

A scanning electron micrograph (SEM) of a blood smear. The image shows several red blood cells, which are biconcave discs, appearing as reddish-purple spheres. A white blood cell is visible in the center, appearing as a larger, more irregularly shaped cell with a textured surface. The background is a dark, brownish color.

# Chemical Biology 03

## BLOOD

Biomolecular Structure

II. Fats

[www.optics.rochester.edu/.../image007.gif](http://www.optics.rochester.edu/.../image007.gif)

x3000  
512 x 480


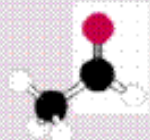

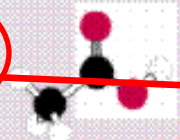
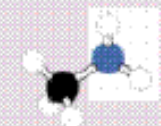
10  $\mu$ m

5kV

11mm

BL06.TIF

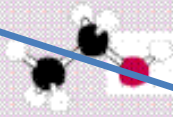


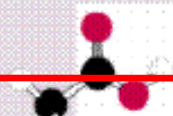

# Organic Functional Groups

Functional group	Class of compounds	Structural formula	Example	Ball-and-stick model
Hydroxyl -OH	Alcohols	$R-OH$	$\begin{array}{c} H & H \\   &   \\ H-C & -C-OH \\   &   \\ H & H \end{array}$ Ethanol	
Carbonyl -CHO	Aldehydes	$R-\overset{O}{\parallel}C-H$	$\begin{array}{c} H & O \\   & // \\ H-C & -C-H \\   & \\ H & \end{array}$ Acetaldehyde	
Carbonyl $\diagup CO \diagdown$	Ketones	$R-\overset{O}{\parallel}C-R$	$\begin{array}{c} H & O & H \\   &    &   \\ H-C & -C & -C-H \\   & &   \\ H & & H \end{array}$ Acetone	
Carboxyl -COOH	Carboxylic acids	$R-\overset{O}{\parallel}C-OH$	$\begin{array}{c} H & O \\   & // \\ H-C & -C-OH \\   & \\ H & \end{array}$ Acetic acid	
Amino -NH <sub>2</sub>	Amines	$R-NH_2$	$\begin{array}{c} H & H \\   &   \\ H-C & -N-H \\   &   \\ H & H \end{array}$ Methylamine	

What functional groups do sugars contain?

Fatty acids all contain an acid functional group

# Organic Functional Groups

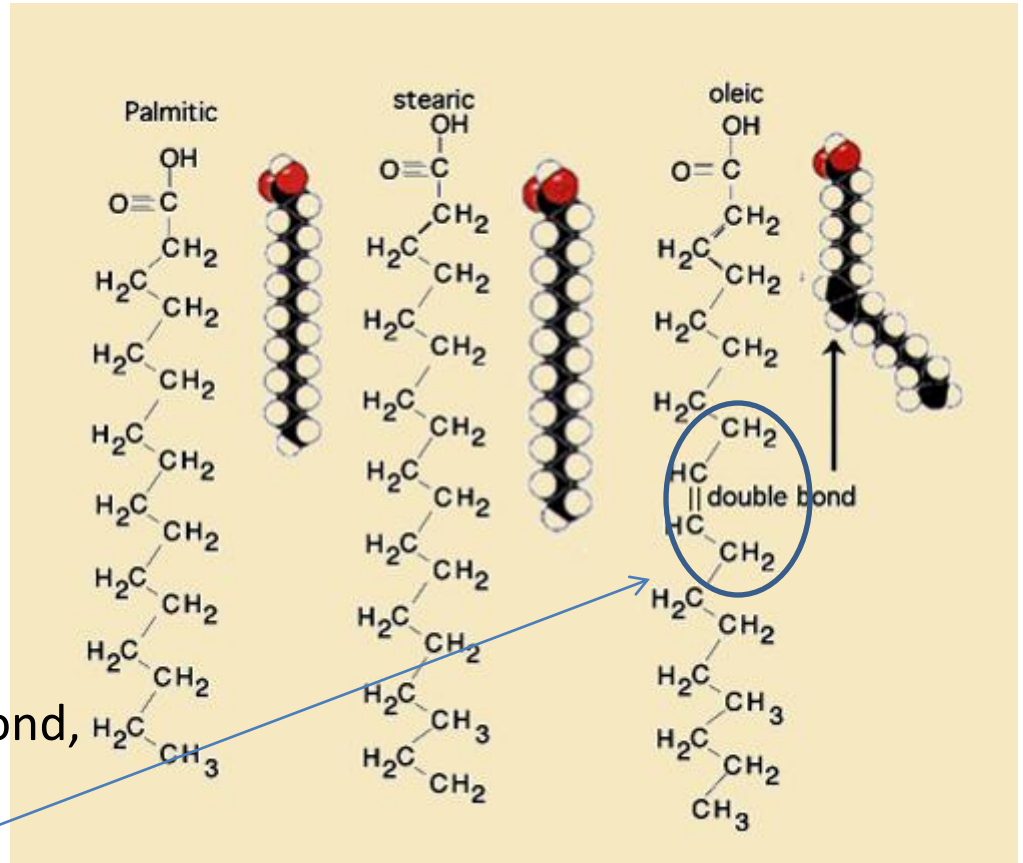
Functional group	Class of compounds	Structural formula	Example	Ball-and-stick model
Hydroxyl -OH	Alcohols	$R-OH$	$\begin{array}{c} H & H \\   &   \\ H-C & -C-OH \\   &   \\ H & H \end{array}$ Ethanol	
Carbonyl CHO	Aldehydes	$R-C(=O)H$	$\begin{array}{c} H & O \\   &    \\ H-C & -C-H \\   & \\ H & \end{array}$ Acetaldehyde	
Carbonyl CO	Ketones	$R-C(=O)R$	$\begin{array}{c} H & O & H \\   &    &   \\ H-C & -C & -C-H \\   & &   \\ H & & H \end{array}$ Acetone	
Carboxyl -COOH	Carboxylic acids	$R-C(=O)OH$	$\begin{array}{c} H & O \\   &    \\ H-C & -C-OH \\   & \\ H & \end{array}$ Acetic acid	
Amino -NH2	Amines	$R-NH_2$	$\begin{array}{c} H & H \\   &   \\ H-C & -N-H \\   &   \\ H & H \end{array}$ Methylamine	

SUGARS

FATS

# Fatty Acids

- Fats are made up of
  - an acid group(-COOH)
  - a hydrophobic group ( $C_nH_m$ )
  - Sometimes have a double bond, usually cis (as shown) but sometimes trans

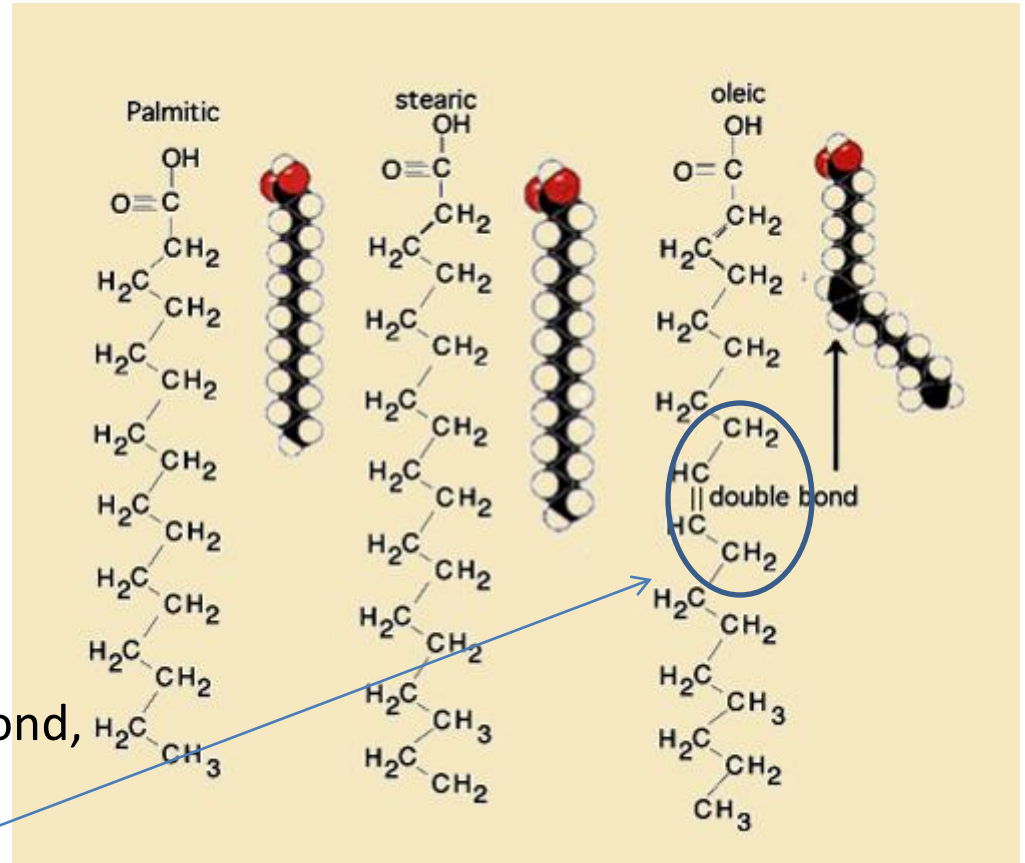


cis: \_\_\_\_\_

trans: \_\_\_\_\_

# Fatty Acids

- Fats are made up of
  - an acid group(-COOH)
  - a hydrophobic group ( $C_nH_m$ )
  - Sometimes have a double bond, usually cis (as shown) but sometimes trans



cis: C atoms on either side of double bond are on the same side

trans: C atoms on either side of double bond are on opposite sides

# *Fatty acids in our diet*

- SATURATED AND UNSATURATED

- Saturated fats

- Have no double bonds
    - Are solids at room temperature
    - Are obtained from animal products like butter and products such as Crisco.
    - likely to increase cholesterol levels and risk atherosclerosis.



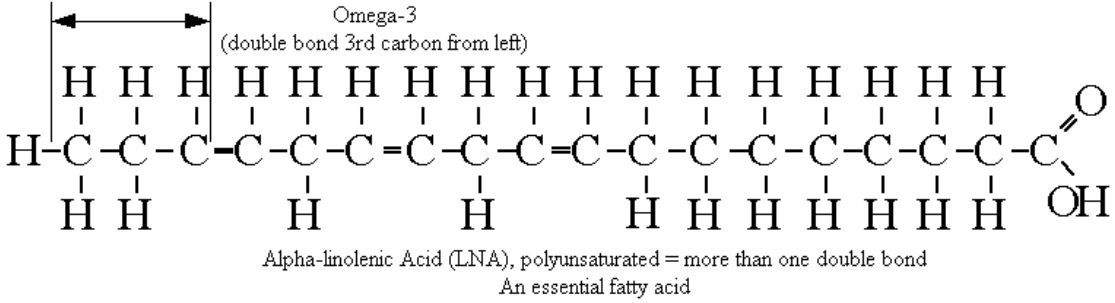
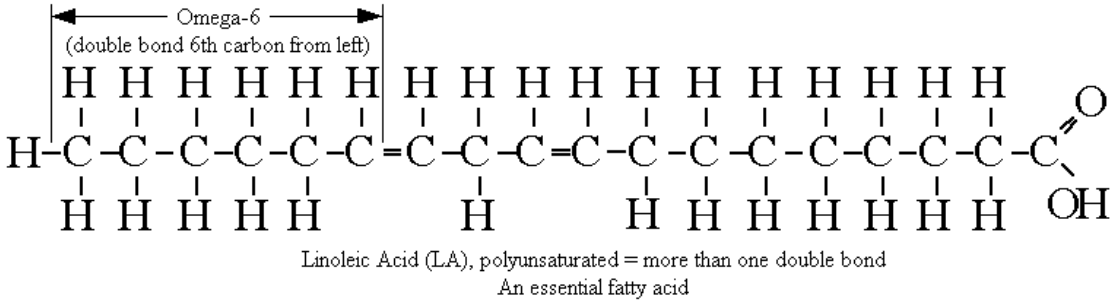
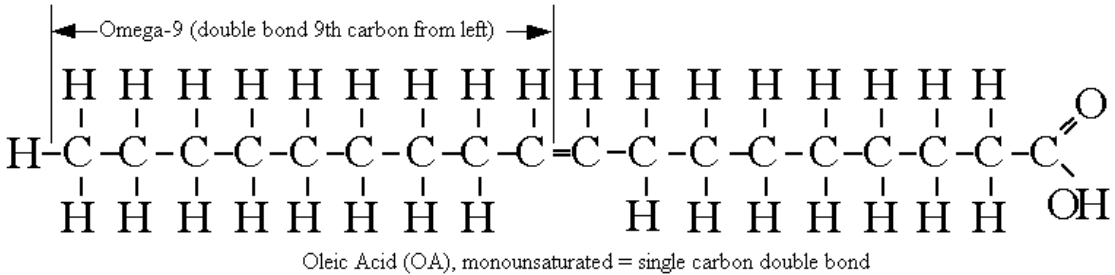
- Unsaturated fats

- Have cis double bonds
    - Are liquids at room temperature
    - Are obtained from plants (olive, corn, safflower)
    - trans double bonds are unhealthy



# What are omega 6, omega 9 fatty acids?

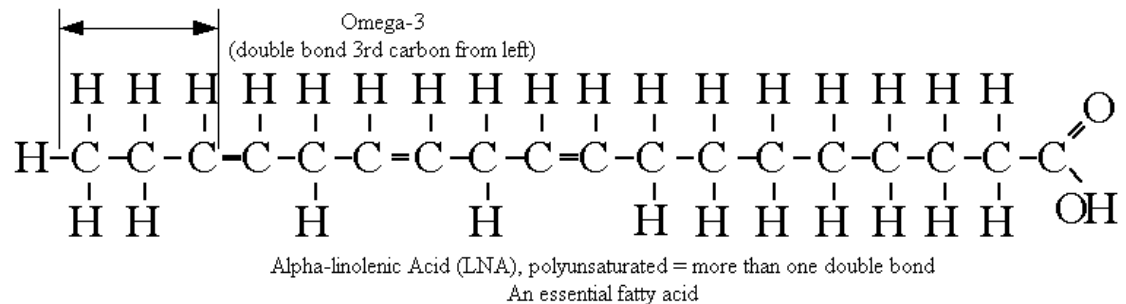
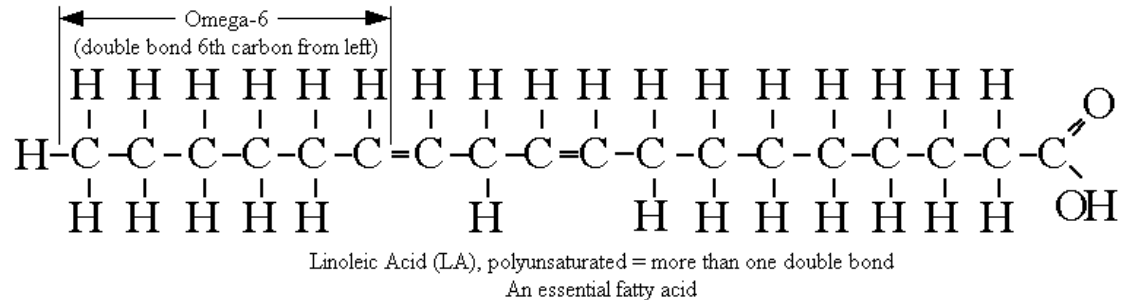
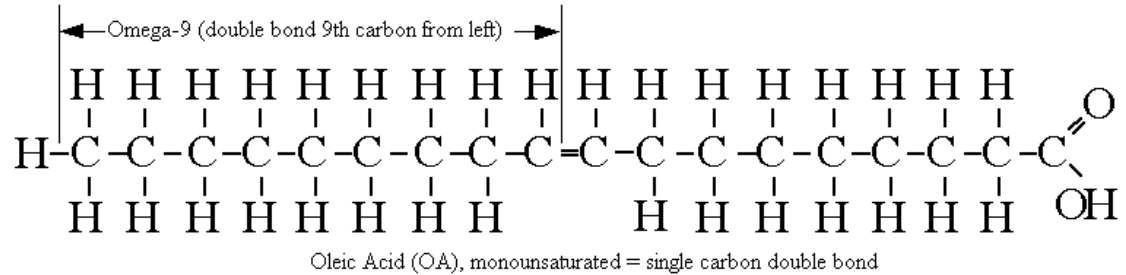
- "Omega" is the last letter of the Greek alphabet, and indicates that the count starts from the *end* of the chain (the -CH<sub>3</sub> side) or left in this drawing.
- The location of the carbon double bond determines the type of Omega fatty acid.
  - **Omega 3** means a double bond occurs at the third carbon from the end carbon of the chain.
  - **Omega 9** means a double bond occurs at the 9th carbon from the end carbon,



H = Hydrogen Atom C = Carbon Atom O = Oxygen Atom  
 — = Single bond    = = Double bond

# What are omega 6, omega 9 fatty acids?

- Draw a shorthand drawing for 1, 2, or 3
- DO NOT DRAW Hs CONNECTED TO C**
- DRAW ONLY LINES THAT CONNECT C (no C atoms)**
- DRAW O atoms**



H = Hydrogen Atom C = Carbon Atom O = Oxygen Atom  
— = Single bond = = Double bond



# Oils we know and love...

Oil	ω3:ω6:ω9:sat
Almond oil	00:17:78:05
Avocado oil	00:10:70:20
Beef Tallow	01:03:43:46
Brazil nut oil	00:24:48:24
Butter (cow)	01:02:29:56
Canola oil (rape)	07:30:54:07
Cashew	00:06:70:18
Cocoa Butter	00:03:32:63
Coconut oil	00:03:06:91
Corn oil	00:59:24:17
Filbert oil	00:16:54:05
Flax oil	58:14:19:09
Grape Seed Oil	00:73:15:12
Hemp oil	20:60:12:08
Lard (pork fat)	00:10:44:42
Macadamia	00:10:71:12
Olive oil	00:08:76:16
Palm	00:10:40:50
Palm Kernel	00:02:15:79
Peanut oil	00:29:47:18
Pecan oil	00:20:63:07
Pistachio	00:19:65:09
Pumpkin seed oil	0-15:42-57:34:9
Rice bran	01:35:48:17
Safflower oil	00:75:13:12
Sesame oil	00:45:42:13
Soybean oil	07:50:26:15
Sunflower	00:65:23:12
Walnut oil	05:51:28:16
Wheat germ oil	05:50:25:18

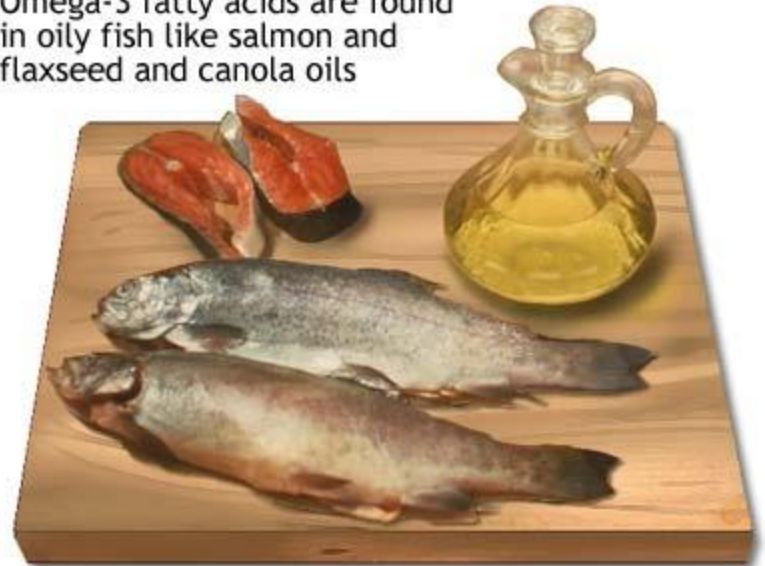
- A breakdown of fatty acid % content of omega-3, omega-6, and saturated, of some oils (in the order of 3:6:9: % saturated)



# *..what's the deal about linoleic acid and omega 3 and 6 fatty acids?*

- Essential fatty acids we need to eat:
  - linoleic acid (omega-6) and linolenic acid (omega-3) mostly found in flax and fish oils) Without these we die.
  - and arachidonic acid, eicosapentaenoic acid, and docosahexaenoic acid (found in fish, flax, and canola oils)

Omega-3 fatty acids are found in oily fish like salmon and flaxseed and canola oils



# Listen and Learn: Draw for yourself the two functional groups common to all fatty acids

1. \_\_\_\_\_

2. \_\_\_\_\_

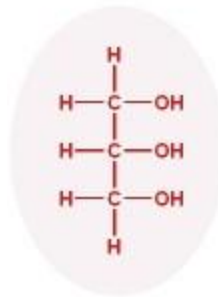
# THINKING AHEAD

1. How soluble are fats in your blood? Use the chemical structure to explain why they have this solubility.
2. Explain why high fat diets are very unhealthy.

# Fatty acids are used to make Triglycerides –

- Lipids (triglycerides) are made from fats
  - synthesized from a 3 carbon glycerol molecule PLUS 3 fatty acid molecules that are 16-24 C long - triglyceride ester bonds
  - Glycerol binds to the fatty acids that you ingest from food and shuttle them off to fat cells in your body if you don't need to burn them immediately for calories

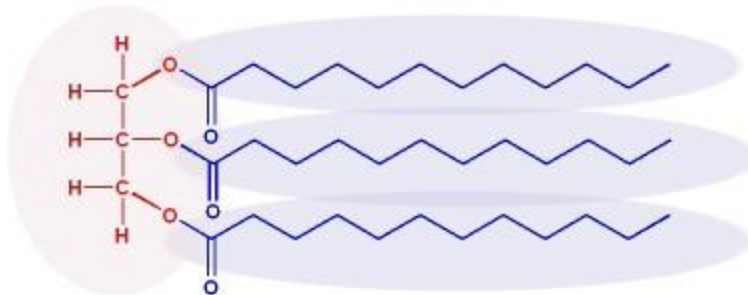
*Glycerol*



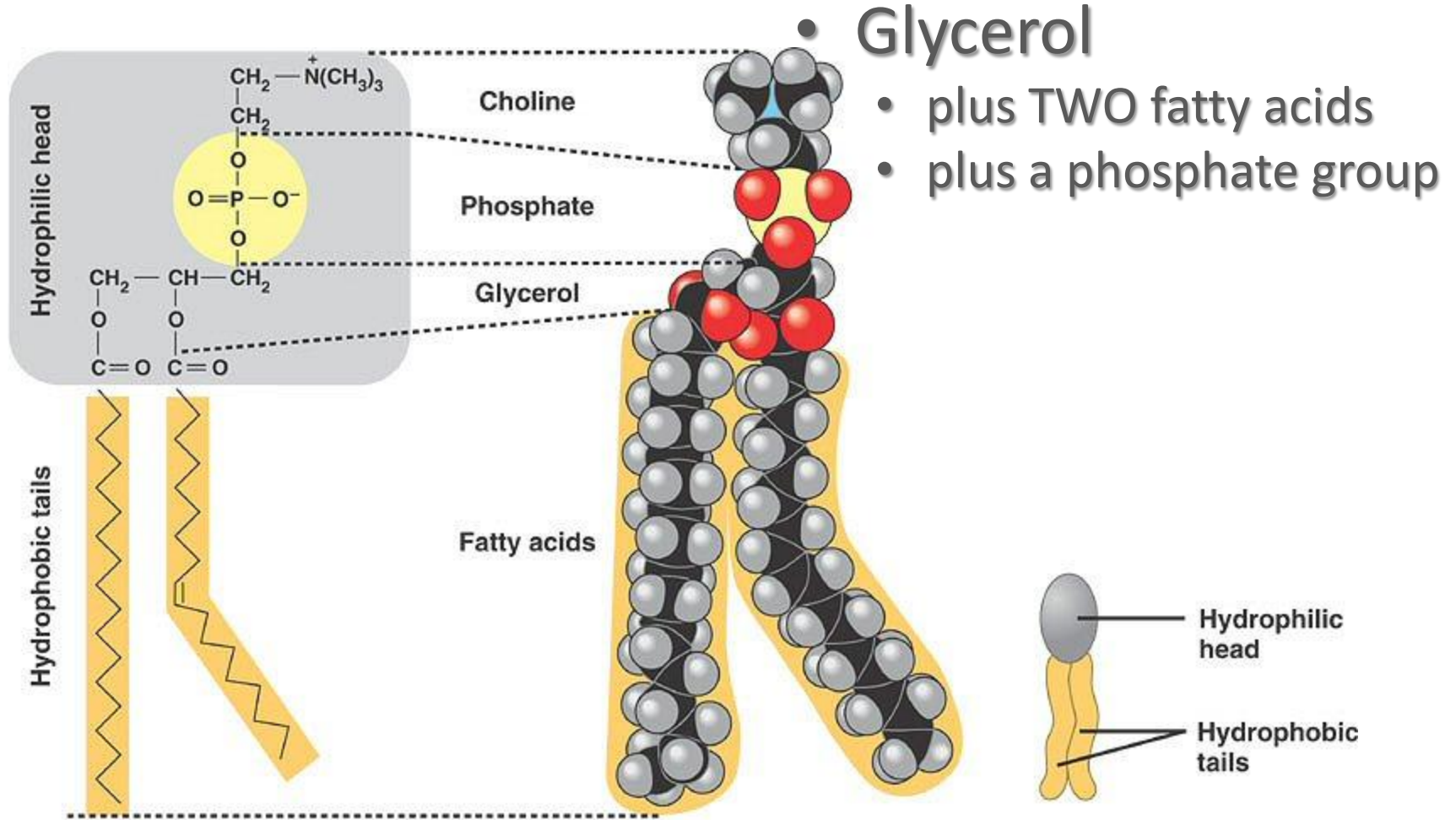
*A "free" Fatty Acid*



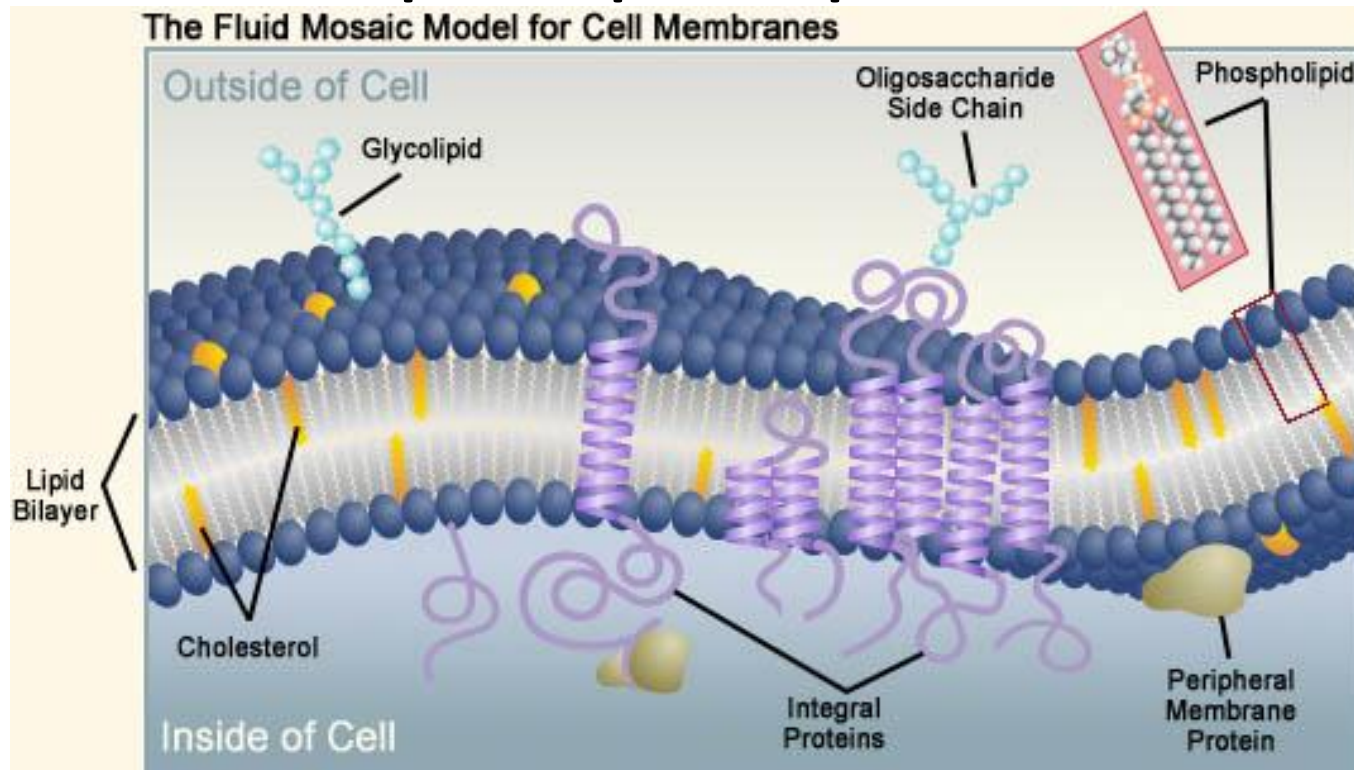
*Triglyceride*



# Fatty acids are used to Phospholipids – components of cell membranes



# Plasma Membranes are made of phospholipids



- Phospholipids: form a bilayer to make cell membrane
- FLUID MOSAIC MODEL: Lots of things are embedded in membrane
- [http://www.youtube.com/watch?v=Qqsf\\_UJcfBc](http://www.youtube.com/watch?v=Qqsf_UJcfBc)

Thinking Ahead: Why do phospholipids form a bilayer in the cell membrane?