Time for Macromolecules!!

Most macromolecules are built from monomers

- What's a macromolecule?

Building Blocks

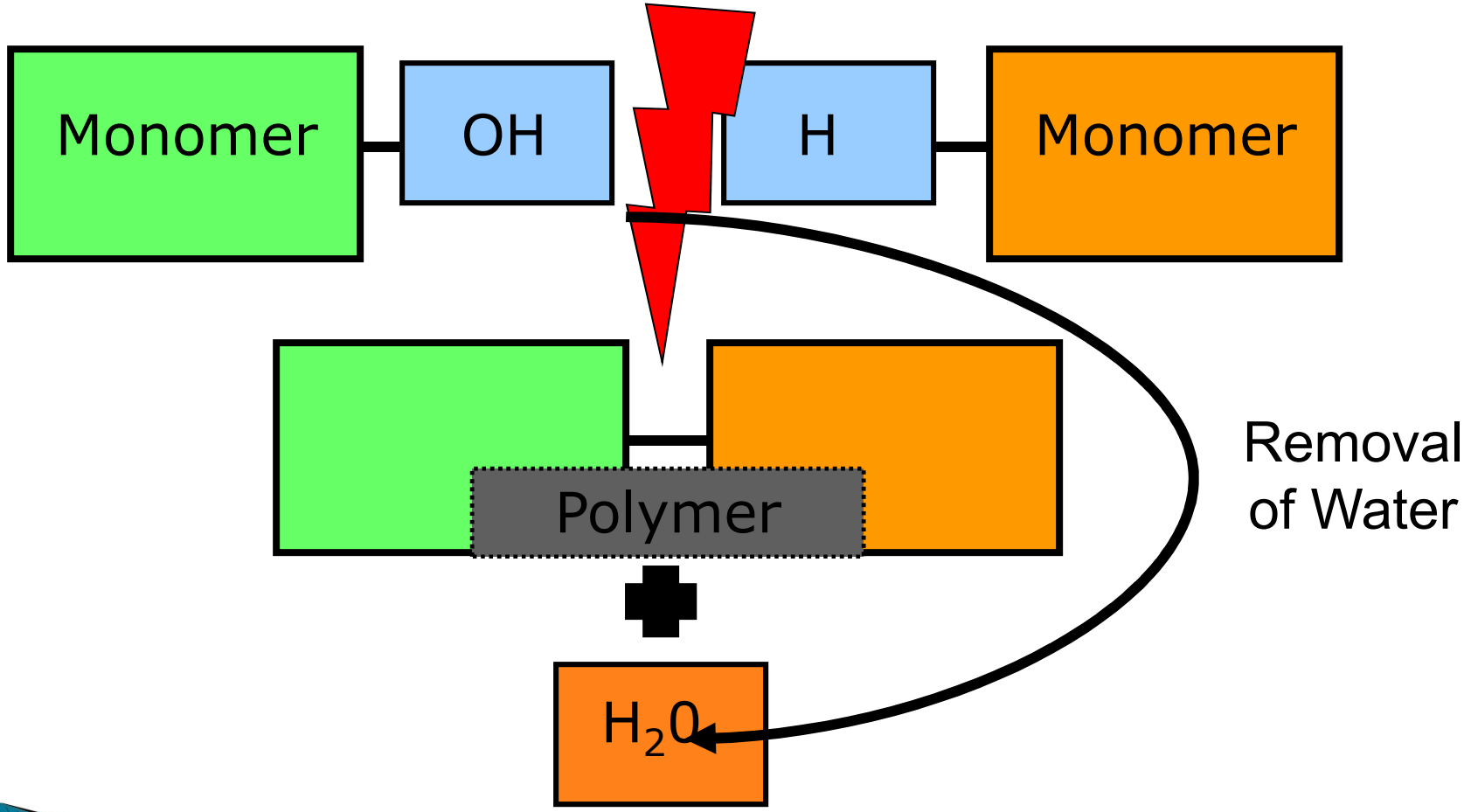
- Monomer

- Polymer

How are polymers made?

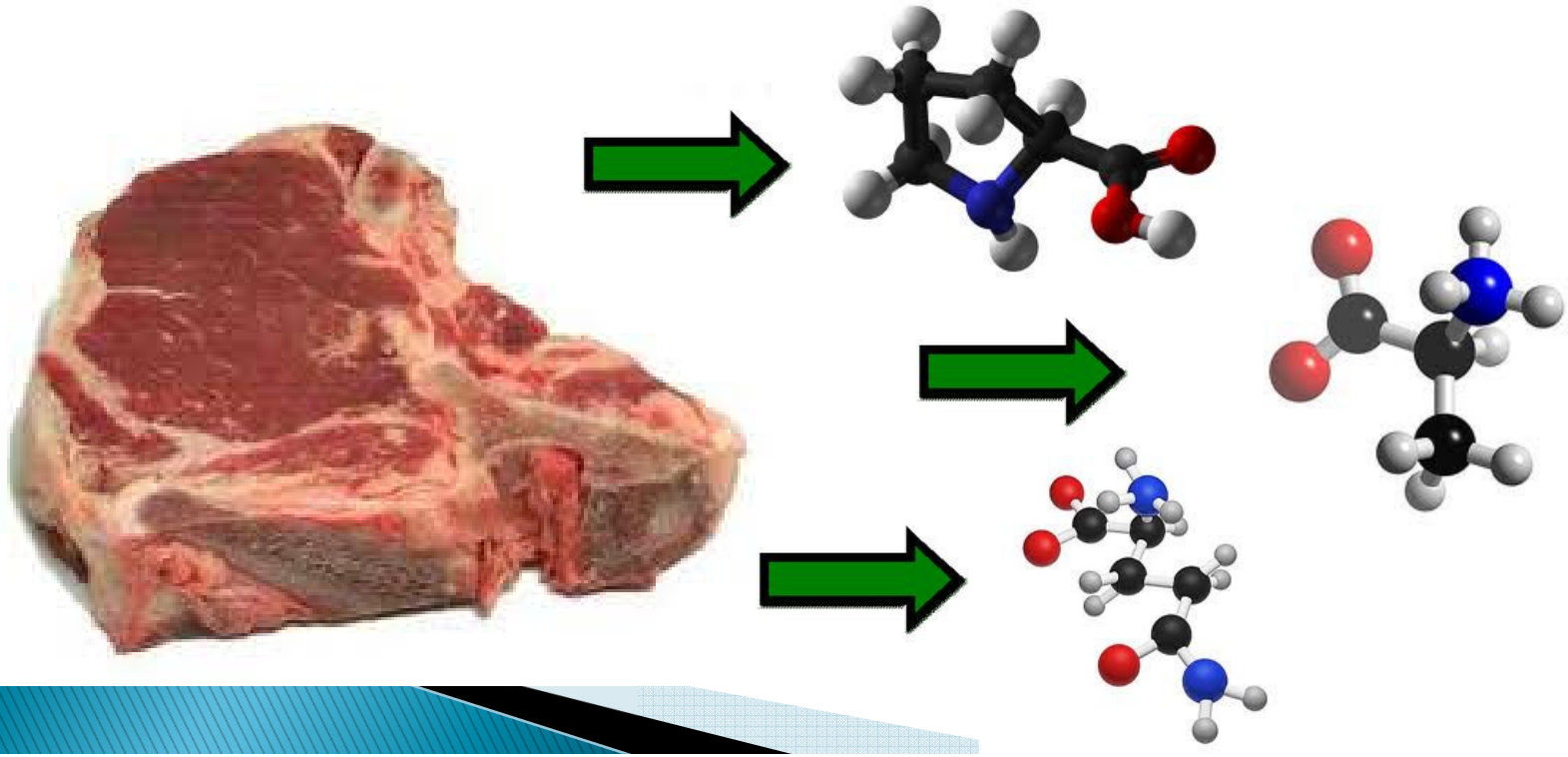
- Condensation reaction also known as a dehydration reaction.
- Where did it get a name like that?

Condensation (Dehydration Synthesis)

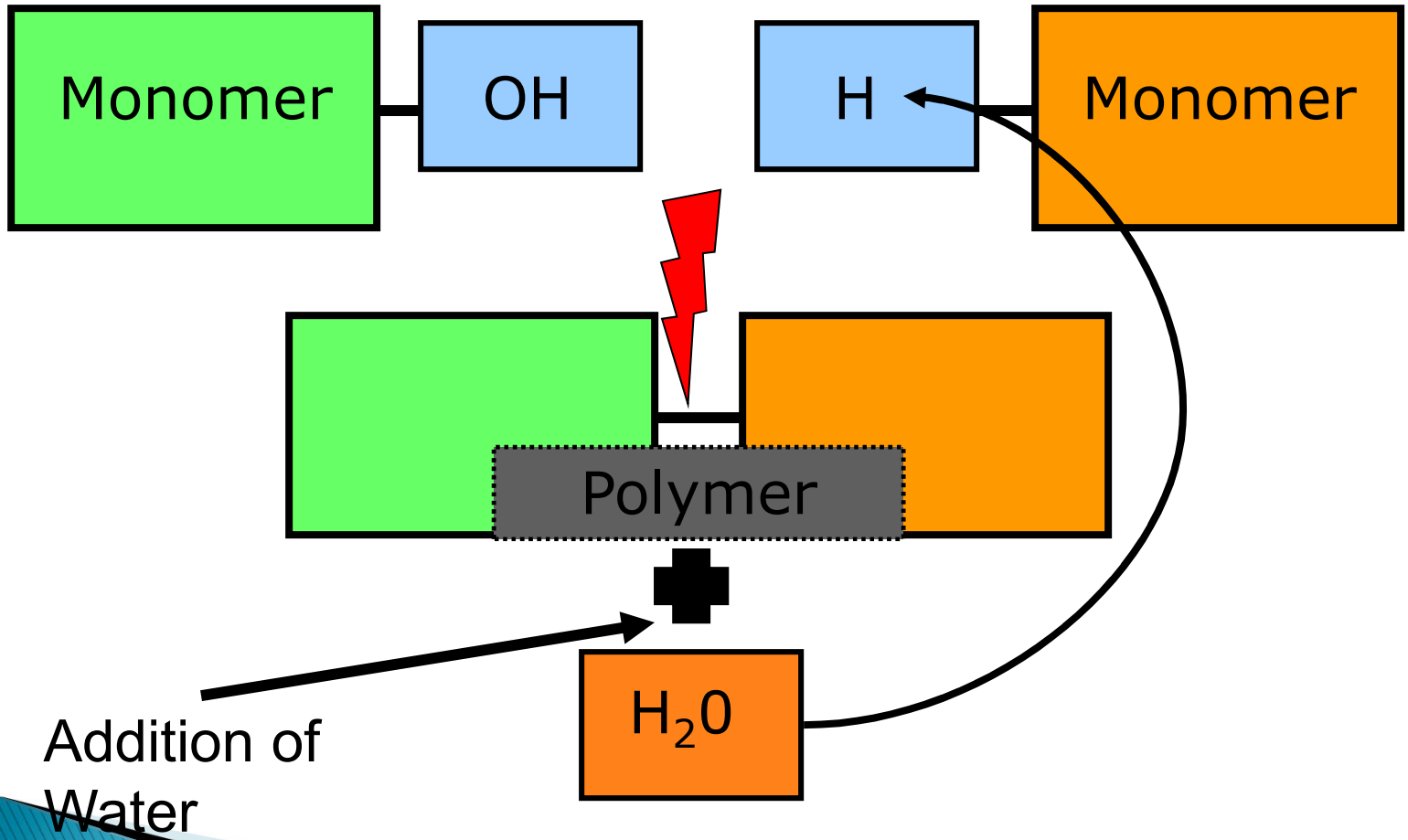


How are polymers broken down?

- Hydrolysis
- A process that is the reverse of a dehydration reaction
- Disassembled back into monomers



Hydrolysis



Macromolecules have direction

- What the heck does that mean?
- ?naem taht soed kceh eht tahw
- Direction will influence structure and function.

The FOUR major classes of molecules

- Carbohydrates
- Lipids
- Proteins
- Nucleic Acids

Carbohydrates!!

Useful for…

- Fuel
- Building materials

- (Yummy)

The size and shape of carbohydrates determine their function and properties

Types:

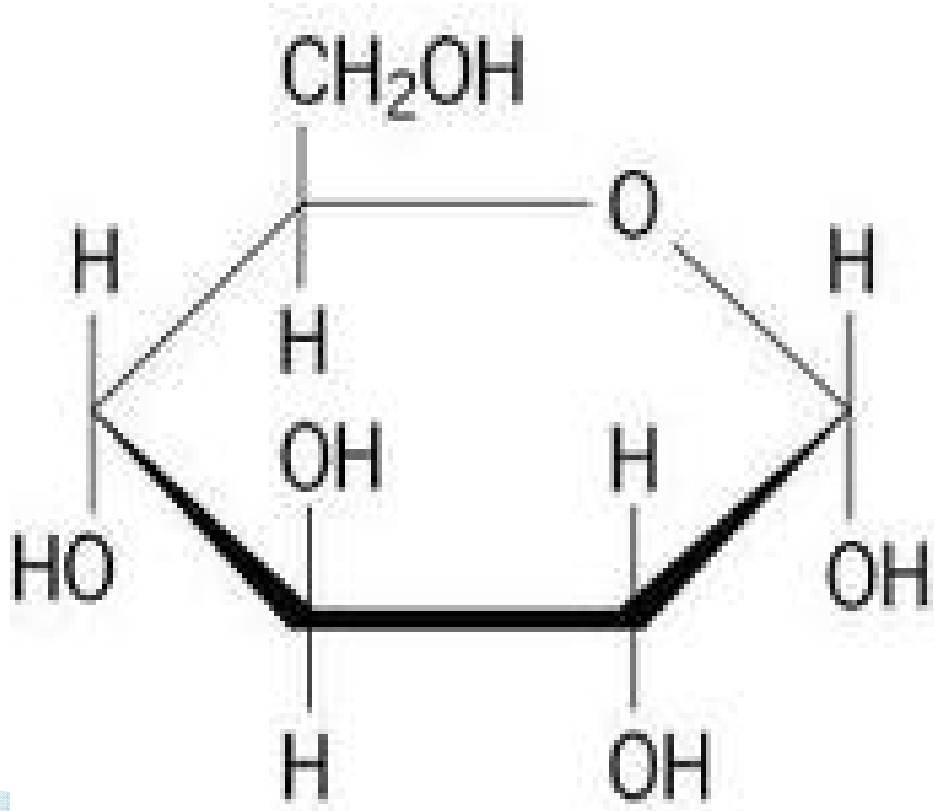
- Monosaccharides
- Disaccharides
- Polysaccharides

- Complex carbohydrates are formed by dehydration synthesis

Carbohydrate monomers are sugars – monosaccharides

- Examples:
  - Glucose (major energy source for cells)
  - Fructose
  - Ribose
  - Galactose

:

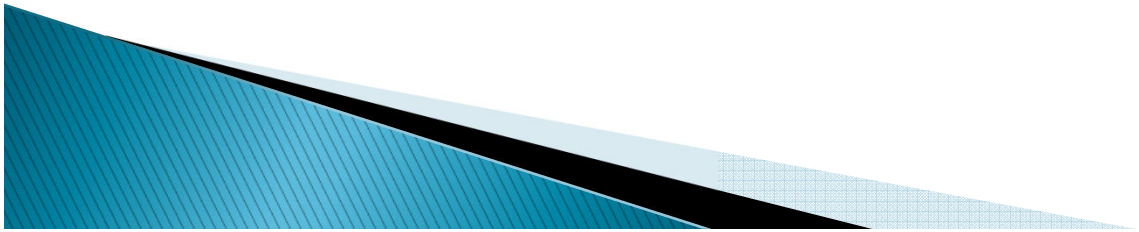


Other interesting but not super important information

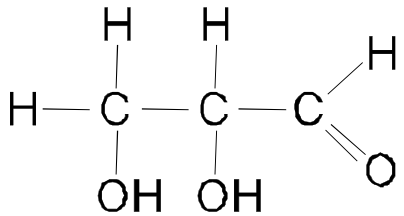
- Typically follow the formula CH_2O
- Carbon skeletons can be used to form amino acids and fatty acids

Monosaccharides

Notice the shapes

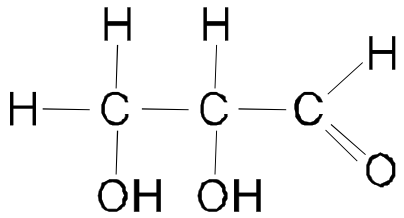


Monosaccharides



Glyceraldehyde
$C_3H_6O_3$

Monosaccharides



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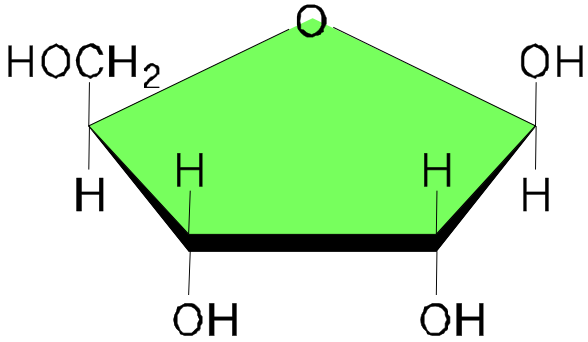
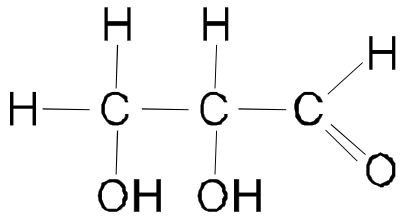


Ribose
$C_5H_{10}O_5$

Monosaccharides



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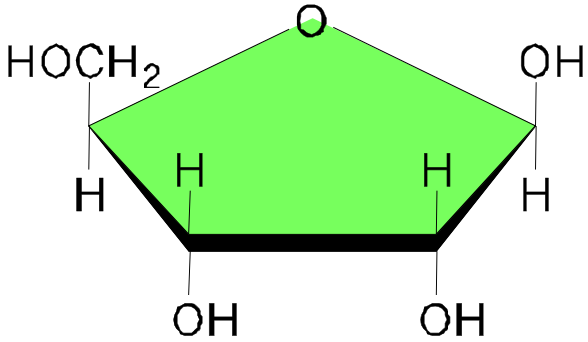

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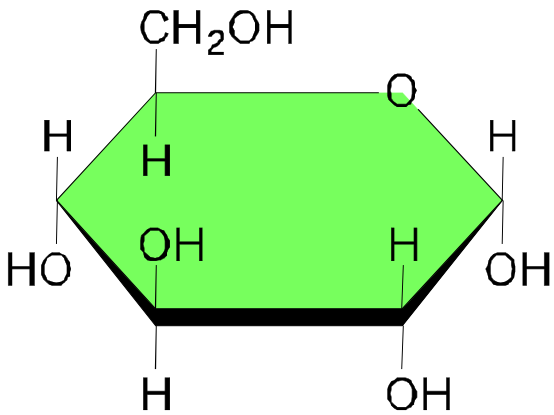
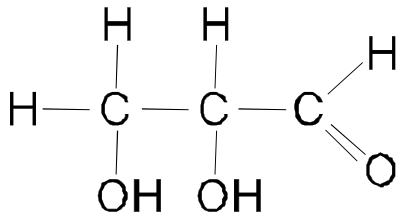


Glucose
$C_6H_{12}O_6$

Monosaccharides



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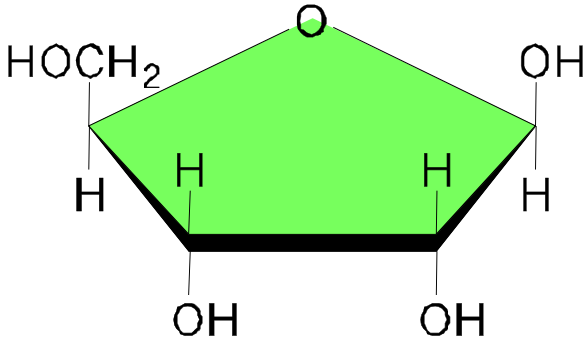

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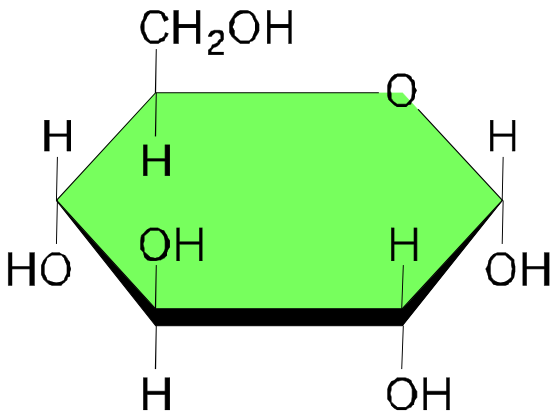
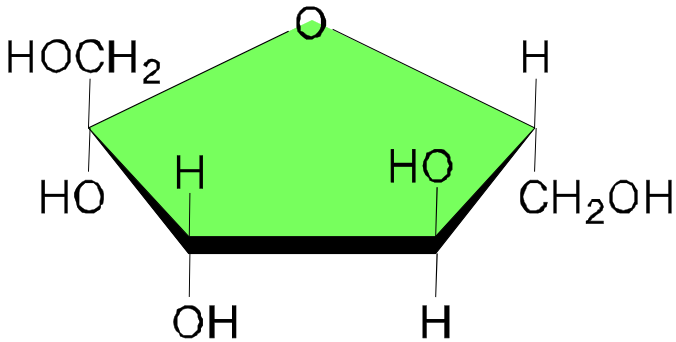


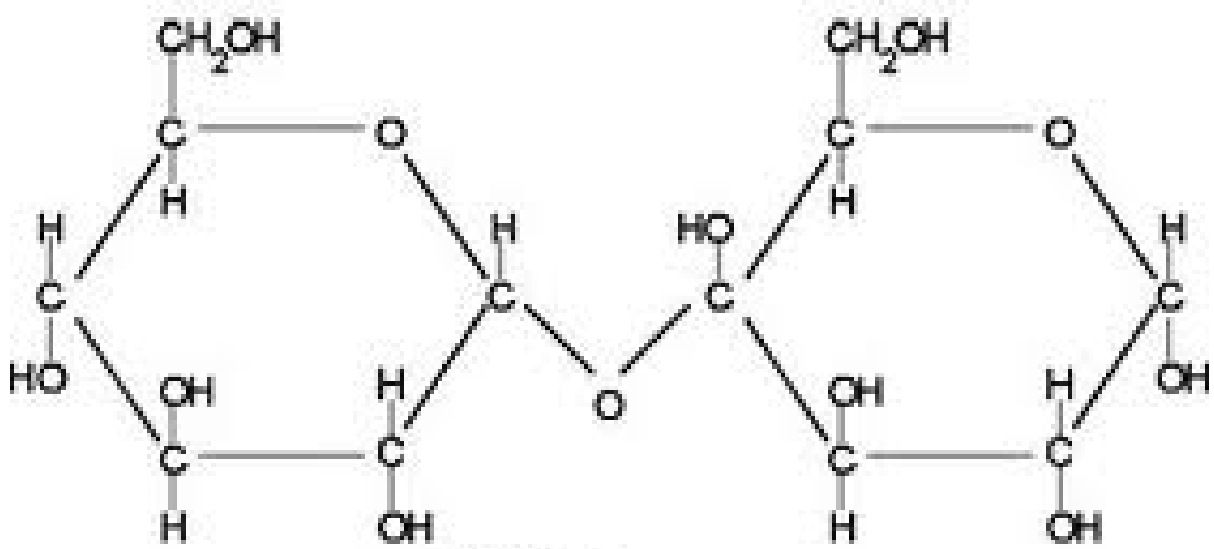
Glucose
$C_6H_{12}O_6$



Fructose
$C_6H_{12}O_6$

Disaccharides

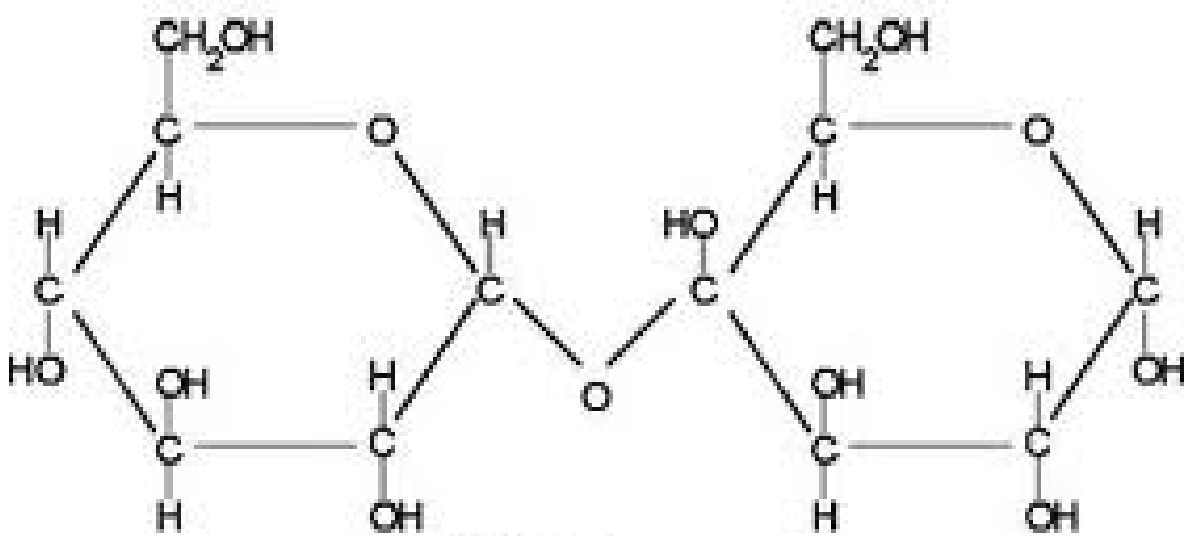
- Glucose + Glucose = Maltose
- Glucose + Fructose = Sucrose
- Glucose + Galactose = Lactose



Maltose

Disaccharides

- 2 monosaccharides joined by a special covalent bond
  - Glycosidic linkage
- What process links them together?



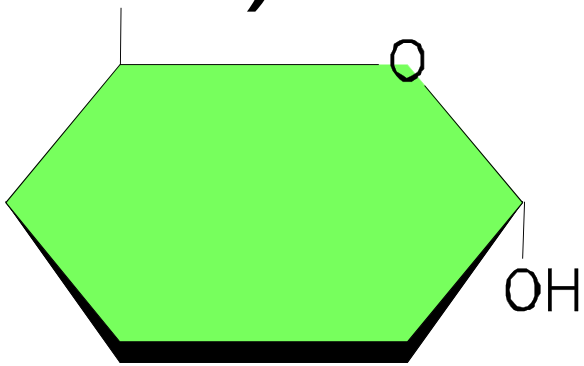
Maltose

Disaccharides

(Dehydration)

Disaccharides

(Dehydration)

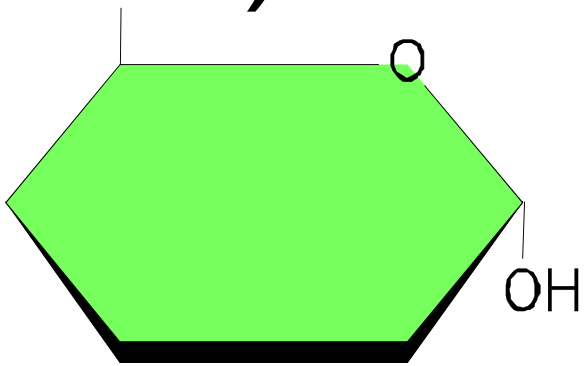


Glucose

$C_6H_{12}O_6$

Disaccharides

(Dehydration)



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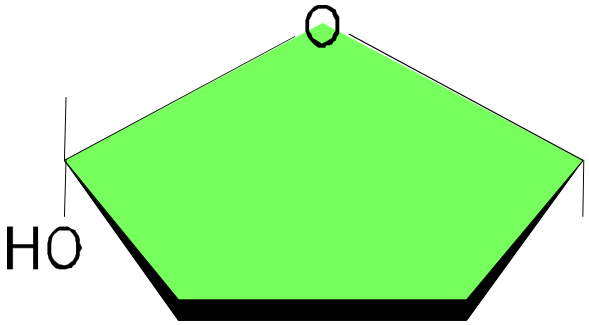
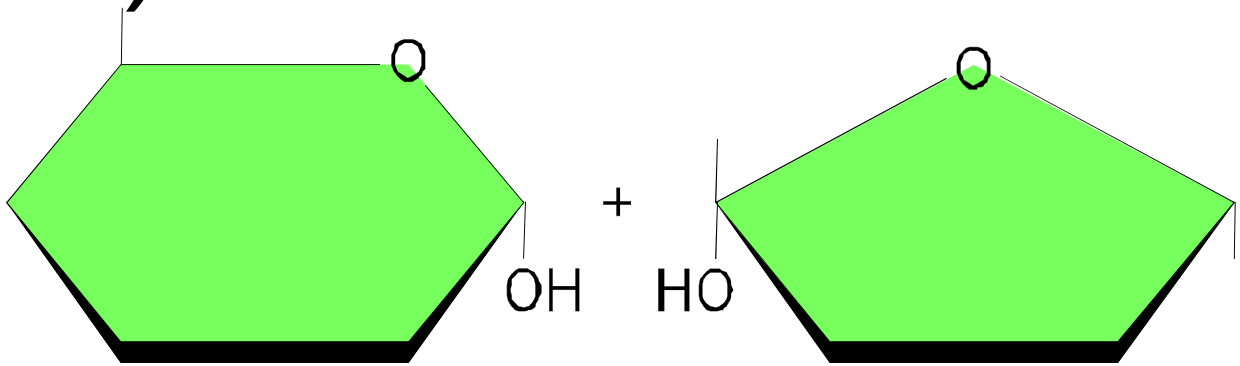


Fructose

$C_6H_{12}O_6$

Disaccharides

(Dehydration)



Glucose

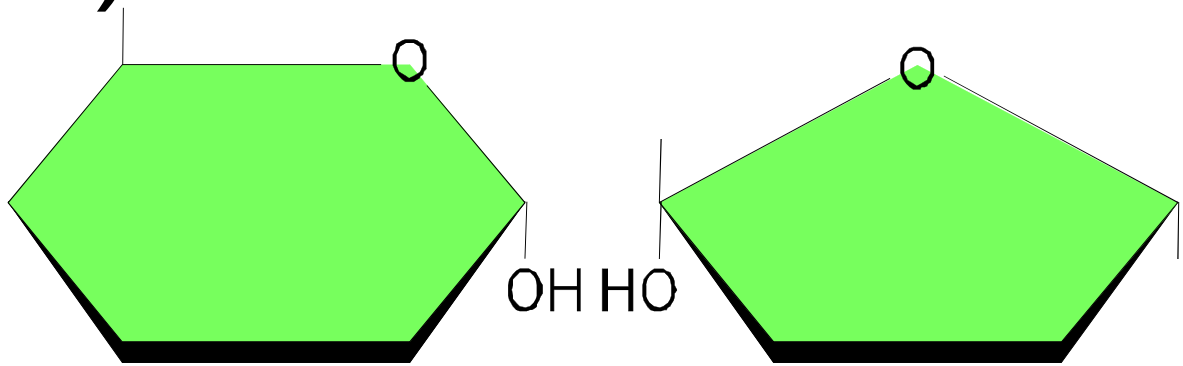
$C_6H_{12}O_6$

Fructose

$C_6H_{12}O_6$

Disaccharides

(Dehydration)



Glucose

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Fructose

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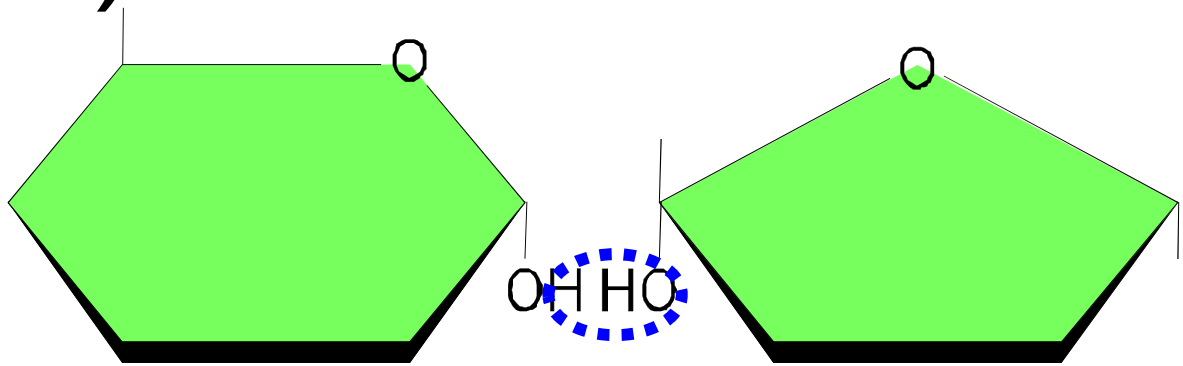
Disaccharides

(Dehydration)



Glucose

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Fructose

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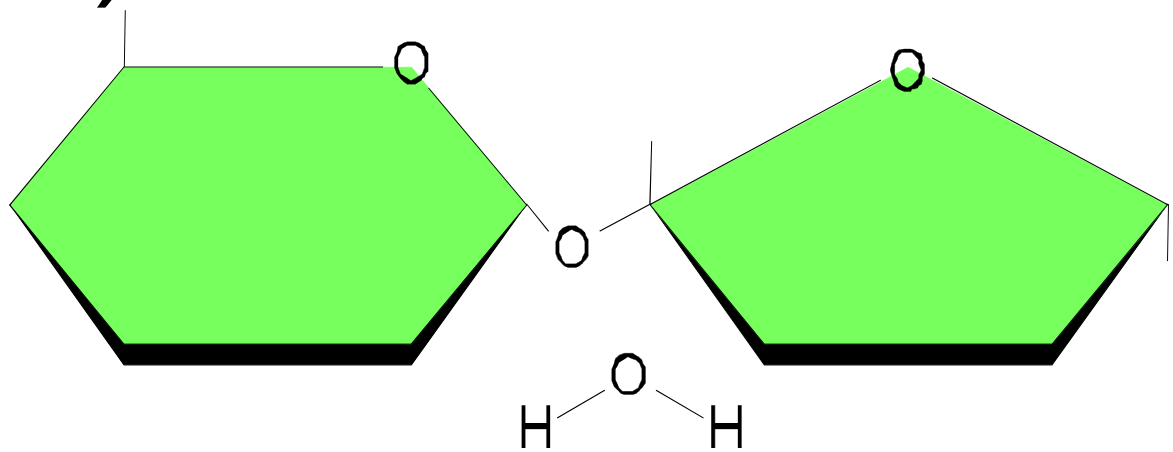
Disaccharides

(Dehydration)

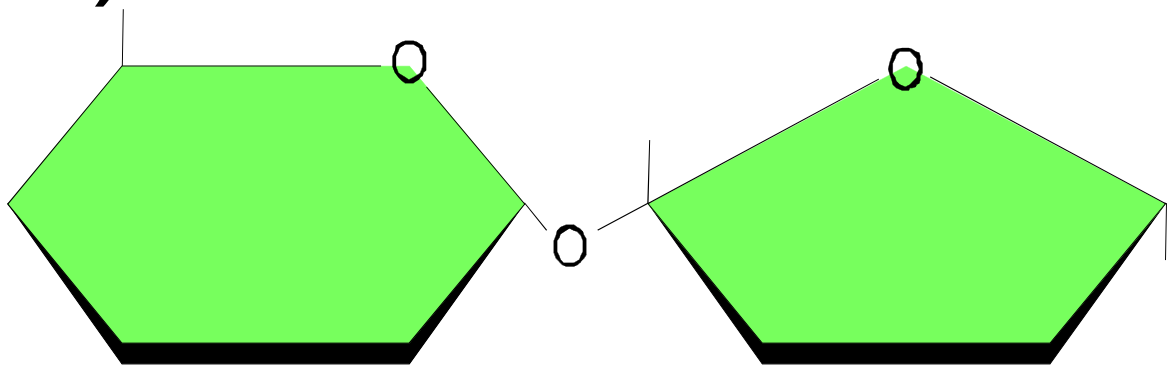


Water

H_2O

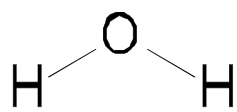
Disaccharides

(Dehydration)



Sucrose

$C_{12}H_{22}O_{11}$

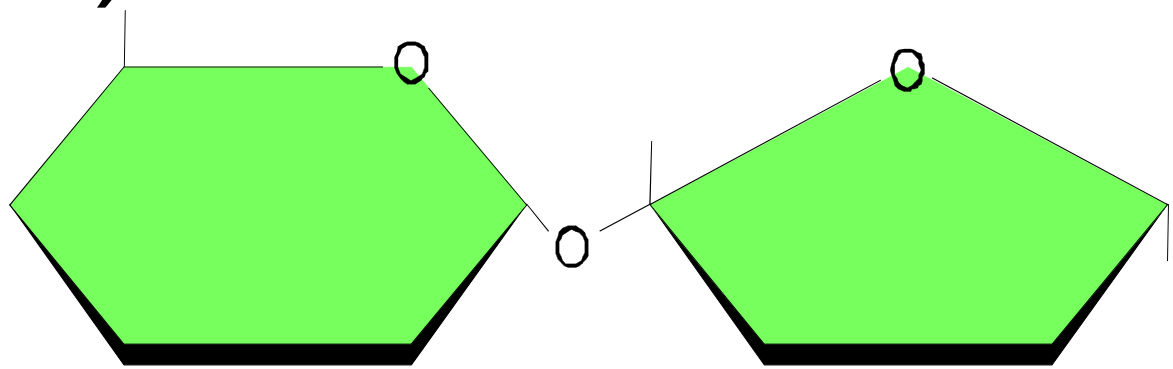


Water

H_2O

Disaccharides

(Dehydration)

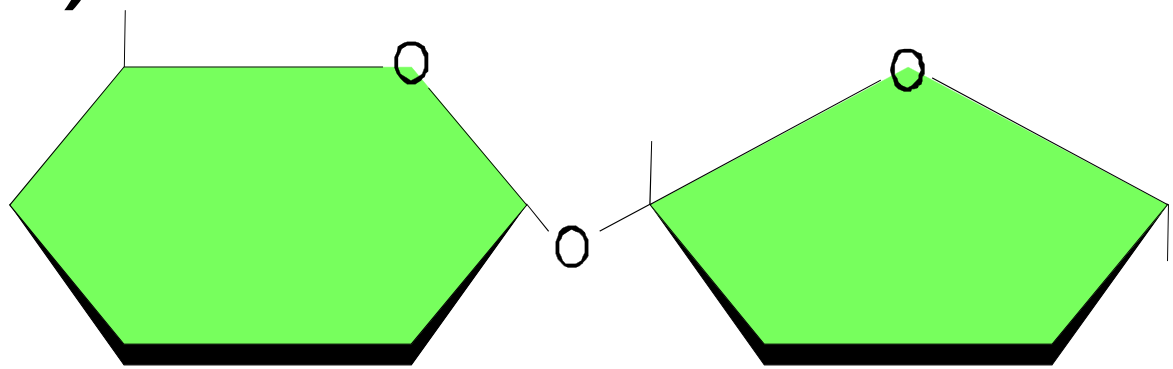


Sucrose

$C_{12}H_{22}O_{11}$

Disaccharides

(Hydrolysis)

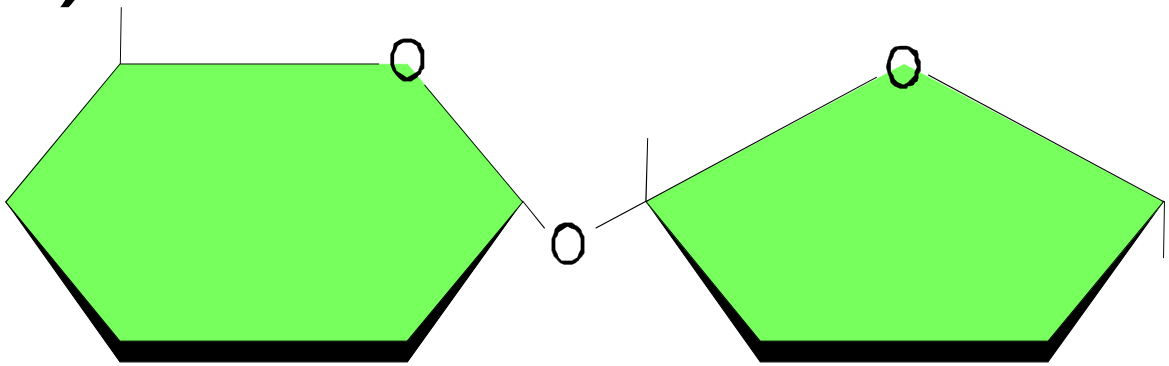


Sucrose

$C_{12}H_{22}O_{11}$

Disaccharides

(Hydrolysis)



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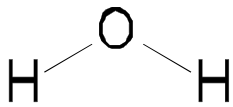
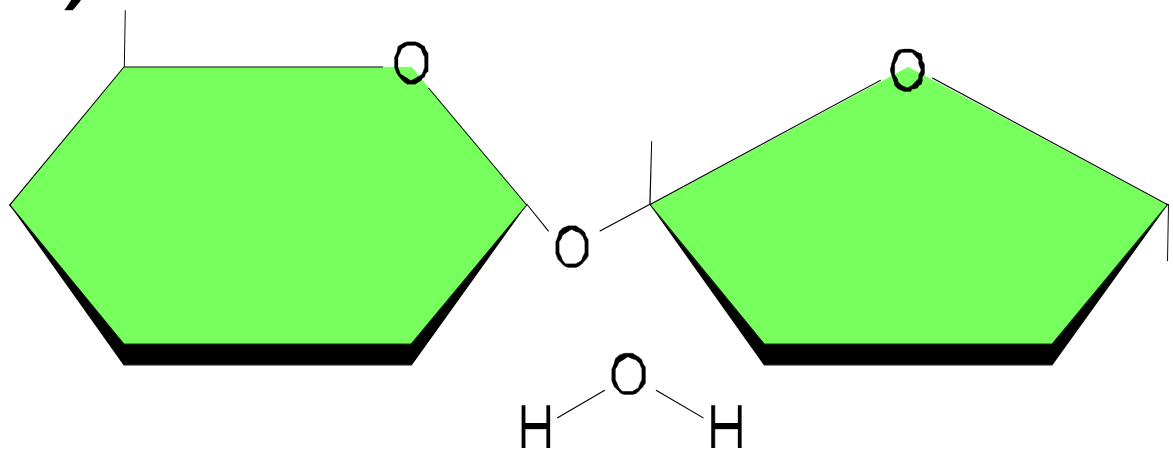


Water

H_2O

Disaccharides

(Hydrolysis)

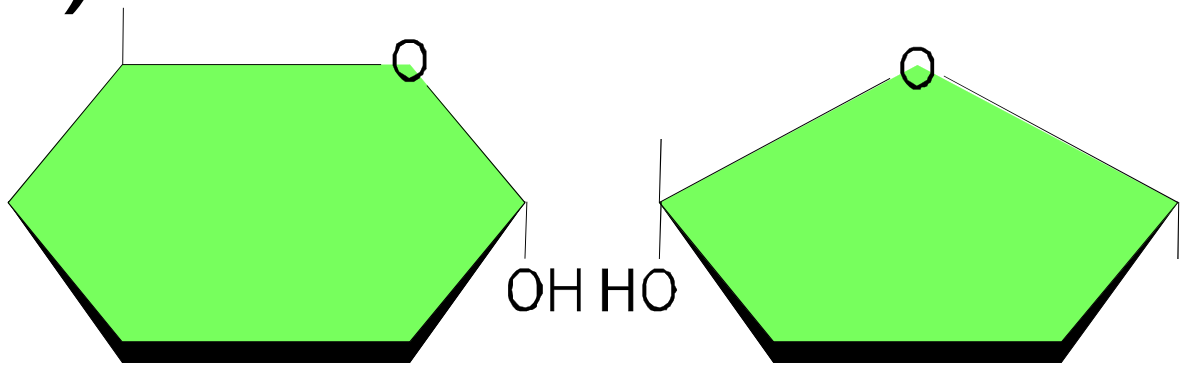


Water

H_2O

Disaccharides

(Hydrolysis)



Glucose

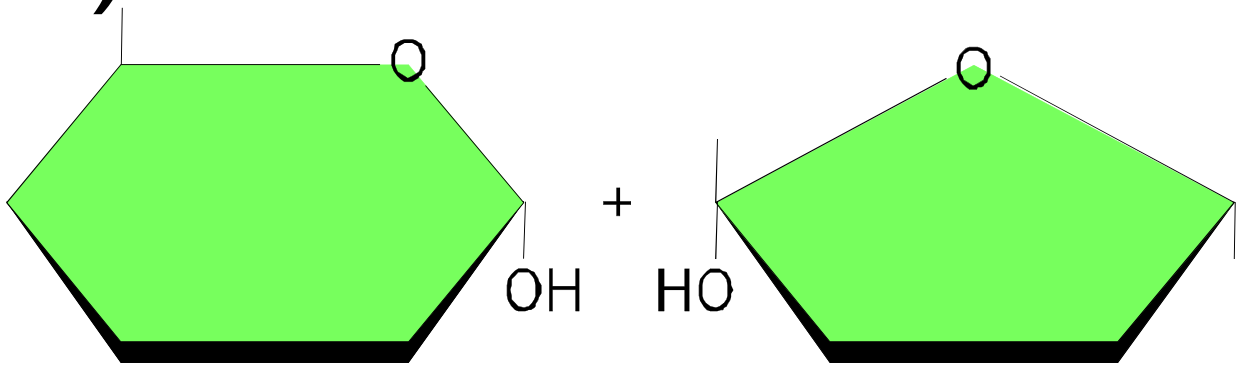
$C_6H_{12}O_6$

Fructose

$C_6H_{12}O_6$

Disaccharides

(Hydrolysis)



Glucose

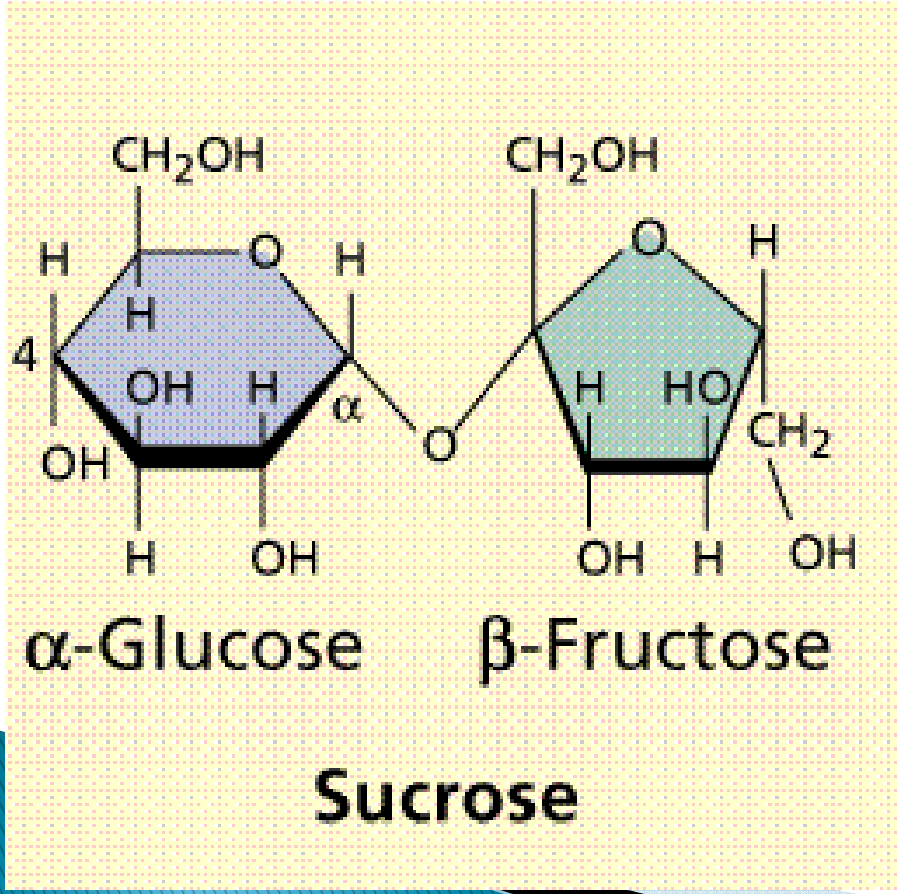
$C_6H_{12}O_6$

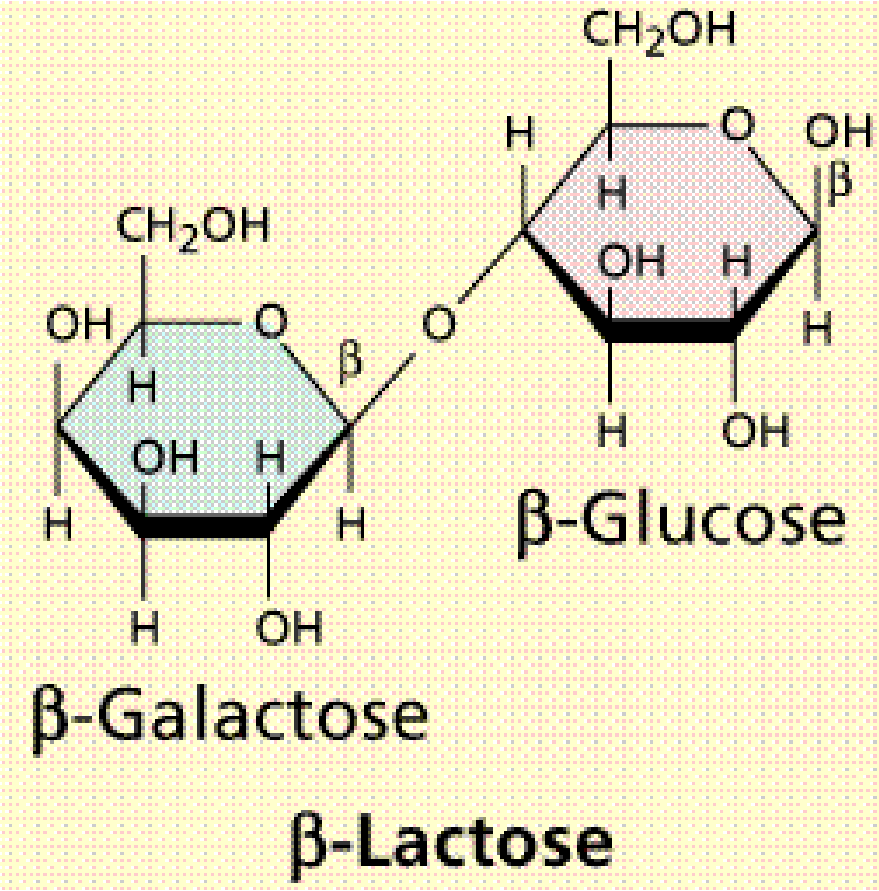
Fructose

$C_6H_{12}O_6$

Common Disaccharide

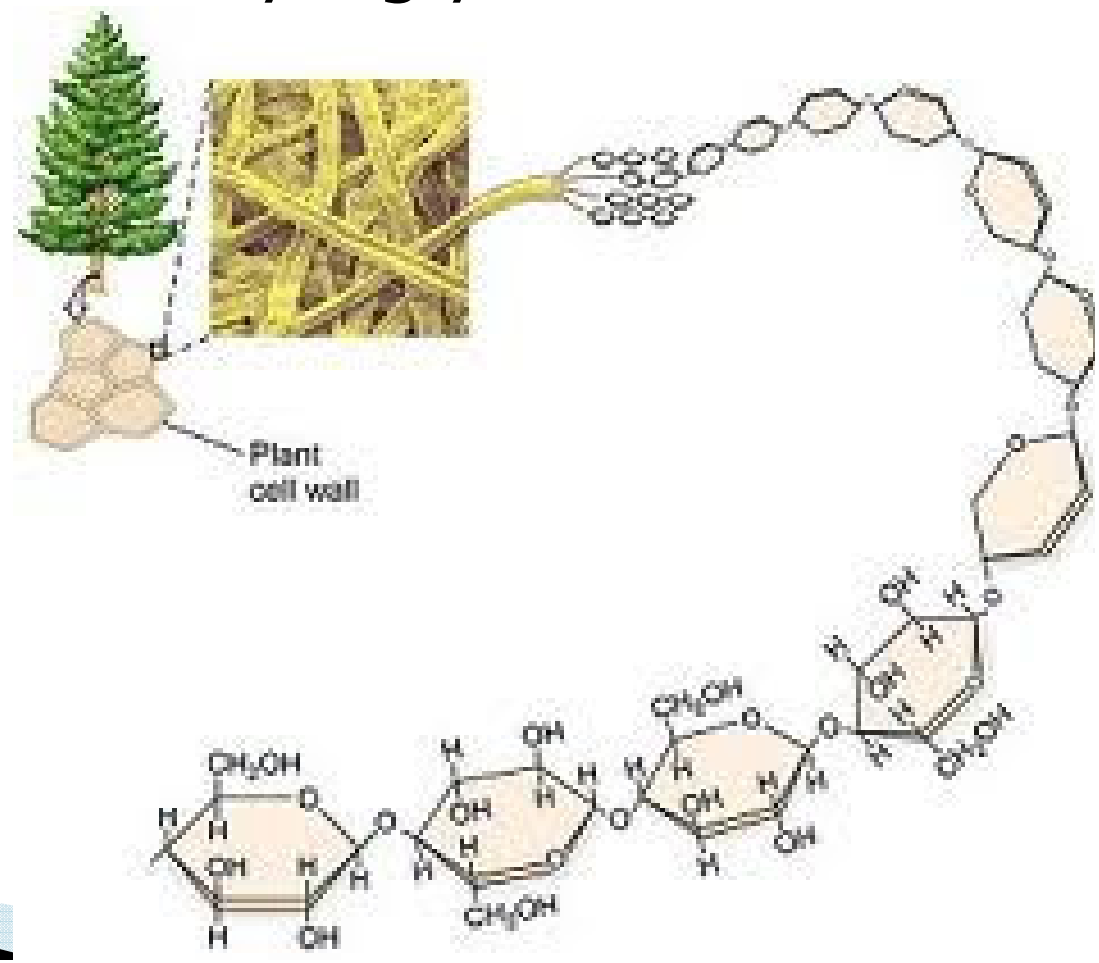
- Notice the Alpha/Beta glucose. What's up with that?





Polysaccharides

- Polymer of hundreds to thousands of monomers, each joined by a glycosidic linkage
- Useful for storage
- Useful as cellular building material

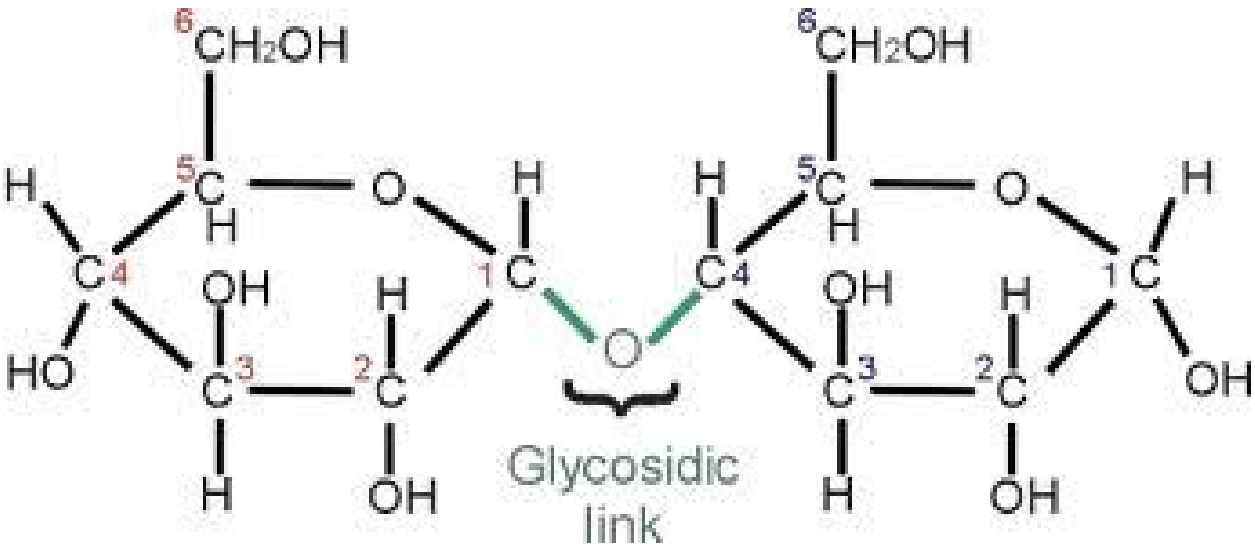


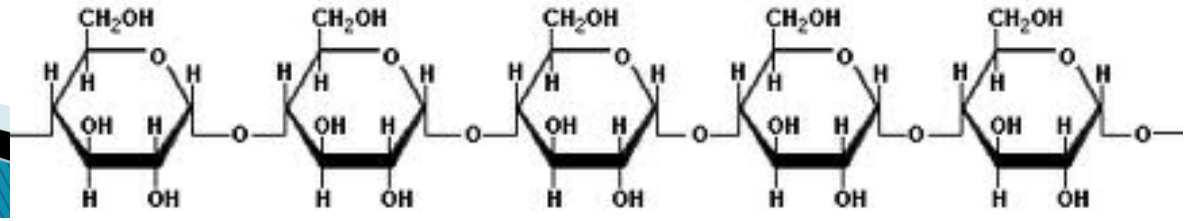
3 polysaccharides made from glucose!!!

- Starch
- Glycogen
- Cellulose

Storage Polysaccharides

- **Starch**– storage polysaccharide of plants
  - Joined in a 1–4 linkage
  - Why do plants need to store anything?





Storage Polysaccharides

- Glycogen – storage polysaccharide of animals

•Stored in the liver and muscles
•Released "on demand"
•Not long lasting

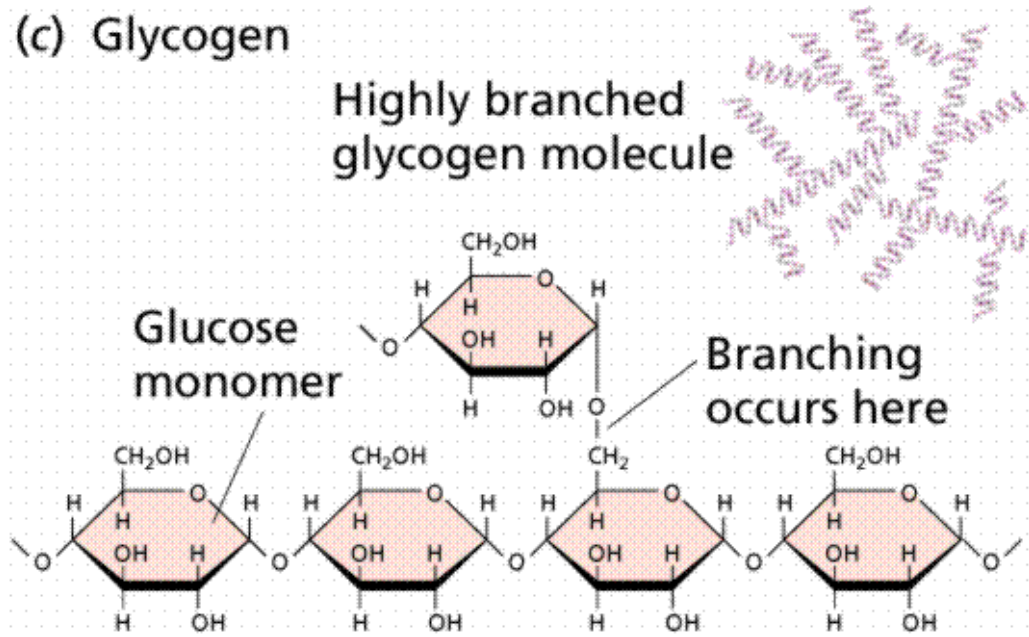
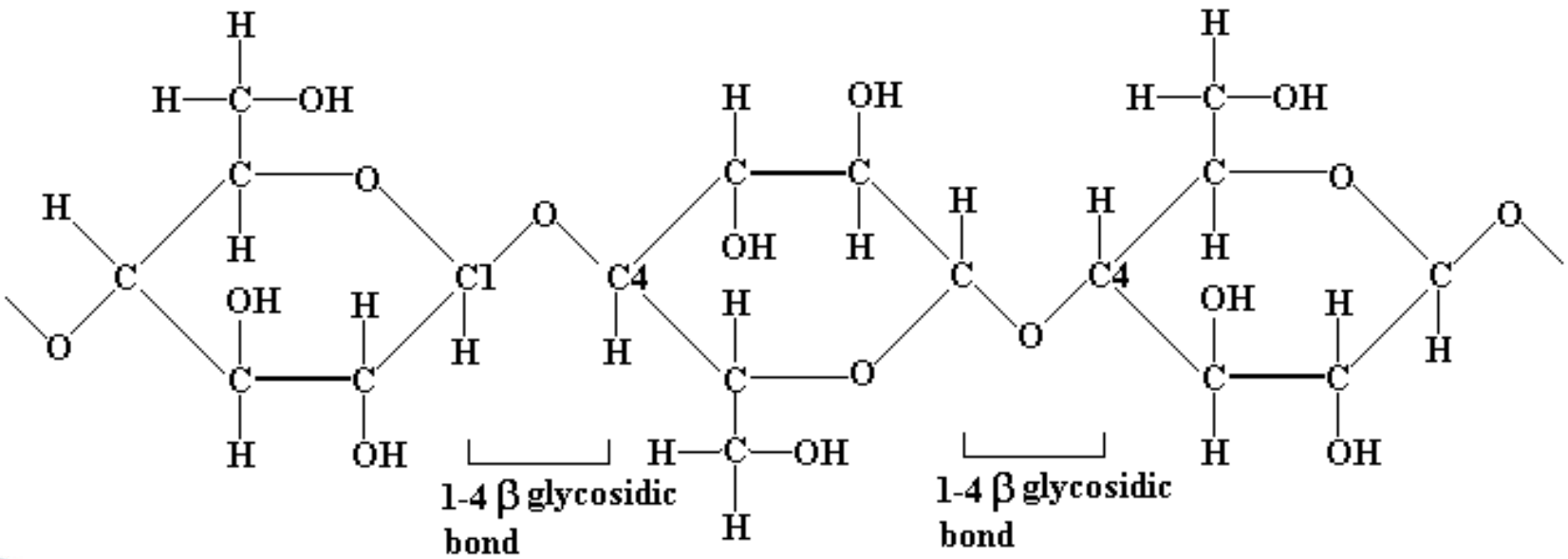


Figure 3.12 (3)

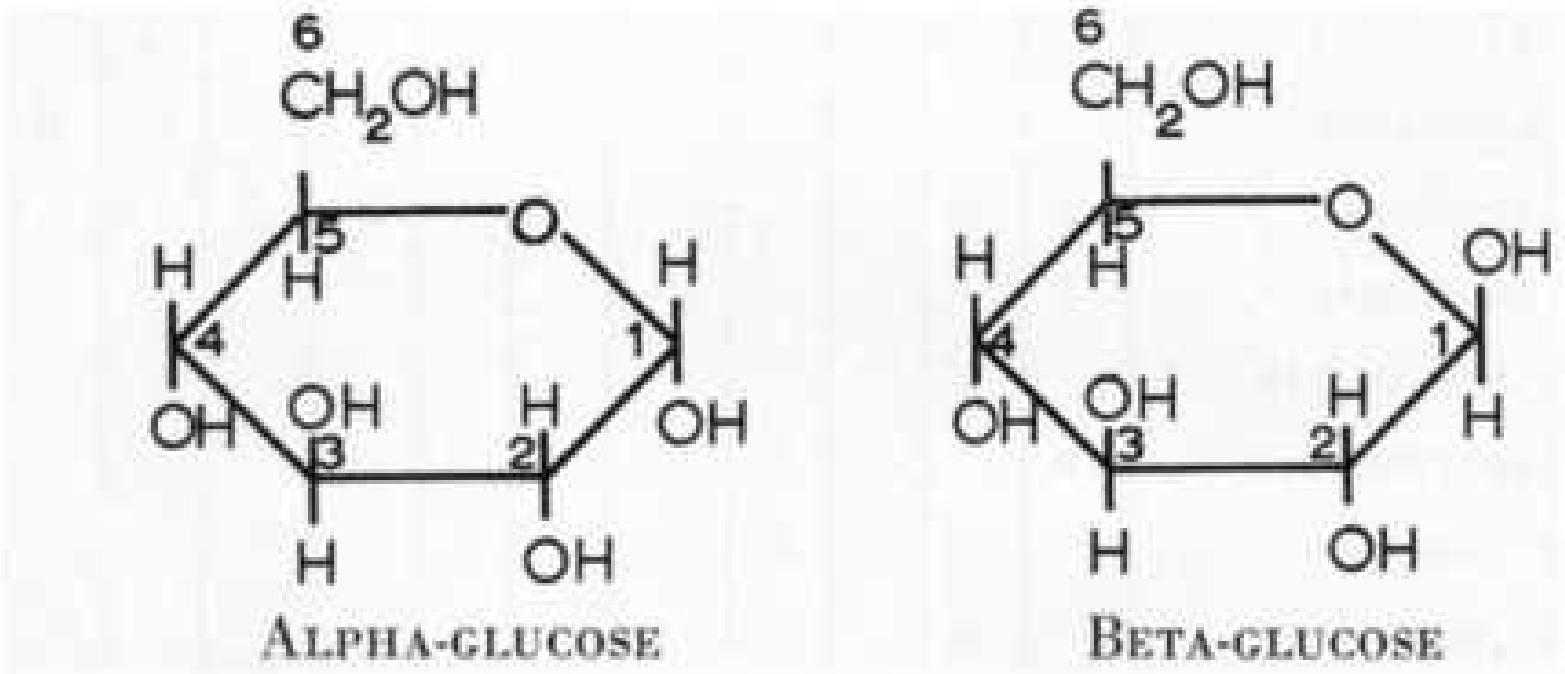
Structural Polysaccharides

- Cellulose – used for building plant cell walls
  - The most abundant organic compound on earth!
- How is cellulose different from starch?



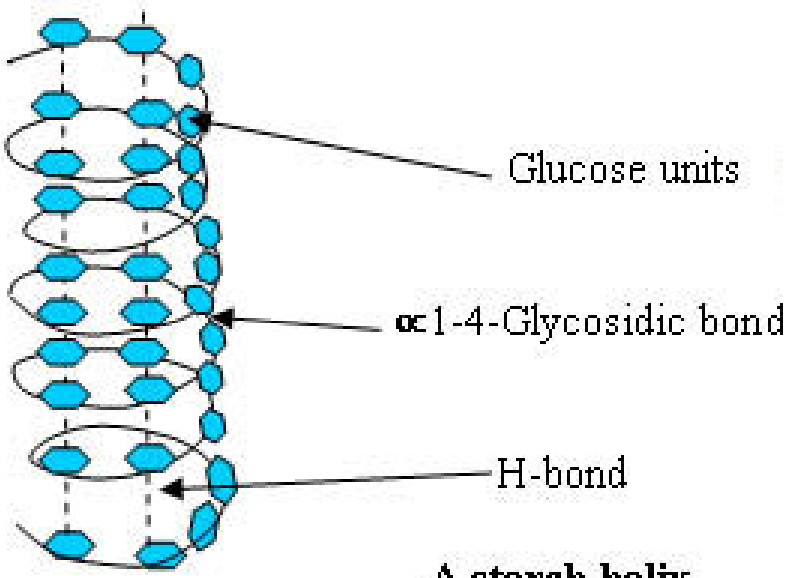
Form and Function

- Its made of a different type of glucose!
  - Two types of glucose rings α (alpha) and β (beta)

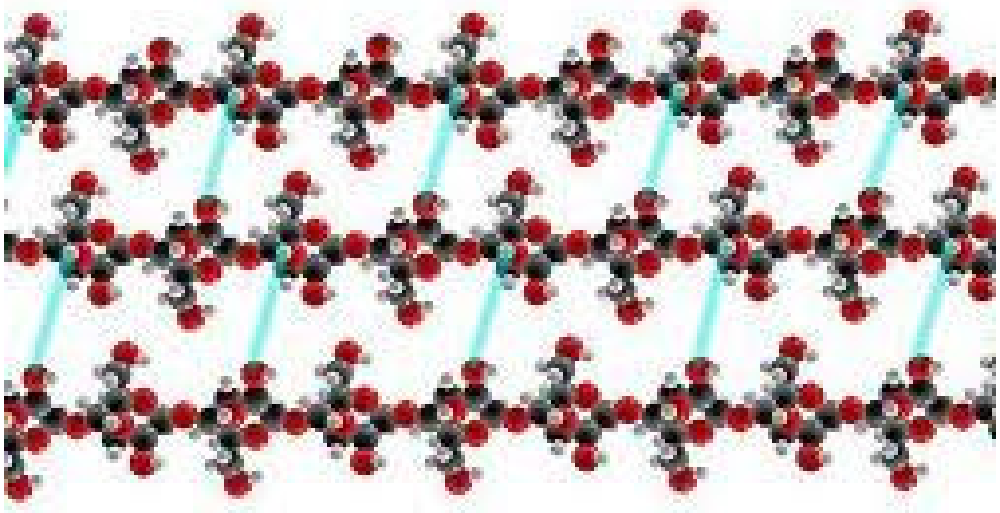


Form and Function

- Starch- heilcal shape
- Cellulose – straight chains
- Different form = different function

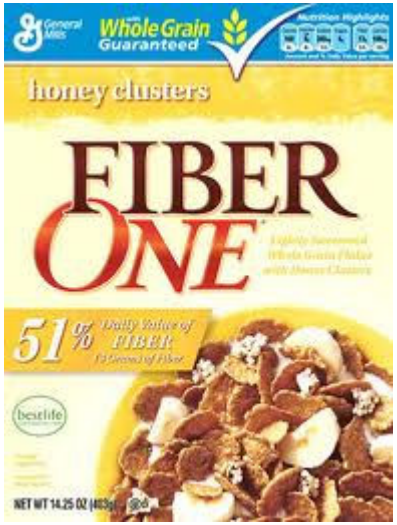


A starch helix

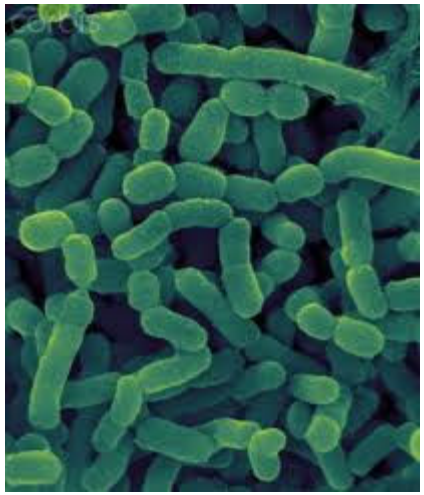


So……..

- Can our bodies use cellulose like we use starch?



Can anything use starch?

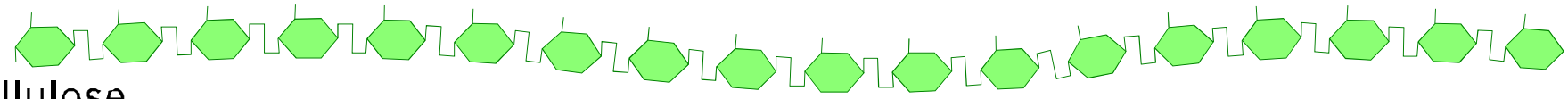


Structural Polysaccharides

- Chitin –Insects, spiders, crustaceans; used for exoskeleton
  - Also found in fungi which use it to build their cell walls

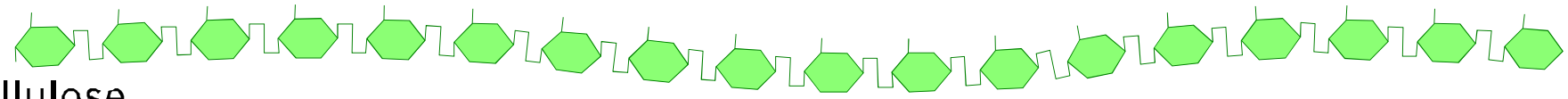
Polysaccharides

Polysaccharides

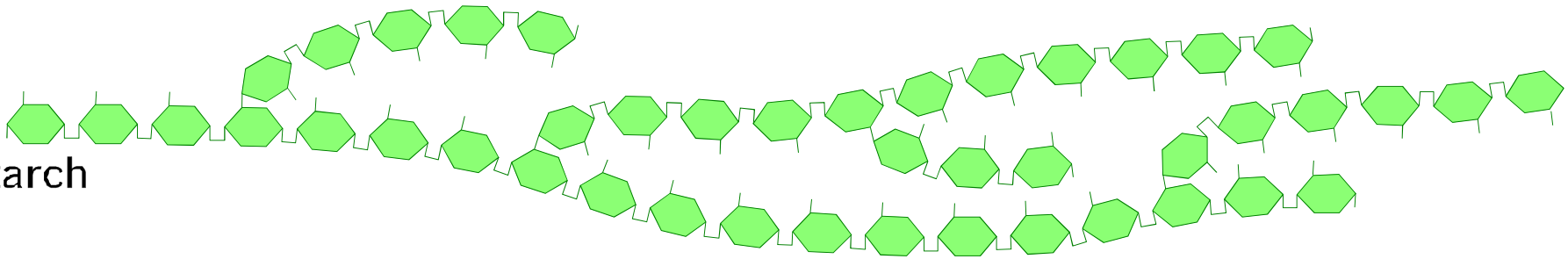


Cellulose

Polysaccharides

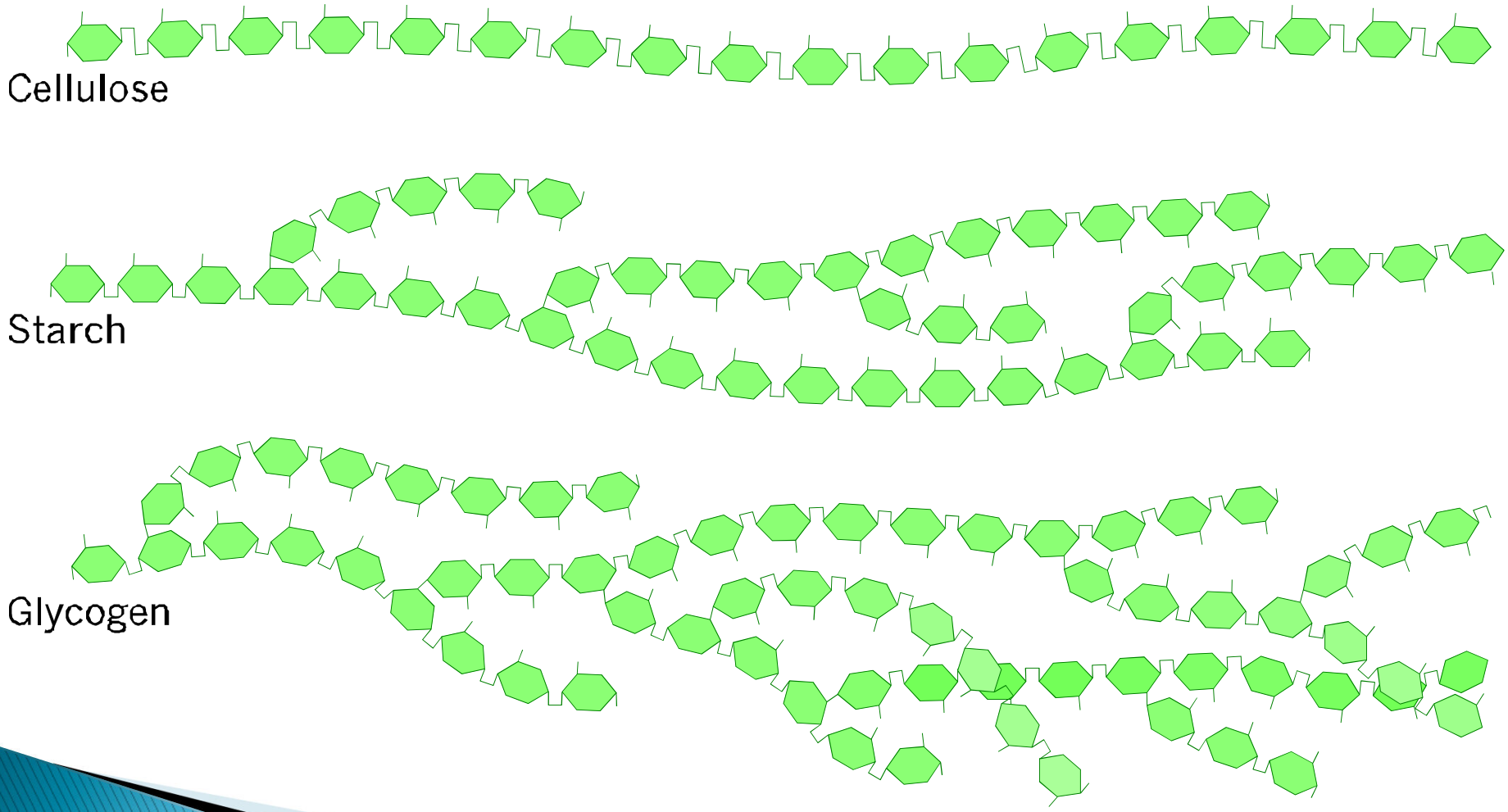


Cellulose



Starch

Polysaccharides



Lipids

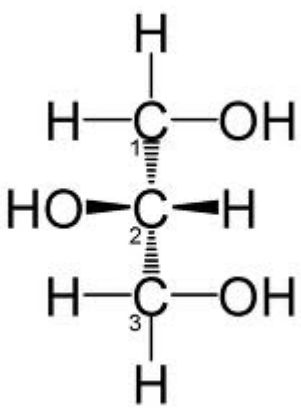
- Lipids are very diverse
  - Fats
  - Phospholipids
  - Steroids

- What unites these molecules in the lipid class?
- They are nonpolar (mostly)

Fats

- Not true polymers
  - Made from glycerol and a fatty acid
- Used for energy storage
  - Adipose tissue- useful as protection and insulator compact in animals

Glycerol



Fatty Acid

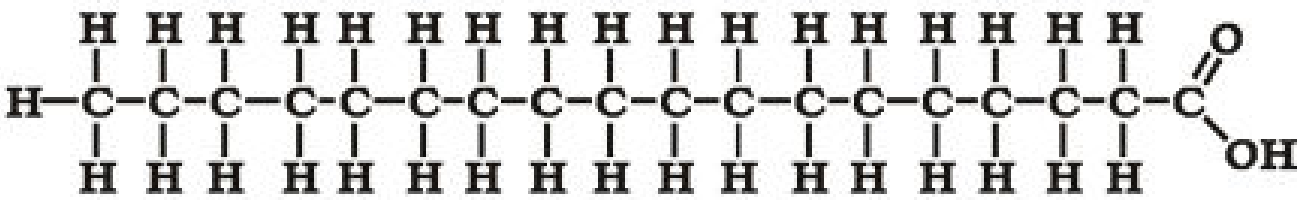
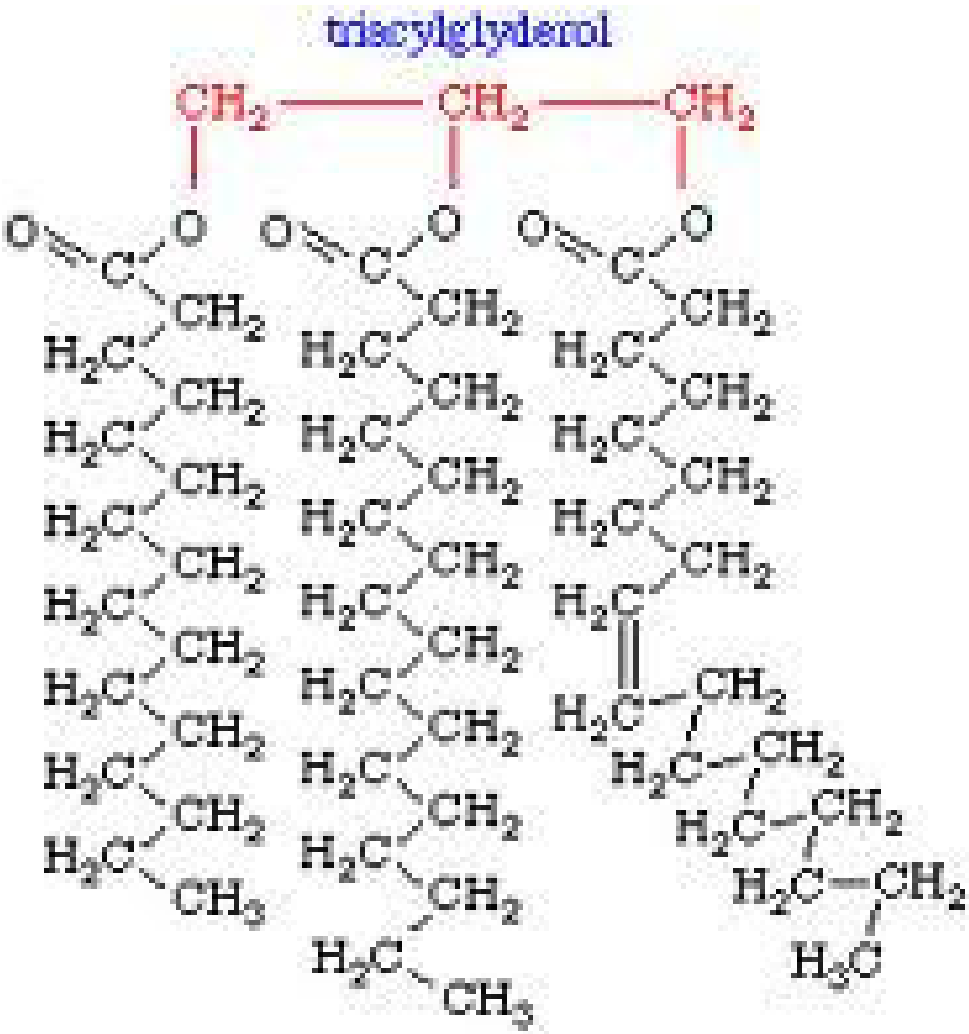


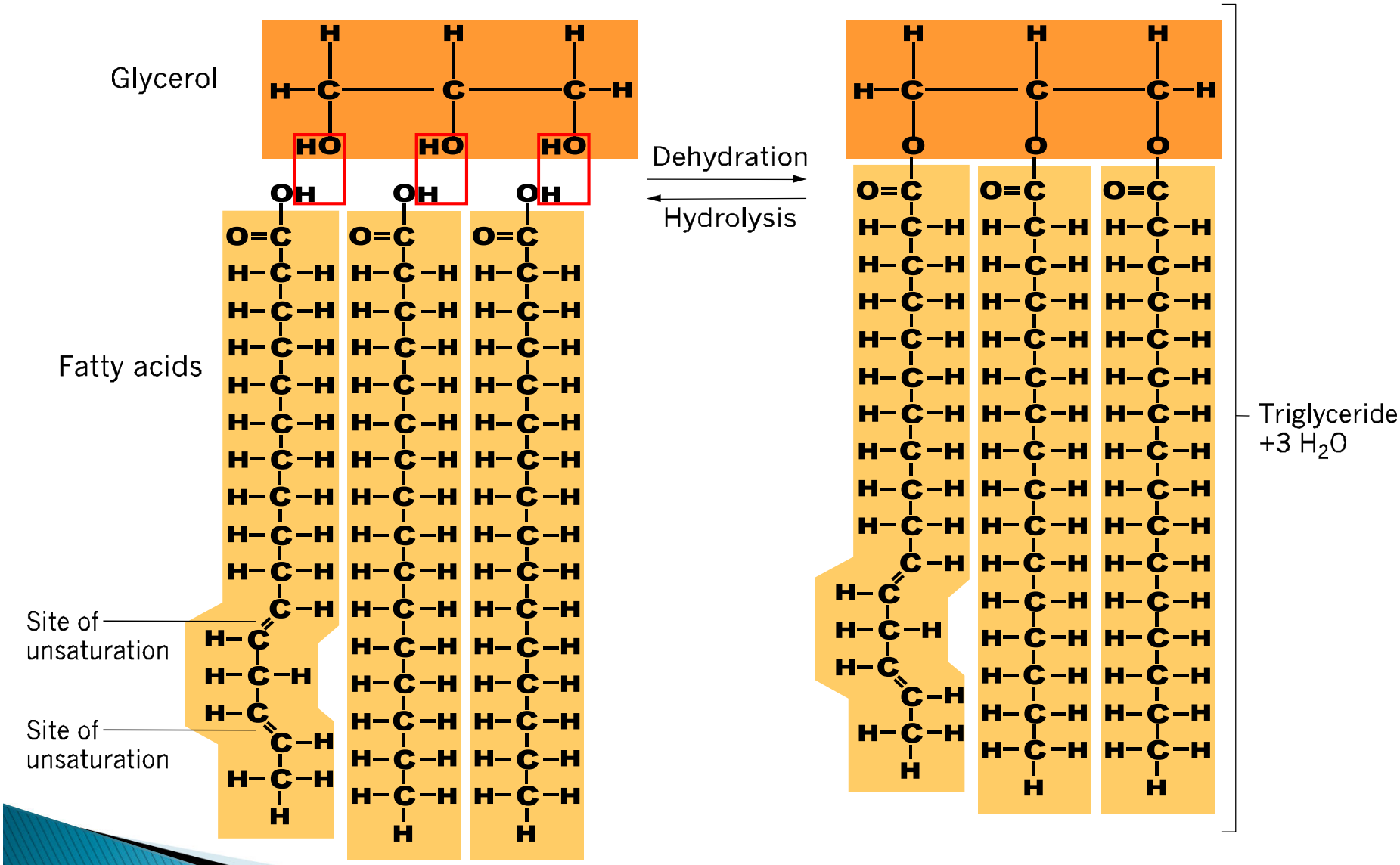
Figure 1. Structures of Fatty Acids

Stearic Acid

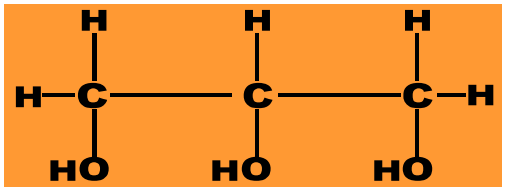
Triacylglycerol

- 3 fatty acids linked to a glycerol
  - Can be different types of fatty acids

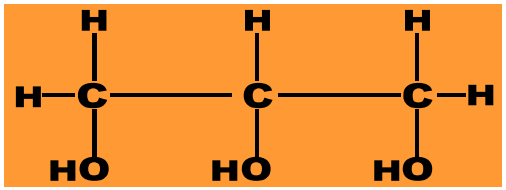




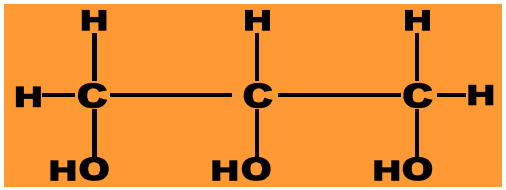
Glycerol + 3 Fatty acids ⟶ Triglyceride + 3 Water


H
H
H
H
C
C
C
H
HO
HO
HO

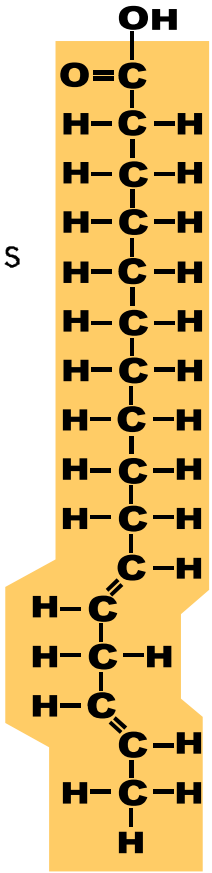
Glycerol



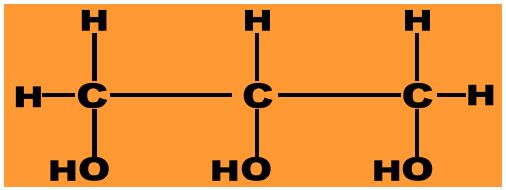
Glycerol



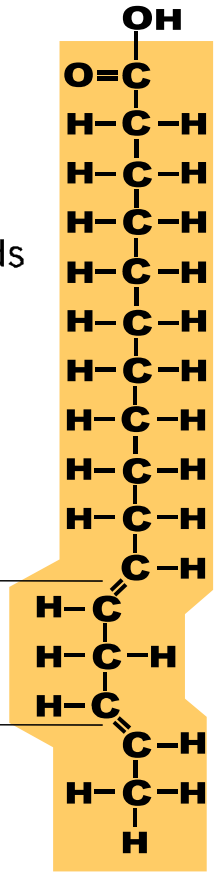
Fatty acids

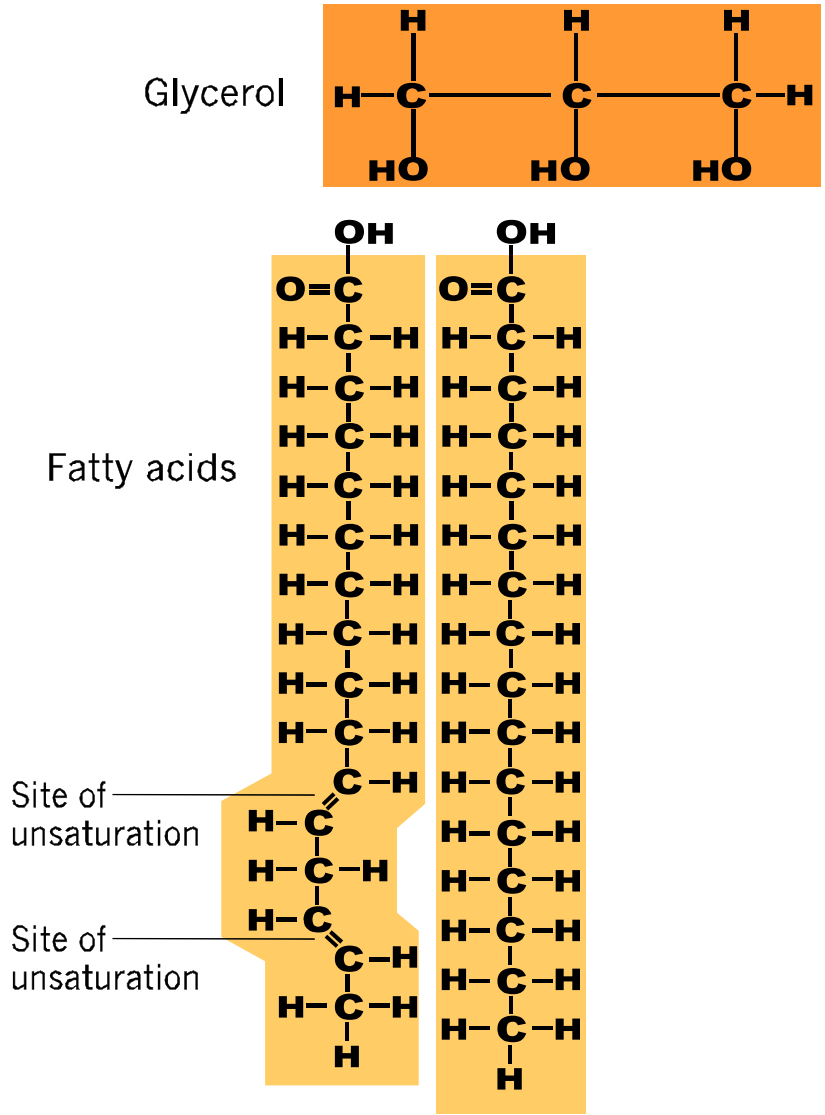


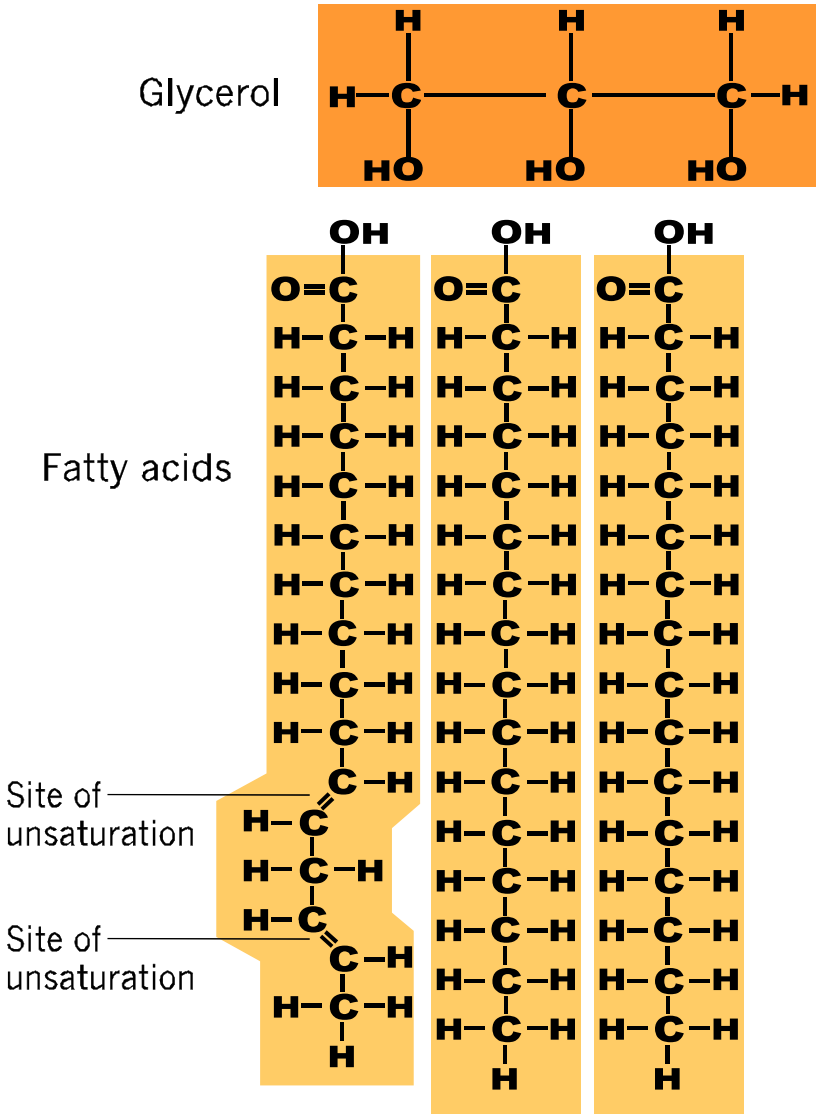
Glycerol



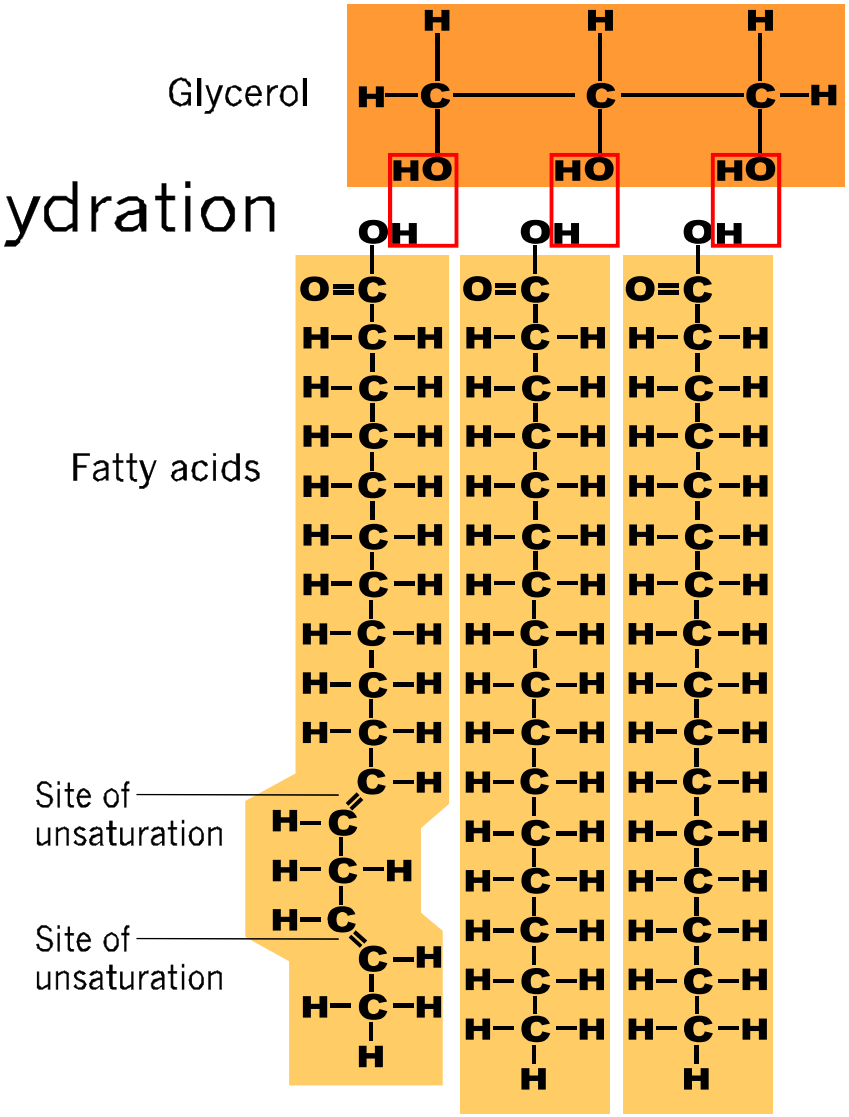
Fatty acids



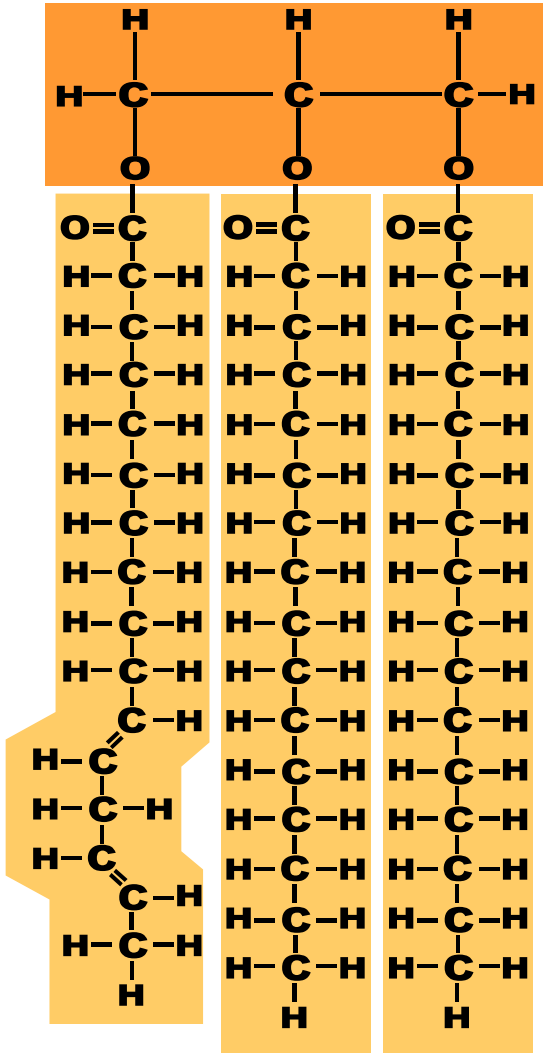

Glycerol
Fatty acids
Site of unsaturation
Site of unsaturation

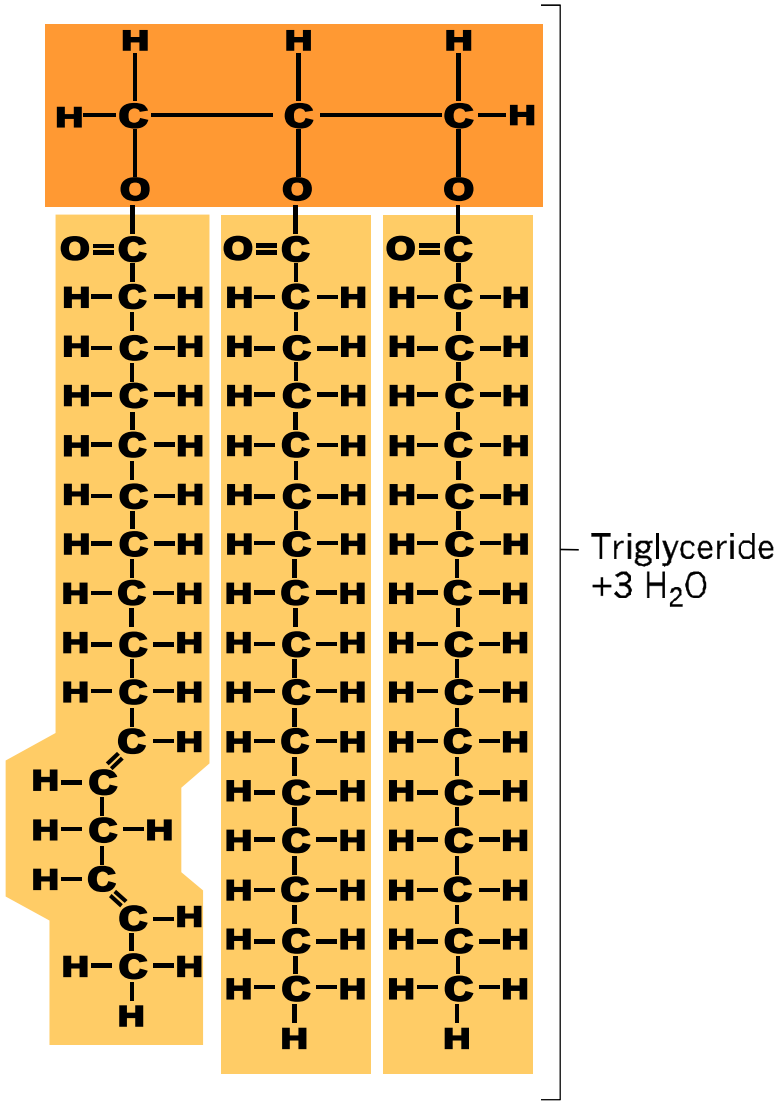

Glycerol
Fatty acids
Site of unsaturation
Site of unsaturation

Dehydration



Dehydration

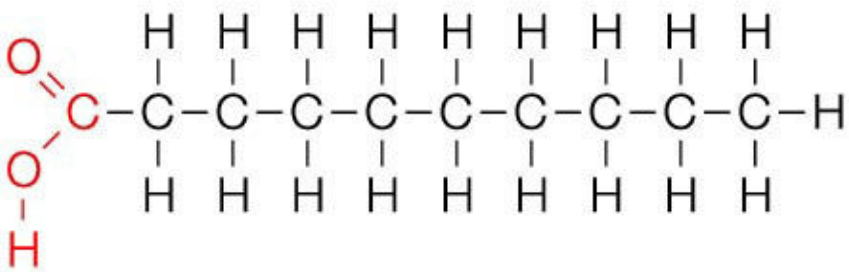



Triglyceride
+3 H_2O

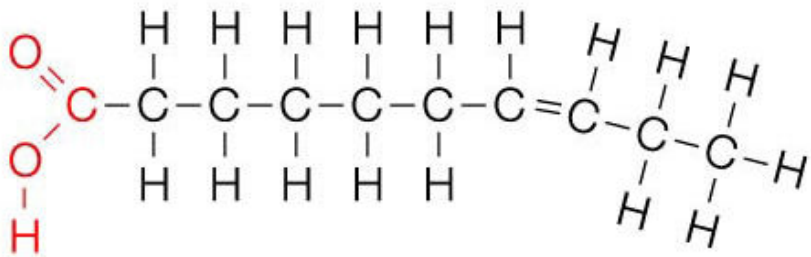
Saturated vs. Unsaturated Fats

- Saturated means saturated with hydrogen atoms: no double bonds
- Unsaturated has double bonds, which creates a kink
  - Cis shape
- Saturation determines structure and function

Saturated



Unsaturated



Fun facts

- Saturated fats can be solid at room temp
- Cis bonds prevent oils from packing too closely together= liquid at room temp
- Hydrogenation- taking a natural unsaturated oil and “adding” hydrogen molecules to make the molecule stay solid at room temp.
  - This produces trans fats, which can be worse than regular saturated fats

Good Fats

Monounsaturated

Foods high in monounsaturated fat

- Canola oil
- Olive oil
- Olives
- Monounsaturated margarine spreads
- Avocado
- Most nuts (almonds, peanuts, cashews, hazelnuts, macadamias, pistachios)
- Egg yolk

Polyunsaturated

Foods high in polyunsaturated fat

- Most vegetable and seed oils (sunflower, soybean, corn, cottonseed)
- Polyunsaturated margarine spreads
- Linseeds
- Some nuts (walnuts, brazil nuts, pecans, pine nuts)
- Wheatgerm
- Oily fish and fish oils

Bad Fats

Saturated

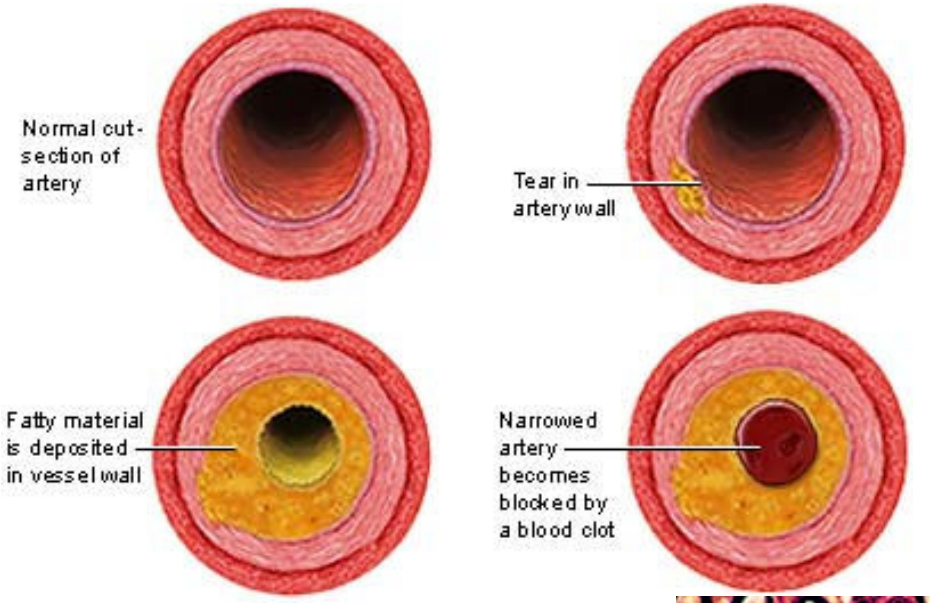
Foods high in saturated fat

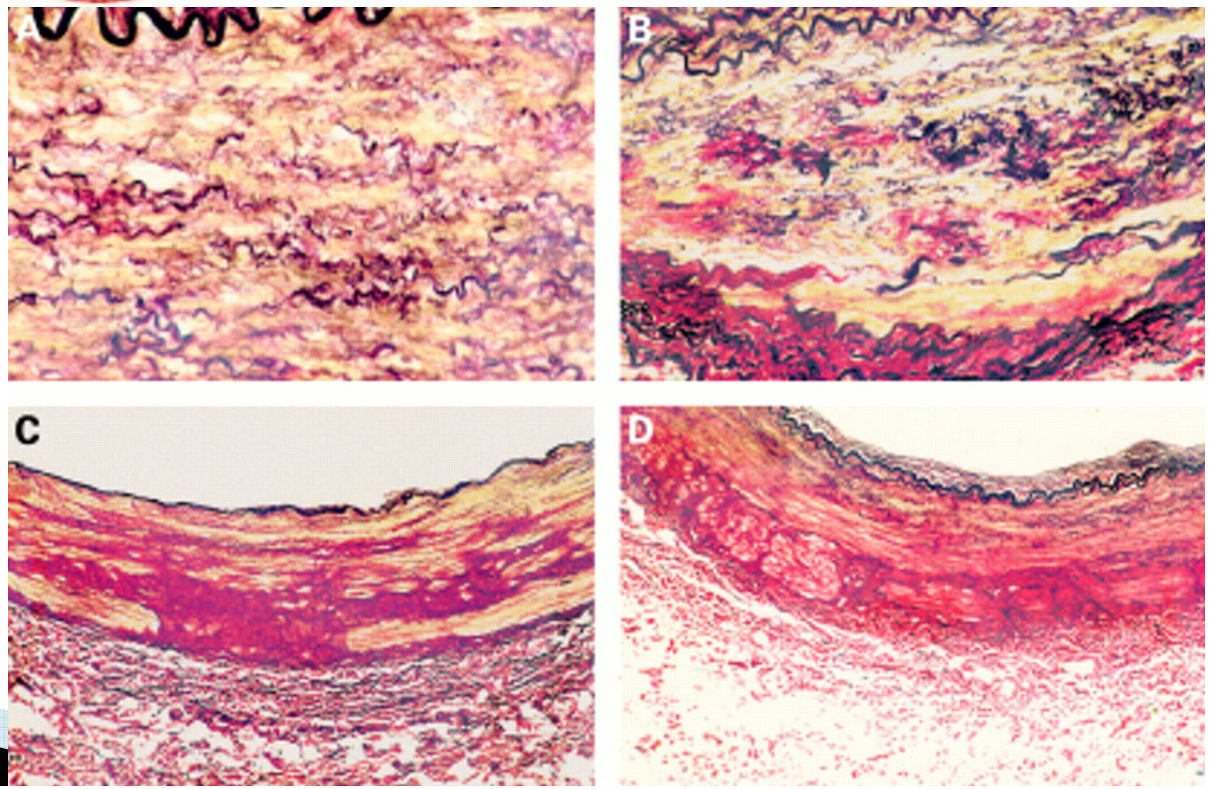
- Fatty meats
- Chicken skin
- Butter
- Cream
- Full cream milk
- Cheese
- Ice cream
- Lard
- Coconut oil (copha)
- Palm oil
- chocolate
- Deep fried foods
- Takeaway and fast foods

Trans

Foods high in trans fat

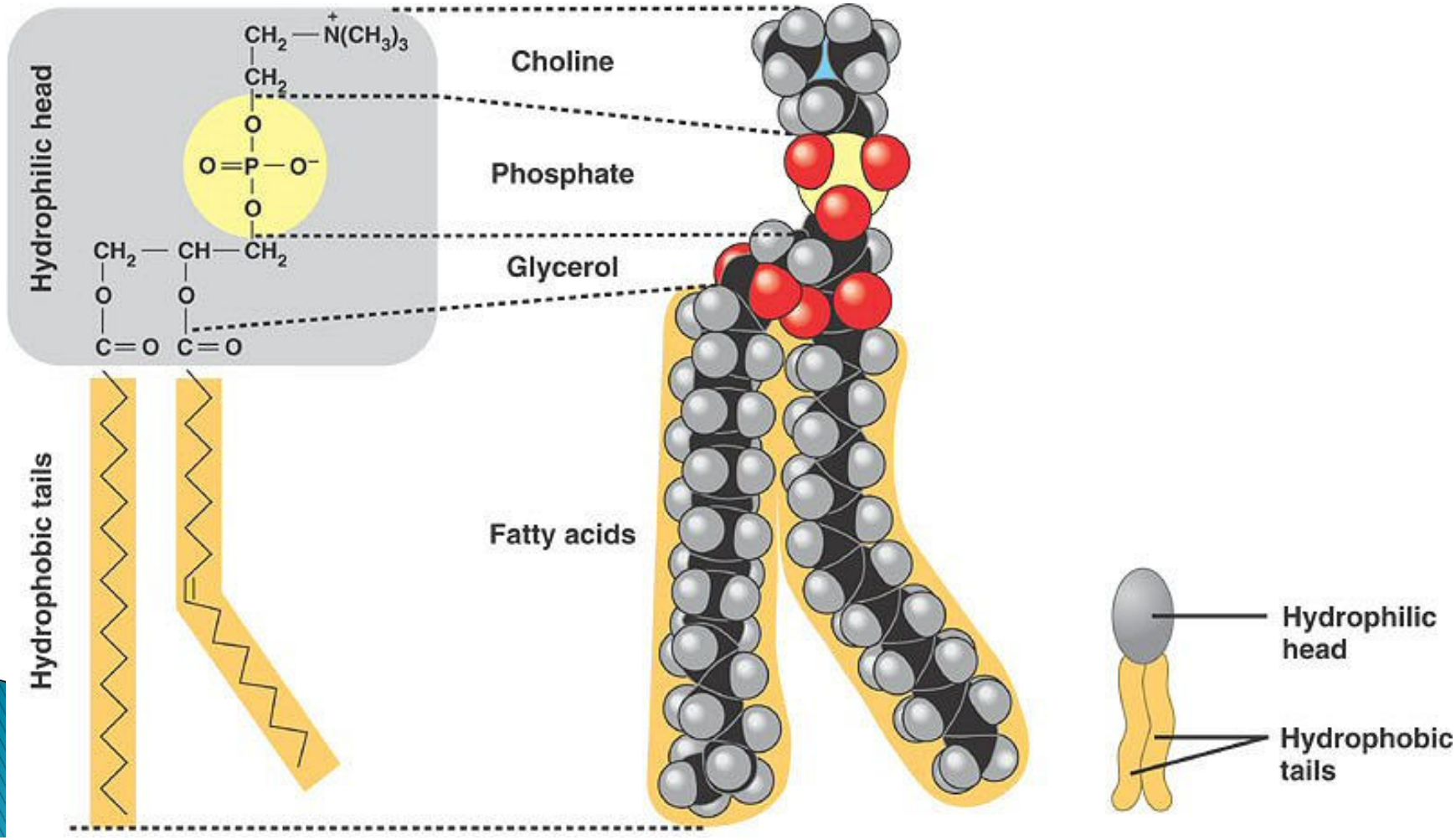
- Biscuits
- Cakes
- Pastries
- Doughnuts


Normal cut-section of artery
Tear in artery wall
Fatty material is deposited in vessel wall
Narrowed artery becomes blocked by a blood clot


A
B
C
D

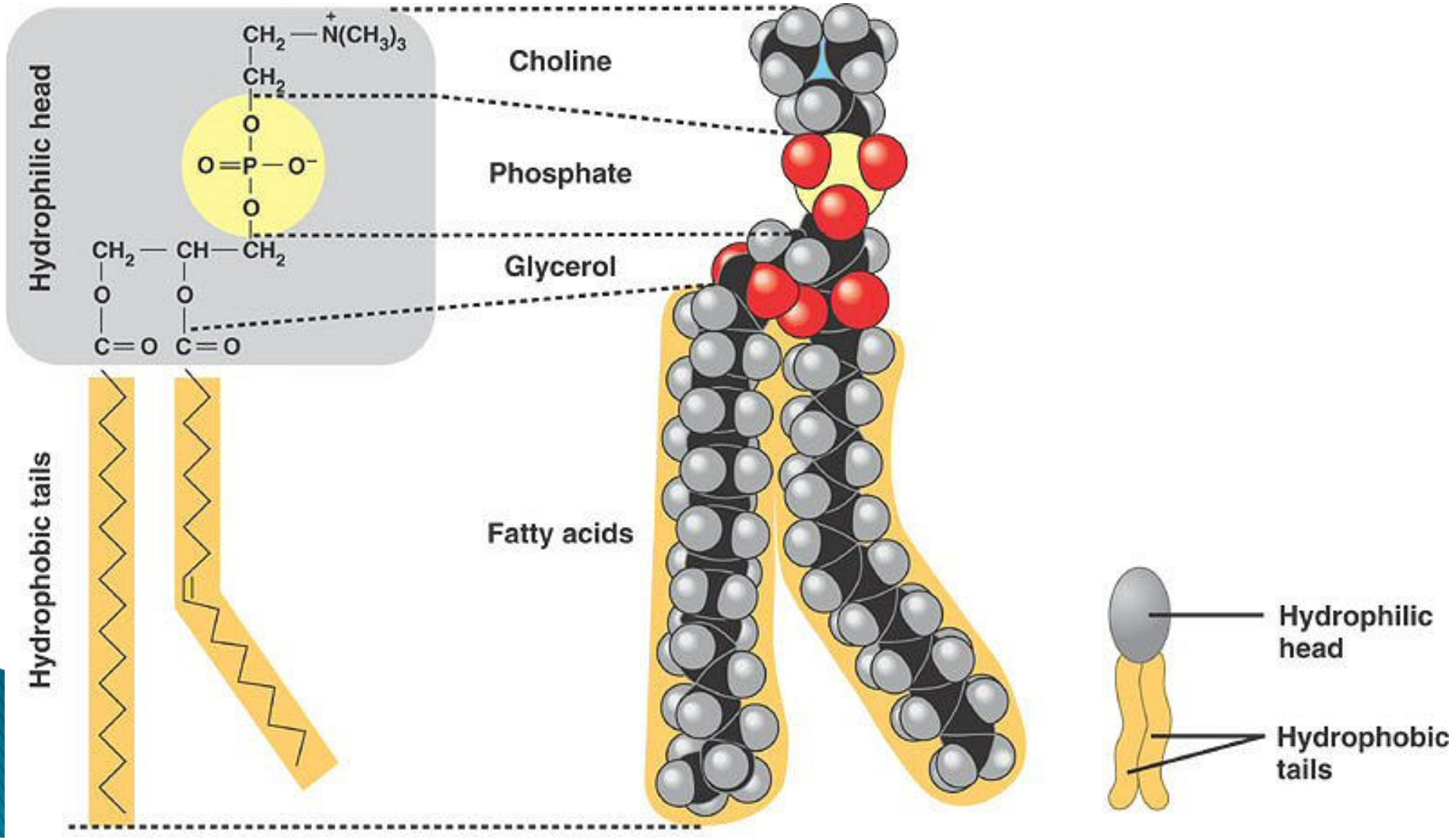
Phospholipids

- How are they structurally different from fats?
- How does the phosphate affect the molecule?

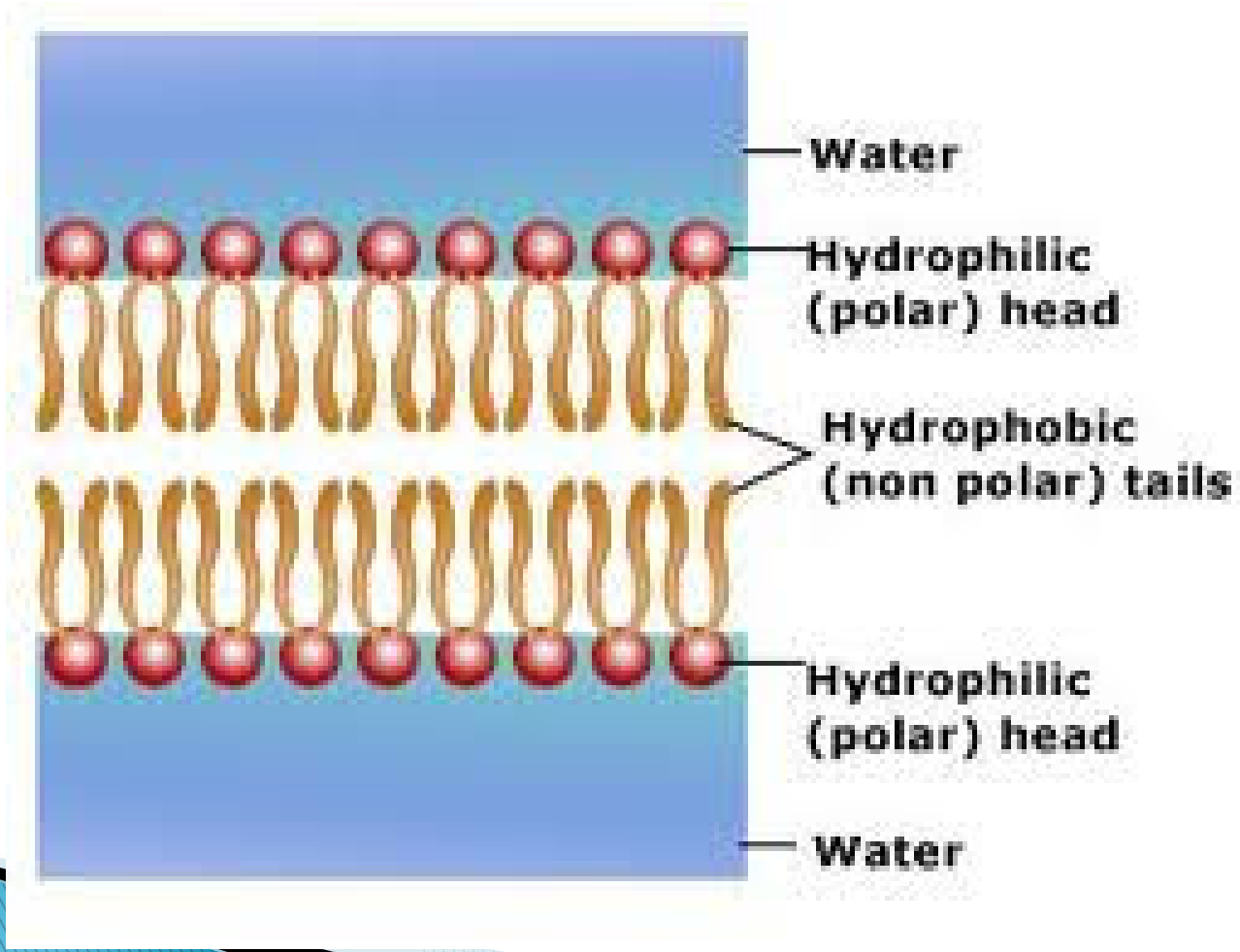


Phospholipids

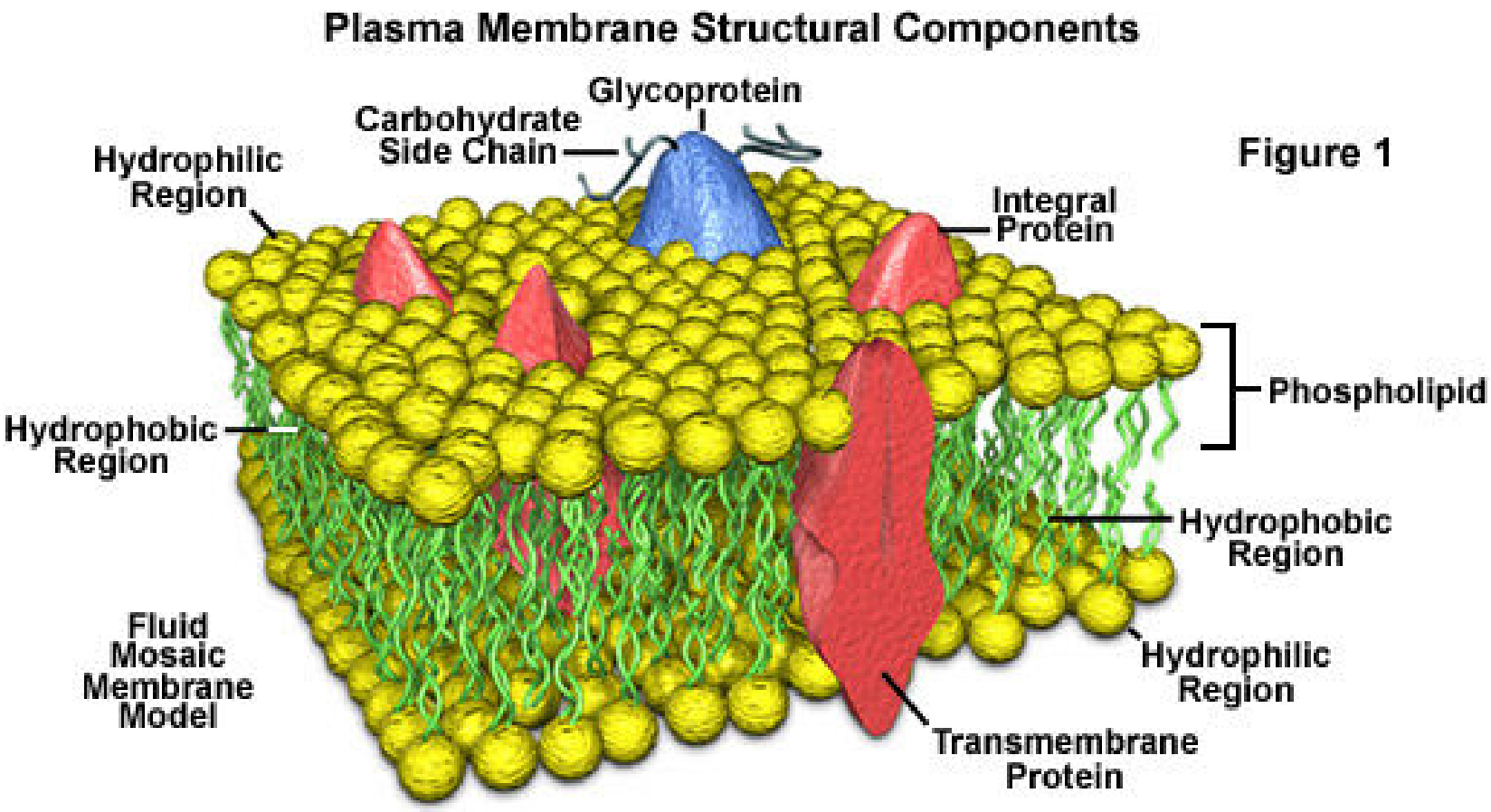
- Have polar and non-polar regions



- Based on these facts, how does a phospholipid behave in water?
- Where do we find phospholipids in life?

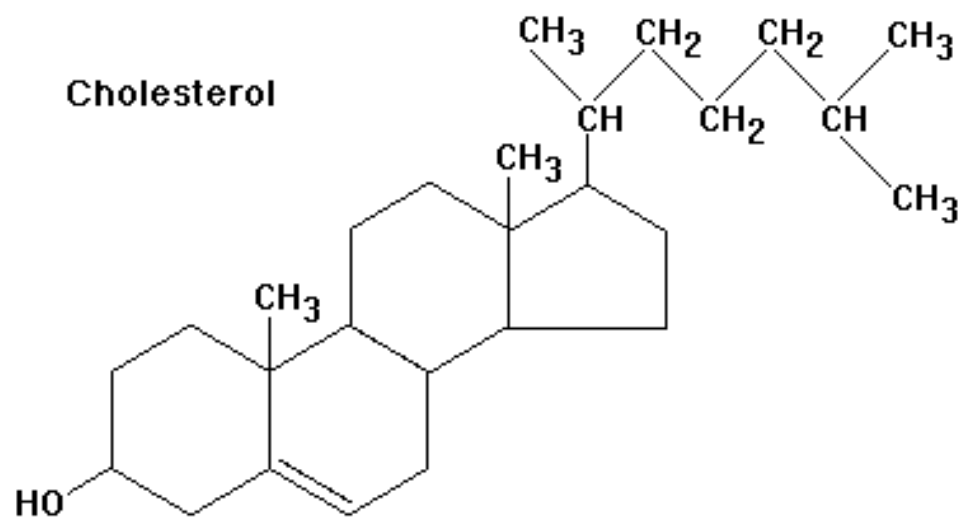


Cellular Membrane

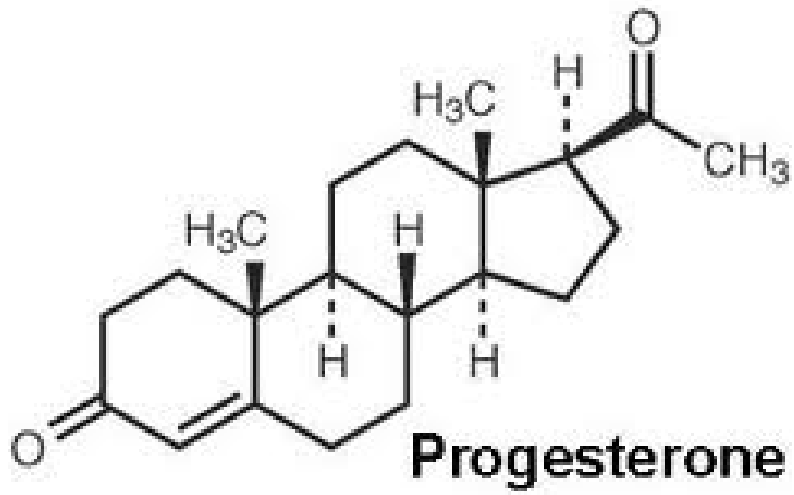


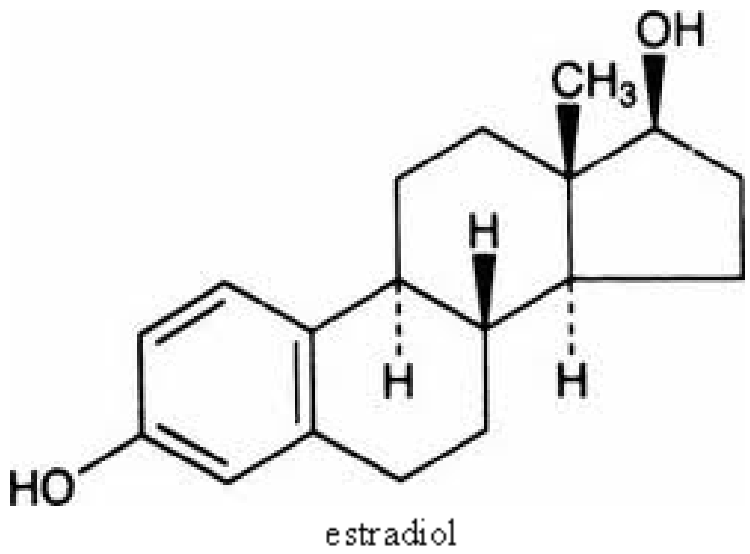
Steroids

- Lipids made of 4 fused carbon rings- used in communication
  - Cholesterol is a precursor to others and component of animal cell membranes
  - Cholesterol is made in the liver during the breakdown of saturated fats – avoid excess

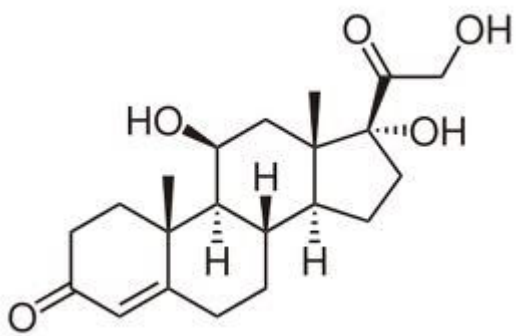


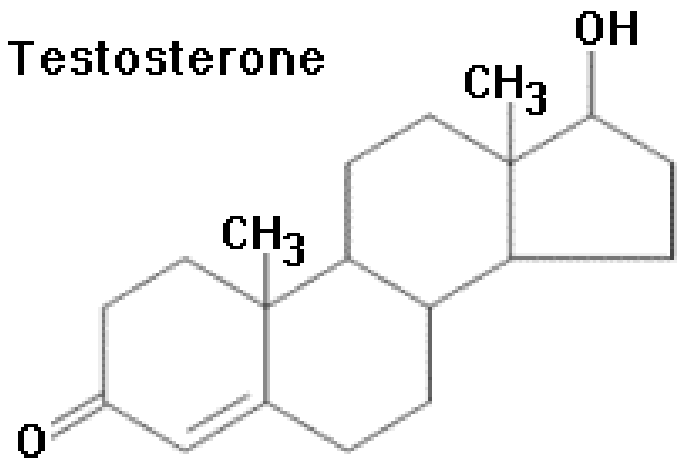
- Functional groups make unique steroids





- Cortisol





Waxes

- Long chain fatty acids linked to a long chain alcohol
- Usually solid at room temp.
- Water-repellent, which helps to waterproof feathers, leaves and insect cuticles.