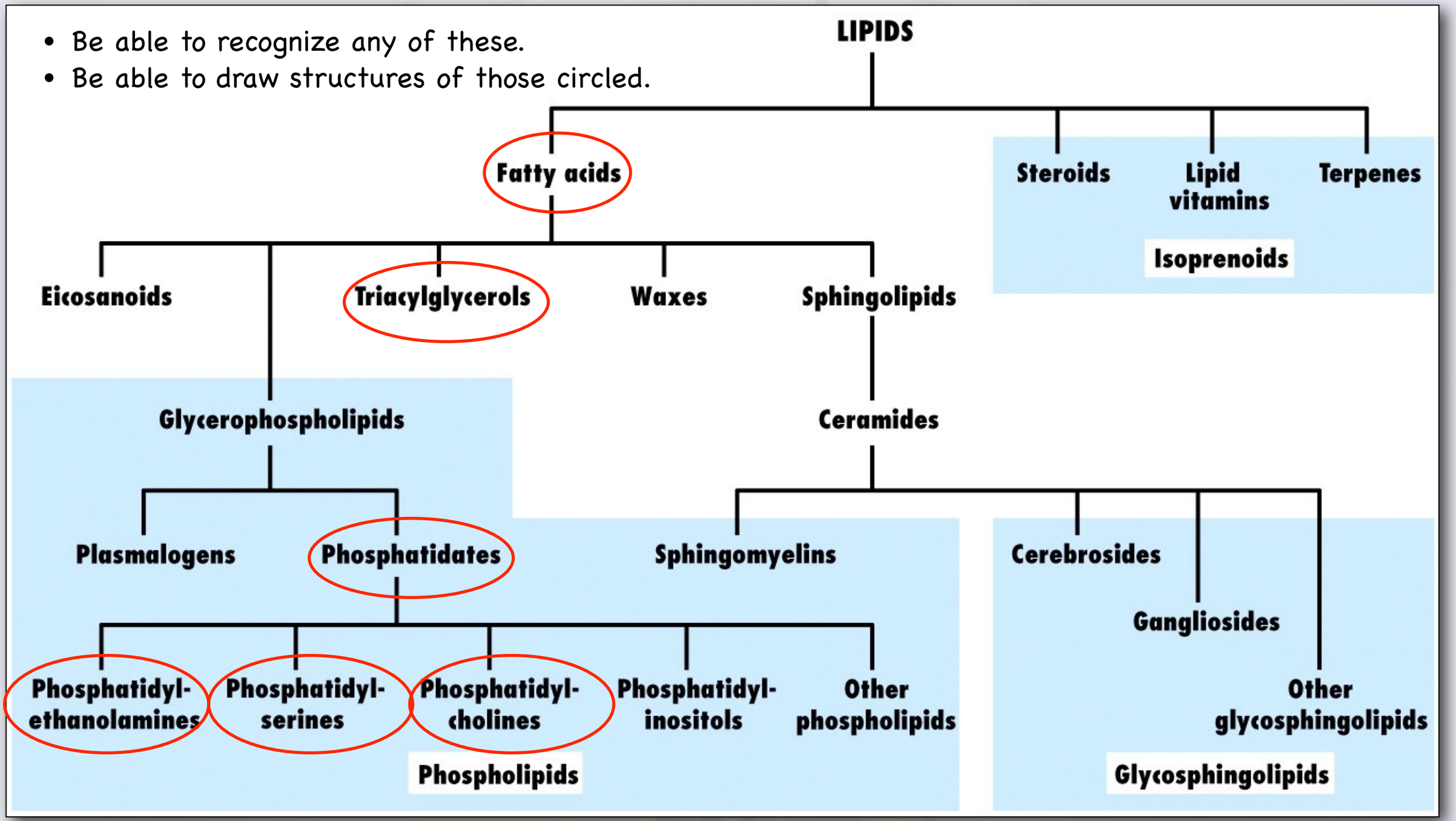

Next Up

- Part II: Membranes (Chapter 9)