

6 C Carbon 12.0107	2 4	1 H Hydrogen 1.00794	1	99 Es Einsteinium (252)	2 8 18 32 29 8 2
12 Mg Magnesium 24.3050	2 8 18 18 7	53 I Iodine 126.90447	2 8 18 18 7	16 S Sulfur 32.066	2 8 8 6
22 Ti Titanium 47.867	2 8 10 2	88 Ra Radium (226)	2 8 18 32 18 8 2	39 Y Yttrium 88.90585	2 8 18 9 2

Chapter 2

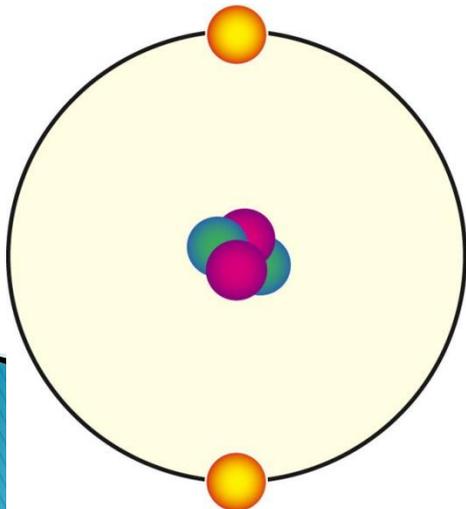
Life's Chemical Basis



As Mr. Weitz used to say....you're doing the wrong kind of chemistry in here

2.1 Start with atoms (this should be review for you!!!!)

- ▶ **Atoms** = the building blocks of all substances
 - Made up of electrons, protons and neutrons
- ▶ **Electrons (e^-)** have a negative charge
 - Move around the nucleus
- ▶ The **nucleus** contains protons and neutrons
 - **Protons (p^+)** have a positive charge
 - **Neutrons** have no charge



- **proton**
- **neutron**
- **electron**

How atoms interact

▶ Chemical bond

- An attractive force existing between two atoms when their electrons interact

▶ Molecule

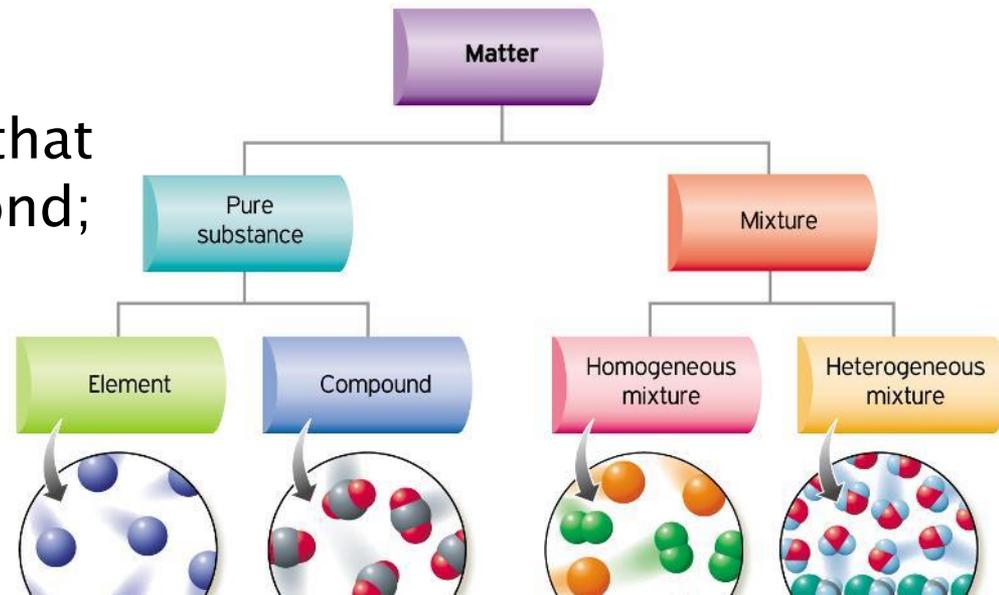
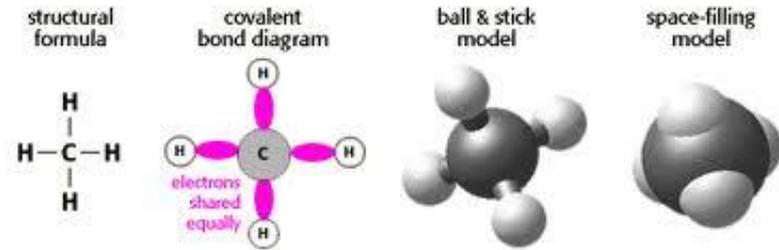
- Two or more atoms joined in chemical bonds

▶ Compounds

- Molecules consisting of two or more elements whose proportions do not vary
- *Example:* Water (H_2O)

▶ Mixture

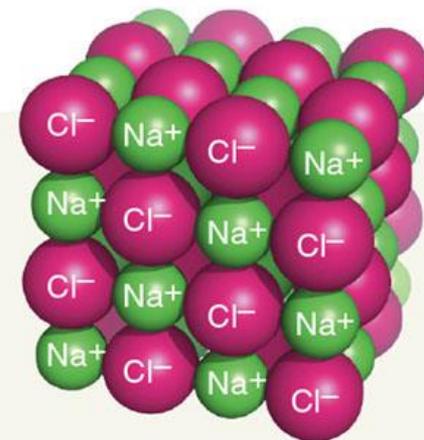
- Two or more substances that intermingle but do not bond;
- proportions of each
- can vary



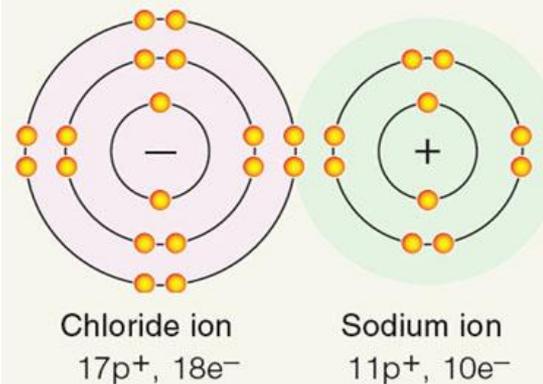
Types of Bonding

▶ Ionic Bonding

- A strong mutual attraction between two oppositely charged ions with a large difference in electronegativity (an electron is not usually transferred)
- *Example:* NaCl (table salt)



A A crystal of table salt is a cubic lattice of many sodium and chloride ions.



B The mutual attraction of opposite charges holds the two kinds of ions together in a lattice.

Covalent Bonding

▶ Covalent bond

- Two atoms with similar electronegativity and unpaired electrons sharing a pair of electrons
- Can be **stronger** than ionic bonds
- Atoms can share one, two, or three pairs of electrons (single, double, or triple covalent bonds)



Nonpolar covalent bond
Bonding electrons shared equally between two atoms.
No charges on atoms.



Polar covalent bond
Bonding electrons shared unequally between two atoms.
Partial charges on atoms.

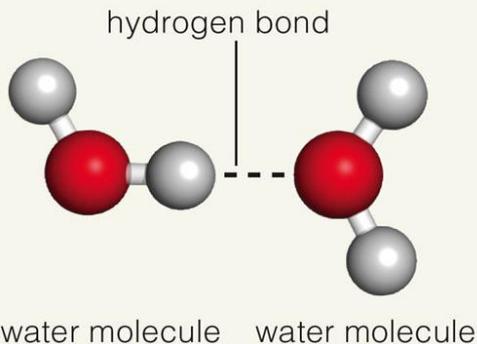


Ionic bond
Complete transfer of one or more valence electrons.
Full charges on resulting ions.

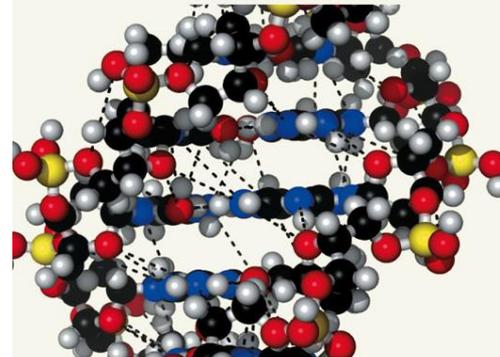
Hydrogen Bonds

▶ Hydrogen bond

- A **weak** attraction between a highly electronegative atom and a hydrogen atom taking part in a separate polar covalent bond
- Hydrogen bonds do not form molecules and are not “chemical bonds”
- Hydrogen bonds stabilize the structures of large biological molecules



A A hydrogen (H) bond is an attraction between an electronegative atom and a hydrogen atom taking part in a separate polar covalent bond.



B Hydrogen bonds are individually weak, but many of them form. Collectively, they are strong enough to stabilize the structures of large biological molecules such as DNA, shown here.

Chemical vs. Physical Reaction

- ▶ Physical – Changes states but can be changed back.
- ▶ Chemical – Can't be changed back to the original substance.

Ask yourself if change is a matter of style or substance.

PHYSICAL (style) change	CHEMICAL (substance) change
	
<p>Physical changes do not result in new substances. Water, whether ice, liquid or steam, is still H₂O. Boiling point and freezing point are just two of several physical properties which identify water.</p>	<p>Chemical changes produce new substances with different chemical makeups and properties than the original substance. When burned, wood produces new substances, one of which is called ash.</p>



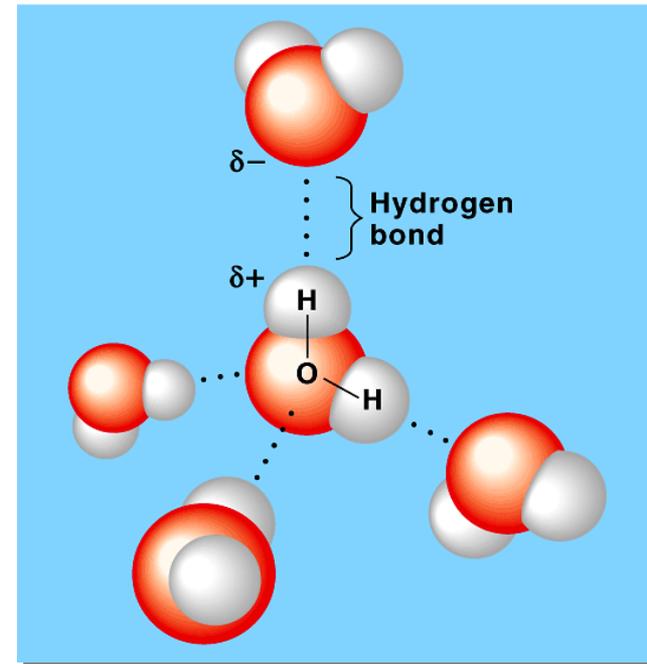
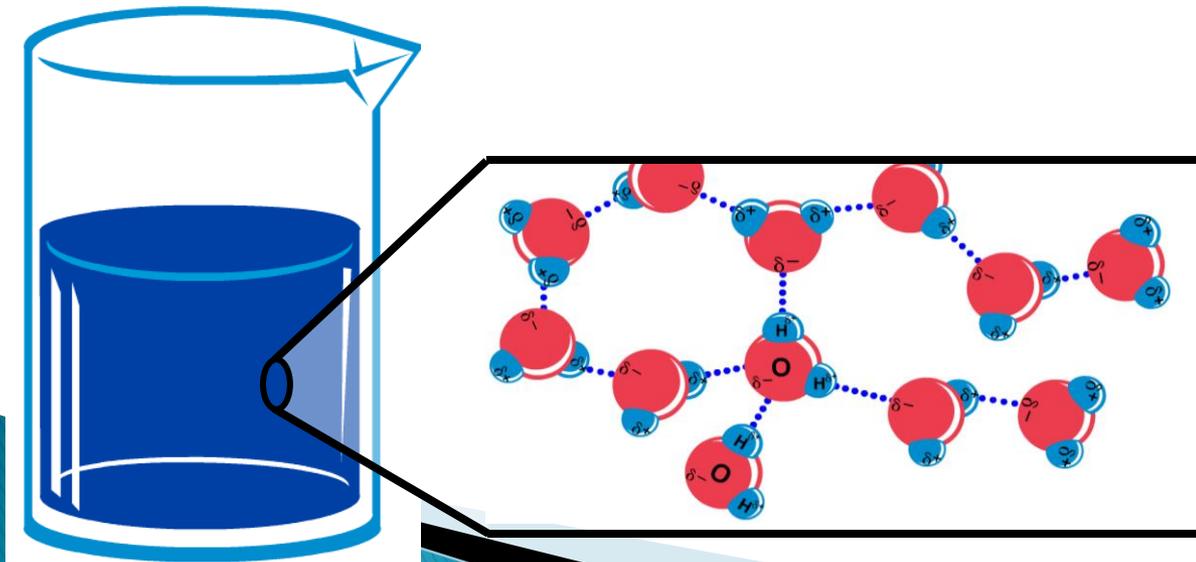
2.2 Water's Life Giving Properties

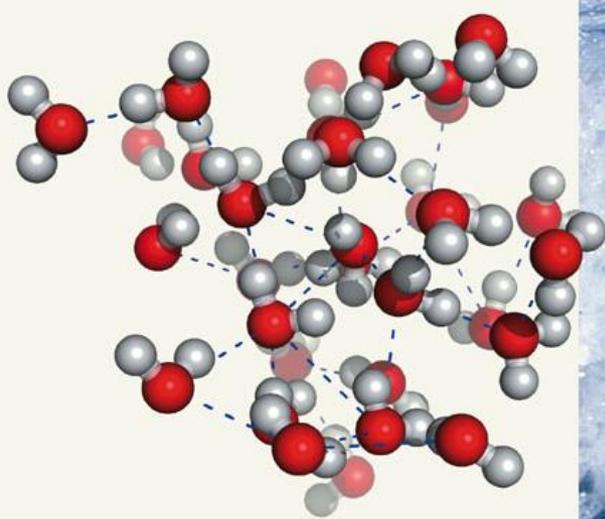
- ▶ Living organisms are mostly water
 - the chemical reactions of life are carried out in water
 - Water is essential to life because of its unique properties



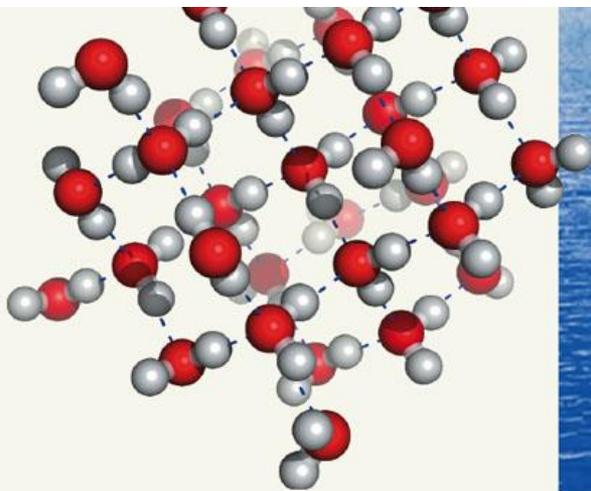
Properties of Water

- ▶ The properties of water are a result of extensive hydrogen bonding with each other
 - Overall, water (H_2O) has no charge
 - slightly positive H attracted to slightly negative O end
 - Creates a “sticky” molecule





B Many hydrogen bonds (dashed lines) that form and break rapidly keep water molecules clustered together in liquid water.



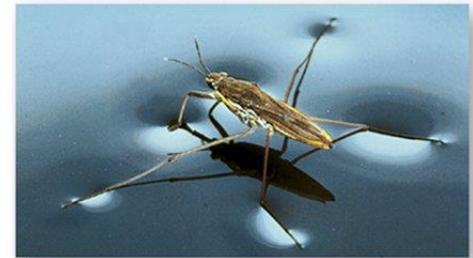
C Below 0°C (32°F), the hydrogen bonds hold water molecules rigidly in the three-dimensional lattice of ice. The molecules are less densely packed in ice than in liquid water, so ice floats on water.

Adhesion and Cohesion

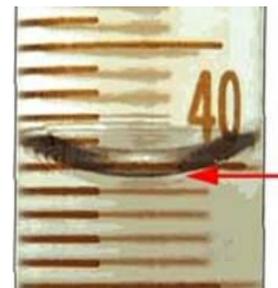
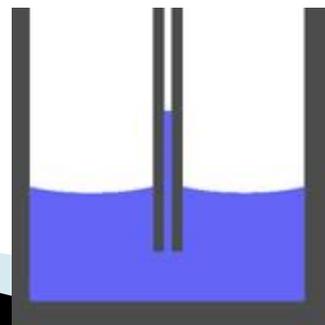
- ▶ **Cohesion** = hydrogen bonding between like molecules
 - Provides surface tension
 - Draws water up from roots of plants
- ▶ **Adhesion** = hydrogen bonding between water and other molecules
 - Capillary action
 - Meniscus



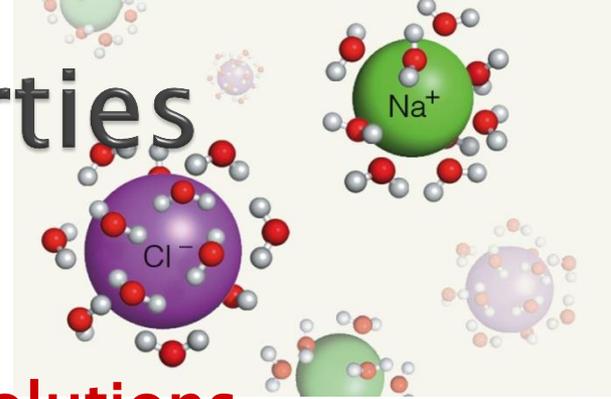
(a)



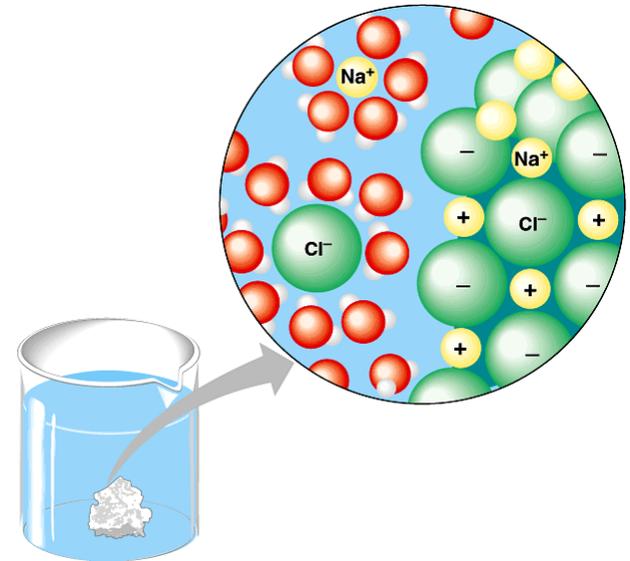
(b)



Water's solvent properties

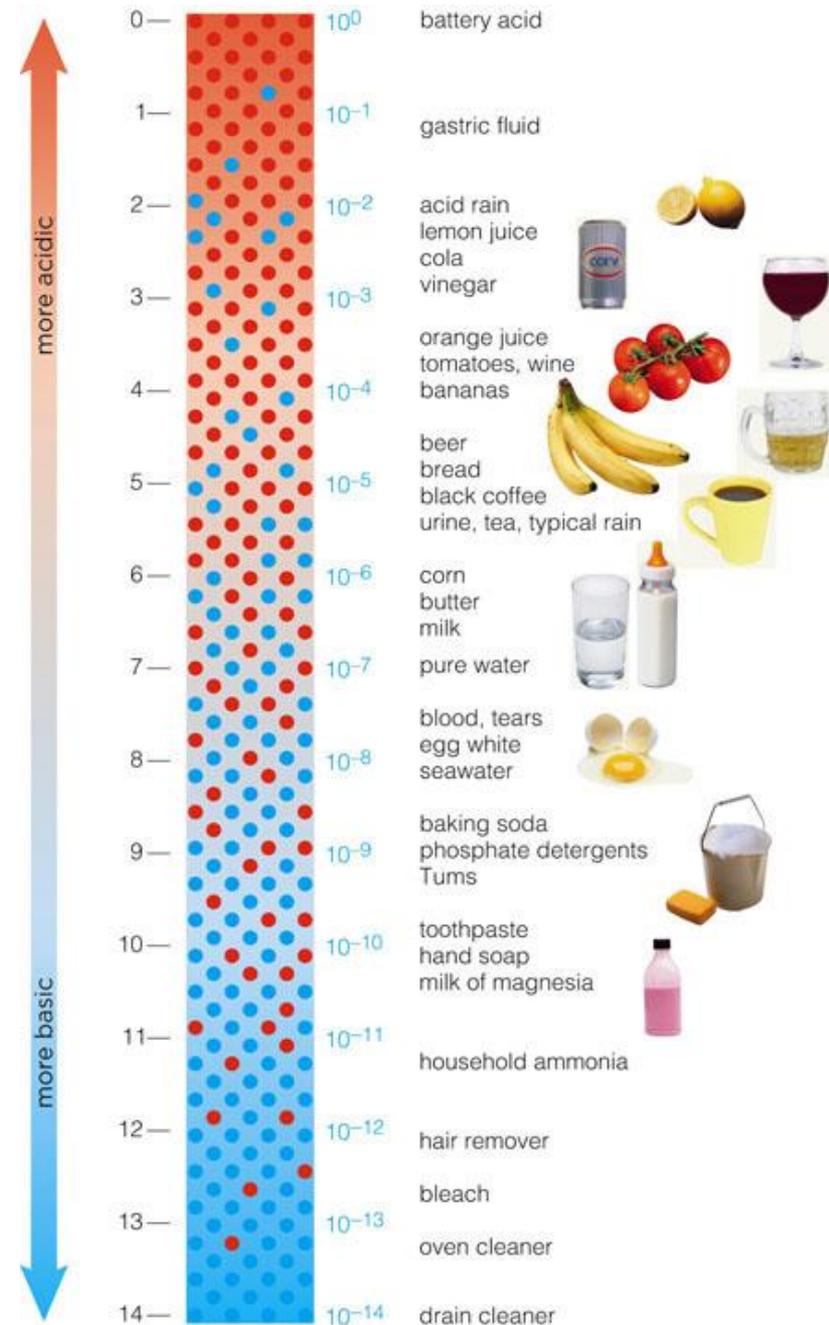


- ▶ Solvents dissolve solutes creating solutions
- ▶ Water dissolves ionic compounds and other polar molecules

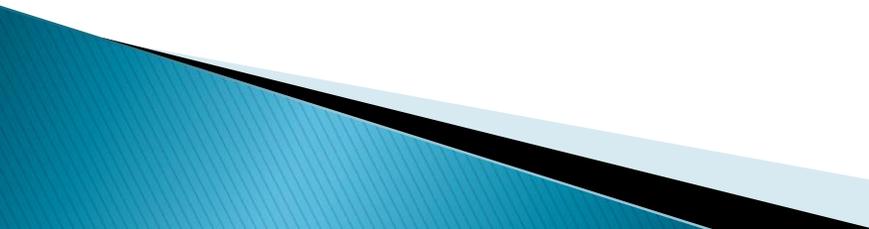


pH Scale

- ▶ **pH** is a measure of the number of hydrogen ions in a solution
 - The more hydrogen ions, the lower the pH
 - pH 7 is neutral (pure water)
 - Most life chemistry occurs around pH 7
 - Each number is a 10x increase in H^+



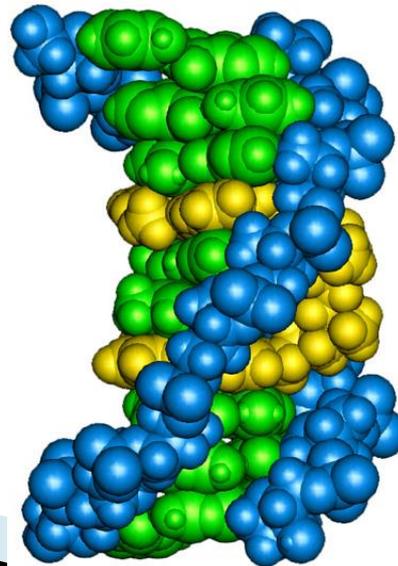
Acids and Bases

- ▶ **Acids** donate hydrogen ions in a water solution
 - pH below 7
 - ▶ **Bases** accept hydrogen ions in a water solution
 - pH above 7
 - ▶ Chemical reactions involving acids and bases are important to homeostasis
- 

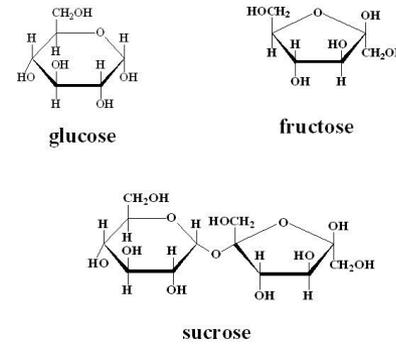
2.3 Macromolecules



- ▶ **Macromolecules**
 - “giant molecules” – made of smaller molecules
 - Monomers = small units that are hooked together
- ▶ **4 Groups of Macromolecules**
 - Carbohydrates
 - Lipids
 - Nucleic Acids
 - Proteins

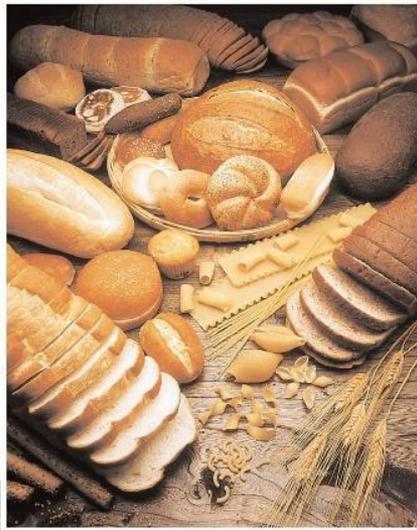
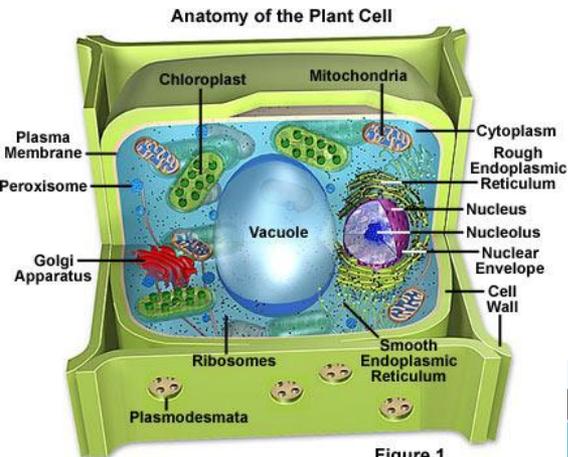


Carbohydrates



▶ Carbohydrates

- Monosaccharides = single sugars
 - Glucose, fructose
- Complex Carbohydrates
 - Starches, glycogen, cellulose
- Used in animals to store energy and in plants for structure and energy.



Twitchy consumes large amounts of carbs!



Lipids

▶ Lipids

- Fats, oils and waxes
- Used to store energy and make up membranes.

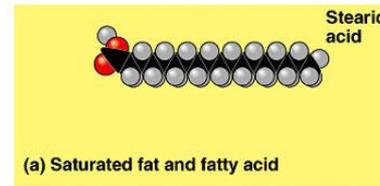
▶ Saturated vs. Unsaturated

◦ Saturated Fats

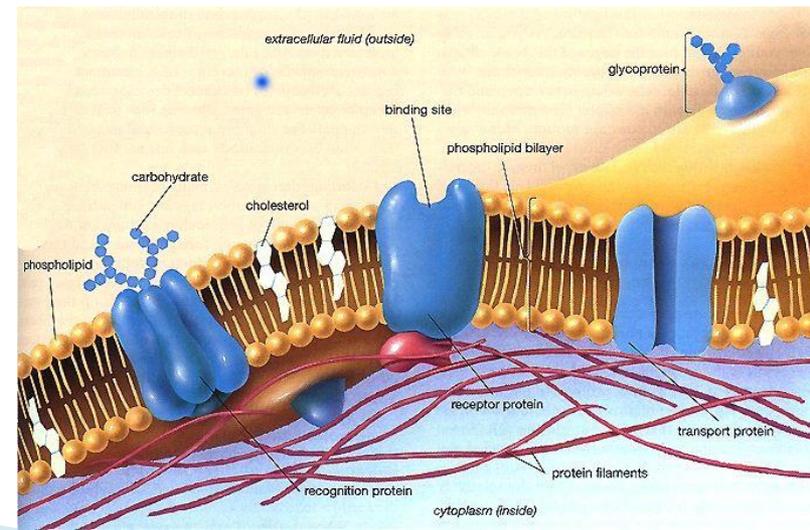
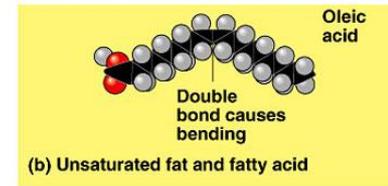
- Fat contains the maximum number of hydrogen atoms

◦ Unsaturated

- Fat w/fewer hydrogen atoms (have more double bonds – kinked)



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Proteins

▶ Proteins

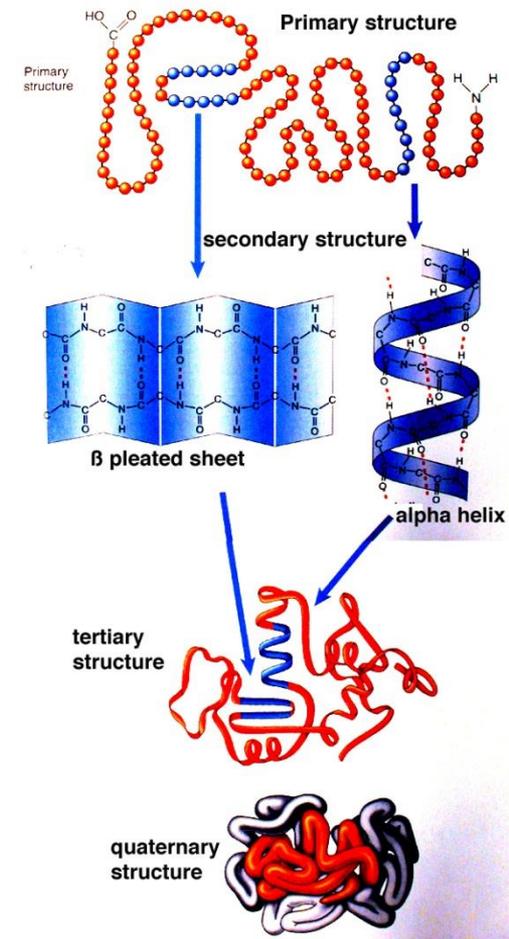
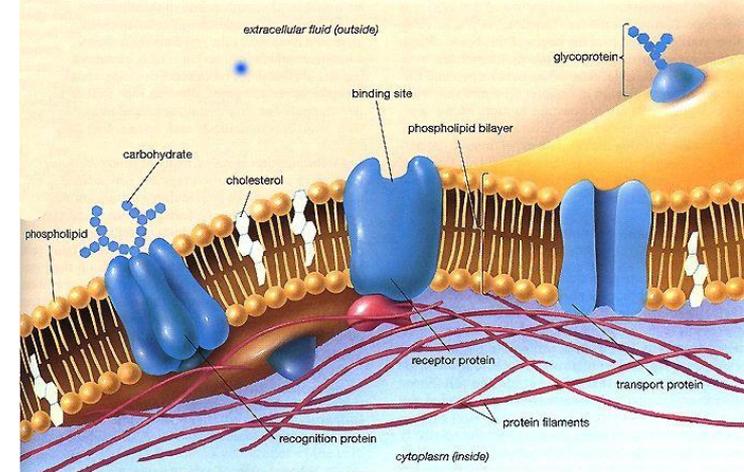
- Chains of folded Amino Acids

▶ Jobs of Proteins

- Chemical reactions, pump molecules in/out of cell, enable cells to move.

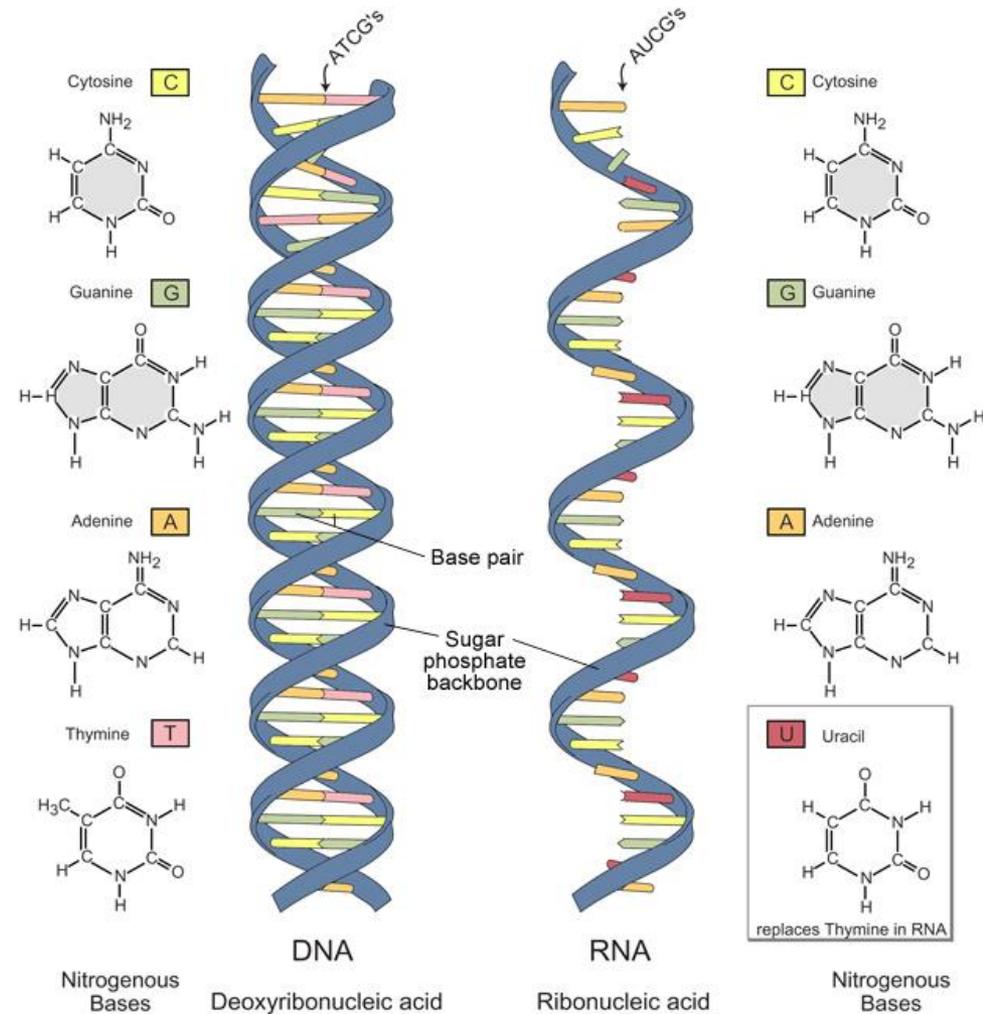
▶ Amino Acids

- There are over 20 different amino acids
- These form different combinations, each combo = a different protein



Nucleic Acids

- ▶ Nucleic Acids
 - Chains of nucleotides
- ▶ Types of Nucleic Acids
 - DNA – deoxyribonucleic acid
 - Contains the sugar deoxyribose
 - Double Stranded
 - RNA – ribonucleic acid
 - Contains the sugar ribose
 - Single Stranded



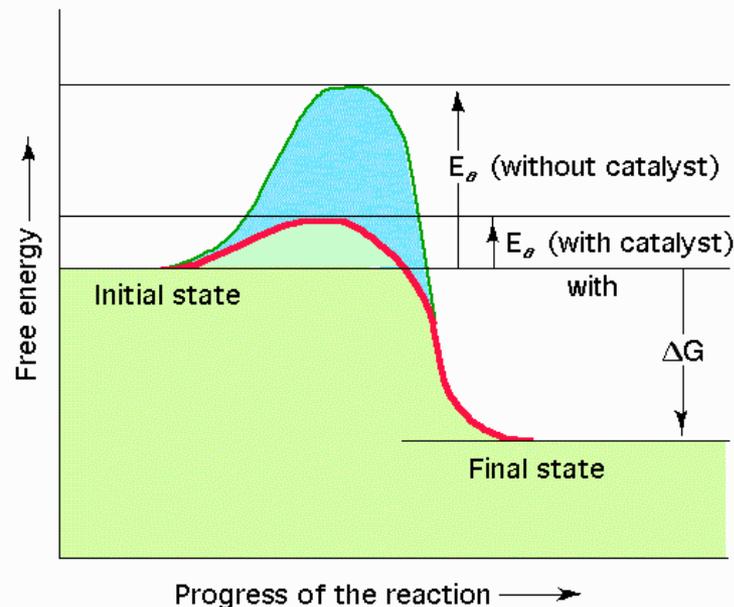
2.4 Activation Energy & Enzymes

▶ Activation Energy

- The energy needed to start a chemical reaction

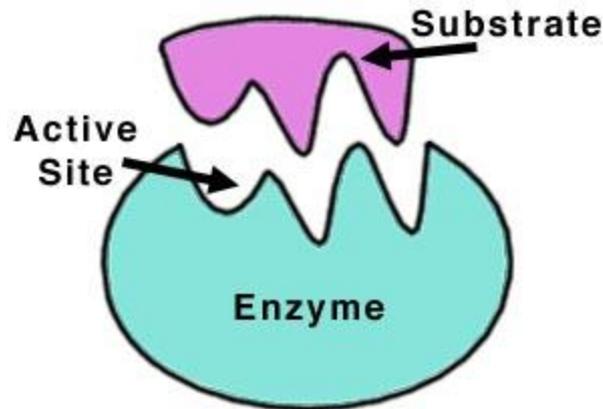
▶ Enzymes

- Proteins that lower the activation energy (they speed up reactions)



Energy Substrate Complex

- ▶ Substrate – a molecule that an enzyme reacts with
- ▶ Enzyme–Substrate Complex – Certain enzymes (proteins) can only bind with specific substrates.



2 Types of Energy Changes

- ▶ Endothermic – Absorbs energy
- ▶ Exothermic – Releases Energy

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