

# Lipids

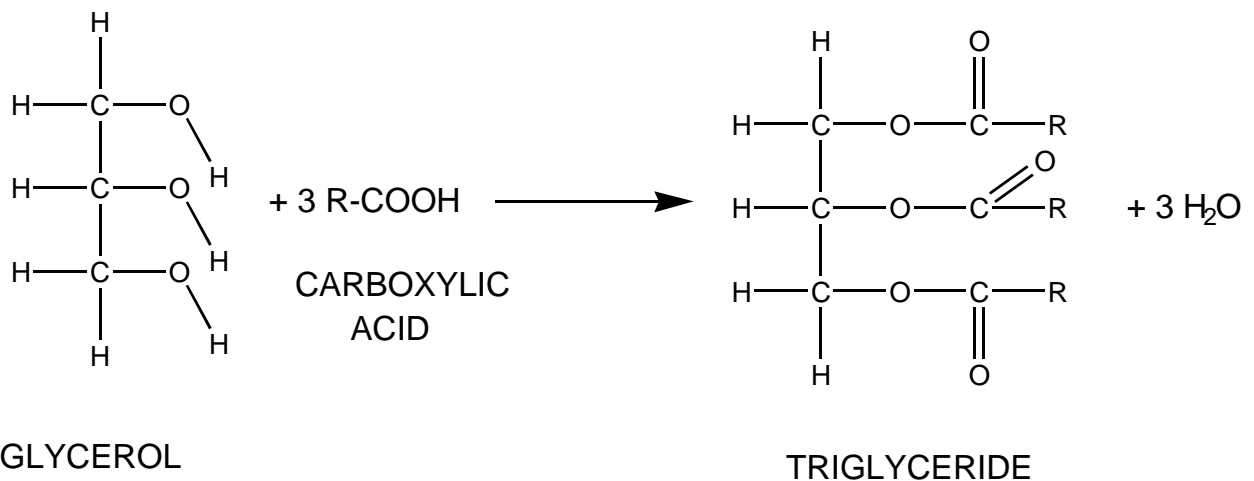
## I. INTRODUCTION

- A. Definition is a bit different. *Lipids: biological compounds that are soluble in non-polar solvents.*
- B. Lipids have many different functions: energy storage, boundary (cell membranes), signaling, insulation, defense, *etc.*

## II. TRIGLYCERIDES

### A. Structure: triesters

1. Alcohol + oxoacid  $\rightarrow$  ester +  $H_2O$
2. For triglycerides the alcohol is glycerol, and the acids are fatty acids (carboxylic acids).



### B. Fatty acid component

1. Varies in length  $C_{12-20}$ , but even # of C atoms
2. Saturated and unsaturated, almost always *cis*-.
3. Comments on effects re. melting point and diet.

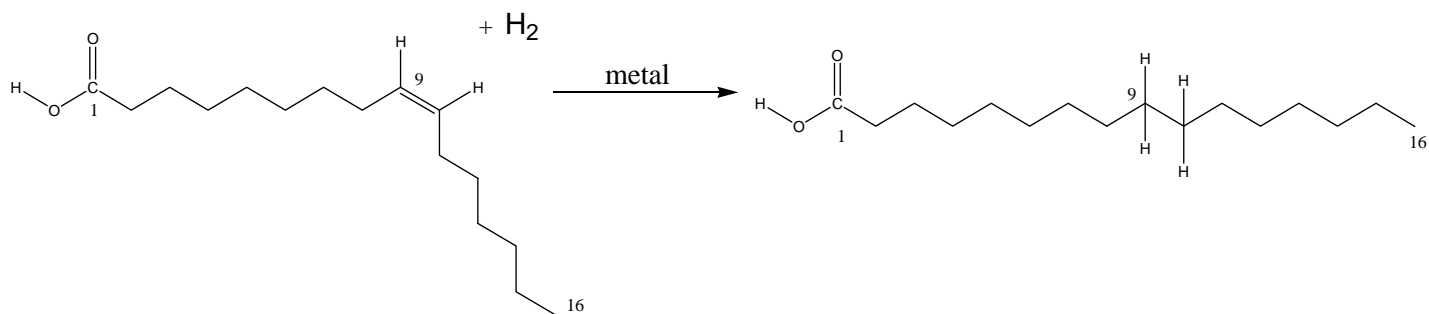
### III. PROPERTIES (including chemical) of FATS

A. Animal fats are often solid at room temperature, while plant fats are often liquid (oils). Why?

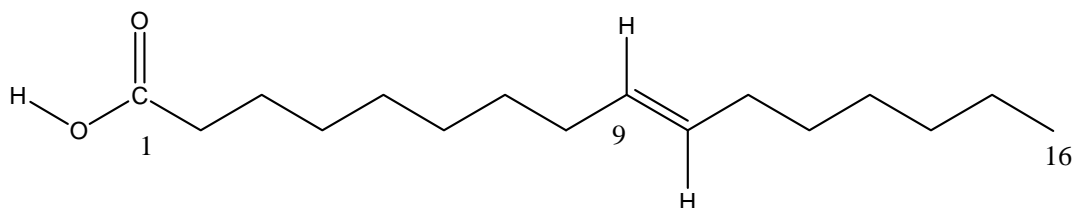
1. Primary intermolecular attractive force? \_\_\_\_\_
2. Effect of *cis*- double bonds on alkane packing?
3. Essential fatty acids: we need but can't make

#### B. Hydrogenation

1. Add H<sub>2</sub> across double bond. (Metal catalyst.)



2. This is how Crisco is made from vegetable oil.
3. Comment on dietary *trans*- fatty acids.



## IV. COMPLEX LIPIDS (can be hydrolyzed, means?)

### A. Phospholipids (more structural details later)

1. Glycerol based
2. Sphingosine based

### B. Interesting medical applications with these.

## V. MEMBRANES (all living things require membranes)

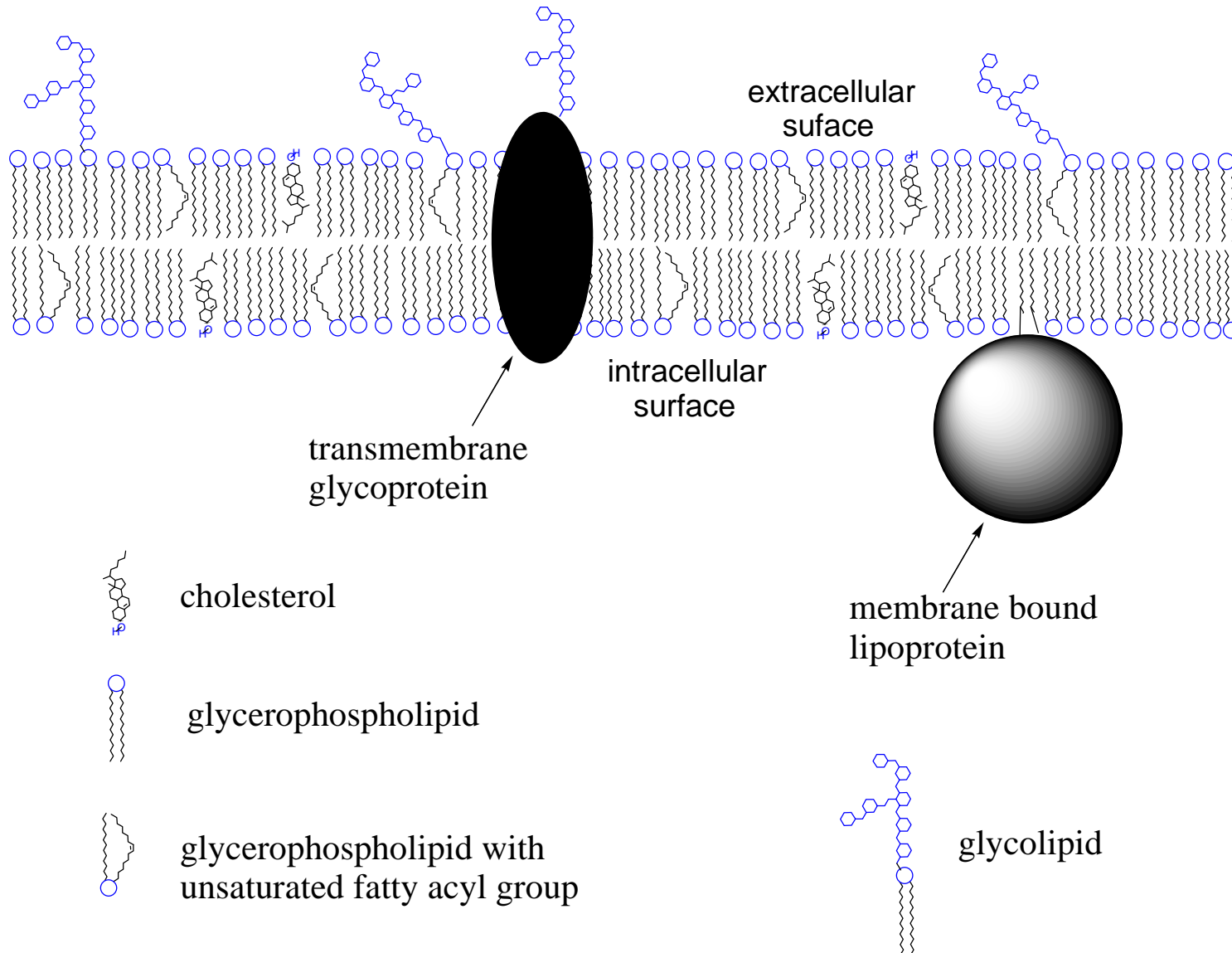
### A. Most membranes contain lipid, protein, and carbohydrate, but right now the lipid is of interest.

1. Because lipids have long hydrophobic regions and small charged or polar regions, **lipids naturally aggregate in aqueous solvents.**
2. Lipids may aggregate by forming:
  - a) micelles
  - b) lipid bilayers (See )
3. The aggregates minimize H<sub>2</sub>O contact with the non-polar lipid parts.

### B. Phospholipids & cholesterol are important membrane components.

1. Bilayer interior is very non-polar. Imagine an organic phase w/ aq. phases on both sides.

# Stereotypical mammalian plasma membrane



2. Do charged and polar molecules readily dissolve in non-polar solvents? \_\_\_\_\_
3. Would you expect charged and polar molecules to cross lipid bilayers rapidly? \_\_\_\_\_
4. Do some charged & polar molecules cross your lipid bilayers (cell membranes) rapidly? \_\_\_\_\_  
Examples: \_\_\_\_\_  
\_\_\_\_\_

C. Why do cells (living things) need membranes?

1. Keep out the “bad stuff”
2. Keep in (and concentrate) the “good stuff”

D. Membrane proteins: What is necessary in physical/chemical terms for a protein to be associated with the membrane?

1. Hydrophobic effect attachment/insertion (see 2omf). Called “integral” membrane proteins.
  - a) Hydrophobic amino acid side chains (~25 in a row!)
  - b) Covalently attached lipid
2. Charge (does the membrane generally have a charge due to the nature of the phospholipids? Do opposite charges attract?)

## E. Transport

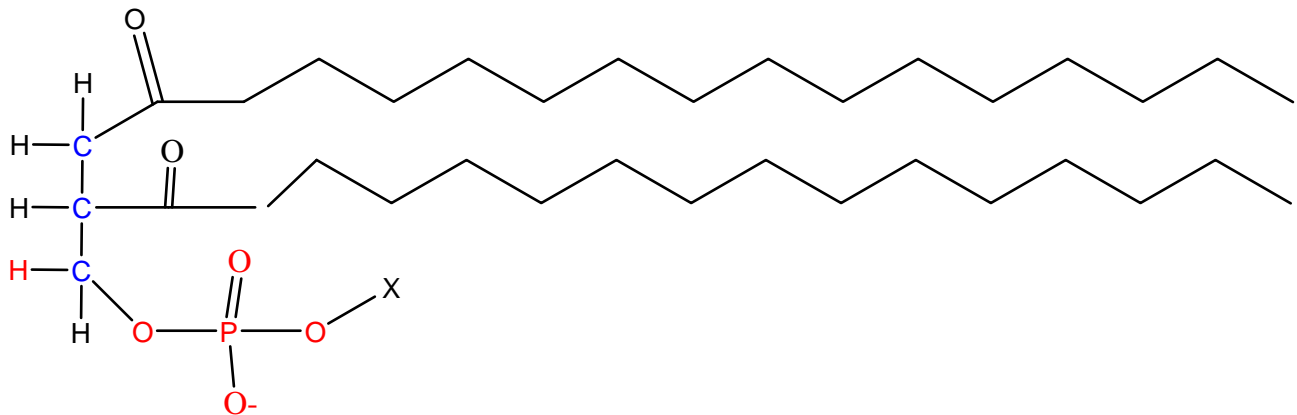
1. Facilitated (w/ concentration gradient), ex.: glucose transporter in most cell types.
2. Active (can transport from regions of lower conc. to higher conc.), example:  $\text{Na}^+/\text{K}^+$  (ATPase) transport in nerve cells.

An aside on diabetes mellitus and cystic fibrosis as membrane dependent diseases.

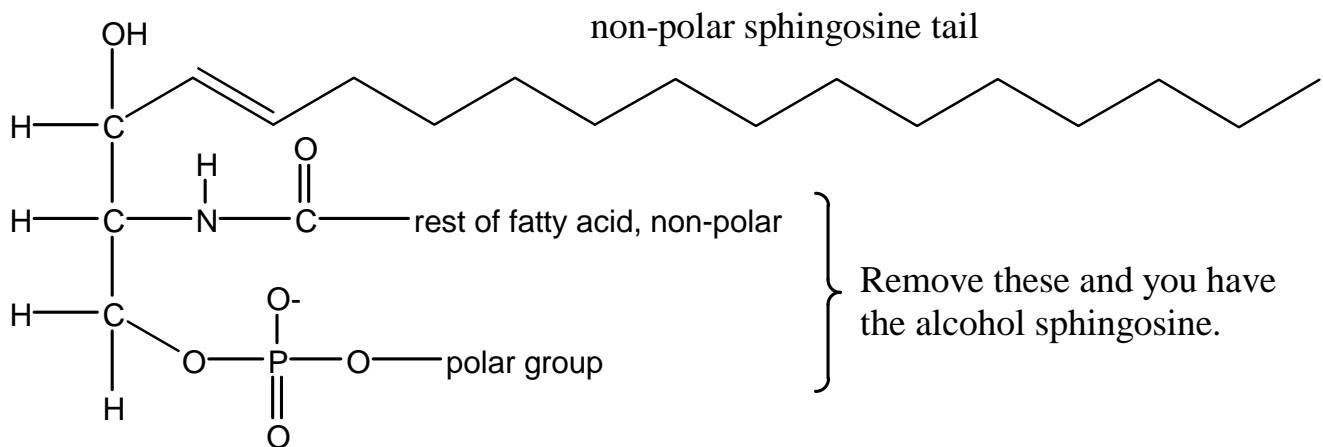
F. Fluid mosaic model of membranes emphasizes a liquid lipid phase. Glycerophospholipids and sphingolipids make up the bulk of the bilayer in many types of membranes. Many biological processes require fluidity in membranes:

1. Red blood cell flexibility in small capillaries
2. Mitogenesis (cell division)

*Glycerophospholipids*: similar in terms of polarity distribution, but have ester linkages to attach the non-polar groups.



*Sphingolipids*: similar polarity to glycerophospholipids, but are not glycerol derived.



We'll come back to these lipids later for diagnostic reasons.

# Membrane videos

Fluid mosaic model

<http://www.youtube.com/watch?v=ULR79TiUj80&feature=related> (1 m 27 s)

Passive transport

General: <http://www.youtube.com/watch?v=s0p1ztrbXPY&feature=related> (27 s)

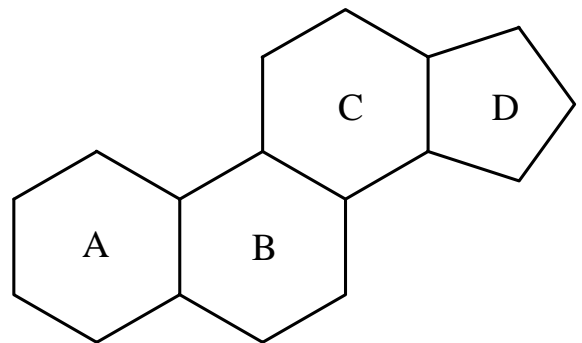
Active transport

General: <http://www.youtube.com/watch?v=STzOiRqzzL4&feature=related> (21 s)

Na<sup>+</sup>/K<sup>+</sup>-ATPase: [http://www.youtube.com/watch?v=bmp2\\_T0c7k&feature=related](http://www.youtube.com/watch?v=bmp2_T0c7k&feature=related) (37 s)

## VI. STEROIDS

A. Steroids all have a common structural unit:



B. Cholesterol

1. Precursor for the synthesis of steroid hormones.
2. Important component of membranes

C. Cholesterol transport

1. HDL (“good cholesterol,” uptake by liver)
2. LDL (“bad cholesterol,” delivery to tissues).

You must have some LDL.

3. Cholesterol levels, LDL/HDL ratios and risk of circulatory disease.

## VII. STEROID HORMONES

### A. Adrenocortical hormones

1. Aldosterone regulates  $\text{Na}^+$ ,  $\text{Cl}^-$ , and  $\text{K}^+$  reabsorption (kidneys). Blood pressure effect.
2. Cortisol regulates a wide range of metabolic processes and is also immuno-suppressive.

### B. Sex hormones (reproductive development/function)

1. Progesterone (f) (develop/maintain pregnancy)
2. Estrogens (f) (“ / ”)
3. Androgens (m) (maintain sexual function, secondary sex characteristics, lose gold medals)

### C. How do birth control pills work???

For refresher on human ♀ reproductive cycle see:

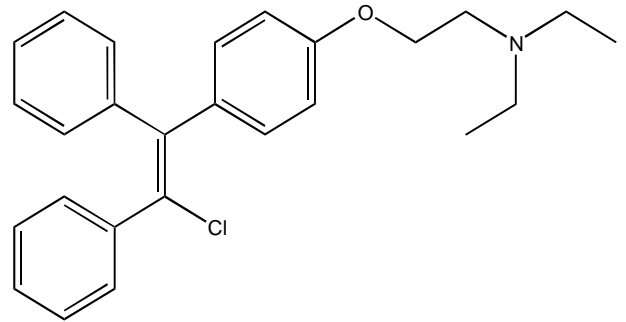
[http://www.merck.com/media/mmhe2/figures/MMHE\\_22\\_241\\_03\\_eps.gif](http://www.merck.com/media/mmhe2/figures/MMHE_22_241_03_eps.gif)

## *Additional comments on lipids & reproduction:*

1. *Can't ovulate?* Try Clomid (clomiphene citrate)!!! It:
  - a) enhances ovulation and
  - b) allows 30% of selected infertile women to conceive
  - c) offspring appear to be normal (I might dispute that.)

*Mode of action?* Enhances GnRH release by mimicking a steroid.

Is this a true lipid?



2. *Want to know if “the frog is ready to drop?”* Check the L/S (lecithin/sphingomyelin) ratio of the amniotic fluid.  
Relationship between L/S ratio & respiratory distress syndrome (RDS):

<u>L/S</u>	<u>odds of RDS</u>	
>2.0	1 in 50	
1.5-2.0	1 in 3	(from Harvey &
<1.5	3 in 4	Parkinson, 1980)

3. *What if the frog is **not** ready?* Mom-to-be, try corticosteroids before delivery!!!