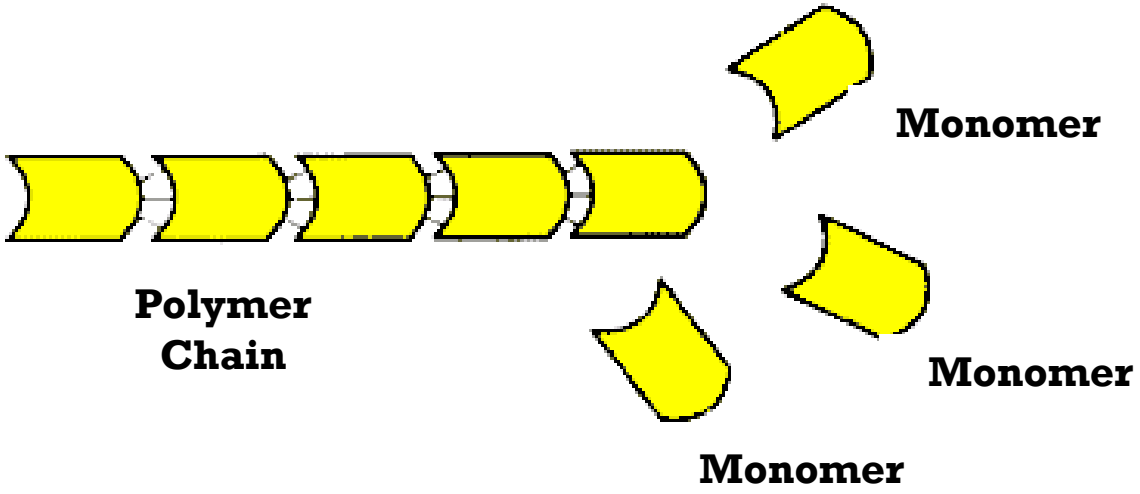
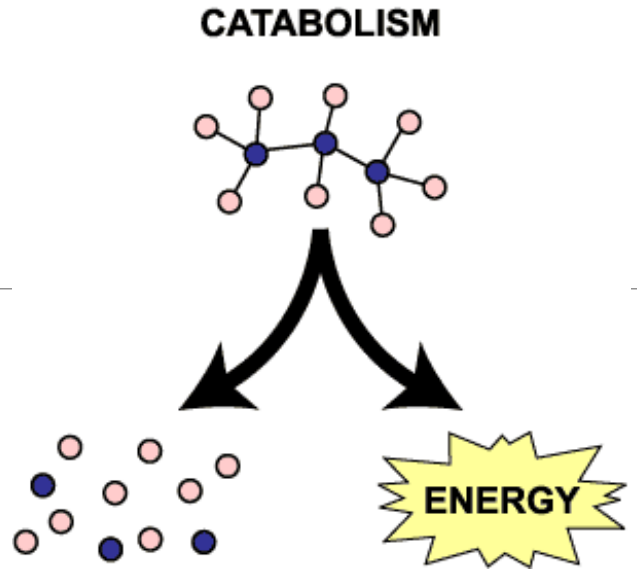
Biologically Important Molecules

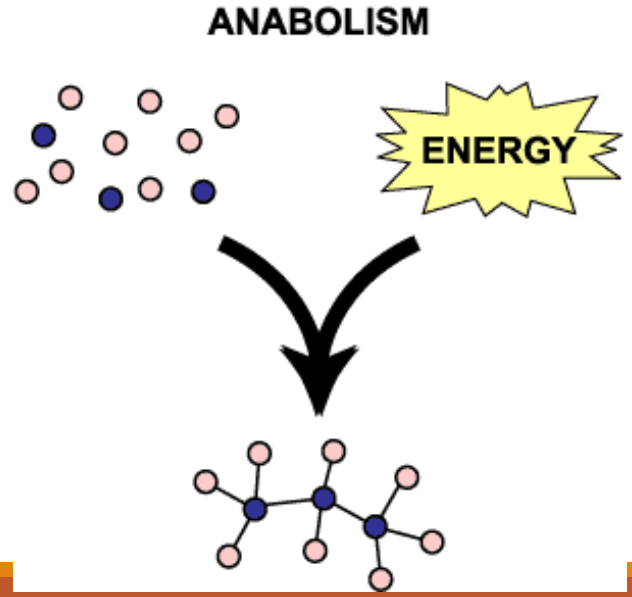
SBI4U

Remember . . .Macromolecules

Catabolic (hydrolysis) *and* ***Anabolic (condensation)*** *reactions occur in biological system to either build or breakdown macromolecules.*







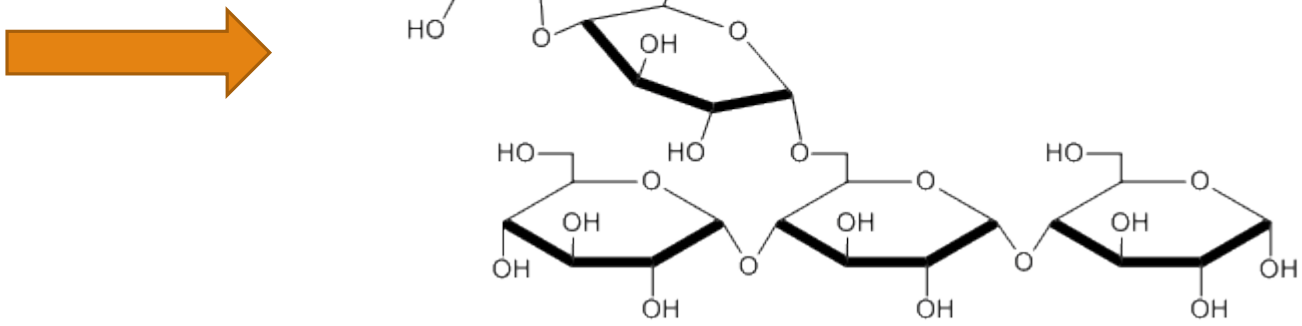
Macromolecules

What are the four main types of macromolecules?

1. Carbohydrates
2. Nucleic Acids
3. Proteins
4. Lipids

1. Carbohydrates

Carbohydrates are molecules that contain carbon, hydrogen and oxygen atoms.



Carbohydrates usually have a ration of **2 H: 1 O: 1 C**

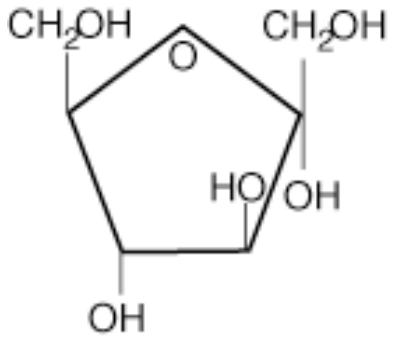
1. Carbohydrates

Roles of Carbohydrates:

- Source of stored energy
- Transports stored energy within complex organisms
- They are structural molecules that give many organisms their shape
- Recognition or signaling molecules in biological responses.

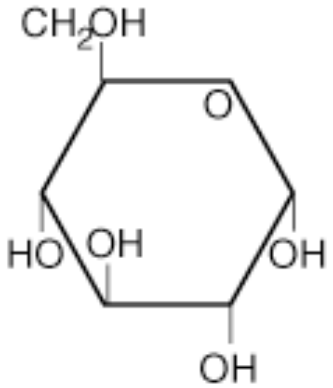
1. Carbohydrates

Monosaccharides are simple carbohydrates that consist of one monomer subunit.



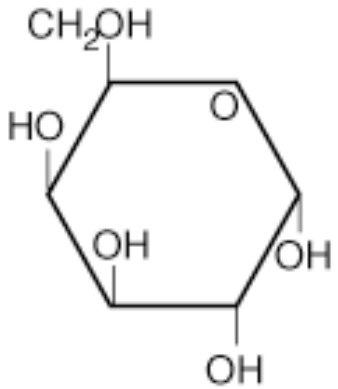
Fructose

Fructose is commonly found in fruit and is known as the fruit sugar.



Glucose

Living cells use glucose as a source of energy. a.k.a blood sugar.



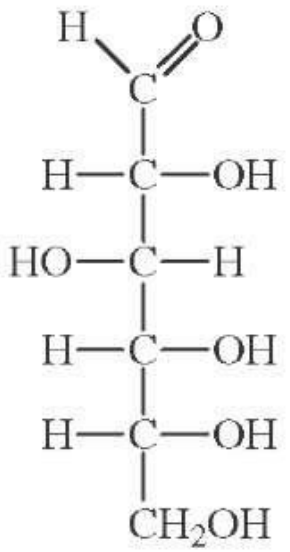
Galactose

This sugar is found in milk products.

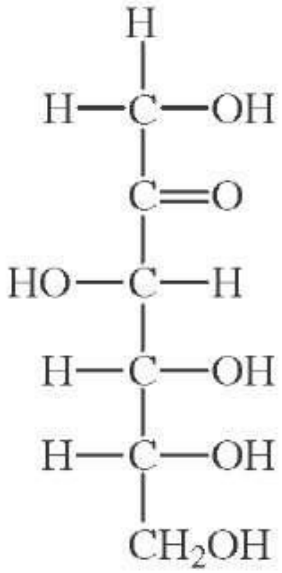
What looks different/similar between all of the monosaccharides?

1. Carbohydrates

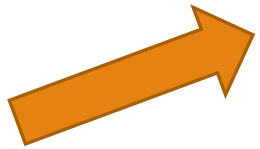
Monosaccharides can be distinguished by the position of the carbonyl group.

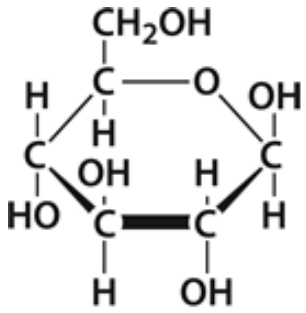


Glucose

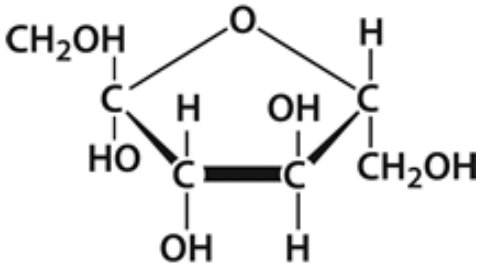


Fructose





Glucose



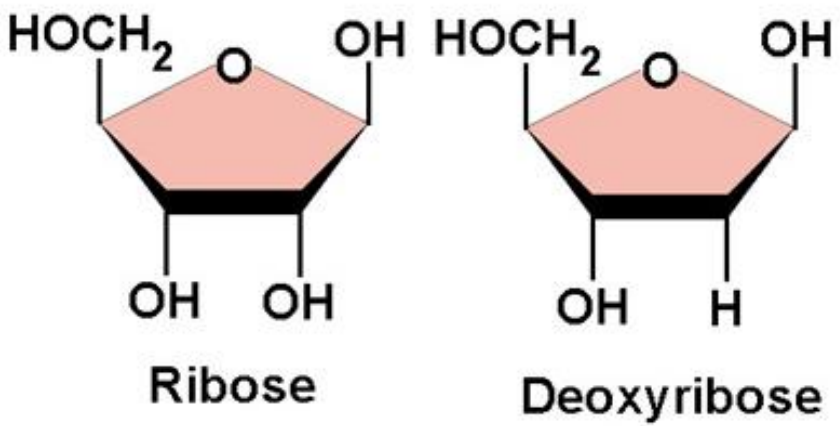
Fructose

Ketone:

Aldehyde:

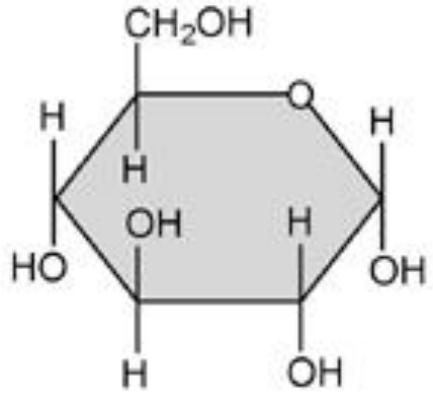
1. Carbohydrates

Monosaccharides can also be distinguished by the number of carbons.



Pentose Sugars

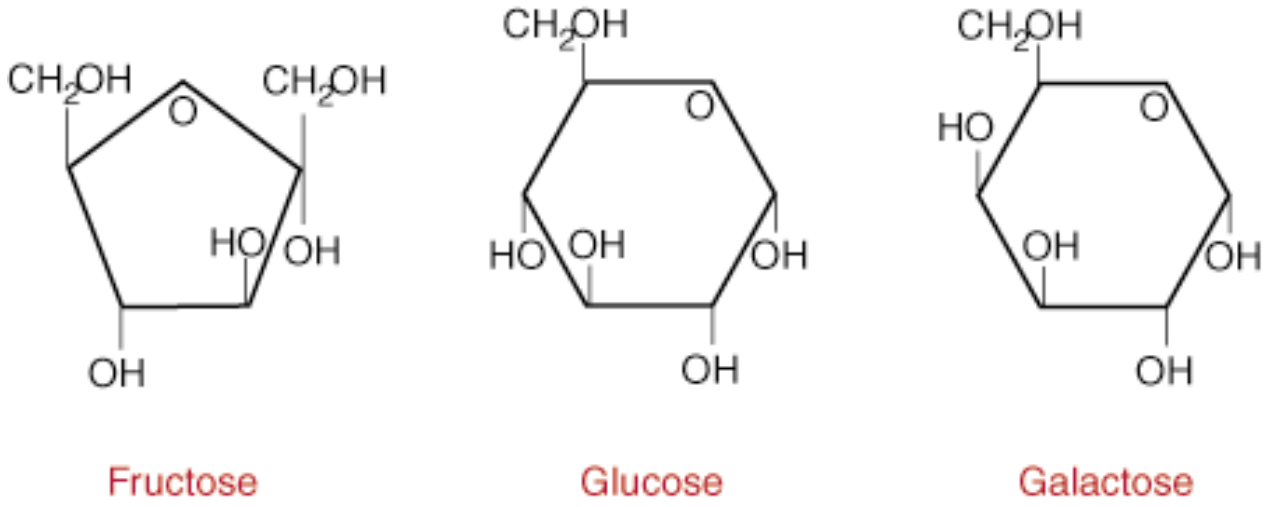
vs.



Hexose Sugar

1. Carbohydrates

Isomers *are compounds with the same number of atoms but different structural arrangement.*

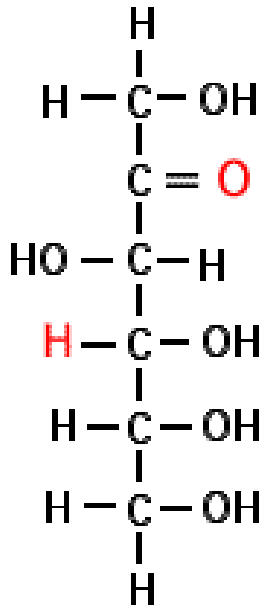


Fructose Glucose Galactose

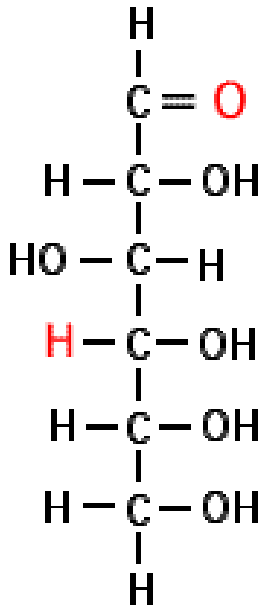
Monosaccharides can be distinguished by their spatial arrangement. Each of the monosaccharides above are isomers of one another.

1. Carbohydrates - Isomers

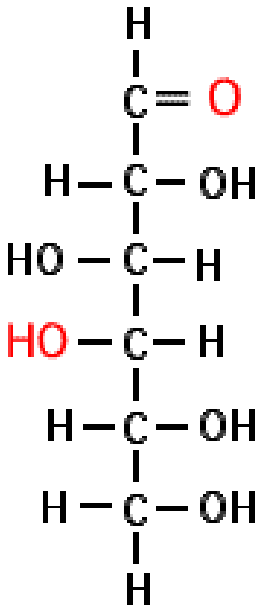
Fructose



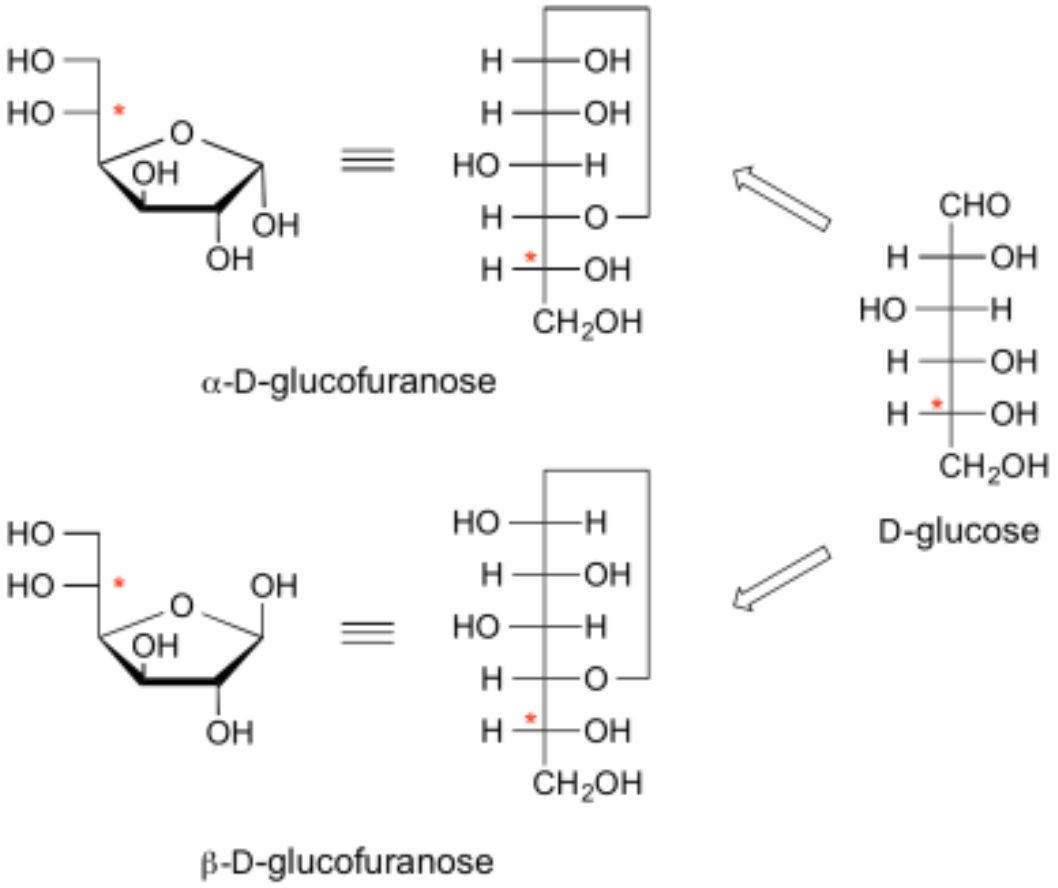
Glucose



Galactose



1. Carbohydrates

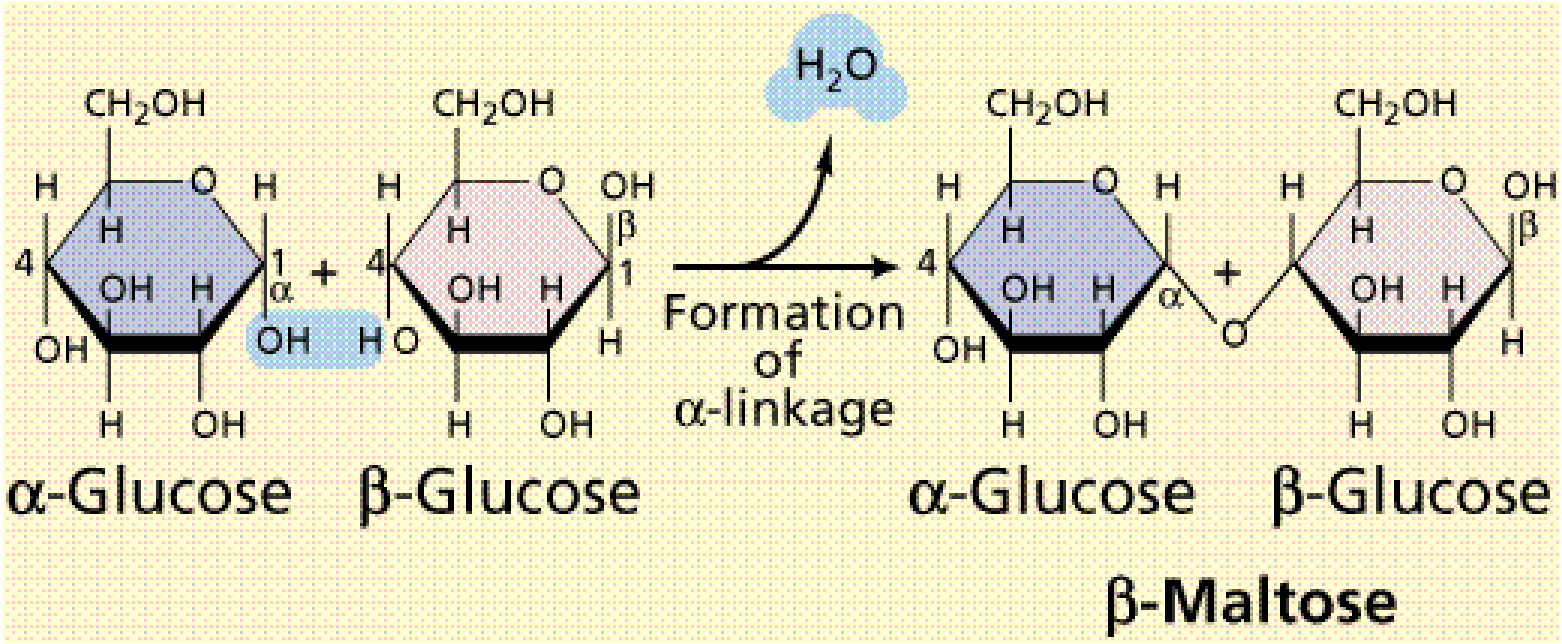


Monosaccharides are linear in a dry state but when exposed to water they form a ring structure.

*The glucose monosaccharide can either be in **alpha** or **beta** form due to the isomerization of the molecule.*

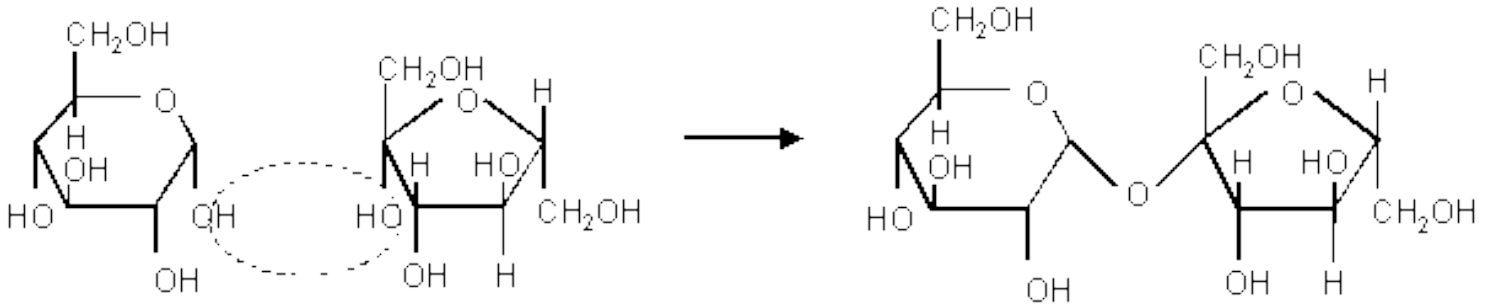
1. Carbohydrates

Monosaccharides can combine through condensation reactions and form **disaccharides** and **polysaccharides**.



1. Carbohydrates

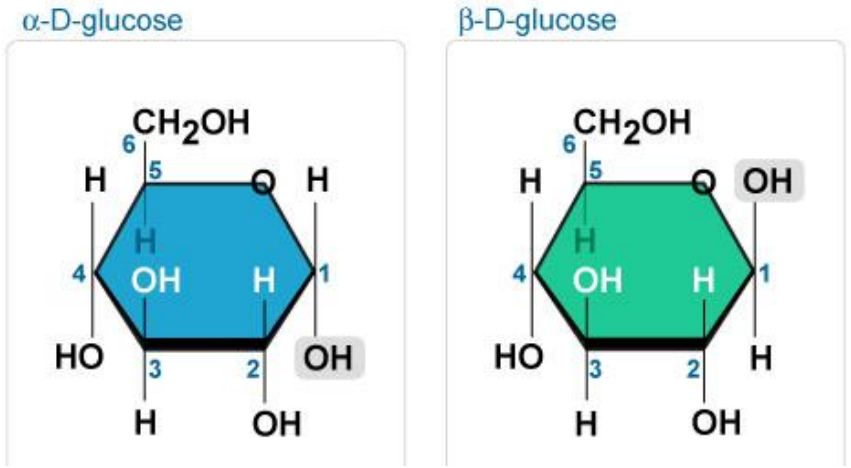
Formation of Sucrose:

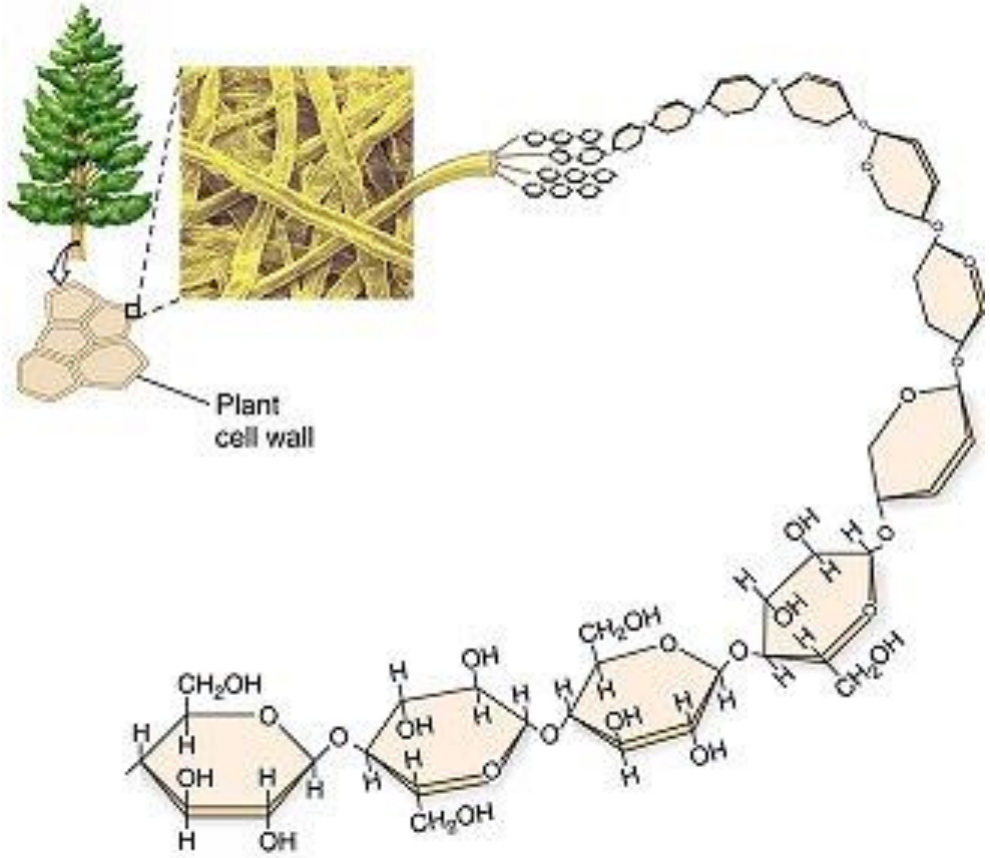


1. Carbohydrates

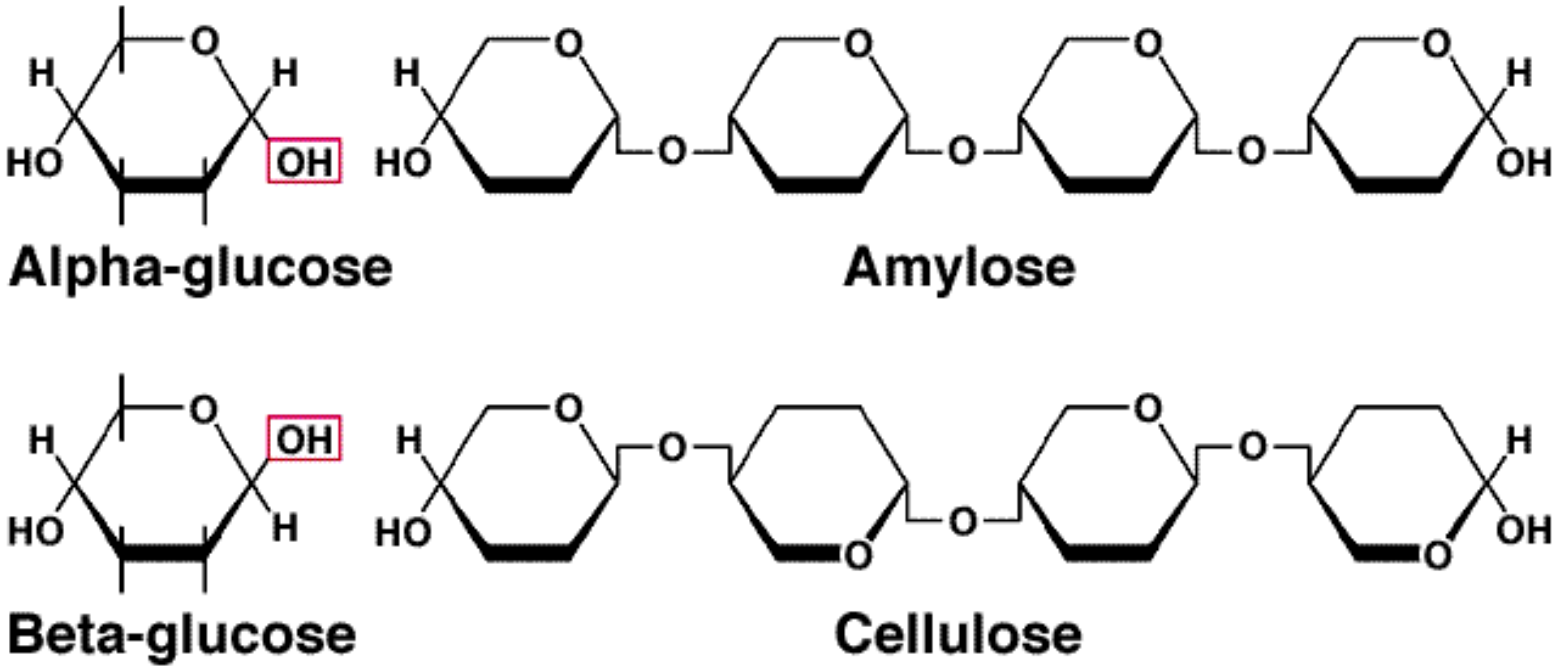
Polysaccharides are large polymers of monosaccharides that are linked by ***glycosidic bonds.***

The manner in which the hydroxyl group (–OH) is positioned (alpha vs. beta) enables the glucose molecule to branch in different ways and numbers.

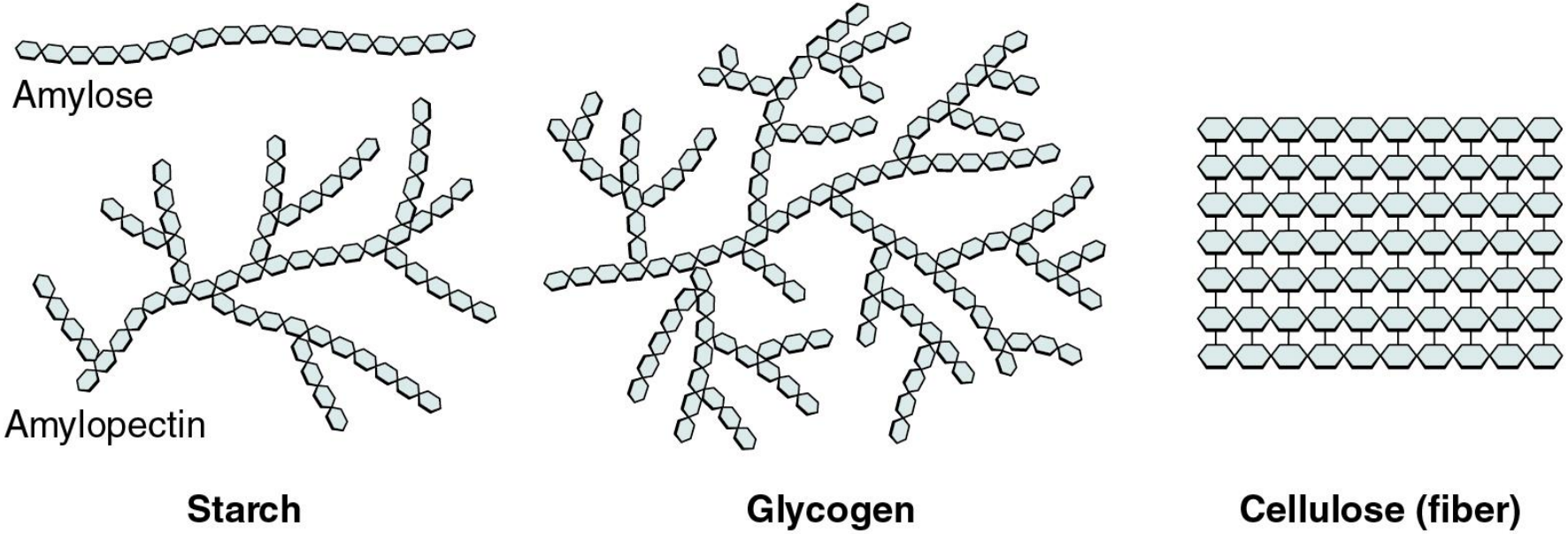




1. Carbohydrates

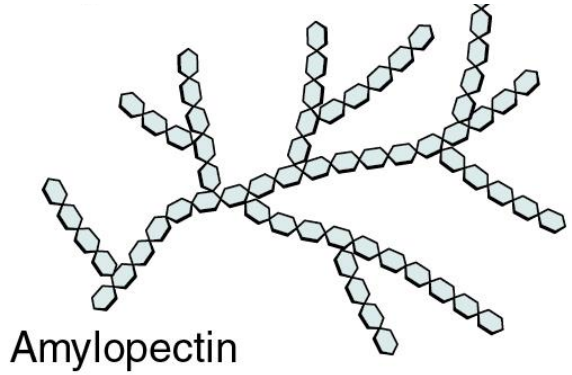


1. Carbohydrates



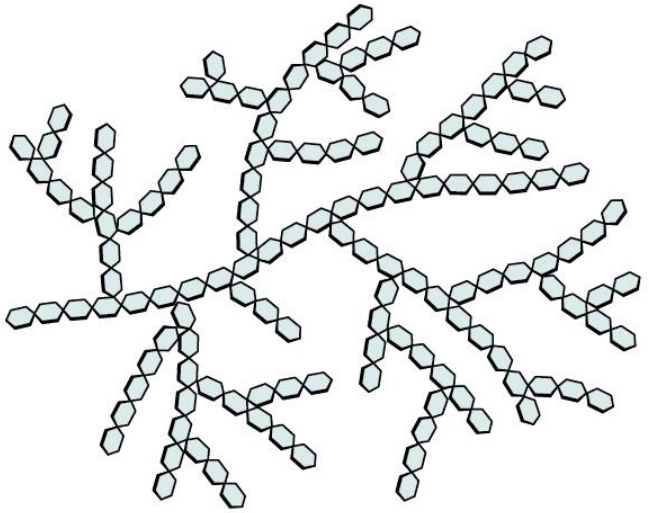
Depending on the type of glucose monomer and the orientation in which they binds, it can give the carbohydrate a completely ***different shape and function***.

1. Carbohydrates



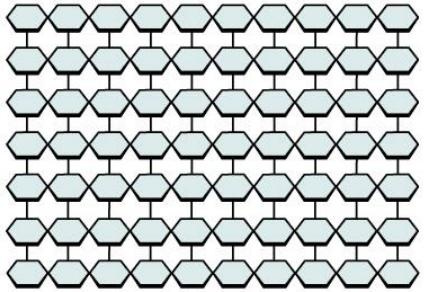
Starch

Starch- storage molecule used by plants. The glucose made through photosynthesis can be stored as a starch polymer.



Glycogen

Glycogen- storage molecules used by animals. The glucose absorbed by the small intestine is stored as glycogen polymer.

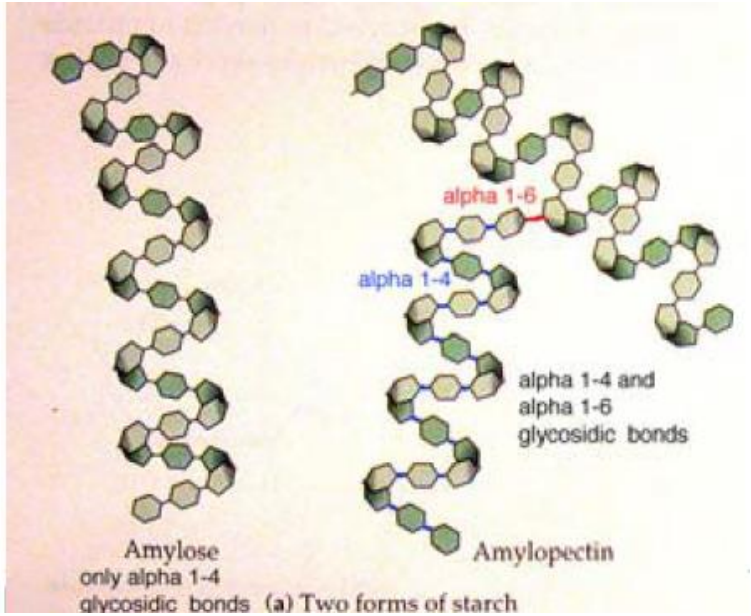


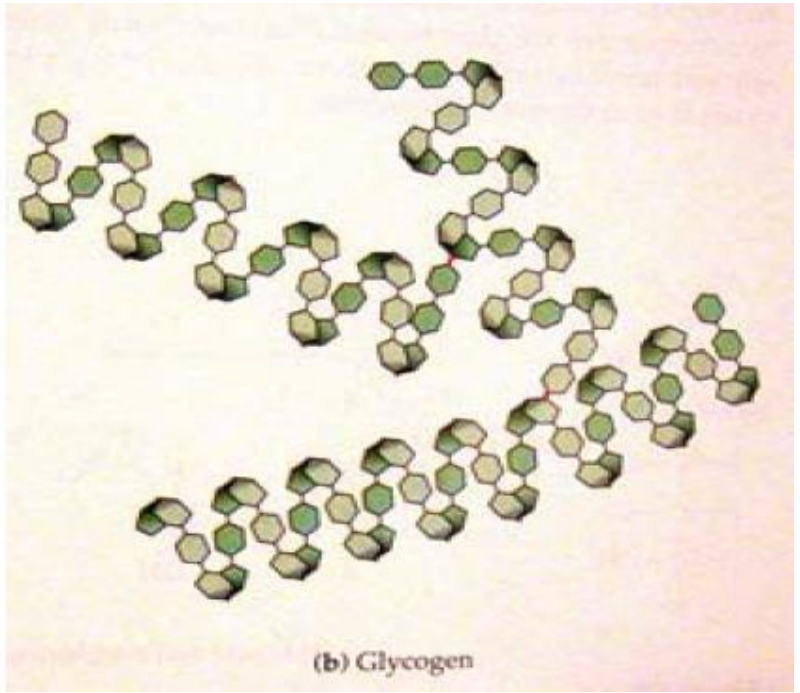
Cellulose (fiber)

Cellulose - plant cell walls and provides support. The beta glucose is forming the glycosidic bond.

1. Carbohydrates

Starch and glycogen tend to form helical structures causing it to be insoluble in water.

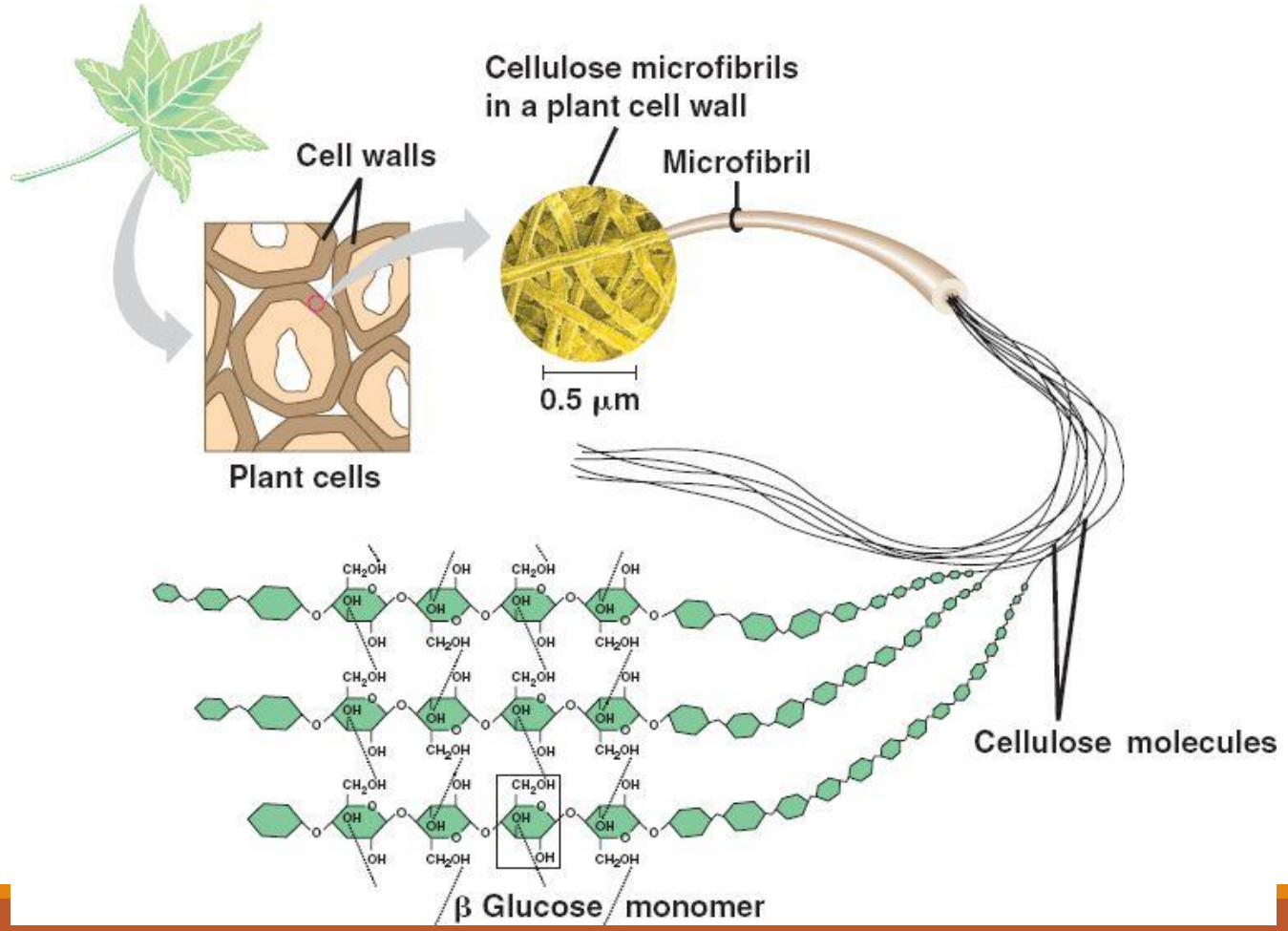




Glycogen is more highly branched than starch.

1. Carbohydrates

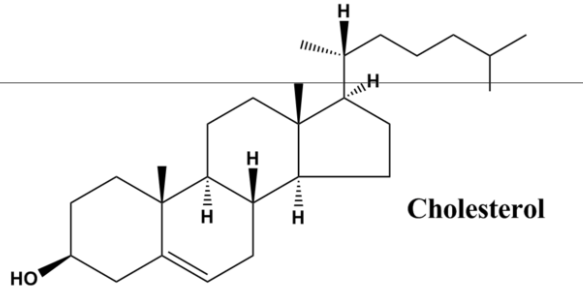
The linear shape of cellulose allows it to interact with water and microfibrils.



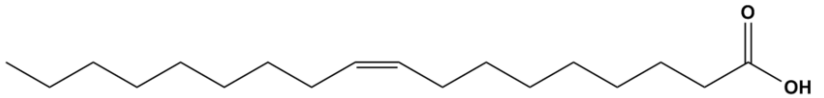
2. Lipids

Lipids contain more carbon-hydrogen bonds in comparison to hydrogen-oxygen bonds.

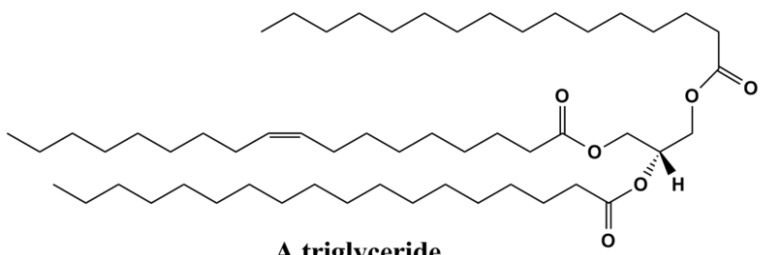
Lipids tend to be hydrophobic and do not dissolve in water.



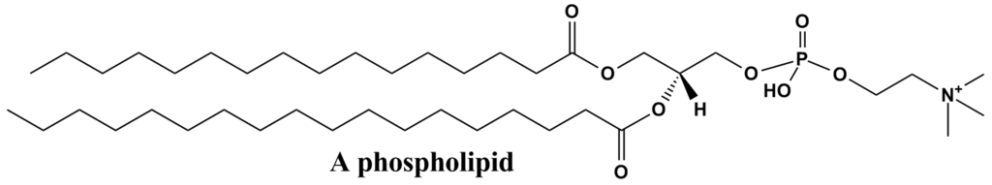
Cholesterol



A free fatty acid



A triglyceride



A phospholipid

2. Lipids

Role of Lipids: Can you think of any?

1. Provides lots of energy through C-C and C-H bonds
2. Helps to maintain structural integrity of the cell membrane
3. Thermal Insulation in animals.

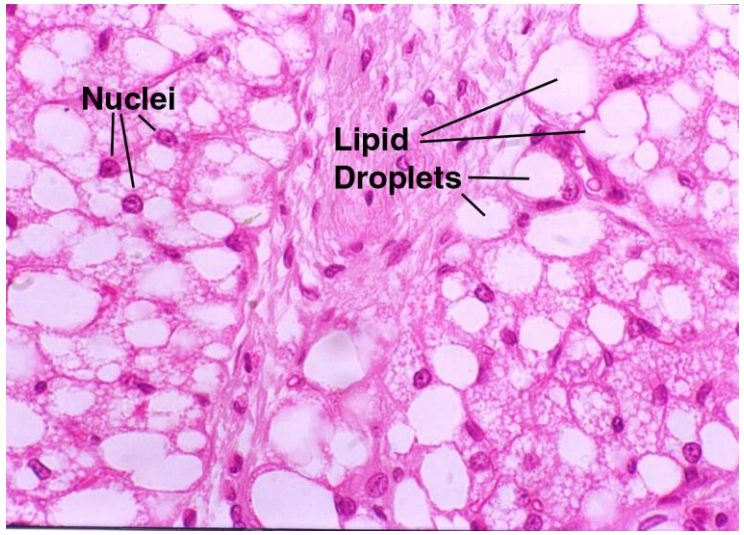
Average Bond Enthalpies (kJ/mol)

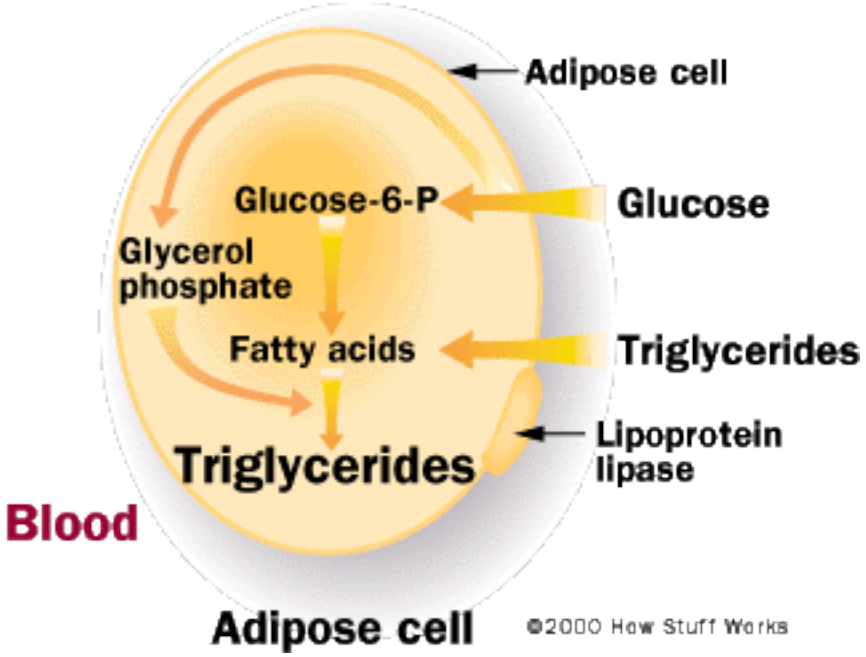
Single Bonds			
C—H	413	N—H	391
C—C	348	N—N	163
C—N	293	N—O	201
C—O	358	N—F	272
C—F	485	N—Cl	200
C—Cl	328	N—Br	243
C—Br	276		
C—I	240	H—H	436
C—S	259	H—F	567
		H—Cl	431
Si—H	323	H—Br	366
Si—Si	226	H—I	299
Si—C	301		
Si—O	368		

Multiple Bonds			
C=C	614	N=N	418
C≡C	839	N≡N	941
C=N	615		
C≡N	891		
C=O	799		
C≡O	1072		

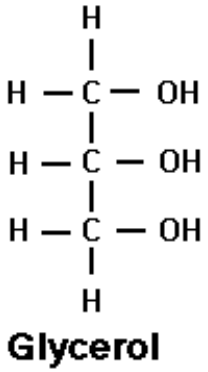
2. Lipids

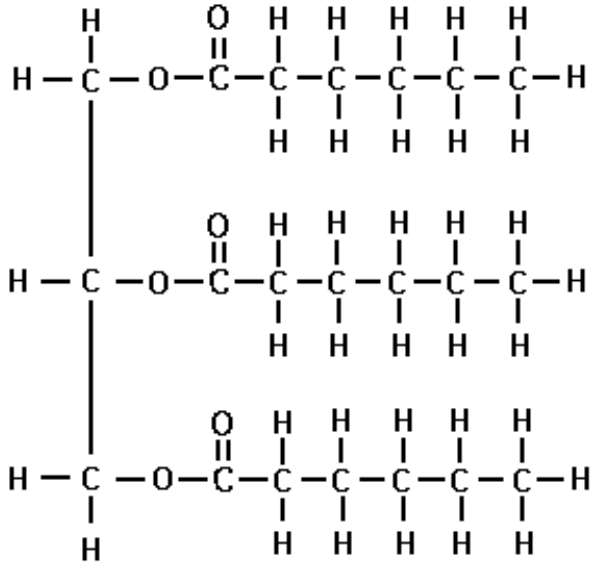
Excess carbohydrates are converted into lipids and stored as fat droplets in the adipose tissue.

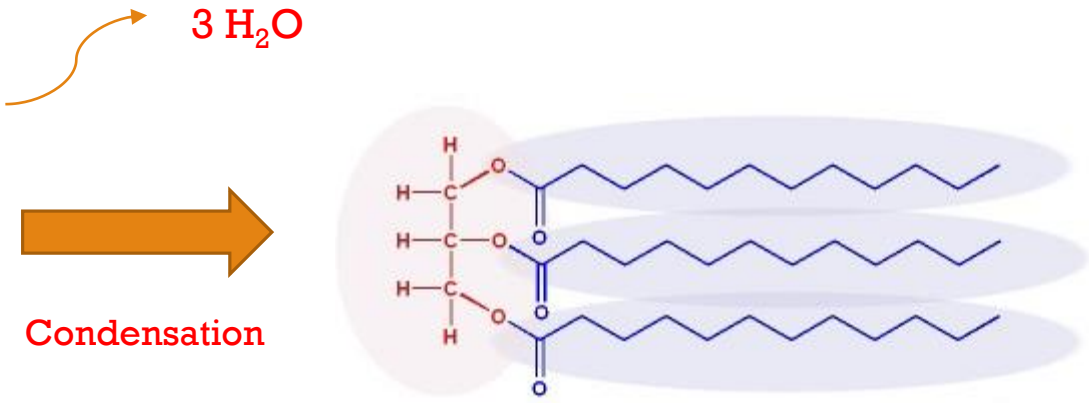




2. Lipids





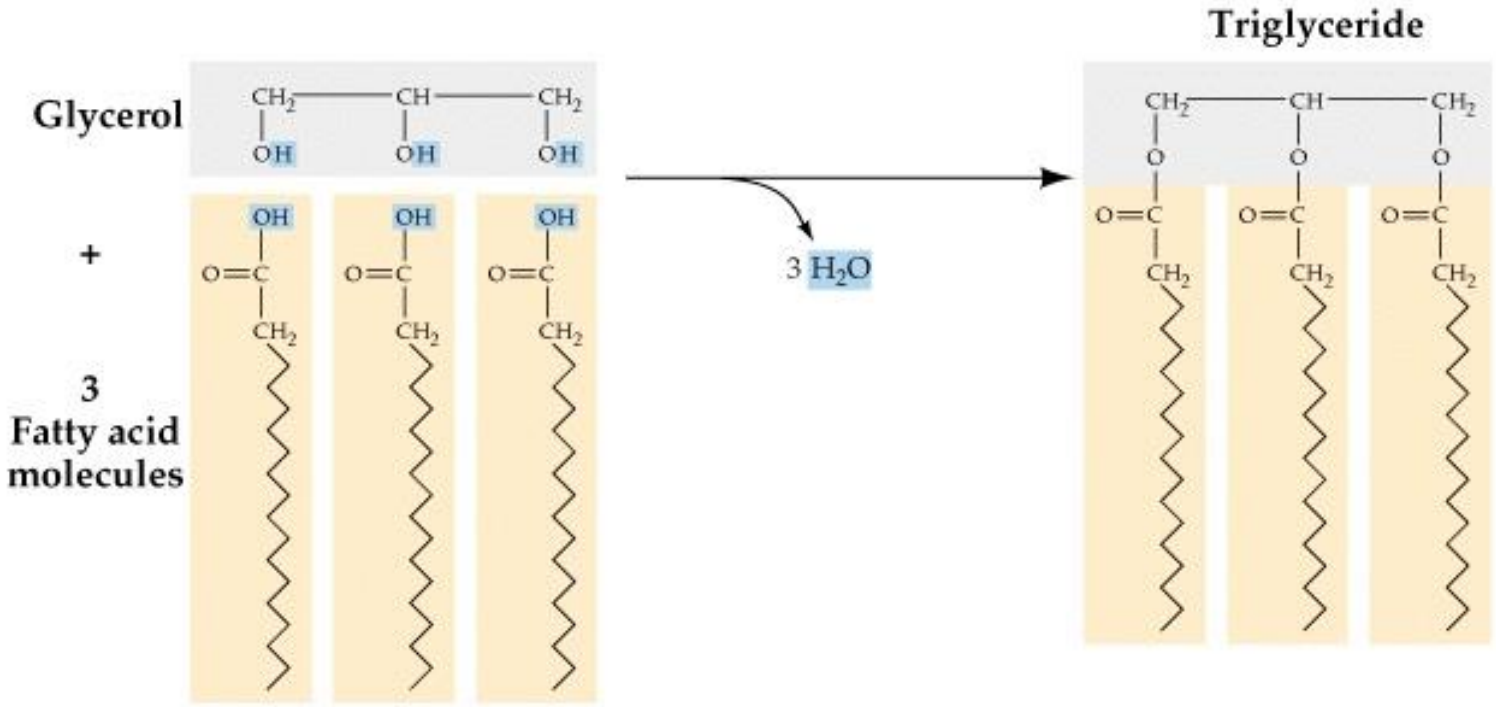


The 3 fatty acid chains contain many C-H and C-C bonds which causes the triglyceride to be highly hydrophobic.

Glycerol: molecule with 3 –OH functional groups

Fatty Acids: long hydrocarbon chains with a carboxyl group at the end of each chain.

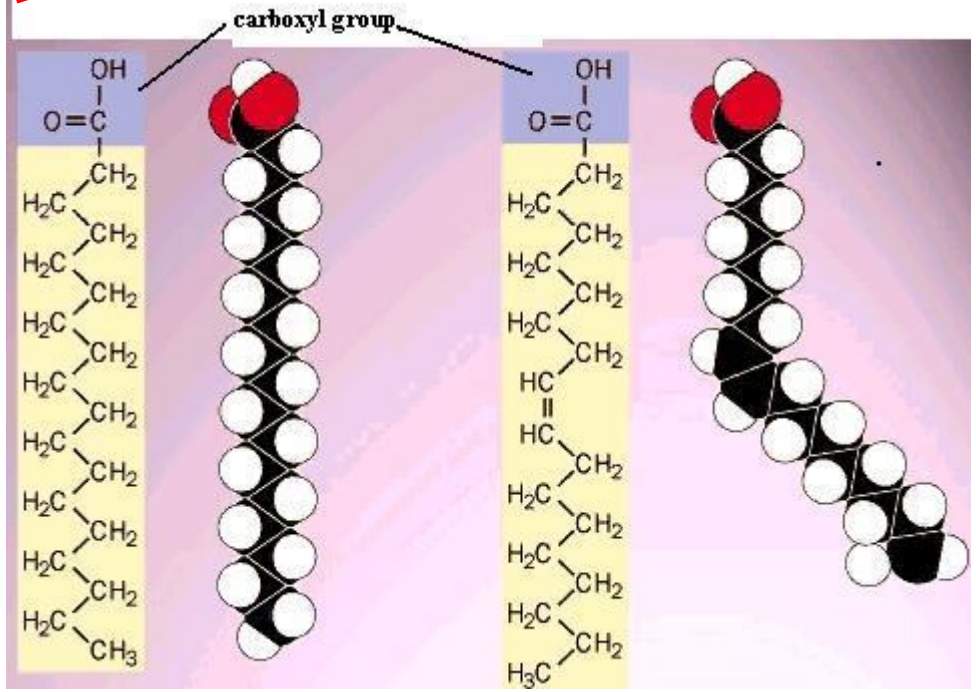
2. Lipids



An ***ester linkage*** is formed during a condensation reaction.

2. Lipids

Which is better for you?

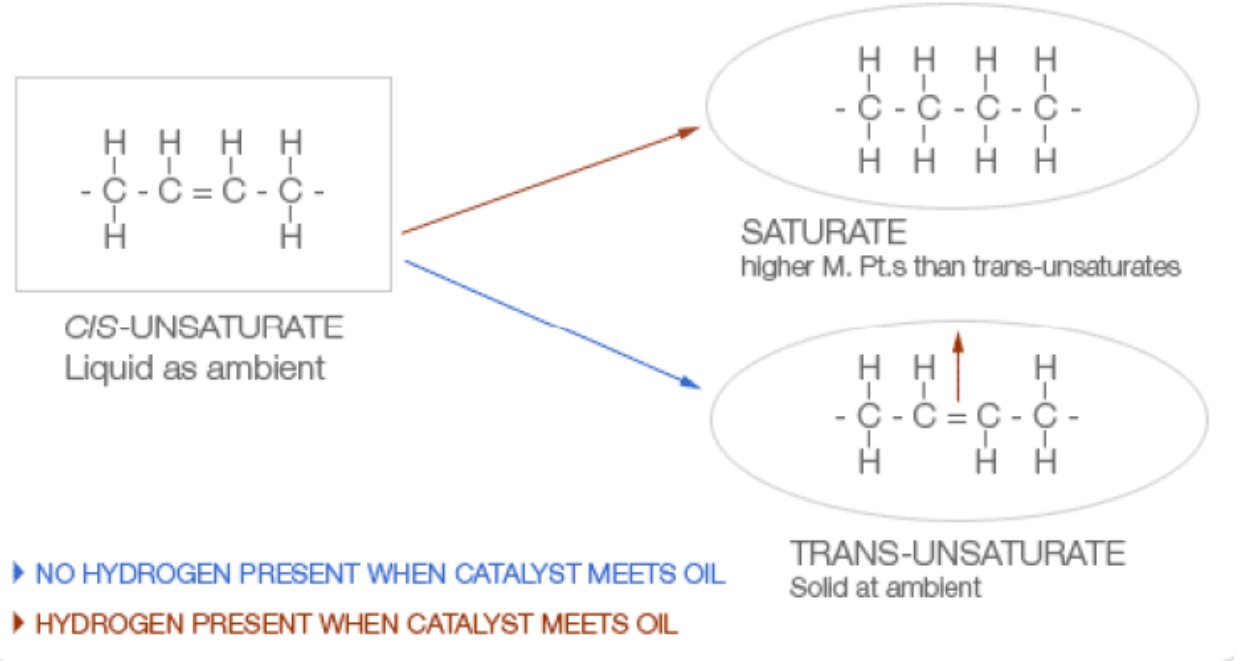


Saturated fats: all C-C bonds are ***single*** in the hydrocarbon chain.

Unsaturated fats: some C-C bonds are a ***double*** bond, causing a 'kink' in the hydrocarbon chain.

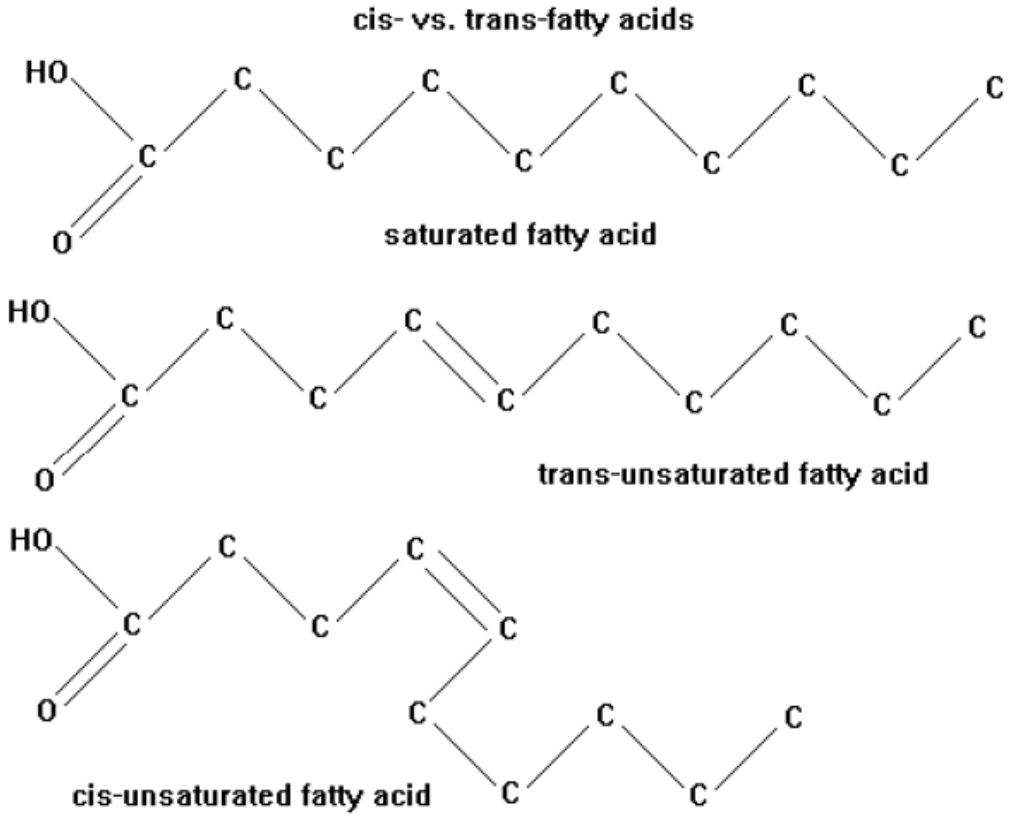
2. Lipids

Hydrogenation: process in which hydrogen is added to a product to convert unsaturated fatty acids to a saturated form.



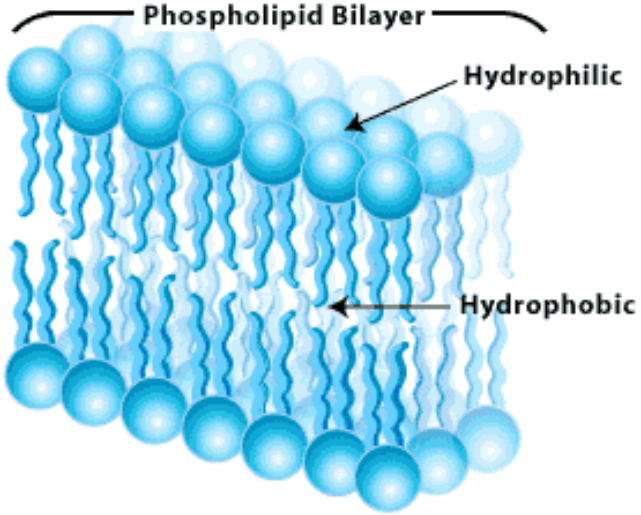
Trans fats contain single bonds and no kinks, however scientists still believe that it may lead to heart disease.

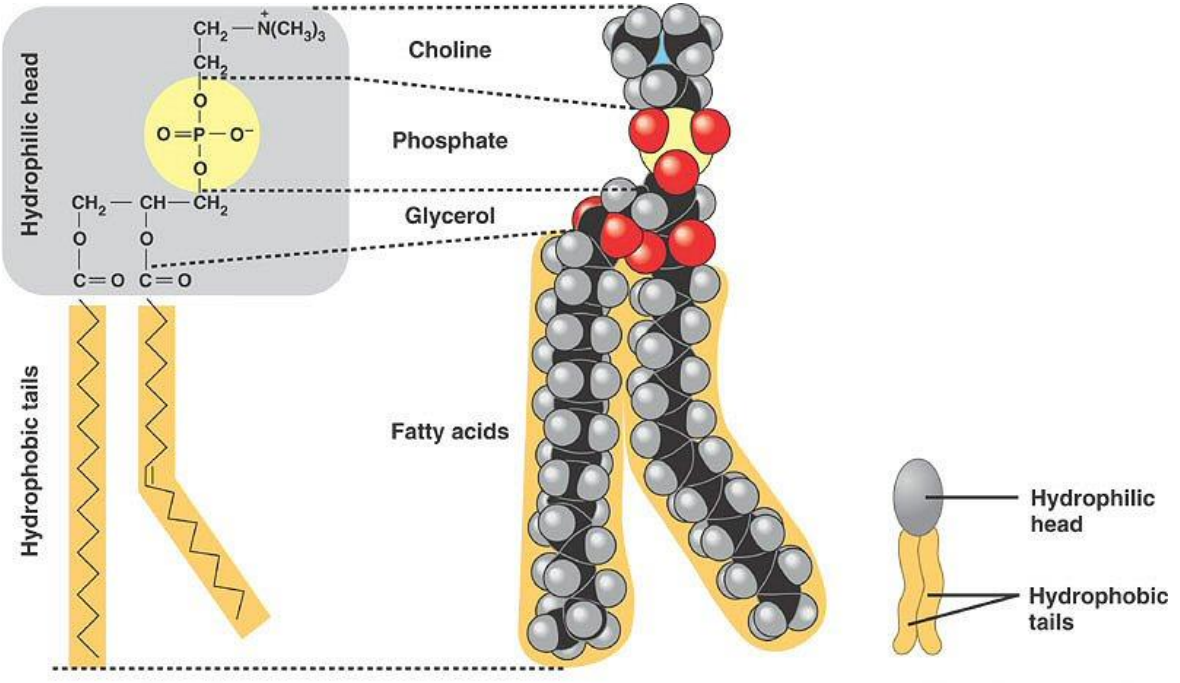
2. Lipids


cis- vs. trans-fatty acids
HO
O
saturated fatty acid
trans-unsaturated fatty acid
cis-unsaturated fatty acid

2. Lipids

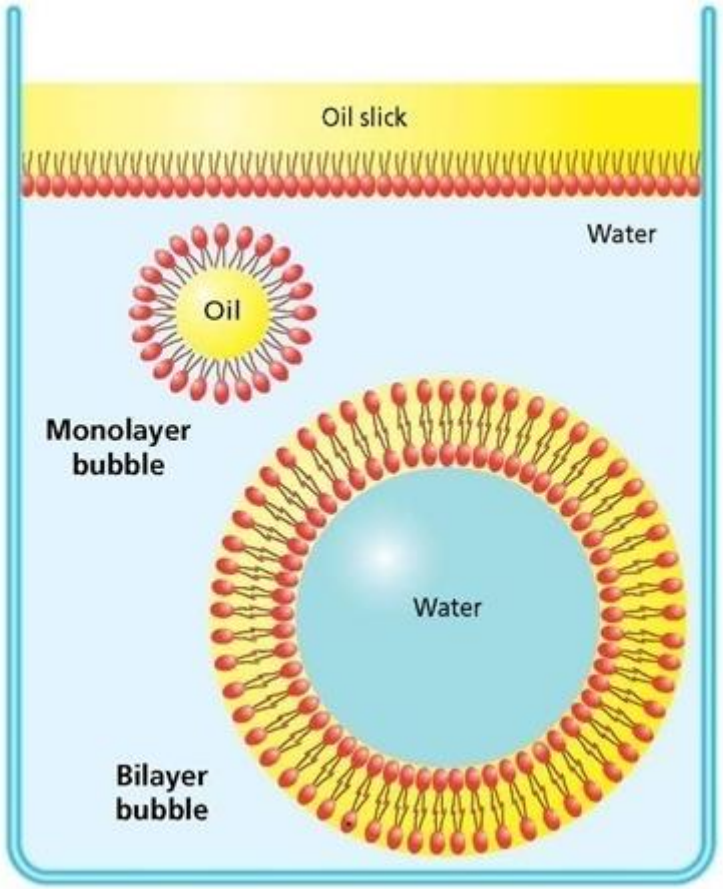
The hydrophobic tails aggregate to the center and expose only the hydrophilic heads to create the lipid bilayer. This creates the spherical structure of the cell.





What might happen to the bilayer structure if many of the phospholipids contained unsaturated fatty acids?

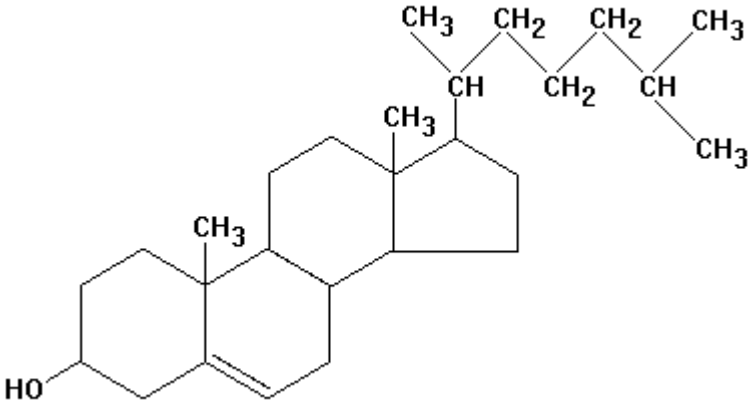
2. Lipids



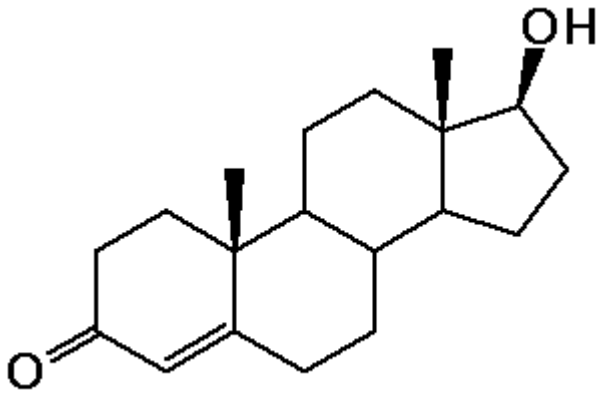
Cell membranes separate the extracellular environment from the intracellular environment.

2. Lipids

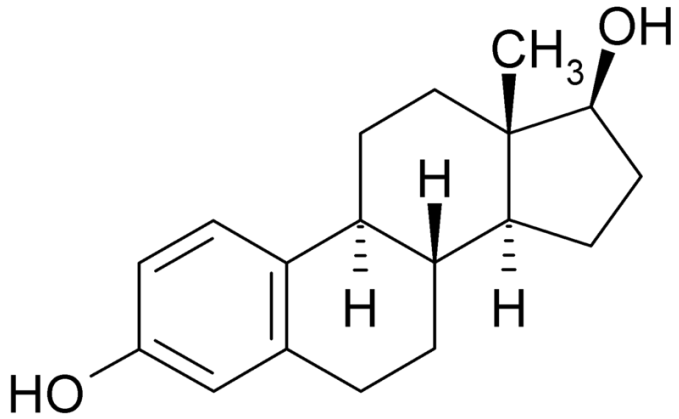
Steroids:



Cholesterol



Testosterone



Estrogen

Depending on the arrangement of atoms of the carbon rings, the structure may differ altering its function.

Homework

Carbohydrates:

Textbook pg. 21 # 7,8, 10 & 12

Lipids:

Textbook pg. # 13 - 16