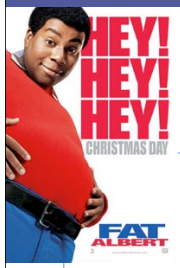
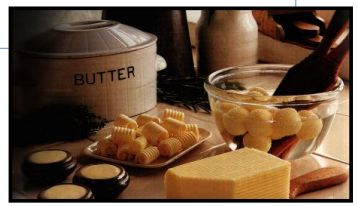


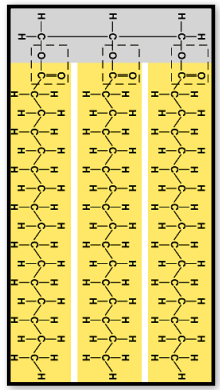
Lipids

Function in long-term, concentrated energy storage, membrane formation, chemical messaging, and hydrophobic barriers creation.



Lipids

- **Lipids are composed of C, H, O just like carbohydrates but have much fewer O compared to the number of C and H.**
  - **Different proportions and combined in a different structure**
    - **They have long hydrocarbon chains**
    - **Do not form true polymers**
      - **They are not a continuous chain of monomers**
    - **They are big molecules made of smaller subunits but *not big enough to be macromolecules***
  - **Very different biological properties**

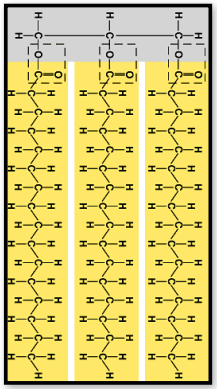


Example: Triglyceride (Fat)

Lipids

Lipids are defined by their poor ability to mix with water due to the non-polar hydrocarbon chains.

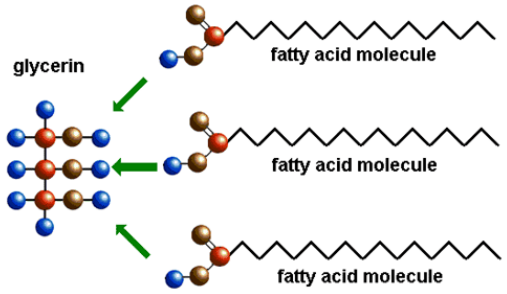
- **"Family groups"**
  - **Fats**
  - **Phospholipids**
  - **Steroids**
  - **Waxes**
  - **Certain Pigments**



Example: Triglyceride (Fat)

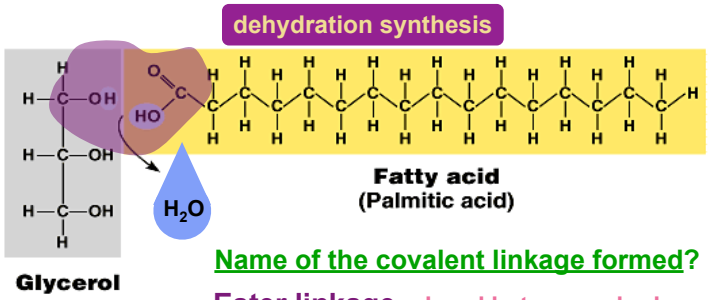
Fats

- **Structure:**
  - **1 glycerol + 3 fatty acid molecules**
    - **Glycerol = 3 C alcohol containing 3 -OH groups**
    - **fatty acid = long hydrocarbon "tail" (often 16 - 18 C) with carboxyl (COOH) group "head"**



Fats

- Fatty acids are combined with glycerol through dehydration synthesis reactions.
- Requires an Enzymes

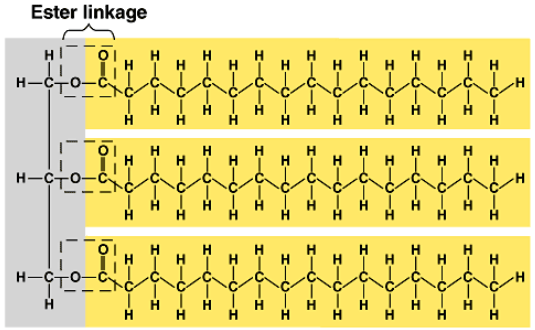


Name of the covalent linkage formed?

Ester linkage = bond between a hydroxyl and a carboxyl group

Building Fats

- Triacylglycerol (a.k.a. triglyceride or fat)
  - 3 fatty acids linked to glycerol
  - Involves the making of 3 ester bonds

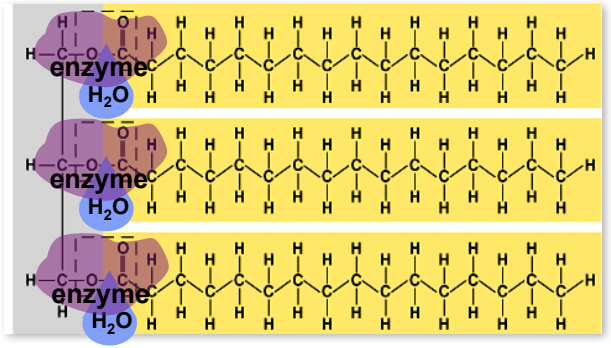


(b) Fat molecule (triacylglycerol)

Dehydration synthesis

Glycerol + Fatty Acids

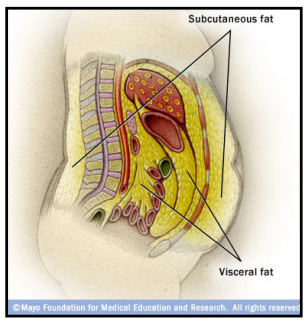
dehydration synthesis



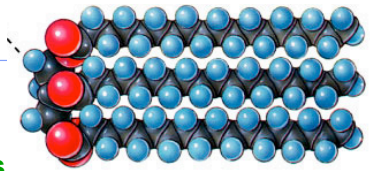
Function of Fats

Why do humans like fatty foods?

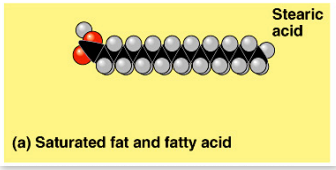
- Long HC chain
  - polar or non-polar?
  - hydrophilic or hydrophobic?
- Function:
  1. energy storage
     - Concentrated form
       - all H-C bonds can be broken to release energy
       - 1 g of fat has 2x the energy of 1 g of carbohydrates
  2. cushion organs
  3. insulates body
     - Slow down heat loss
       - think whale blubber!



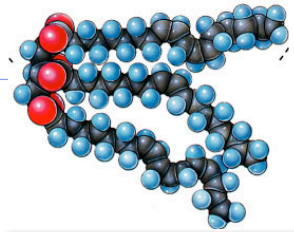
Saturated fats



- Composed of saturated fatty acids bonded to glycerol
- Carbons of the fatty acid tails are bonded to maximum number of H's
- No C=C double bonds
  - long, straight chain
  - most animal fats
  - solid at room temp.
    - Tails can pack together tightly.
      - contributes to cardiovascular disease (atherosclerosis) = plaque deposits in arteries

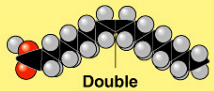


Unsaturated fats



- Have C=C *cis* double bonds in the fatty acids
  - plant & fish fats
  - vegetable oils
  - liquid at room temperature
    - the kinks made by double bonded C prevent the fat molecules from packing tightly together

Mono-unsaturated?
One double bond in the fat molecule
Poly-unsaturated?
Many double bonds in the fat molecule

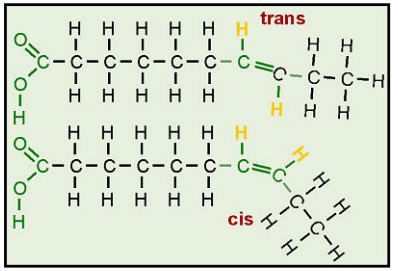


(b) Unsaturated fat and fatty acid

The evil trans fats

The evil trans fats

- Naturally-occurring unsaturated vegetable oils have:
  - Almost all cis bonds
  - But exposure to high heat (frying) causes some to convert to trans bonds.
    - If oil is used only once like when you fry an egg, only a few of the bonds do this so it's not too bad.
    - If oil is constantly reused, like in fast food French fry machines, more and more of the cis bonds are changed to trans bonds



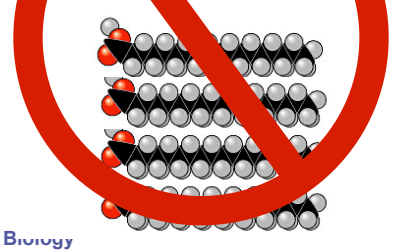
- Diets high in fatty acids are also correlated with coronary artery disease
- They may also be carcinogenic (= cancer-causing) & raise LDL cholesterol levels.

Making saturated fats artificially

- Hydrogenated vegetable oil (as in commercial peanut butters where a solid consistency is sought) started out as "good" unsaturated oil.
- However, this commercial product has had all the double bonds artificially broken and hydrogens artificially added to turn it into saturated fat that bears no resemblance to the original oil from which it came
  - Now it will be solid at room temperature
  - It breaks down slower so acts a bit as a preservative.
- Many fast foods that advertise new 'healthier' meals by removing trans fats actually just converted them to saturated fats!

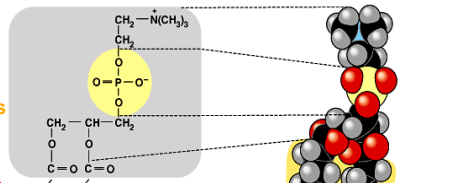
Saturated vs. unsaturated

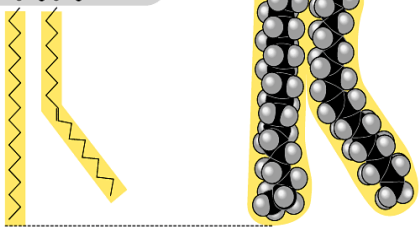
saturated **unsaturated**

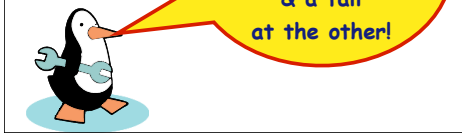


Phospholipids

- Structure:
  - glycerol + 2 fatty acids + PO_4
  - PO_4 = negatively charged
  - Diversity:
    - Differences in 2 fatty acids
    - Groups attached to the phosphate group heads

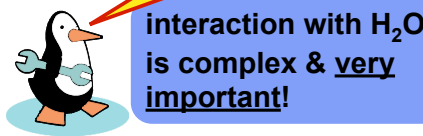




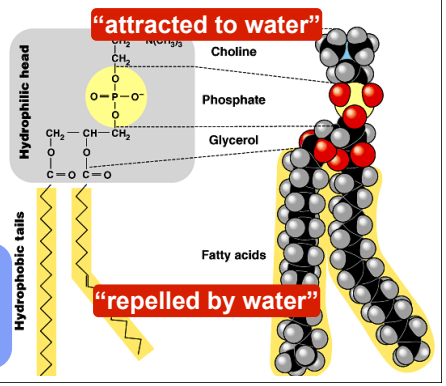


Phospholipids

- Hydrophobic or hydrophilic?
  - fatty acid tails = hydrophobic
  - PO_4 head = hydrophilic
  - These molecules are AMPHIPATHIC and have a "split personality"

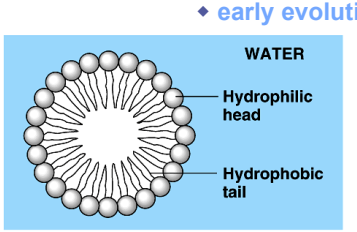


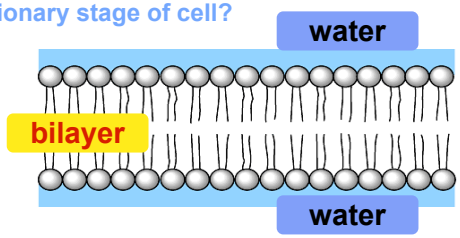
interaction with H_2O is complex & very important!



Phospholipids in water

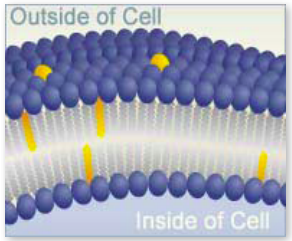
- Hydrophilic heads "attracted" to H_2O
- Hydrophobic tails "hide" from H_2O by grouping together
  - These non-polar regions are excludes by water as water molecules hydrogen bond with each other.
- Self-assemble into "spheres"
  - Spheres are called "micelles"
  - can also form a phospholipid bilayer
    - early evolutionary stage of cell?

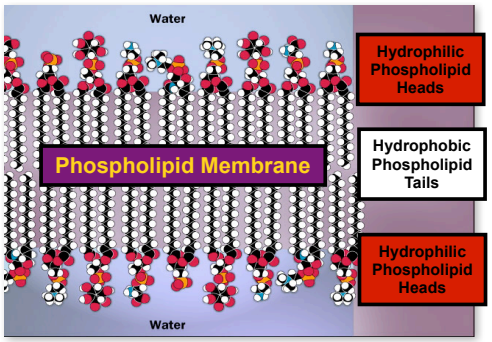




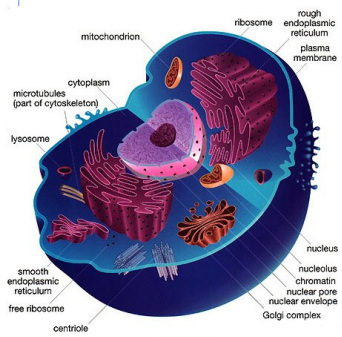
Why is this important?

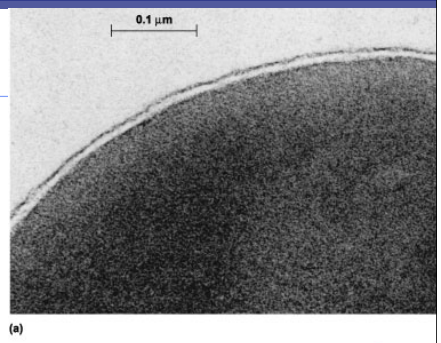
- Phospholipids create a barrier to water
  - define outside vs. inside
  - they make cell membranes!

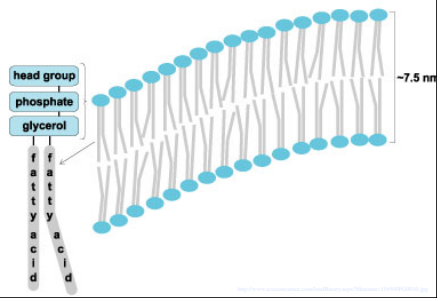




Cell membrane



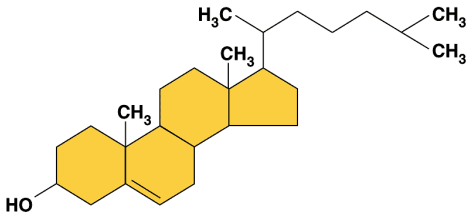




Steroids

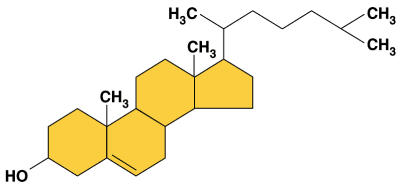
- Structure:
  - Lipids composed of 4 fused C rings + ??
    - Different steroids are created by attaching different functional groups to rings
    - Different structure creates different function
  - Examples: cholesterol, sex hormones

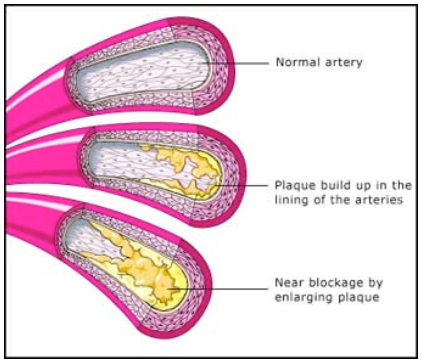
cholesterol



Cholesterol

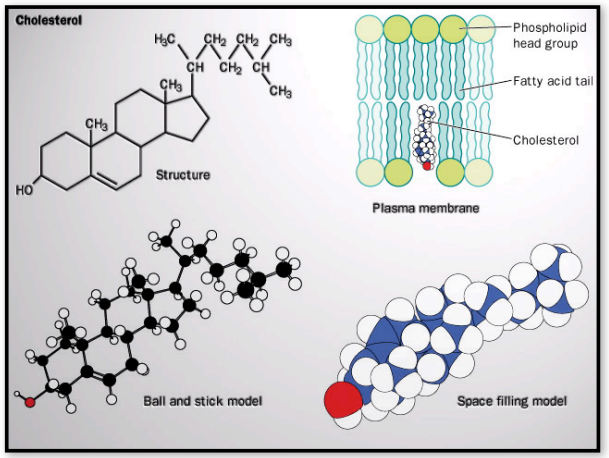
- Important cell component:
  - Key component in animal cell membranes
  - Precursor of all other steroids
    - including vertebrate sex hormones
  - high levels in blood may contribute to cardiovascular disease





Cholesterol

Membranes act as a semi-permeable membrane so a different environment can be maintained inside the cell than outside of it.

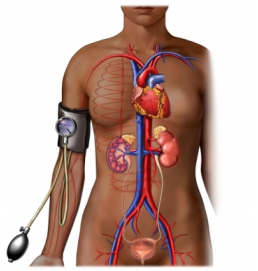


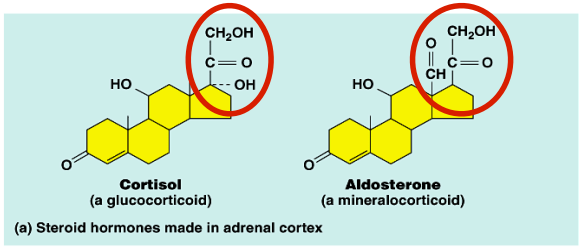
Without cholesterol the cell membrane would be too fluid, not firm enough, and too permeable to many molecules.

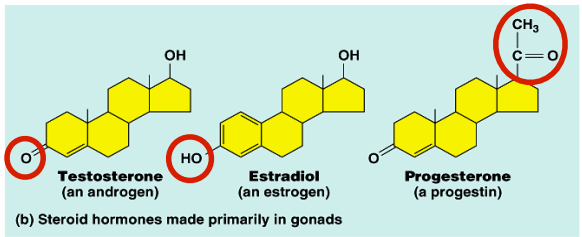
Keeps cell membranes flexible but not too fluid.

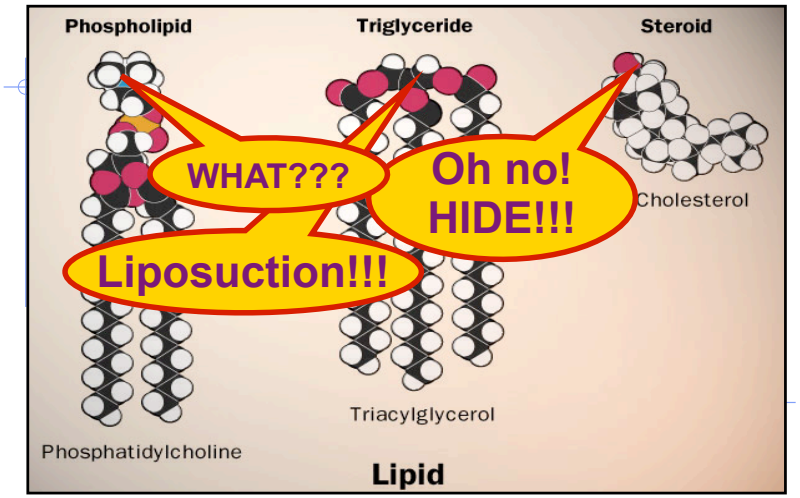
From Cholesterol → Sex Hormones

- What a big difference a few atoms can make!









Any questions?