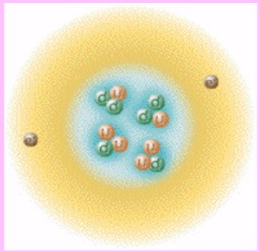
Before we talk more about life, we need to discuss what life is made of.

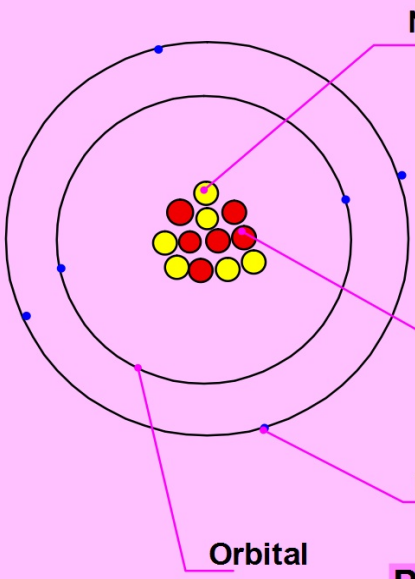
Everything, living or not is made of <u>atoms.</u>

Atoms are very small. How small?
Small enough that millions can fit into the period at the end of a sentence.

Let's take a look inside one of these incredibly small particles...



The Atom



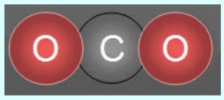
Neutrons have no charge.
Protons are positively charged.
Electrons are negatively charged.

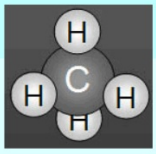
Protons and neutrons reside in the nucleus.
Electrons reside in orbitals around the nucleus.
The rest of the atom is empty space!

Atoms can be by themsleves as <u>Elements</u> OR can join to make up <u>Compounds</u>

Elements are things like oxygen, carbon, magnesium and lead.

Compounds are things like water, salt and carbon dioxide





Let's review some element symbols

C

O

oxygen

lithium

H

Li

hydrogen

sulfur

carbon

helium

He

S

Let's try some more...

Sodium	Iron	Na
		Co
Sulfur	Cobalt	Fe
		Si
Silicon	Copper	Cu
		Sn
Tin	Chlorine	Cl
		S

Elements can become ions if they lose or gain electrons.

If an element loses electrons, it becomes a positive ion (+).

If an element gains electrons it becomes a negative ion (-).

Elements and their ions do NOT have the same properties!

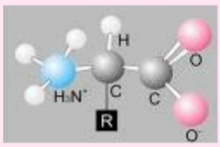
Many elements are found as ions in our bodies!

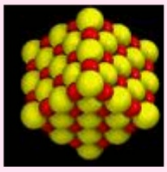
Na^{+}, K^{+}, Cl^{-}, Mg^{+2}, Ca^{+2}

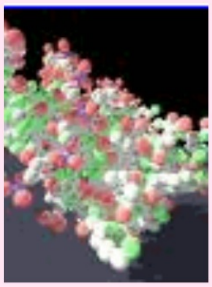
Elements and ions combine to form compounds

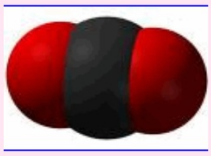
Some important compounds in biology are:

- water (H2O)
- salt (NaCl)
- carbon dioxide (CO2)
- DNA
- Proteins
- Amino Acids
- Carbohydrates





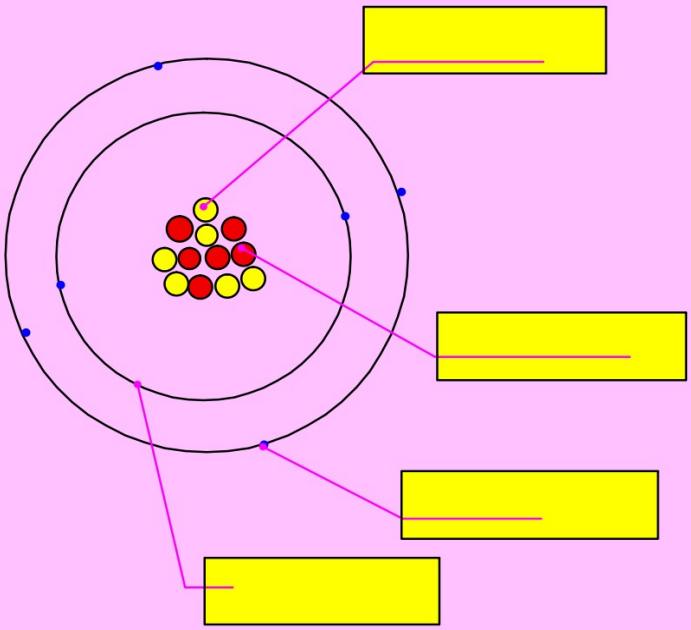




When ions join together, they form ionic bonds. They bond because opposite charges attract. NaCl is an example. Ionic compounds contain metal ions.

When neutral atoms join, they form covalent bonds. They bond because they share electrons. H_2O is an example. Covalent compounds do not contain metals!

Review:



orbital

neutron

electron

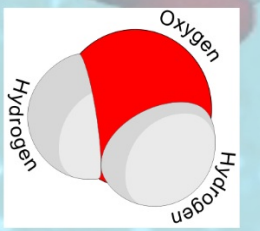
proton

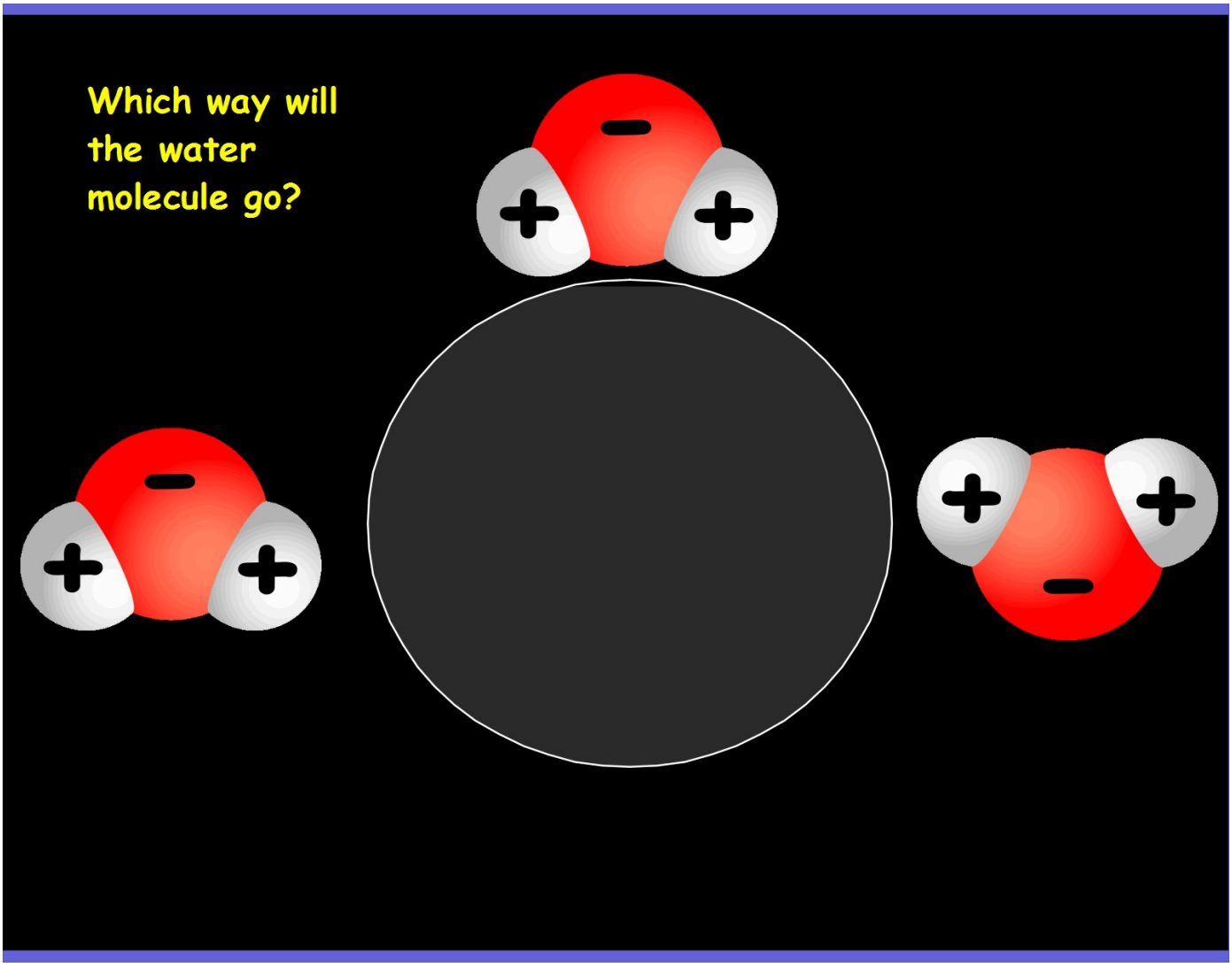
Water!

What's so special about water?

Water is made of 2 hydrogen atoms and 1 oxygen atom

Oxygen is in the middle. The hydrogens are attached at an angle




Which way will the water molecule go?

The slightly negative oxygen will attract the slightly positive hydrogens of ANOTHER water molecule --> this is called a hydrogen bond

This is what makes water so special!

Let's list some of the important properties of water...

High _____ = takes a while to heat up & cool down

_____ = the attraction among water molecules

_____ = attraction to different molecules

Many substances _____ in water

Ice is less _____ than liquid water

Water has a high _____

surface tension

cohesion

specific heat

dissolve

dense

adhesion

Using a textbook, illustrate:

1. water as a polar molecule *(be able to explain what polarity is)*

2. Water's ability to form hydrogen bonds with other water molecules

3. Water's ability to dissolve other substances

What do YOU think?

How would life be different if water had a low specific heat?

How would life be different if ice was more dense than liquid water?

How would life be different if water didn't dissolve many substances?

Acids, Bases & pH

Some compounds will break up into ions when they dissolve in water. If one of the ions is an H+ ion, the compound is an acid.

A base will remove the H+ ions from a solution, and will sometimes have an OH- ion in the compound.

A solution with a high concentration of H+ ions is said to be acidic. A solution with a low concentration of H+ ions is said to be basic.

The way we measure the acidity of a solution is pH.

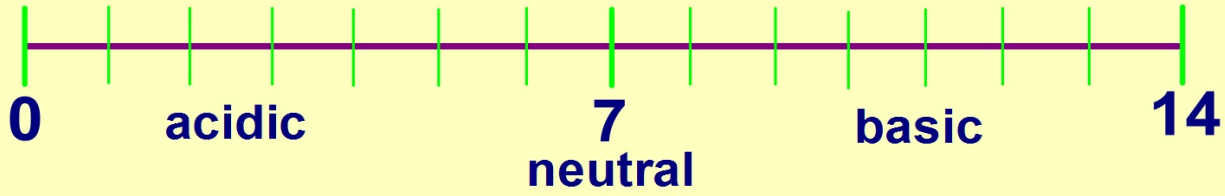
An acid will have a low pH.

A base will have a high pH.

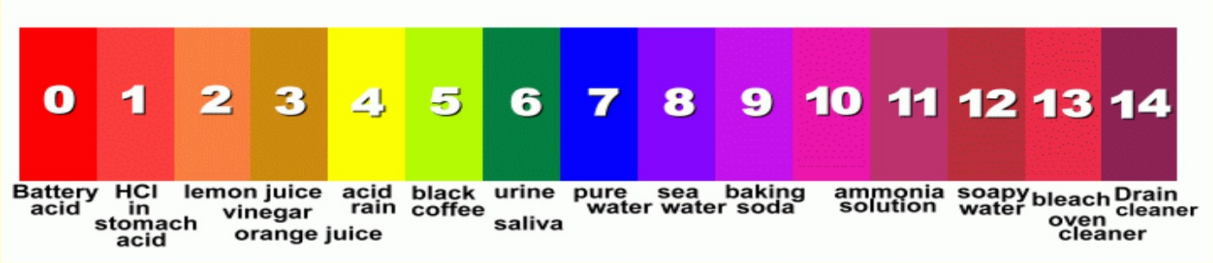
The pH Scale

The pH scale runs from 0 (very acidic) to 14 (very basic), with 7 being neutral.

A substance with pH 5 is 10 times more acidic than a substance with pH 6.



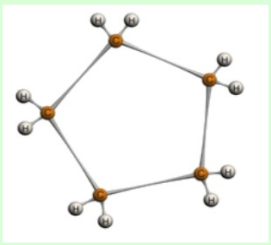
Living things usually need a pH range of 6 to 8 to live, but many household solutions have a much lower or much higher pH.

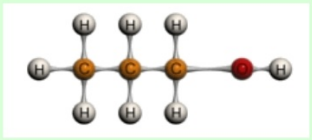


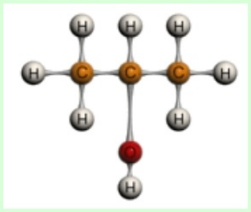
Carbon Based Molecules

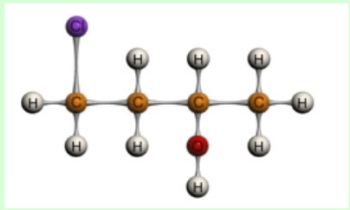
Carbon is a unique atom because of its ability to bond with many other elements, and even itself, many times.

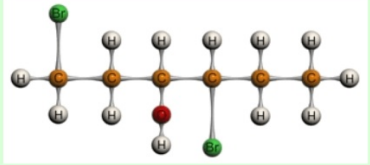
Carbon needs 4 bonds to be happy!

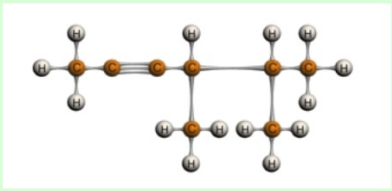


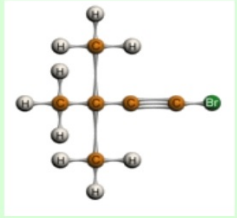




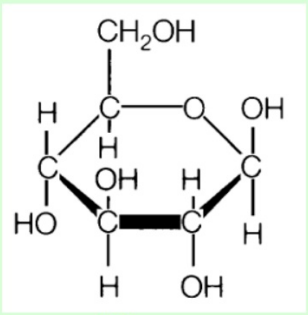






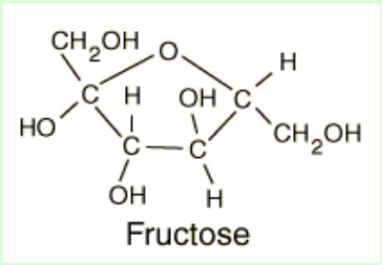


Some carbon-based molecules link together to form polymers. Sucrose is an example.



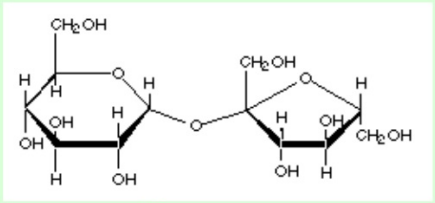
Glucose

+

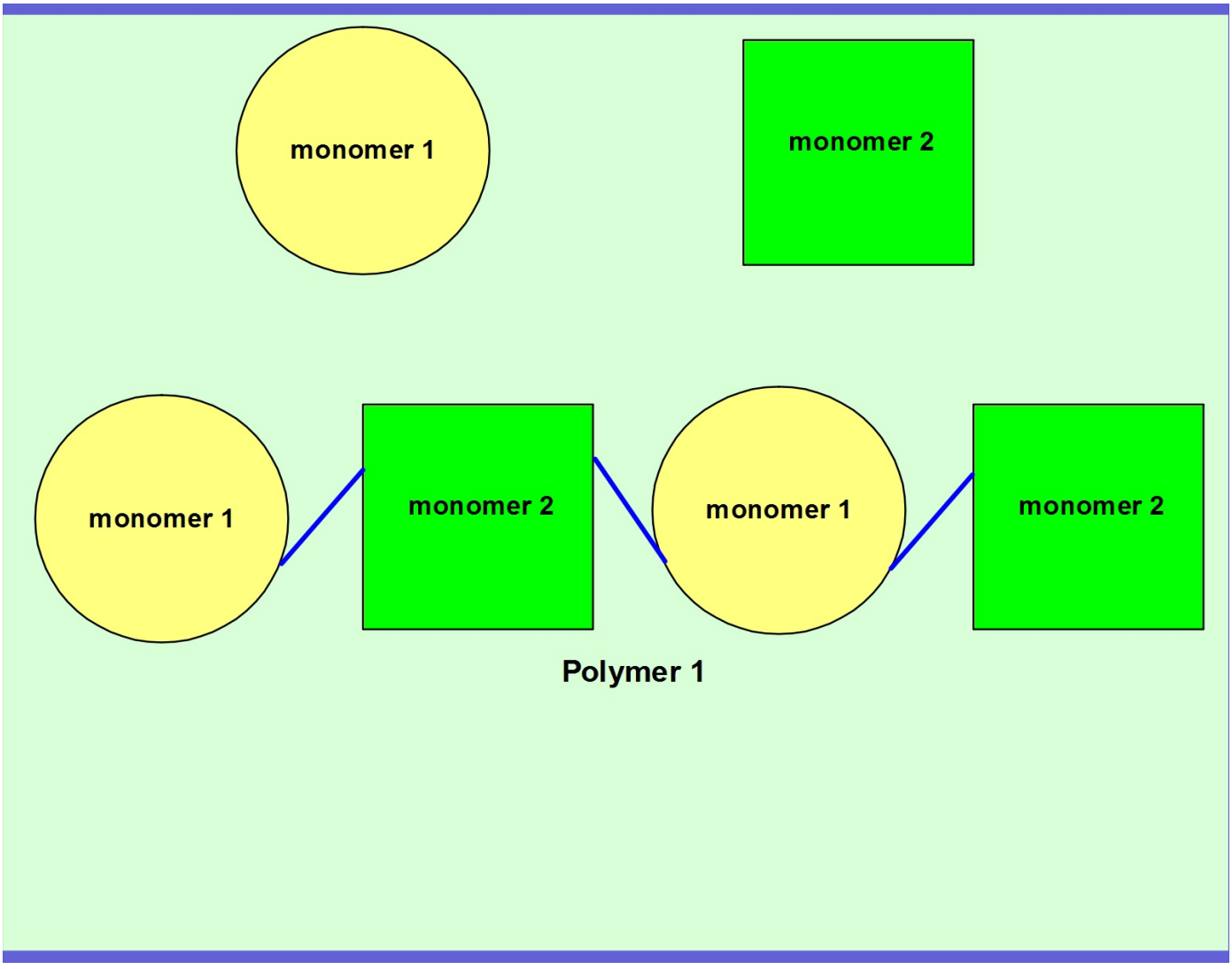


Fructose

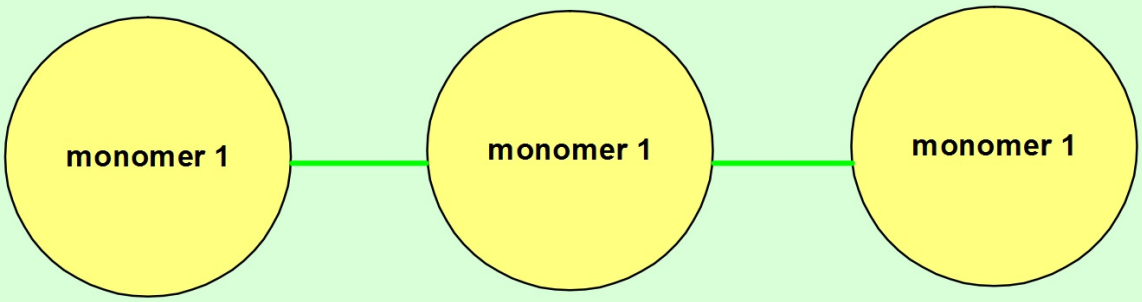
=



Sucrose


monomer 1
monomer 2
monomer 1
monomer 2
monomer 1
monomer 2
Polymer 1

OR



Polymer 2

There are 4 main groups of carbon molecules important to life:

- **Carbohydrates**
- **Lipids**
- **Proteins**
- **Nucleic Acids**

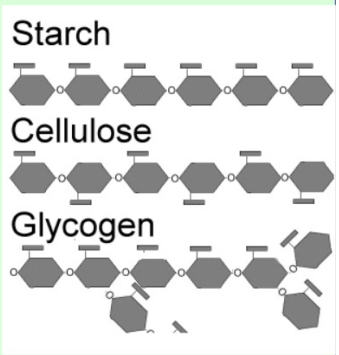
Carbohydrates

Carbohydrates are composed of Carbon (C), Hydrogen (H) & Oxygen (O).

Carbohydrates include sugars and starches

Some are monomers, like glucose. Others are polymers like sucrose and starches.

Carbohydrates



Glucose is a monosaccharide (monomer)

Sucrose is a disaccharide polymer

Starch is a polysaccharide polymer

Cellulose is another polysaccharide polymer

Glycogen is a branched polysaccharide

Cellulose: the substance in plant cells that makes it hard to chew - cellery, for example

Humans cannot digest cellulose - this is why corn looks the same on the way out as it does on the way in ☺

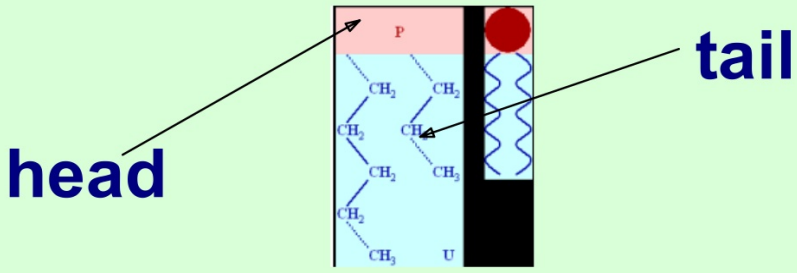
Glycogen is made in humans and other animals
Glycogen is more highly branched than starches in plants.

Lipids

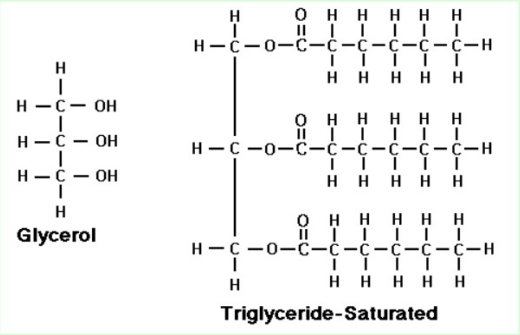
Lipids are fats and oils
Another example of a lipid is cholesterol
Lipids are nonpolar

Lipids are made of carbon, hydrogen and oxygen, but have a different structure from carbohydrates.

The structure of a lipid is twofold - a head and a tail:



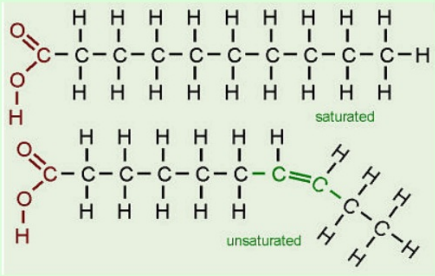
Fats and oils *store* large amounts of energy for the cell's metabolism Both are made of a glycerol molecule and molecules called fatty acids



There are saturated and unsaturated fatty acids

<u>Saturated</u> means there are no more hydrogen atoms that can bond (no double bonds)

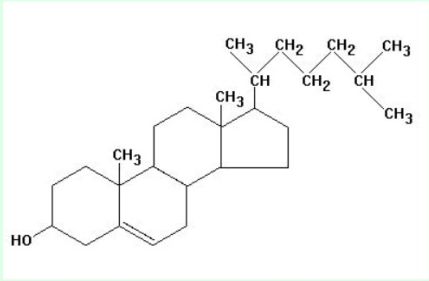
<u>Unsaturated</u> means more H can bond (there will be double bonds)



Saturated fatty acids will be solids.

Unsaturated fatty acids will be liquids.

Cholesterol is an exception - it includes a ring structure.
It is an important part of your cell membranes and is also the basis for some steroids.
Steroids are not all bad - when produced naturally in the body, they help regulate sexual development for example, among other important things.



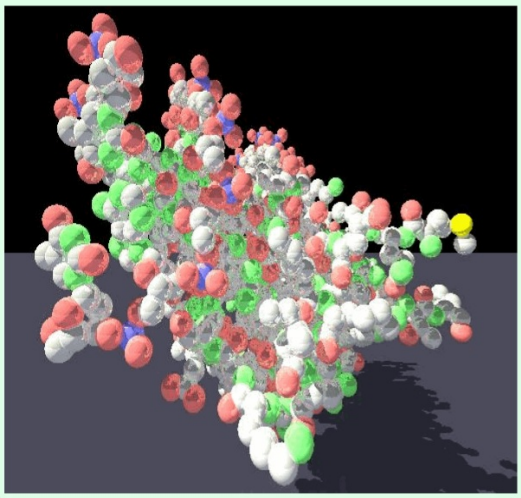
Proteins

Proteins are the most varied of the carbon-based molecules.

Proteins are important in almost everything you do!

What is a protein?

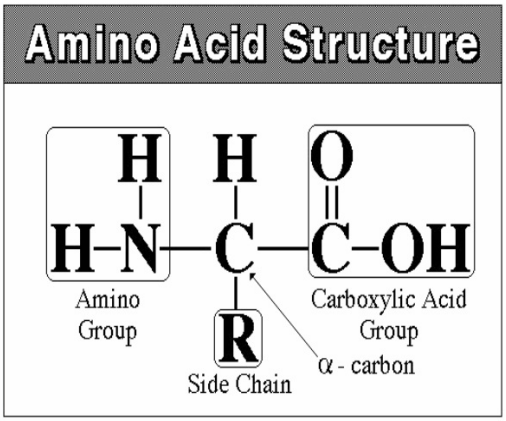
A polymer made of monomers called amino acids. There are 20 different amino acids that organisms use - they are made of carbon, hydrogen, oxygen, nitrogen and sometimes sulfur. Your body can make only 12 of these amino acids.



The 8 amino acids you cannot make must be ingested via the food you eat.
This is why proteins are an important part of any diet.
Our bodies break down the proteins and reuse the amino acids.

The 20 amino acids all have very similar structures.
There is a carbon bonded to 4 other groups.

1. H atom
2. NH2 (amino group)
3. COOH (carboxyl group)
4. "R" group - varies with each amino acid

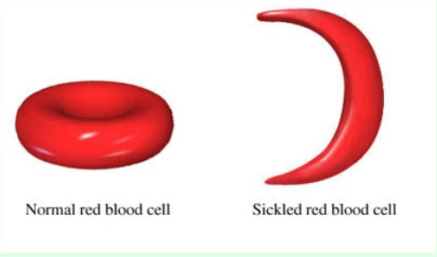


Amino acids form bonds called peptide bonds with one another to form poly-peptides.
Proteins are made of one or more polypeptides.

The order of the amino acids in a protein determine the properties and the function of the protein. If just one amino acid is changed or added or deleted, the whole protein can be rendered useless or not as efficient.

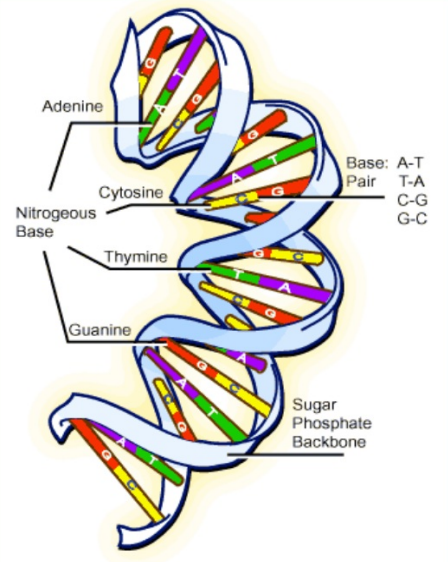
In sickle-cell anemia, the hemoglobin protein is shaped differently than the normal hemoglobin structure. This can cause numerous painful problems.

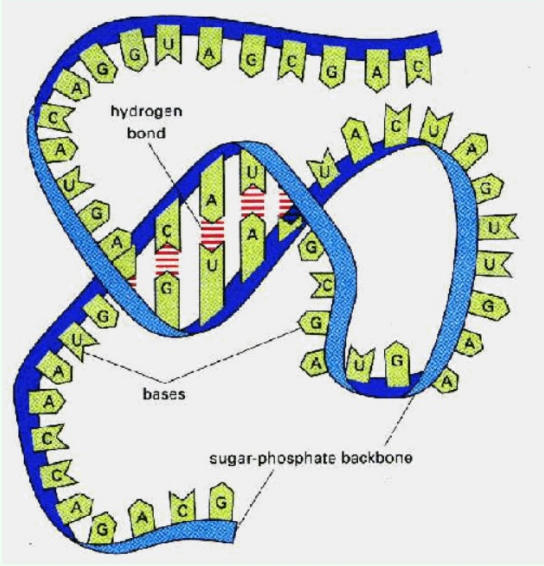
There is a one amino acid difference!



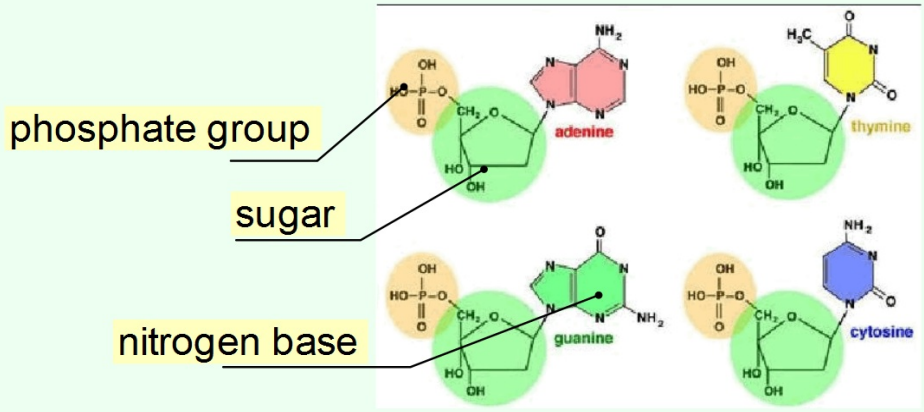
Nucleic Acids

There are two types of nucleic acids - DNA & RNA





DNA & RNA are each polymers made of monomers called nucleotides. Nucleotides are made up of a sugar molecule, a phosphate group and a nitrogen-containing molecule called a base.



Nucleic Acids have one function - to work together to make proteins!

DNA is used to store the info and RNA is used to actually build the proteins.

DNA is the basis of genes & heredity, but RNA is required to make everything work.