

Lipids

Lipids

Defined on the basis of solubility.

Lipid- water insoluble organic substances extractable by nonpolar solvents, most often chloroform:methanol (2:1 v/v).

- Many distinct chemical species in a "lipid fraction"

Functions of Lipids

1. Energy storage source for animals
2. Structural elements (plasma membrane) of cells and organelles
3. Signal transduction molecules
4. Sleep-inducing lipids recently identified

Fatty Acids

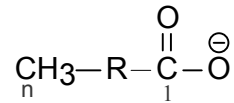
Over 100 known naturally.

Numbered from carboxyl end.

Even number of carbon atoms (exceptions).

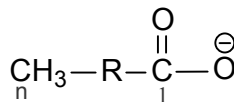
Unbranched (exceptions).

Saturated or unsaturated (only cis).



Fatty Acids Are Charged Physiologically

C length	pKa
1	3.74
2	4.74
3	4.87
4	—
5	—
6	—
7	4.85
	pKa ~5



16- and 18-C Fatty Acids Are Most Abundant

Beef fat 96% 16- and 18-C

29% 16:0

21% 18:0

46% 16:n and 18:n

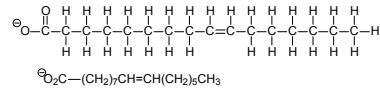
Saturated Fatty Acids

Palmitic (16:0)

Stearic (18:0)

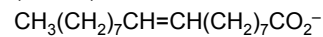
Unsaturated Fatty Acids

Palmitoleic (16:1 Δ^9)



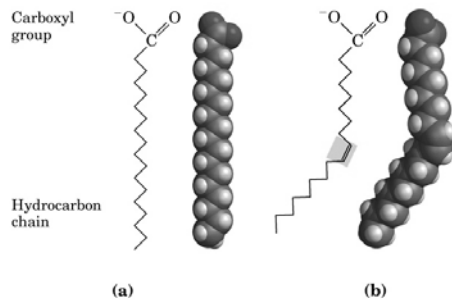
ω 6 or n-6 alternative

Oleic (18:1 Δ^9)



Unsaturated Fatty Acids Are Kinked

Fig. 11-1 Lehninger POB 3rd Ed.



Polyunsaturated Fatty Acids are Essential Fatty Acids

Linoleic (18:2 $\Delta^{9,12}$) ω 6

Linolenic (18:3 $\Delta^{9,12,15}$) ω 3

Arachidonic (20:4 $\Delta^{5,8,11,14}$) ω 6

Fatty Acids Are Not Found Free

human serum
total lipid averages 570 mg/dL (450-1,000)
FFA 12 mg/dL
Present in triglycerides
Present in phospholipids

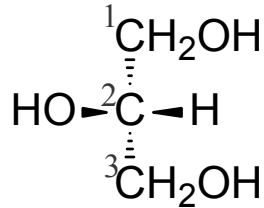
Reactions of Fatty Acids

Carboxylic acid functional group leads to ester formation

Triacylglycerols

sn (stereospecific numbering)

Pro-S carbon on top
pro-R carbon on bottom



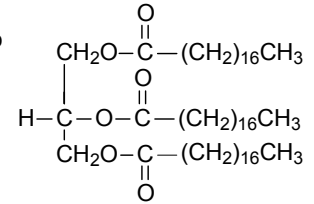
Triacylglycerols (TAGs)

Triesters of glycerol and 3 fatty acids

Store a lot of energy- do not function as structural elements

Insulation

Lipases act when we need energy



Fats vs. Oils

melting point (2 factors)

Number double bonds: "iodine number"

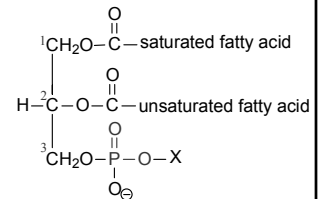
Average chain length: "saponification number"

Animal fat and vegetable oil

Phosphoacylglycerols

The sn-3 C of glycerol has a "head group" attached through a phosphate ester.

PA

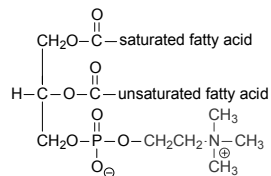


Phosphoacylglycerols

The sn-3 C of glycerol has a "head group" attached through a phosphate ester.

PA

PC



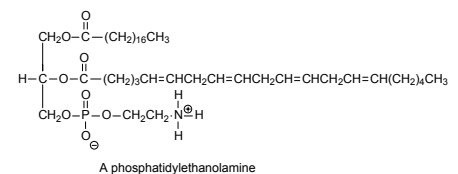
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Phosphoacylglycerols

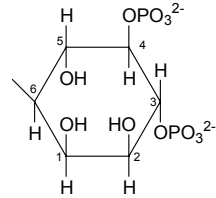
The sn-3 C of glycerol has a "head group" attached through a phosphate ester.

PA
PC
PE
PS-phosphatidylserine

Phosphoacylglycerols

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Phosphoacylglycerols

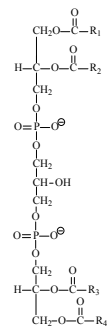
The sn-3 C of glycerol has a "head group" attached through a phosphate ester.

PA
PC
PE
PS-phosphatidylserine
PI
PG-phosphatidylglycerol

Phosphoacylglycerols

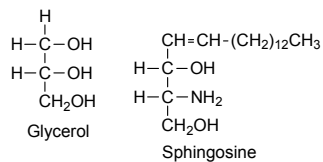
The sn-3 C of glycerol has a "head group" attached through a phosphate ester.

PA
PC
PE
PS-phosphatidylserine
PI
PG-phosphatidylglycerol
Cardiolipin



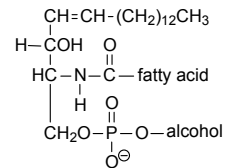
Sphingolipids

Sphingosine instead of glycerol



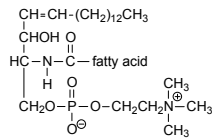
Sphingolipids

Sphingosine instead of glycerol
amide linkage= ceramide



Sphingolipids

Sphingosine instead of glycerol
amide linkage= ceramide
sphingomyelin



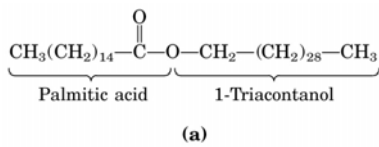
Glycolipids Are *Not* Phospholipids

Glucosylceramide
Ganglioside
G_{M1} vs. G_{D2}

Wax

Fig. 11-5a Lehninger POB 3rd Ed.

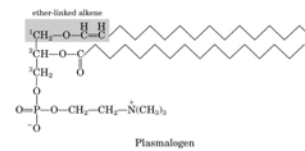
Wax- ester of fatty acid and long chain alcohol
Beeswax



Plasmalogens

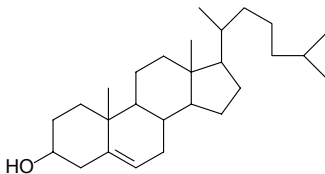
Fig. 11-5a Lehninger POB 3rd Ed.

Note similarity to sphingomyelin



Steroids

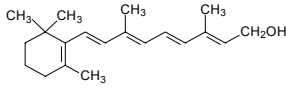
Know structure of cholesterol
Converted to many lifesaving compounds



Derived Lipids

1. Fat-soluble vitamins (recognize)
2. Eicosanoids
3. Isoprenoids

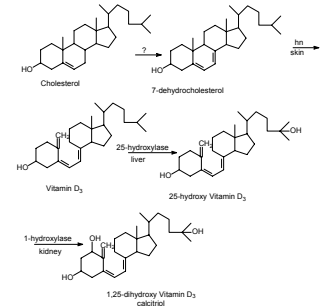
Vitamin A (Retinol)



- Derived from β -carotene
- Oxidized to retinal
- Functions in vision cycle
- Deficiency: Night blindness
- Excess: bone pain

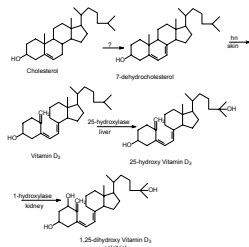
Vitamin D

- Metabolism helps remember structure



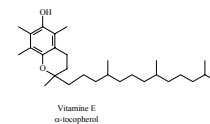
Vitamin D

- Metabolism helps remember structure
- Functions in calcium metabolism
- Deficiency: rickets in children
- Excess: "lumpy bones", kidney stones

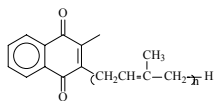


Vitamin E

- Functions as antioxidant
- Deficiency: not known
- Excess: blurred vision and headache



Vitamin K



- Different forms, most common n=8
- Functions in blood clotting by unknown means
- Deficiency: blood clotting
- Excess: hemolytic anemia

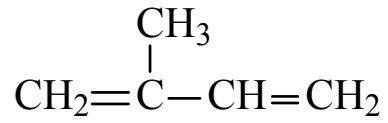
Three Classes of Eicosanoids

Derived from arachidonate

Recognize by common structural feature of the three classes

- Prostaglandins (PG) 5 membered ring
- Thromboxanes (TX) 6 membered ether ring
- and Leukotrienes (LT) conjugated double bonds

Isoprene



- Can polymerize
- reason for branched chains on numerous examples

Signal Transduction *via* Lipids

An important hot area in current biochemical research

One Example

Fig. 11-15 Lehninger POB 3rd Ed.

