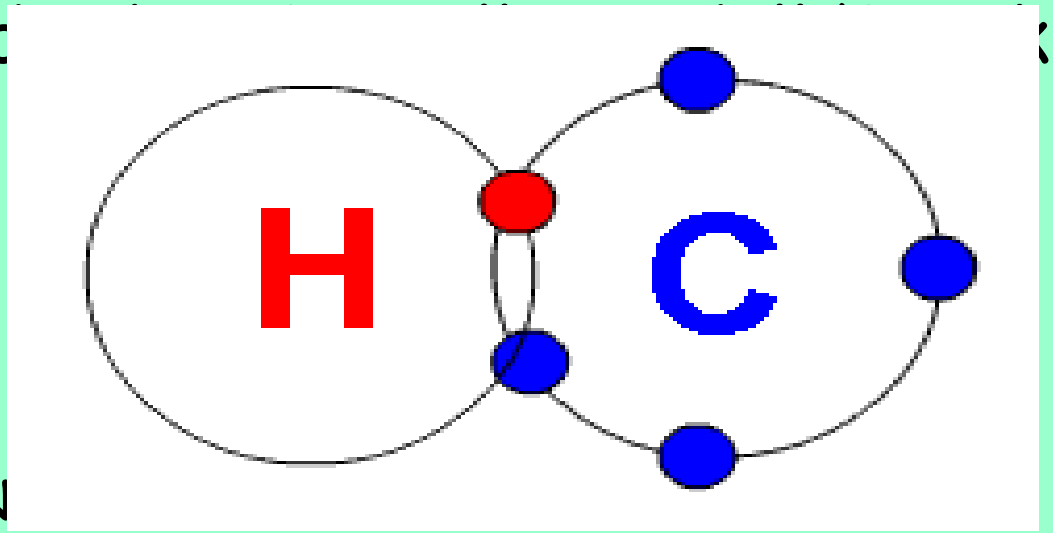
Image from: http://www.school-for-champions.com/science/chemhydrocarbon.htm

The Chemical Context of Life

Chapter 2-1 & 2-2

Slic…kings Biology



KEY CON…

2.1 Matter consists of chemical elements in pure form and in combinations called compounds.

2.2 An elements properties depend on the structure of its atoms

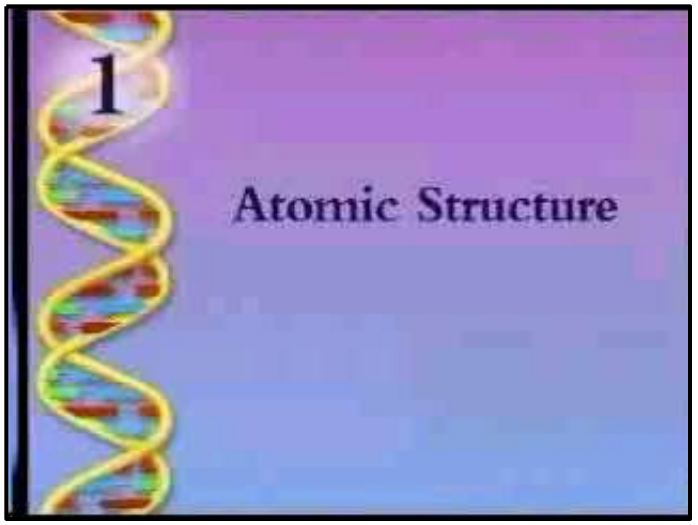
2.3 The formation and function of molecules depend on chemical bonding between atoms

2.4 Chemical reactions make and break chemical bonds.

Slide show by Kelly Riedell/Brookings Biology

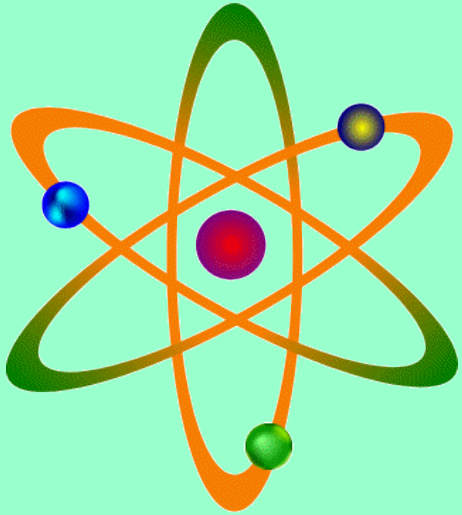
Video 1

Atomic Structure 2A



Click the image to play the video segment.

Atoms are the basic unit of MATTER:



PROTONS (+)

NEUTRONS

are found in NUCLEUS

ELECTRONS (-)

orbit outside nucleus in energy levels

Animation from: http://www.wjcc.k12.va.us/ROBB/Atom%20Animation%20Resources_files/image003.gif

Atoms differ in NUMBERS of PROTONS, NEUTRONS, & ELECTRONS

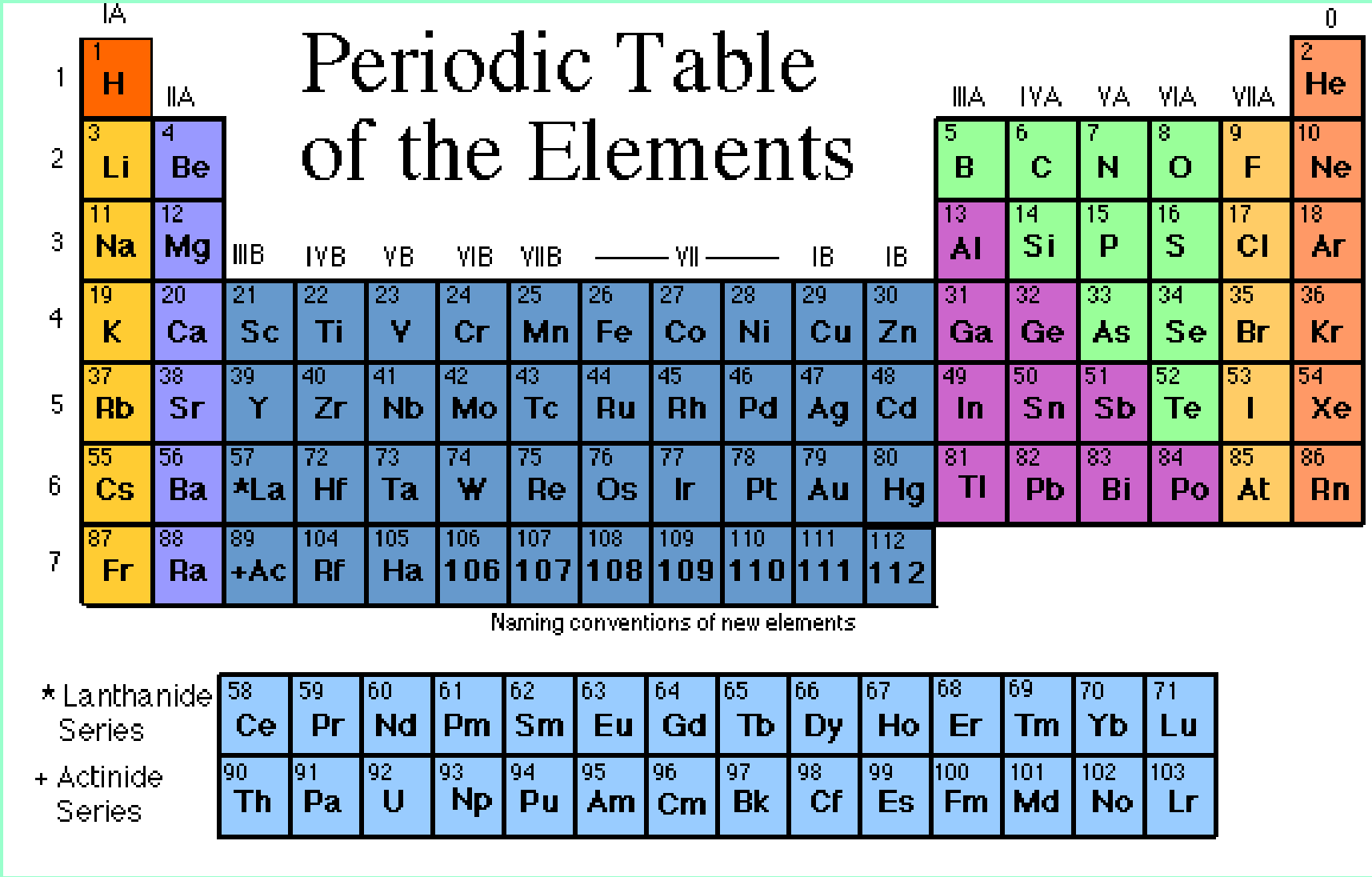


Image from: http://www.uic.edu/classes/bios/bios100/summer2004/lect02.htm

Atoms that have gained or lost electrons

have an electric charge and

are called IONS

Na^+

Cl^-

They are written with a + or − next to their symbol

Atoms/ions important for living things

Used to make bigger molecules

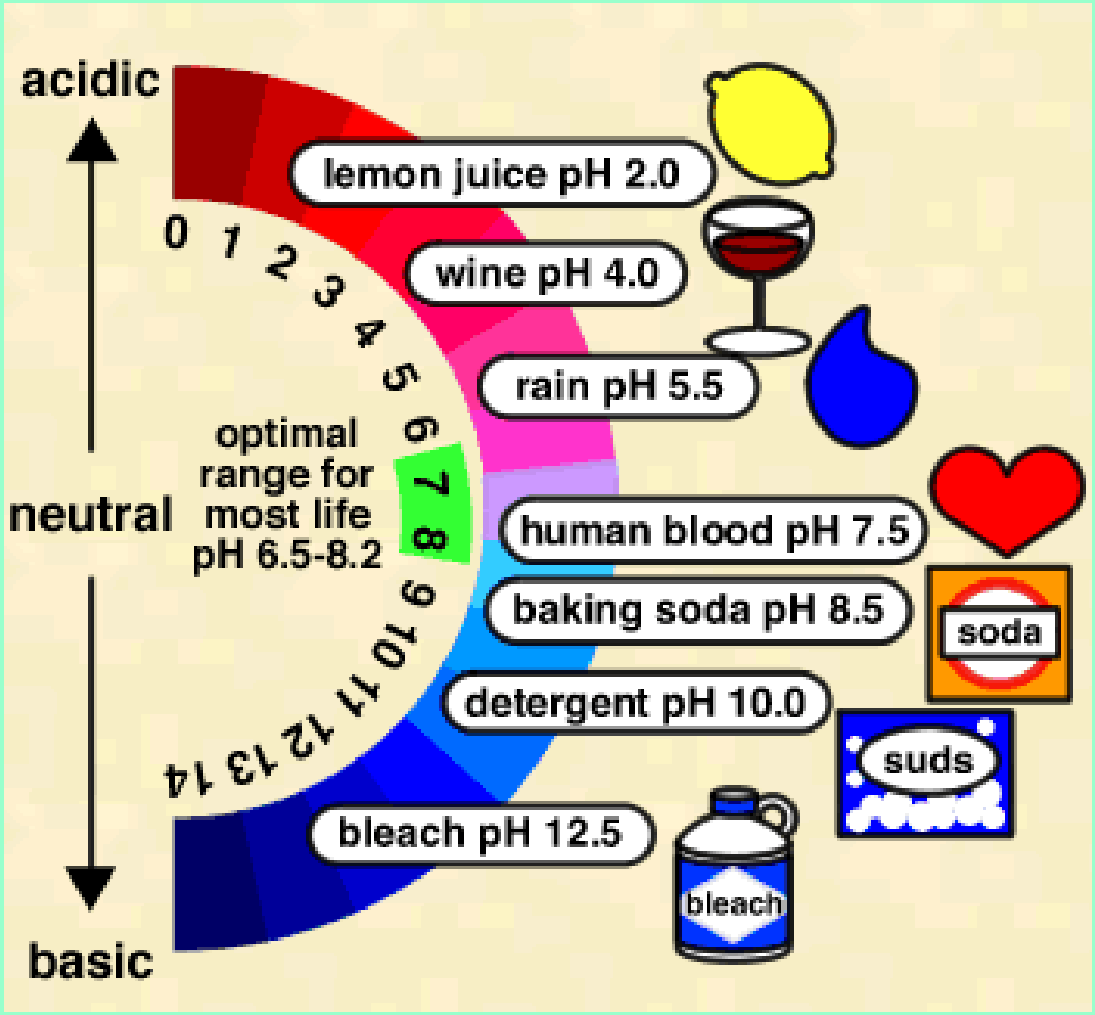
- Carbon - C
- Oxygen - O
- Hydrogen - H
- Nitrogen - N
- Sulfur - S
- Phosphorus - P

Ions = electrically charged atoms

- Sodium - Na^+
- Chloride - Cl^-
- Potassium - K^+
- Calcium - Ca^{++}
- Hydrogen - H^+

Hydrogen Ions (H^+)

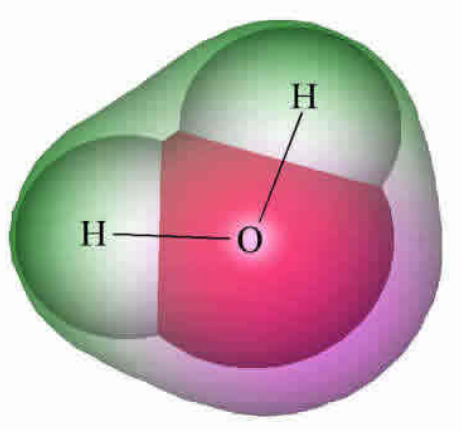
http://www.guardiantrader.com/images/ph_scale.gif



The number of H+ ions determines how acidic a solution will be.

More H^+ = more acidic

ATOMS CAN JOIN TOGETHER TO MAKE MOLECULES



Ex:

Joining 2 HYDROGEN atoms with 1 OXYGEN atom makes one WATER molecule.

A chemical formula tells what kind of and how many atoms are in a molecule

EX: H_2O

http://www.lsbu.ac.uk/water/molecule.html

VERY, VERY LARGE MOLECULES

= MACROMOLECULES

EXAMPLE:

Insulin =

$C_{254}\ H_{377}\ N_{65}\ O_{76}\ S_6$

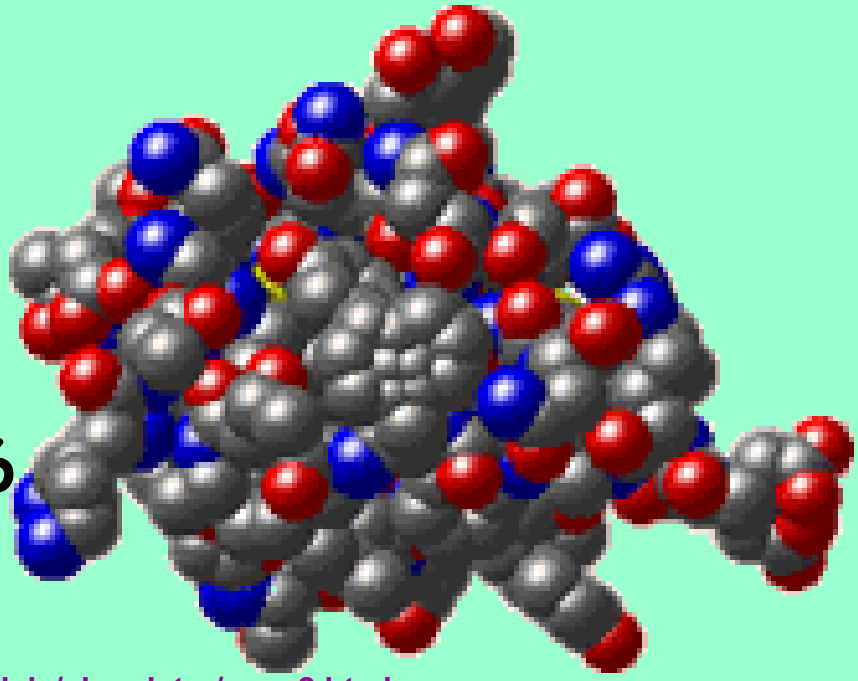
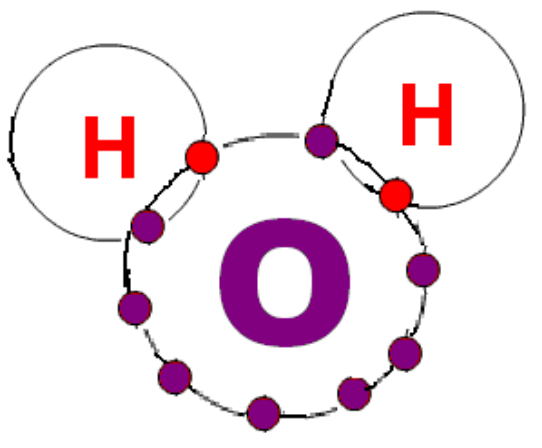
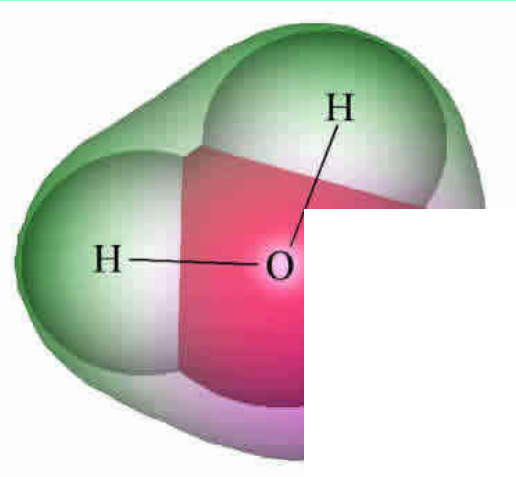


Image from: http://www.biology.arizona.edu/biochemistry/tutorials/chemistry/page2.html

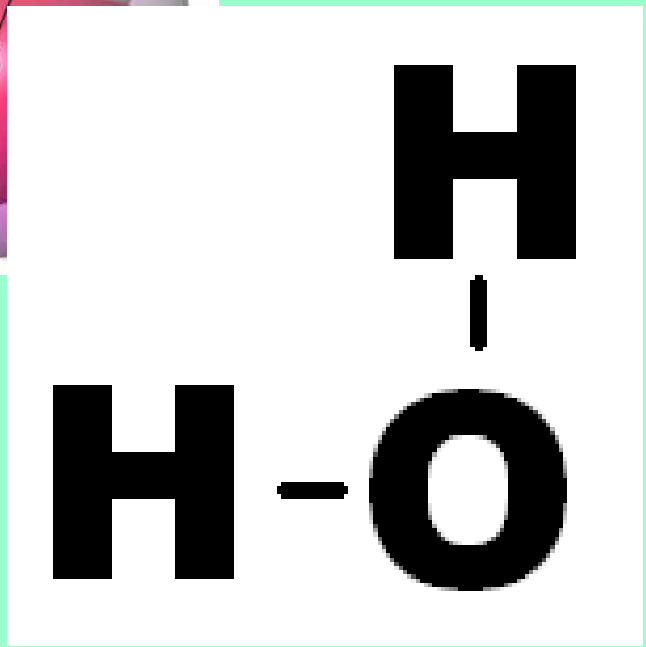
MOLECULES CAN BE SHOWN IN DIFFERENT WAYS



Water molecule: http://www.lsbu.ac.uk/water/molecule.html



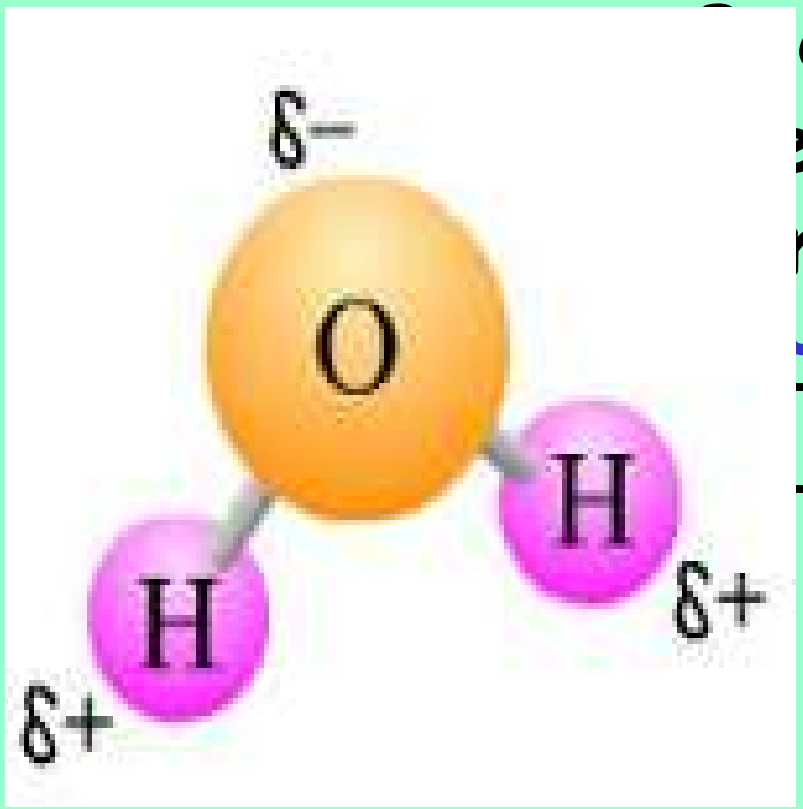
H_2O



Other Images by: Riedell

Image from: http://www.estrellamountain.edu/faculty/farabee/biobk/BioBookCHEM2.html

Polar Molecules



Because of the location of electrons in molecules, some molecules have an UNEVEN pattern of electric charge

More + on one side;
More − on the other

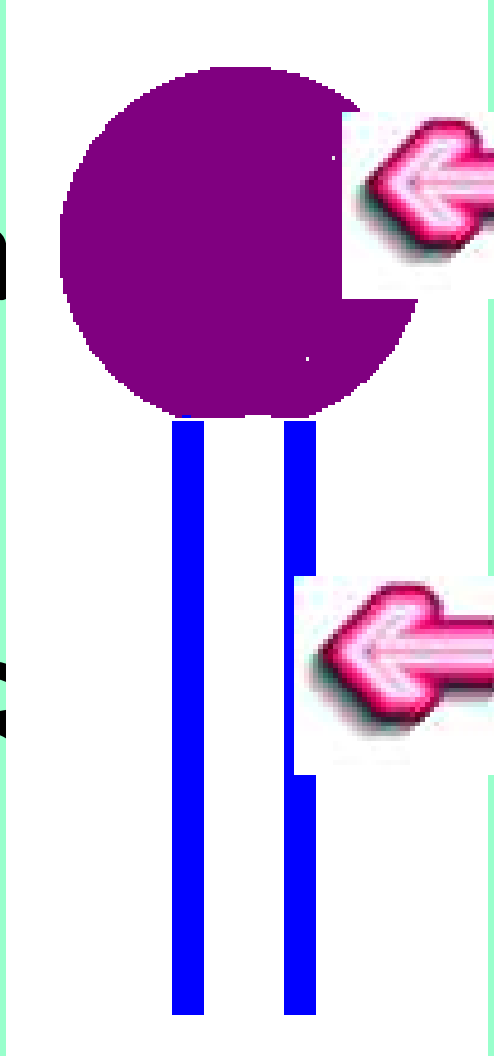
EX: water

Bending water video

More about this in Chapter 7

EX: PHOSPHOLIPIDS

The same molecule can have both POLAR and NON-POLAR parts

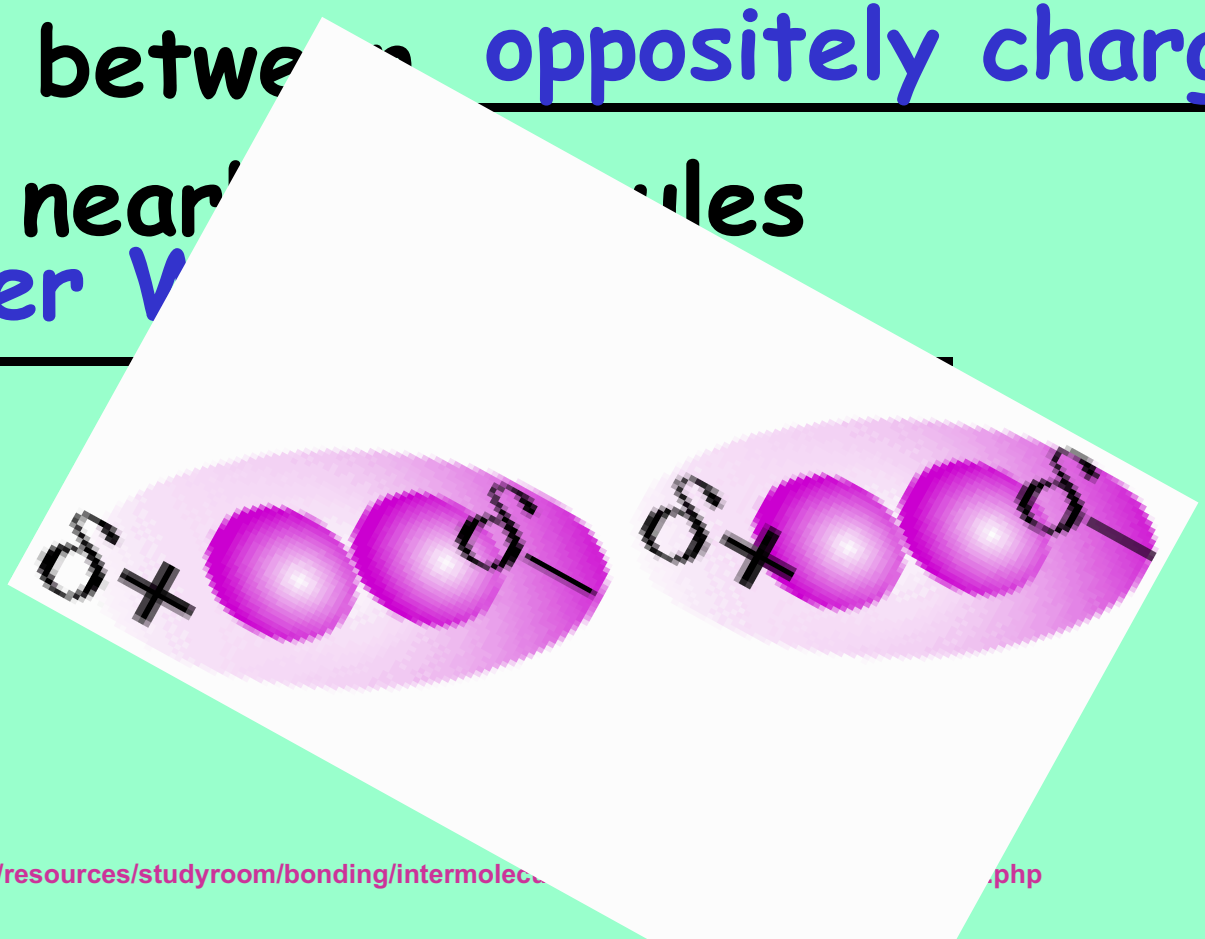


More about this in Chapter 7

Image by Riedell

WHAT HOLDS MOLECULES TOGETHER?

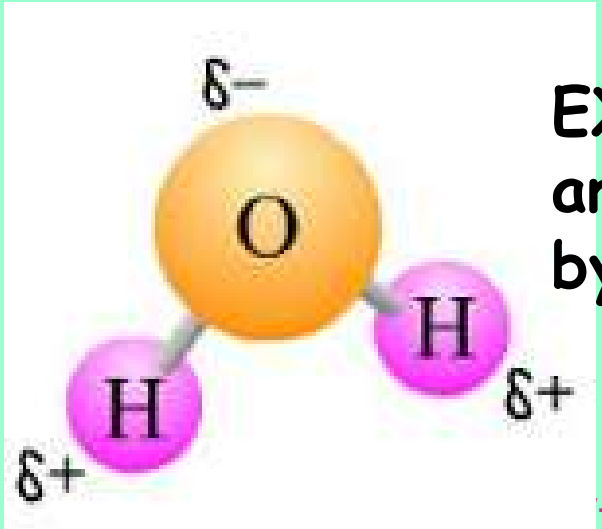
Molecules are held together by the attraction between oppositely charged regions of nearby molecules = van der Waals forces



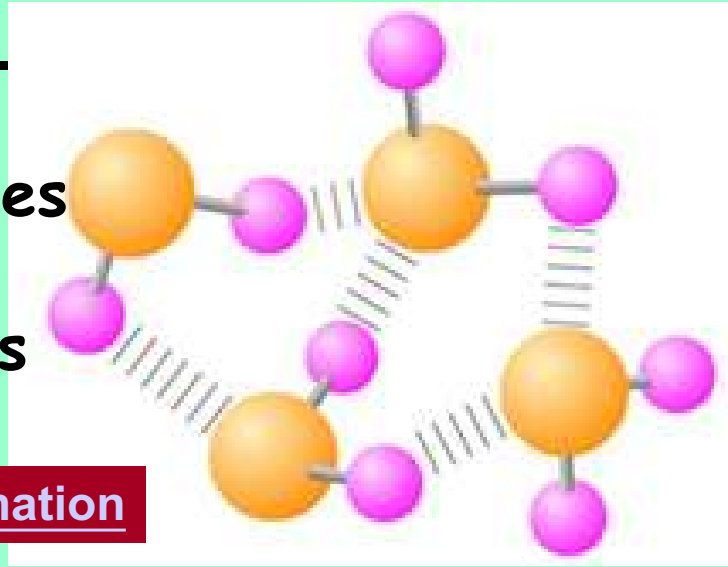
http://www.examstutor.com/chemistry/resources/studyroom/bonding/intermolec .php

HYDROGEN BONDS

Bonds that form between the positively charged HYDROGEN atom in one molecule and a negatively charged atom in a nearby molecule are called HYDROGEN BONDS



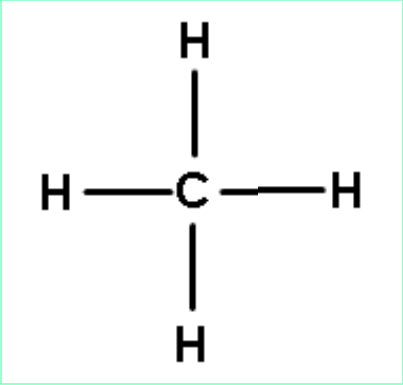
EX: water molecules are held together by Hydrogen bonds



Hydrogen bond animation

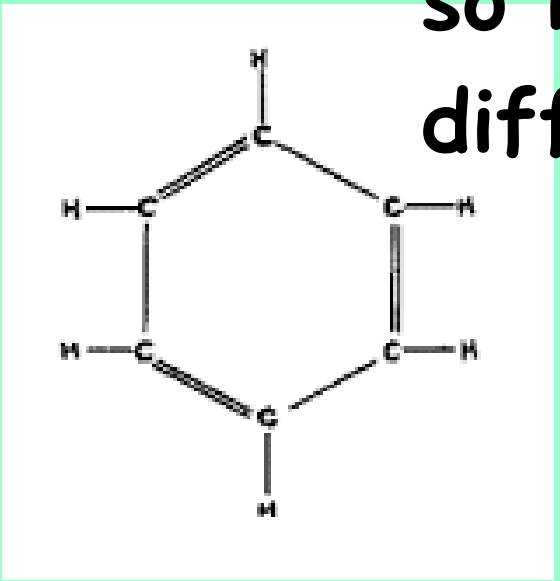
.estrellamountain.edu/faculty/farabee/biobk/BioBookCHEM2.html

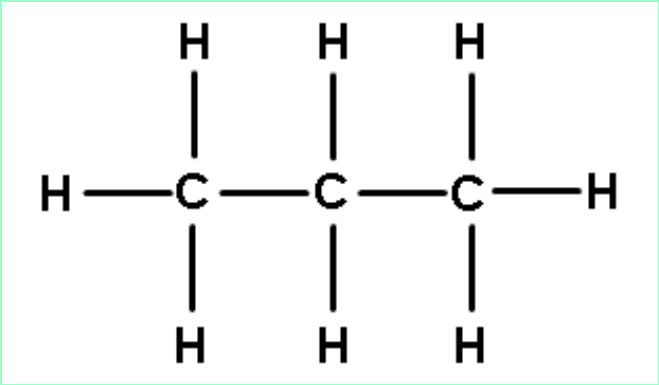
CARBON is the most important atom found in living things



It can join to four other atoms at same time

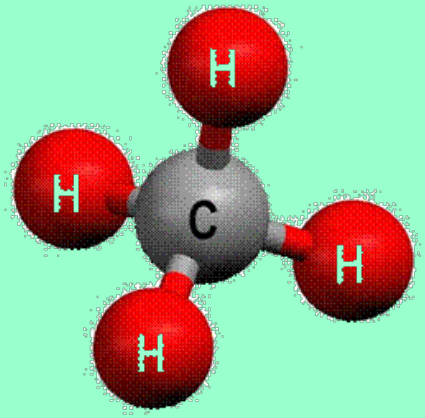
It can form rings or chains so it can make lots of different kinds of molecules.



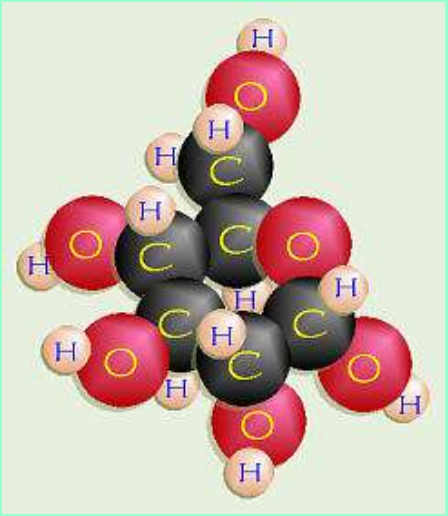


Images from: http://www.school-for-champions.com/science/chemhydrocarbon.htm

http://www.mrbigler.com/Chem1-C1/topics/vsepr/VSEPR_files/image002.gif



ORGANIC molecules are found in living things and contain CARBON atoms



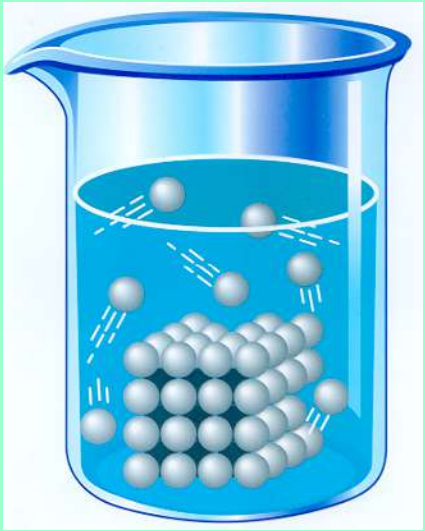
http://biologyjunction.com/organic_model_project_bi.htm

"Like dissolves like"

HYDROPHILIC means "water loving"

POLAR groups/molecules try to be near and touch water or other polar molecules

Water makes a great solvent in living things because so many molecules found in living things are polar or have a charge.



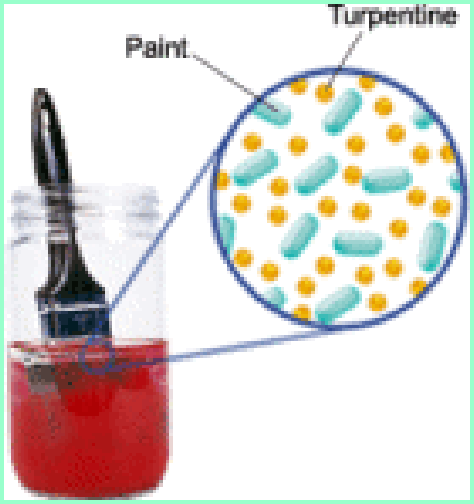
http://www.makash.ac.il/h_school/hst/hstsb/chem/luach/dissolve.jpg

http://egullet.com/imgs/egci/nonstocksauce/nons1.JPG

"Like dissolves like"

HYDROPHOBIC means "water fearing"

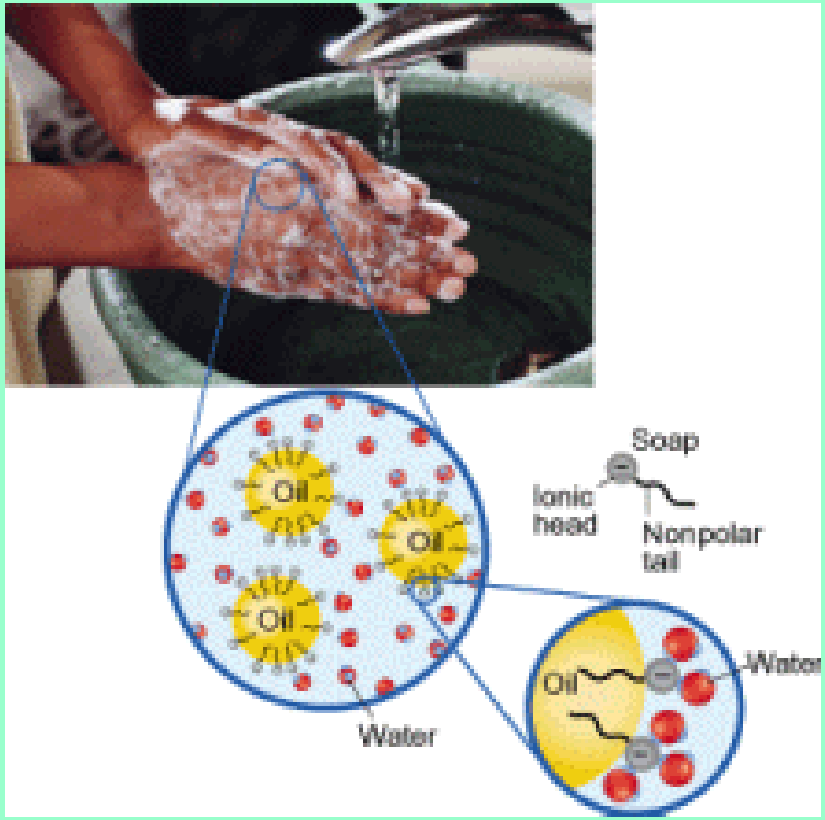
NON-polar groups/molecules try to be near other NON-polar molecules and away from polar molecules



Oil based paints dissolve in solvents such as turpentine

. . . not water.

http://mchi.mcallenisd.org/mchi/site/hosting/ipc/ipc/ipcch23htm/ipcch23sec2.htm



"Like dissolves like"

SOAP works because it has a NON-polar end that dissolves grease and a Polar end that dissolves in water to wash away oily dirt.

A chemical equation tells what happens in a chemical reaction when molecules interact.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

REACTANTS $\longrightarrow$ **PRODUCTS**

Molecules that react

Molecules that are produced

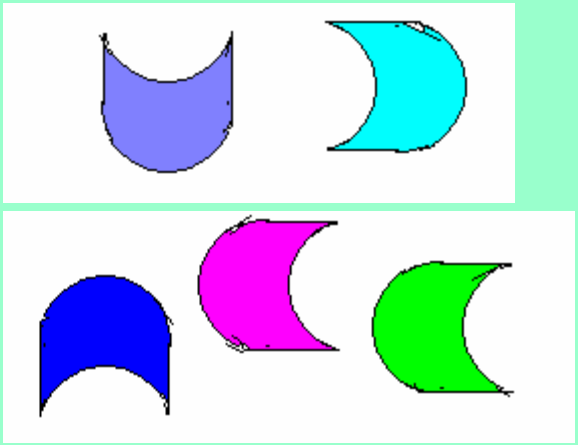
REMEMBER:
ALL the chemical reactions that happen in cells = _METABOLISM_

Chemical reactions can _join_ molecules together.

Chemical reactions can _break_ molecules apart.

One way to join molecules to make a bigger molecule is by removing a WATER molecule to make a bond.

= dehydration synthesis reaction



See an animation

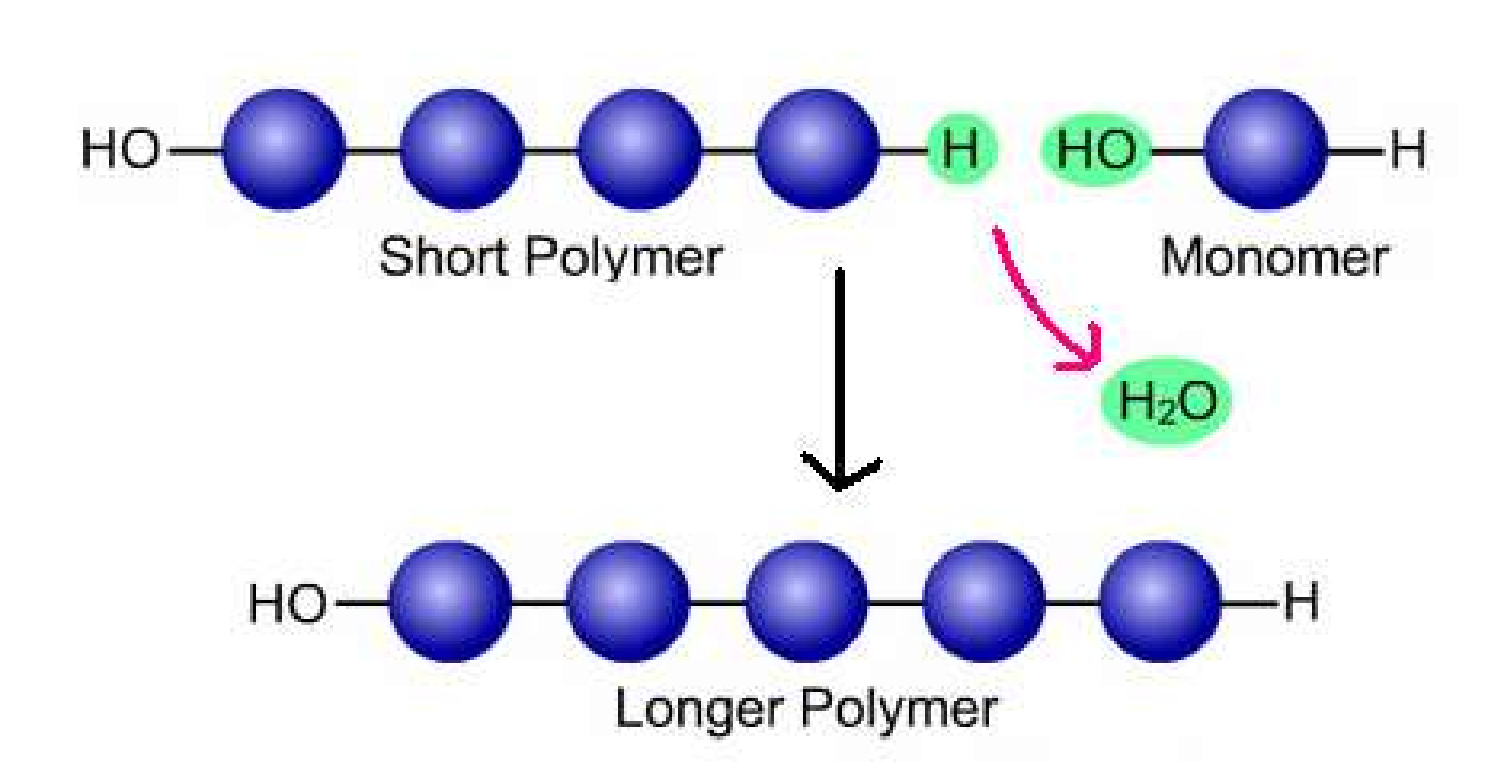
http://www.cengage.com/biology/discipline_content/animations/reaction_types.html

http://apchute.com/dehydrat/dehydrat.html

DEHYDRATION SYNTHESIS

"dehydration" "synthesis"

= water loss put parts together



http://www.usd116.org/apalla/biology/unit3/notes/3notes1.htm

POLYMERIZATION is a kind of synthesis reaction in which many small subunits that are similar join to make a bigger molecule

These small units are called MONOMERS

The big molecule they make is called a POLYMER

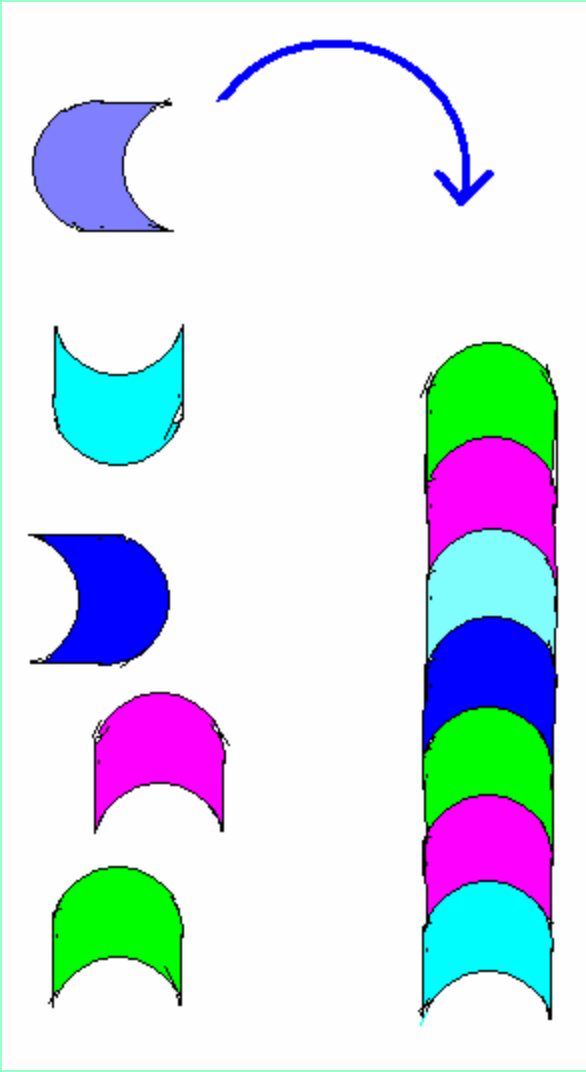
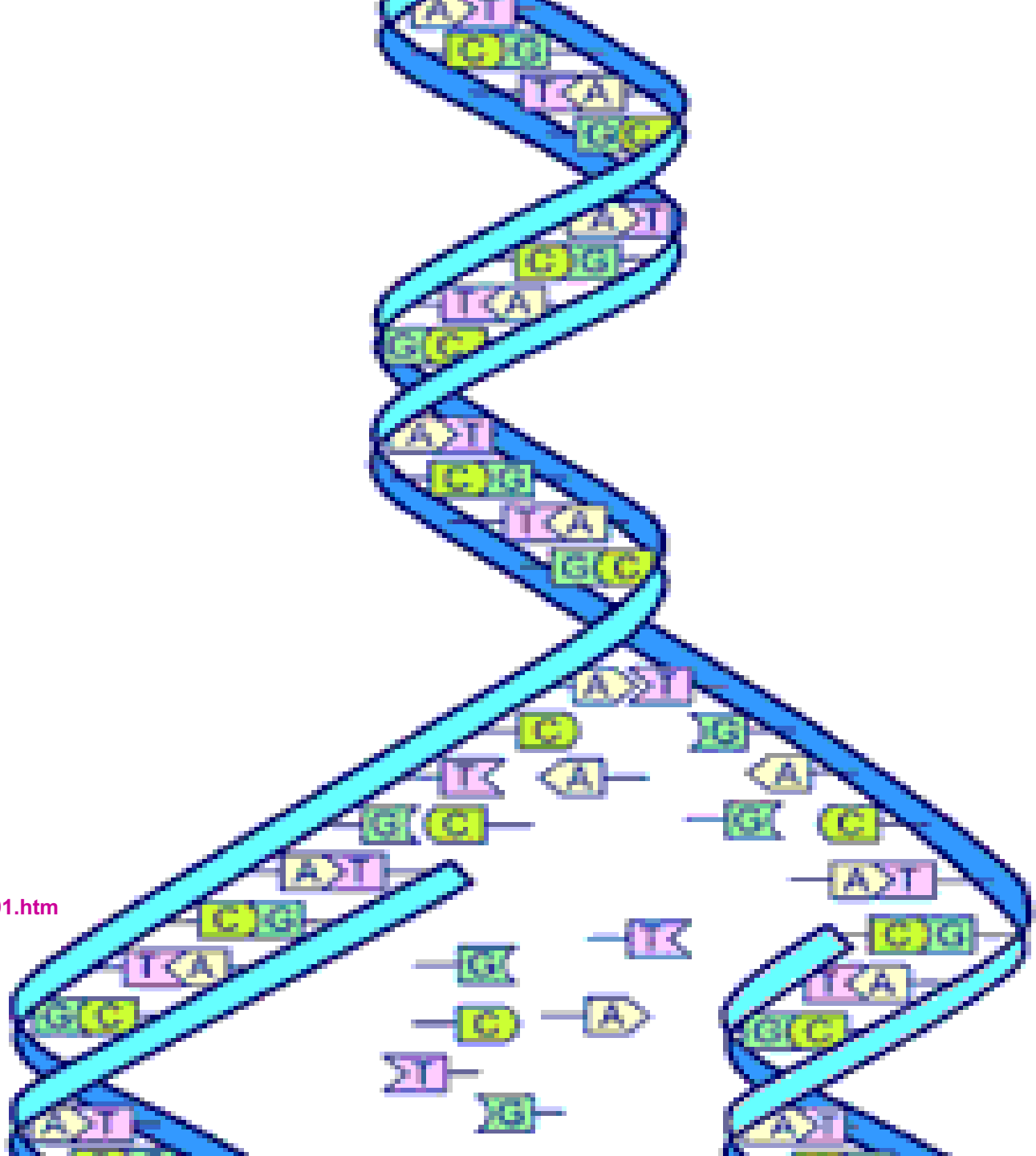


Image by Rledell

EXAMPLE:

Nucleotide s
(A,T,G,C)
join together
to make
a DNA mo



http://www.freewebs.com/genetics37/genetics101.htm

Chemical reactions can also break molecules apart.

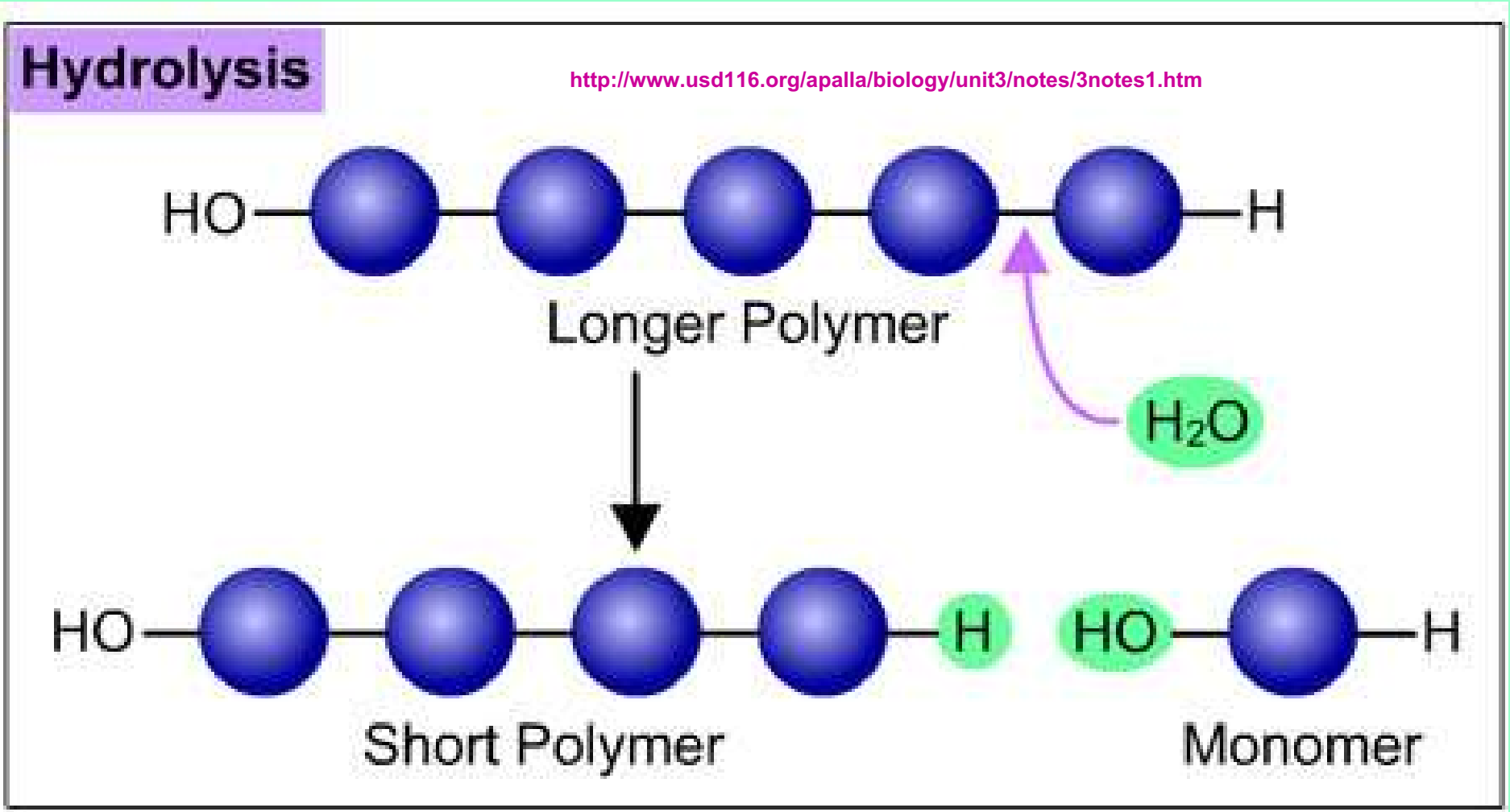
HYDROLYSIS = kind of chemical reaction in which a molecule is broken apart by adding a WATER molecule.

"hydro" = water "lysis" = break apart

See an animation

http://apchute.com/dehydrat/dehydrat.html

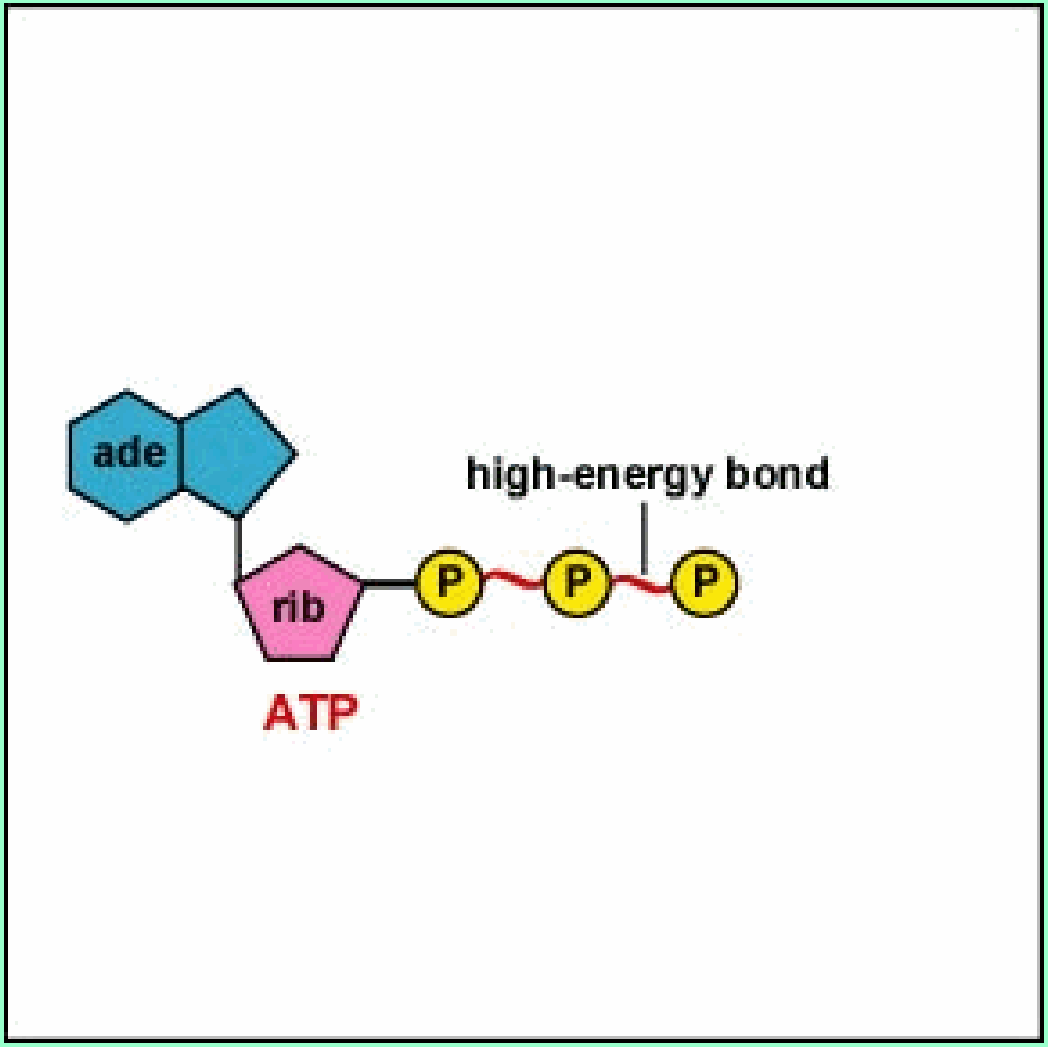
HYDROLYSIS is the opposite of DEHYDRATION SYNTHESIS.
Adding a water molecule breaks the bond.



ATP is the energy molecule used by all cells.

Breaking a bond using hydrolysis is the way ENERGY is released.

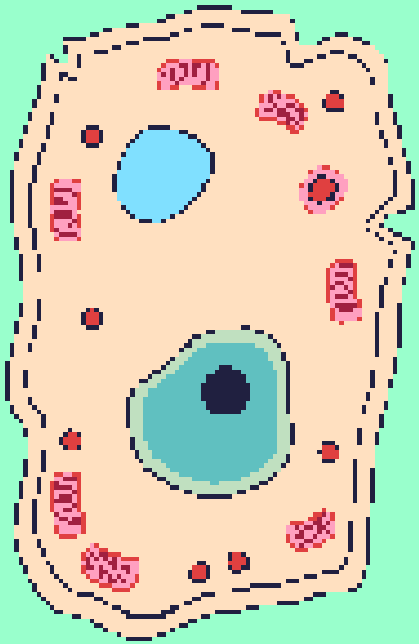
http://student.ccbcmd.edu/biotutorials/energy/adpan.html



More on this is Chapters 7, 8,& 9

Living things use BOTH of these kinds of reactions (and MORE) to get the materials they need.

http://www.cibike.org/CartoonEating.gif



http://www.animationlibrary.com

WATER is important for all living things

Average person ~~ 60-70% water
Babies ~~ 78%
Human brain ~~ 90%

Image from: http://sjr.state.fl.us/programs/outreach/pubs/irl_update/images/water_glass.jpg

WHY Water is important to cells:

1. It's POLAR so it can DISSOLVE lots of different substances.

2. It can absorb lots of HEAT WITHOUT changing temperature very much. (That helps with HOMEOSTASIS)

3. HYDROGEN BONDS form between water molecules so they stick together.

4. Water is an important REACTANT/PRODUCT in many CHEMICAL REACTIONS.

SOUTH DAKOTA
CORE SCIENCE STANDARDS

LIFE SCIENCE:

Indicator 1: Understand the fundamental structures, functions, classifications, and mechanisms found in living things

9-12.L.1.1. Students are able to relate cellular functions and processes to specialized structures within cells.

SOUTH DAKOTA ADVANCED STANDARDS

LIFE SCIENCE

Indicator 1: Understand the fundamental structures, functions, classifications, and mechanisms found in living things.

9-12.L.1.1A. Students are able to explain the physical and chemical processes of photosynthesis and cell respiration and their importance to plant and animal life. (INTRO TO BE ABLE TO DO THIS LATER)

9-12.L.1.2A. Describe how living systems use biofeedback mechanisms to maintain homeostasis. (SYNTHESIS)

9-12.L.1.4A. Identify factors that change the rates of enzyme catalyzed reactions. (APPLICATION)

Core High School Life Science Performance Descriptors

High school students performing at the ADVANCED level:	INTRODUCTION TO BE ABLE TO DO THE FOLLOWING LATER: explain the steps of photophosphorylation and the Calvin Cycle; analyze chemical reaction and chemical processes involved in the Calvin Cycle and Krebs Cycle; predict the function of a given structure; explain how protein production is regulated;
High school students performing at the PROFICIENT level:	describe and give examples of chemical reactions required to sustain life (hydrolysis, dehydration synthesis, photosynthesis, cellular respiration, ***ADP/ATP***, role of enzymes); INTRODUCTION TO BE ABLE TO DO THE FOLLOWING LATER describe the relationship between structure and function (cells, tissues, organs, organ systems, and organisms); tell how DNA determines protein formation; predict how life systems respond to changes in the environment;
High school students performing at the BASIC level	name chemical reactions required to sustain life (hydrolysis, dehydration synthesis, photosynthesis, cellular respiration, ***ADP/ATP***, role of enzymes); INTRODUCTION TO BE ABLE TO DO THE FOLLOWING LATER recognize that different structures perform different functions; identify DNA as the structure that carries the genetic code;