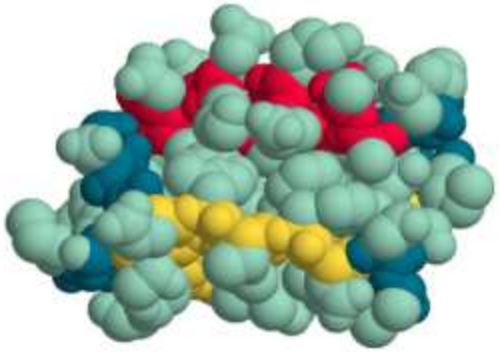
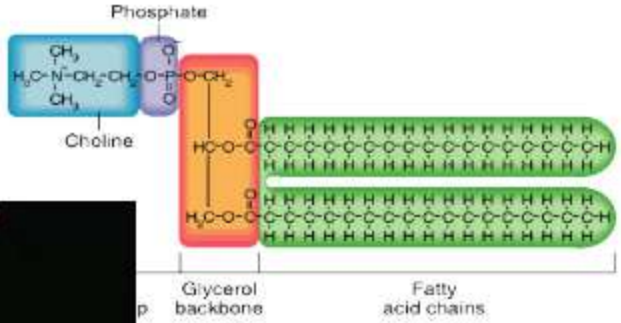
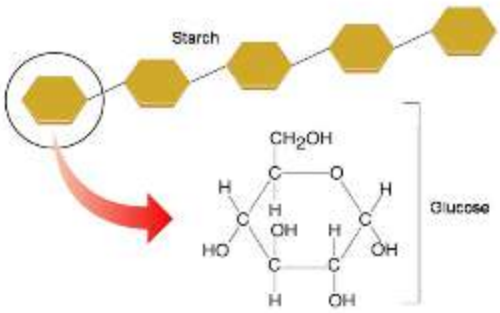
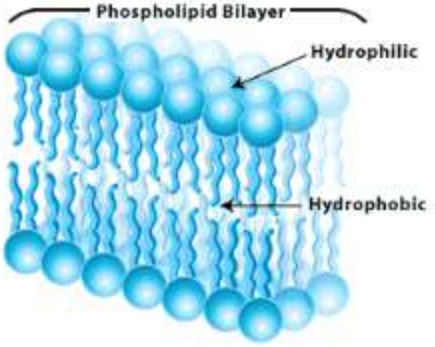
Why does Life Depend on Chemistry?





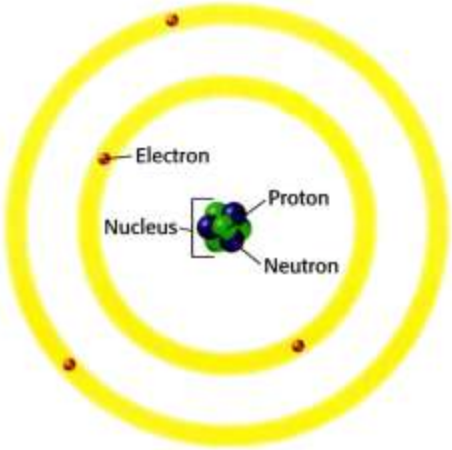




Chapter 2 - The Chemistry of Life

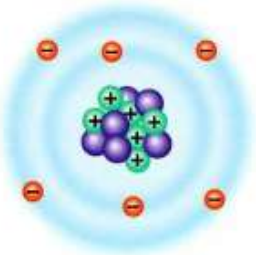
I. The Nature of Matter

A. Atoms - made of p+, e-, no

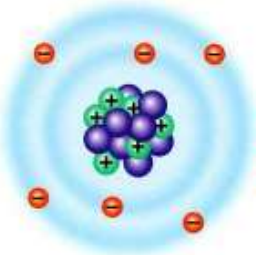


B. Elements and Isotopes -

- Element has only one type of atom,
- Ex: C, H, O, N, P, S



Carbon-12 (normal)



Carbon-14 (isotope)

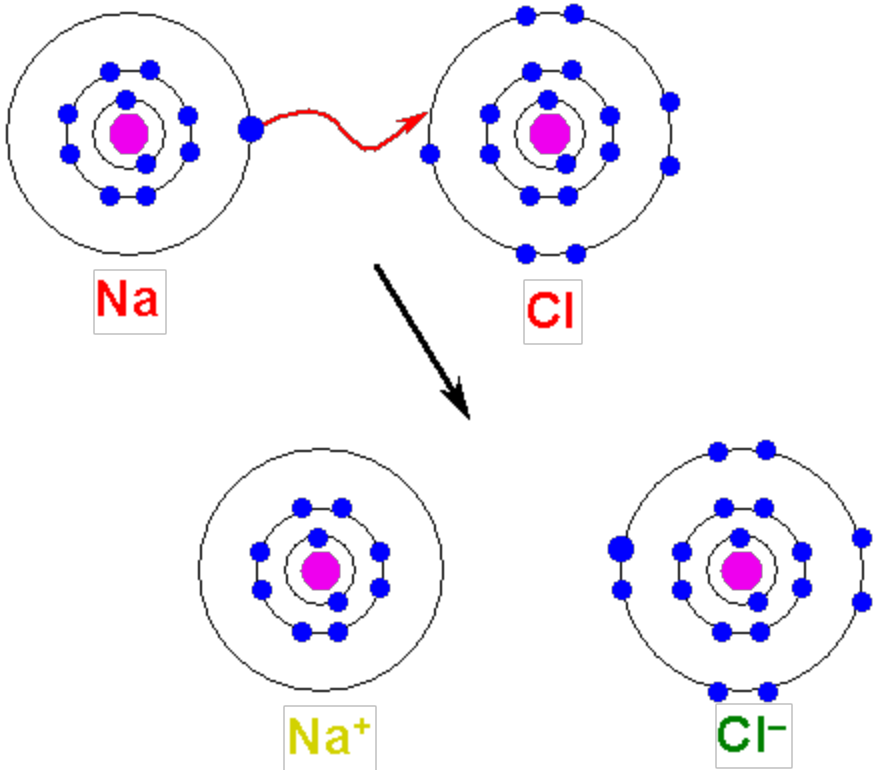
Which atomic particles add the extra mass?

- C. Compounds – 2 or more elements (in a fixed ratio)
  - Example = NaCl
  - Elements can change properties when combined

Sodium in water

Chemical Bonds

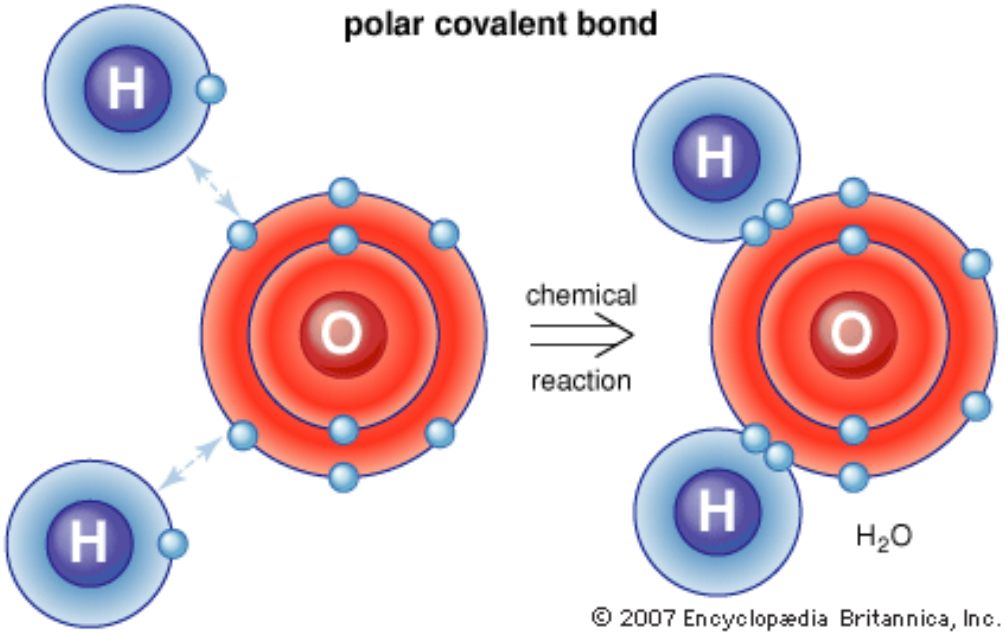
- Ionic Bonds
  - Electrons are transferred
    - One atom becomes positive
    - One atom becomes negative



Ionic Bond!

More Chemical Bonds

- Covalent Bonds
  - Electrons are shared!



Covalent Bond!

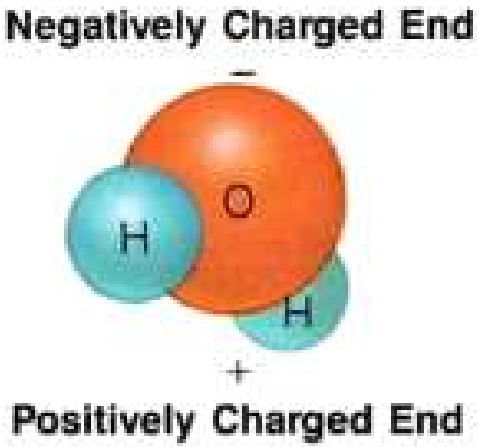
Van der Waals Forces

- Weak attraction between molecules

Example of Van der Waals in biology

II. Properties of Water

- Features of a water molecule
- 1. Polarity - each end has different charge



- 2. Hydrogen bonds - weak bonds BETWEEN water molecules

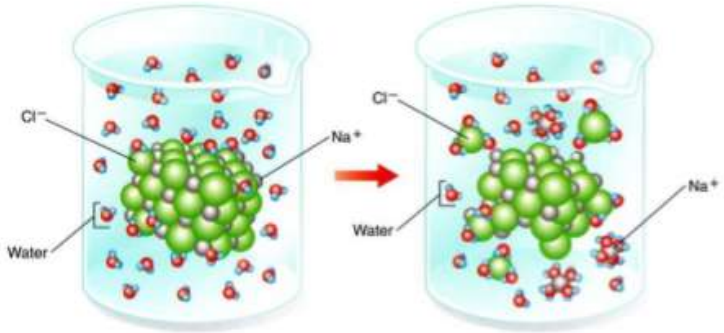
Properties

- - cohesion - attraction of same substance
-
- - adhesion - attraction of two different substanc

Is this cohesion or adhesion?

Cohesion!

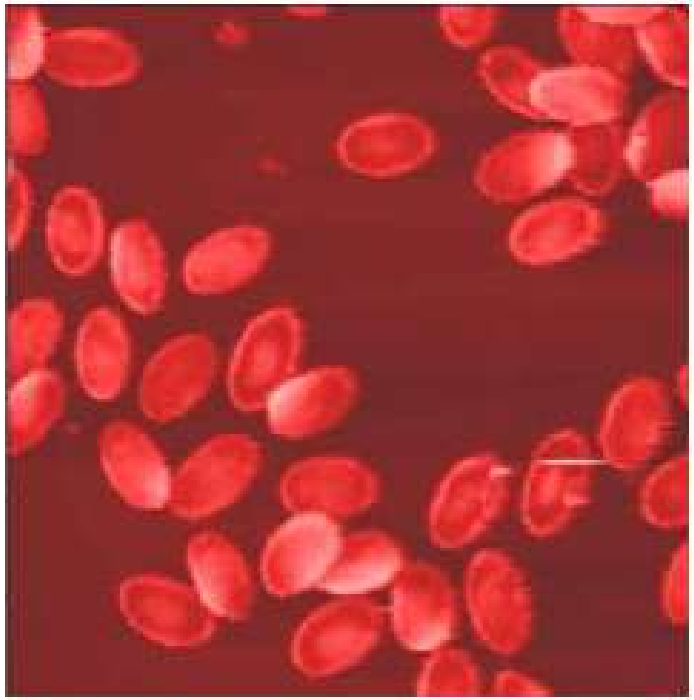
bit more on water…



- B. Water Mixtures -
- 1. Solutions - one material dissolved into another
- - **solute** (gets dissolved) vs. **solvent** (does the dissolving)
- - water is the universal solvent!!!

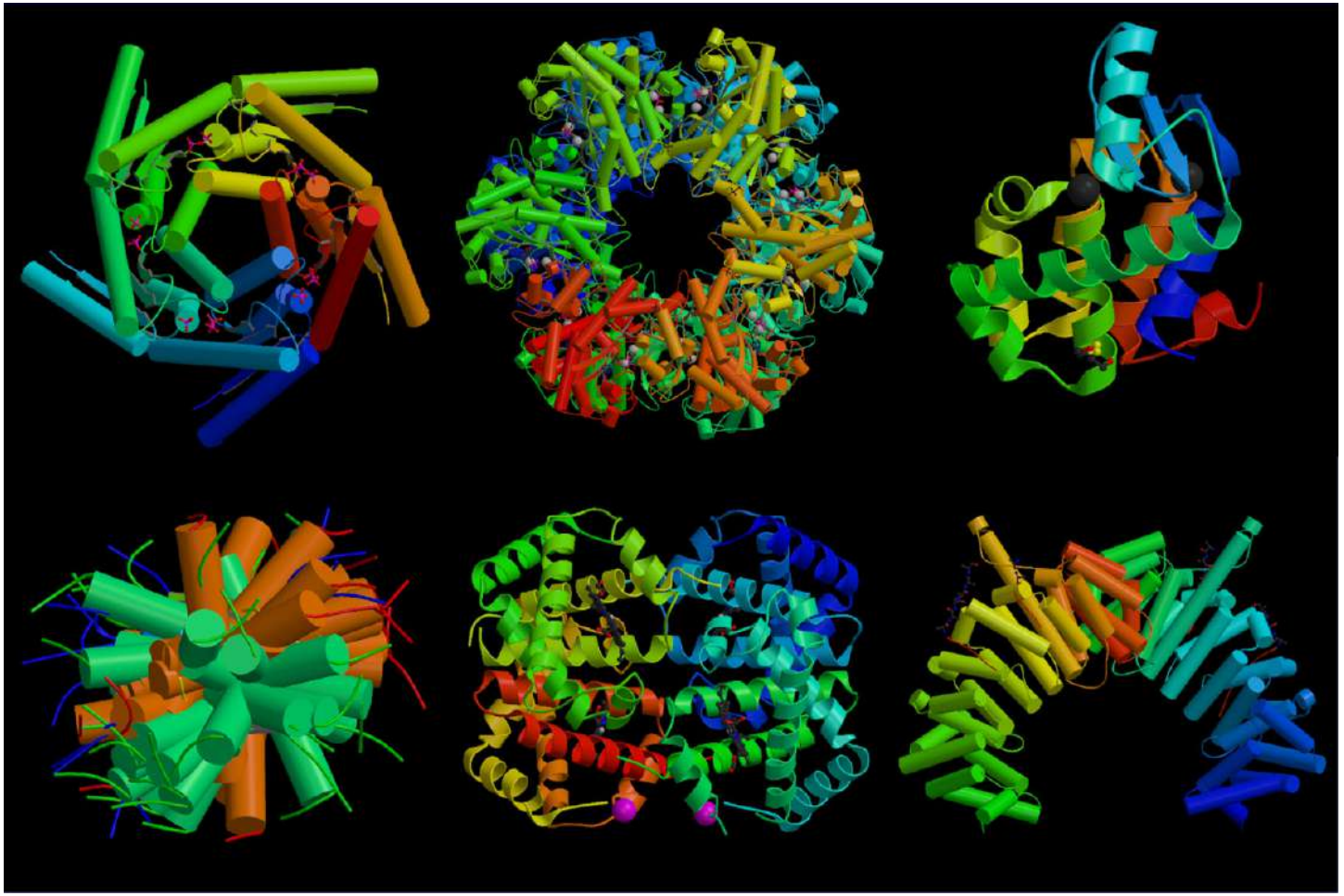
- 2. Suspensions - one material floats within another

What is in this blood suspension?



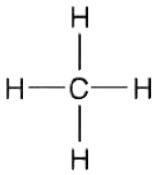
Macromolecules

The Building Blocks of Life



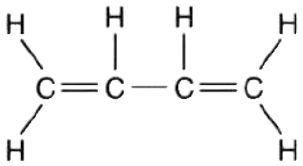
Carbon Based Compounds

- Carbon had four valence electrons
  - Readily bonds with up to four other atoms

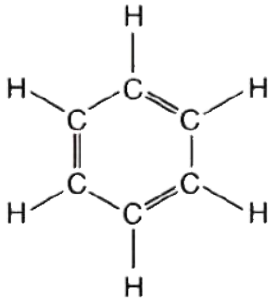


Methane

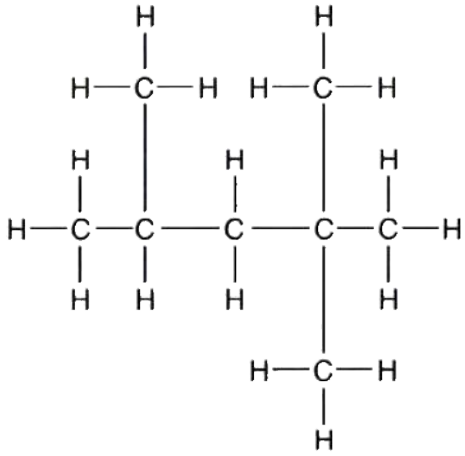
Acetylene



Butadiene



Benzene



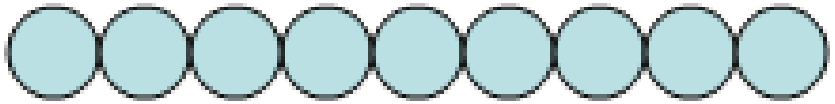
Isooctane

Macromolecule

- Macromolecule:
  - The large molecules that make up cells and carry out cellular functions; made up mainly of carbon and hydrogen atoms.
  - Examples/Related Words:
    - Carbohydrates
    - Lipids (fats)
    - Proteins
    - Nucleic acids

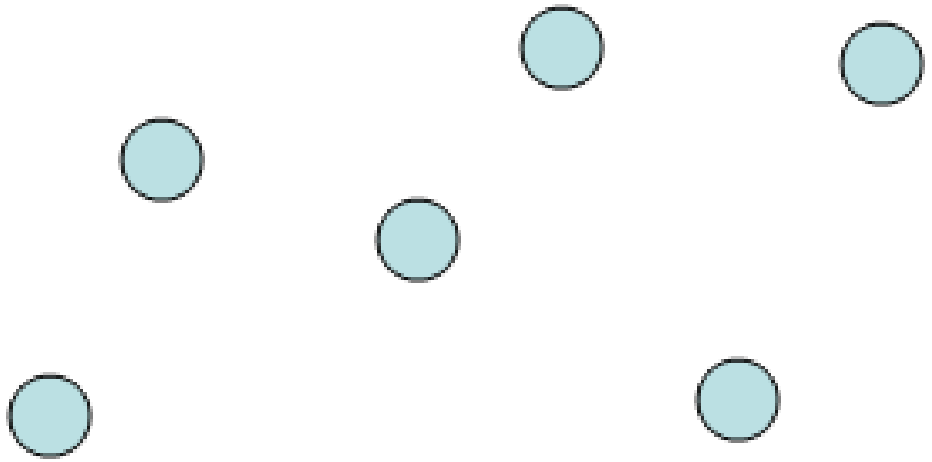
Polymer

- Polymer:
  - A molecule that consists of a long chain of repeating parts
  - Examples:
    - Starch
    - Keratin
    - DNA
  - Illustration:



Monomer

- Monomer:
  - A single subunit of a polymer
  - Examples:
    - Glucose
    - Amino acid
    - nucleotide
  - Illustration:



Monomers vs. Polymers

- Monomer: small unit
  - Mono = one
- Polymer: lots of monomers put together
  - Poly = many

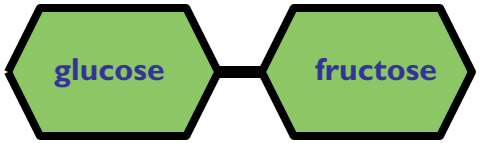
Carbohydrates (sugars)

- **Made of:** carbon, hydrogen, and oxygen
  - Usually ratio 1:2:1
- **Monomer:** monosaccharide
- **Jobs:** main energy source, structures
- **Energy:** 4 Calories/gram
- **Common Suffix:** -ose
- **Example:** Dextrose, Galactose, Glucose

Types of Carbohydrates

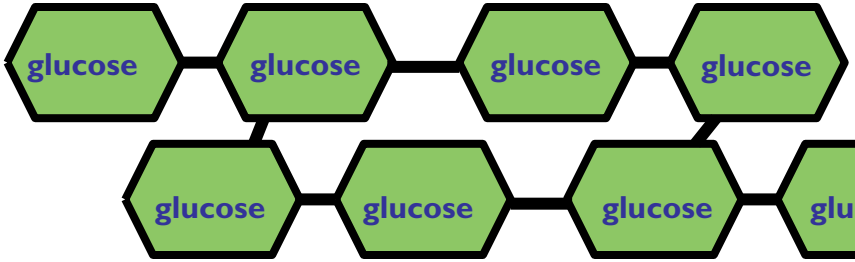
- Monosaccharides (1 sugar)
  - Ex: Glucose
    Fructose (fruit sugar)

- Disaccharides (2 sugars)
  - Ex: Sucrose (table sugar)
    Lactose (milk sugar)



sucrose

- Polysaccharides (many sugars)
  - Ex: Glycogen (stored animal sugar)
    Starch (stored plant sugar)
    Cellulose (cell walls)



cellulose

Lipids (fats)

- **Made of:** mostly carbon and hydrogen (very little oxygen)
- **Simple Unit:** Triglyceride
- **Jobs:** Stored energy, cell membranes, waterproof coverings
- **Energy:** 9 Calories/gram – stores the most energy
- Not soluble in water

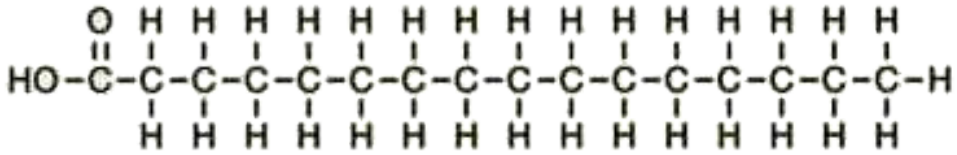
Types of Lipids

Groups: fats, oils, waxes, sterols

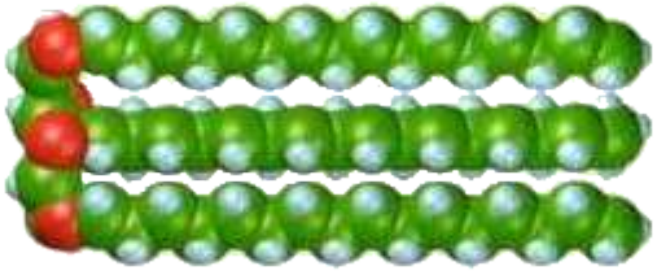
- Saturated—has as many H as possible, usually solid at room temp, and comes from animals
  - Ex: butter, cheese
- Unsaturated—missing 1 or more H, usually liquid at room temp, and comes from plants
  - Ex: Oils
- Trans—chemically modified to be saturated, gives food a long shelf-life, bad for cholesterol
  - Ex: shortening or margarine

Lipids

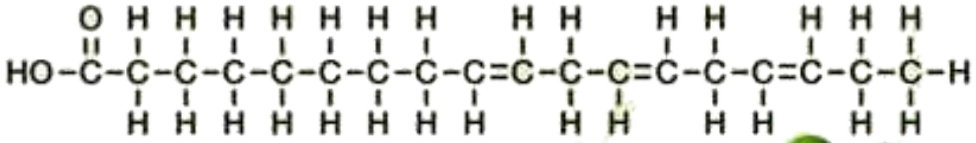
Saturated fatty acid



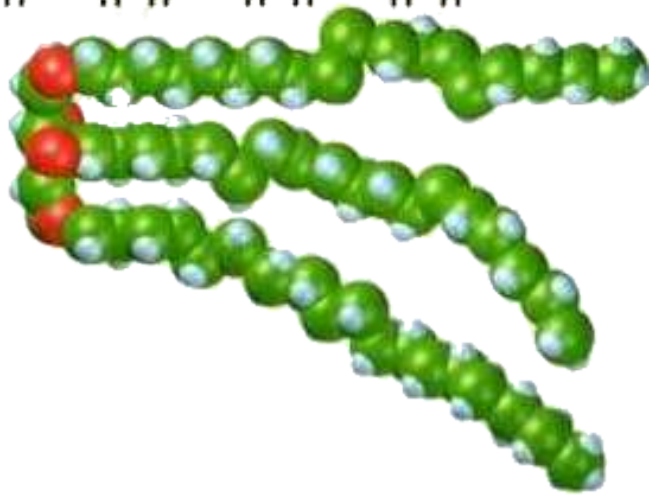
Saturated fats, such as butter, are solid at room temperature.



Unsaturated fatty acid



Unsaturated fats, such as canola oil, are liquid at room temperature.

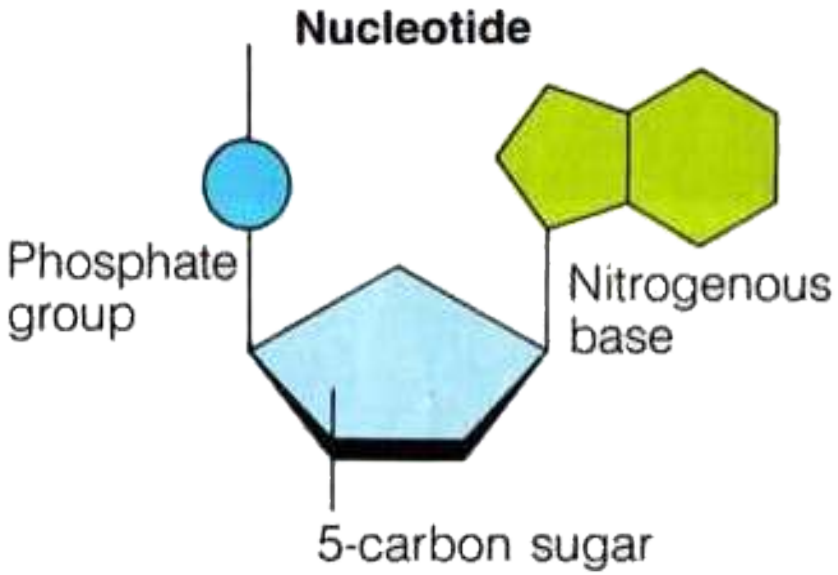


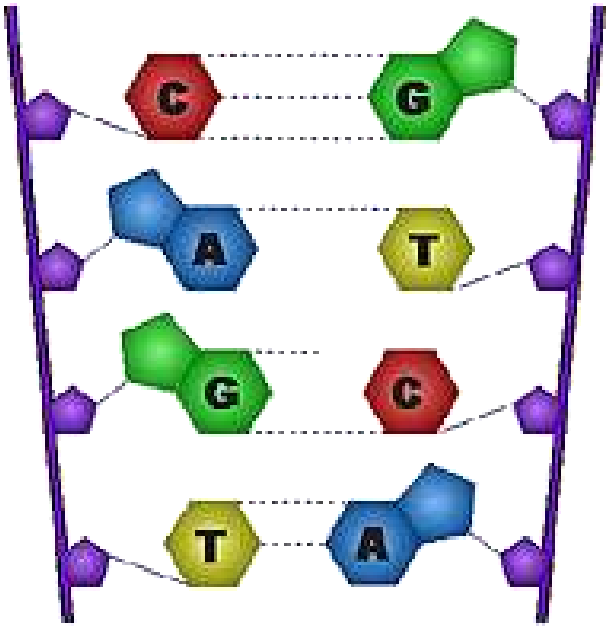
Nucleic Acids

- **Made of:** carbon, hydrogen, oxygen, *nitrogen*, and *phosphorous*
- **Monomers:** nucleotides
- **Job:** Store and transmit genetic information
- **Two Major Types:** RNA and DNA

Types of Nucleic Acids

- ATP (adenosine triphosphate)**is actually a nucleotide
- RNA (ribonucleic acid)
- DNA (deoxyribonucleic acid)



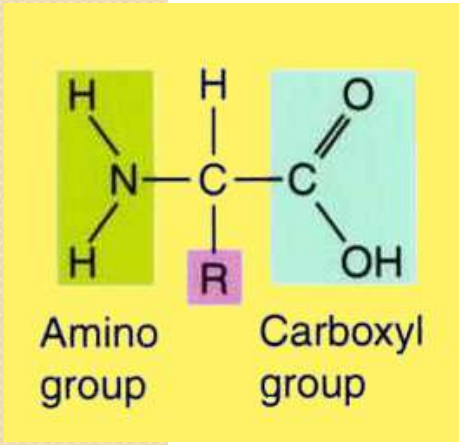


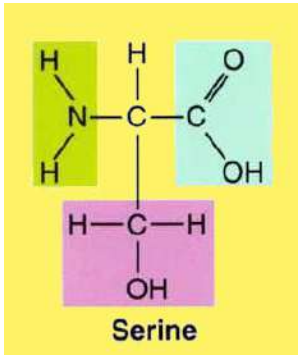
Proteins

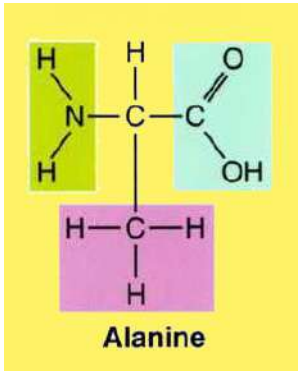
- **Made of:** carbon, hydrogen, oxygen, and *nitrogen*
- **Monomer:** amino acid
- **Jobs:** Control rate of cell reactions and other processes, form muscles and bones, move things into and out of cells, fight disease (immune system)
- **Energy:** 4 Calories/gram
- **Common Suffix:** -in, or -ase
- **Examples:** Helicase, Insulin, Hemoglobin,

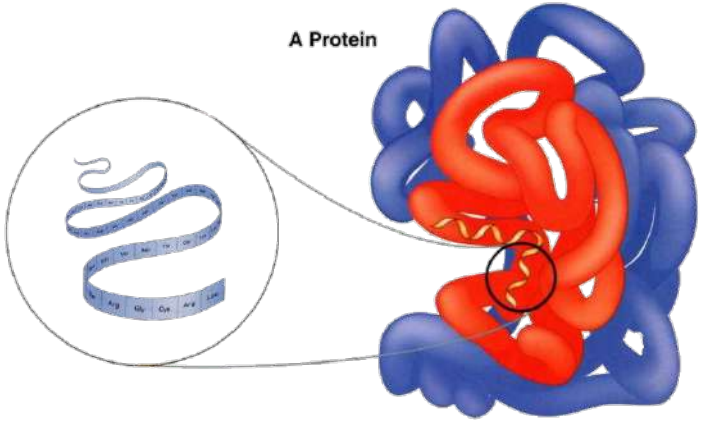
Proteins

- Most diverse type of macromolecule; proteins can be made from a combination of 20 different amino acids
- Have unique SHAPE that determine their job; if they lose it, they don't work!



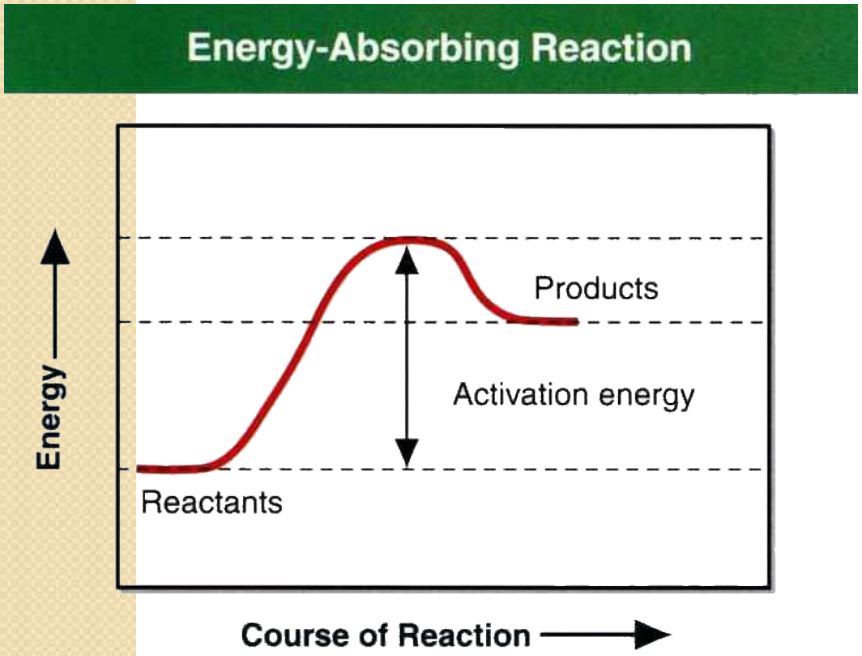


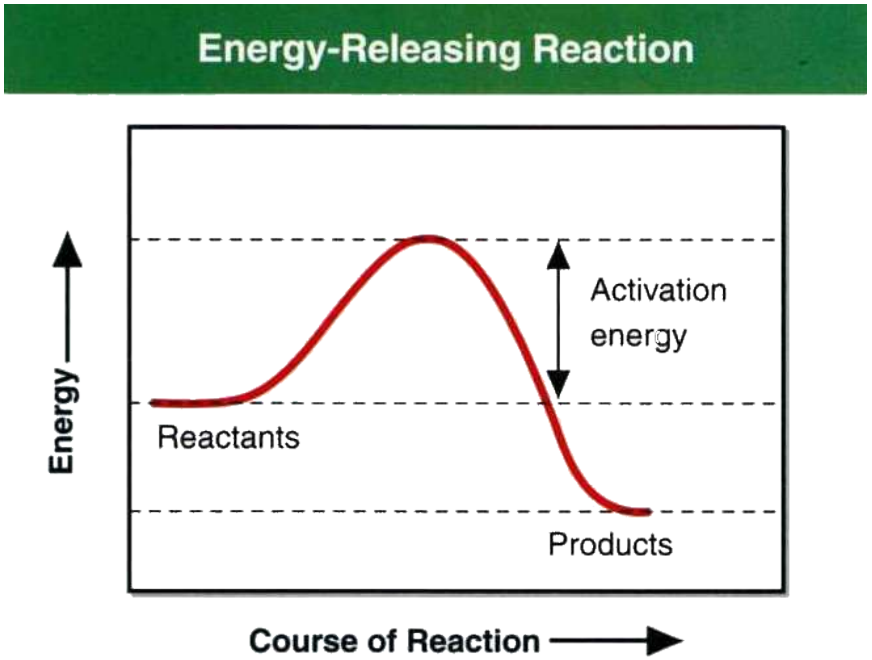




Proteins - Enzymes

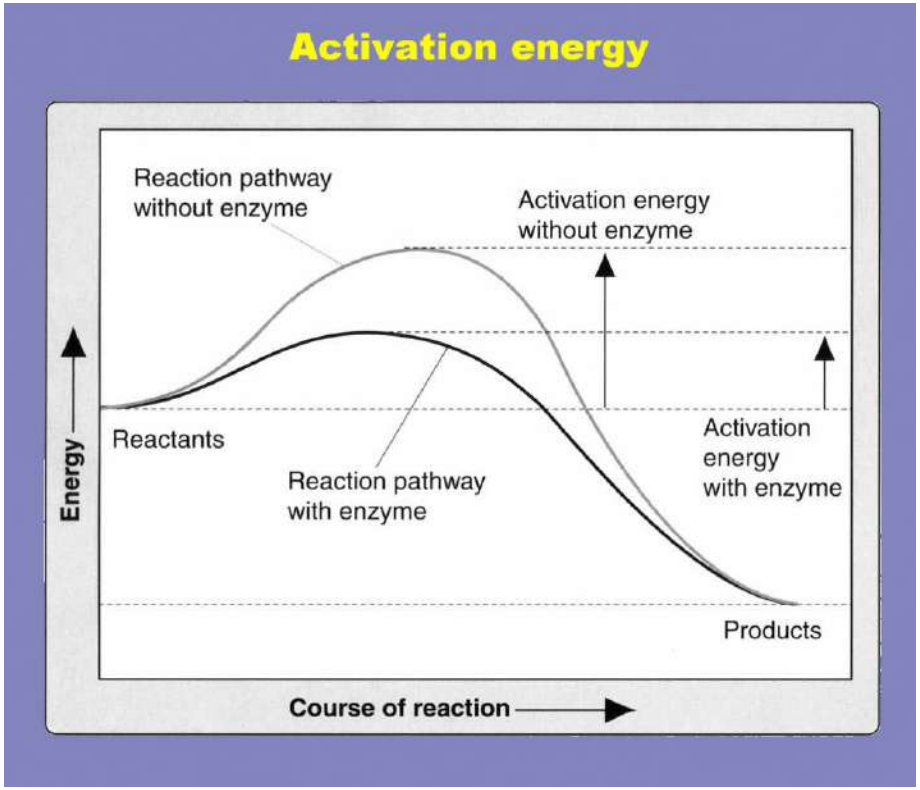
- Chemical reactions need energy in order to take place
- This energy is called activation energy





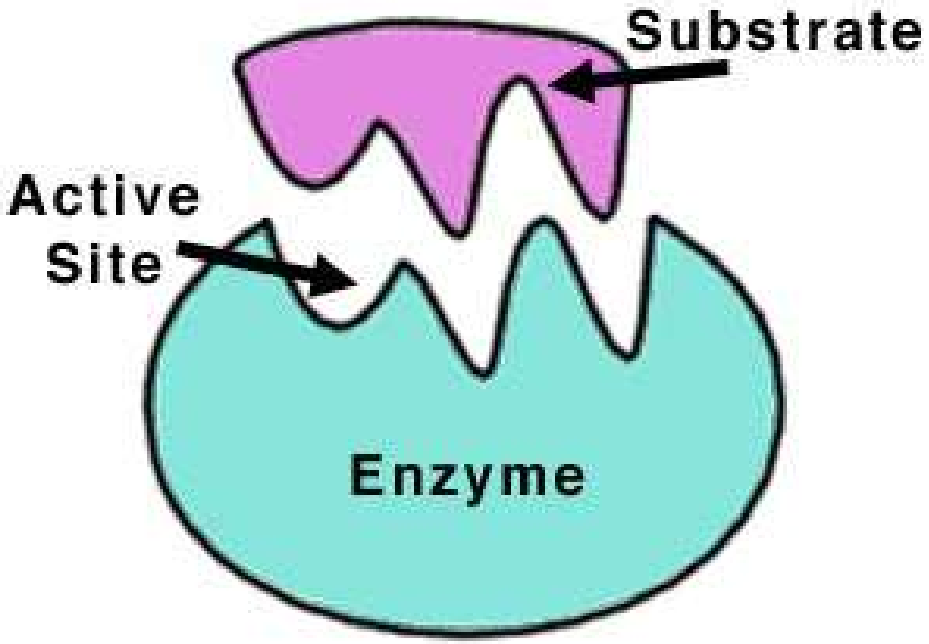
Proteins - Enzymes

- Enzymes are special proteins that act as catalysts to lower the activation energy (speed up) chemical reactions

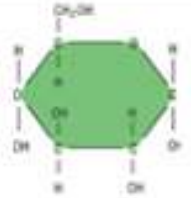
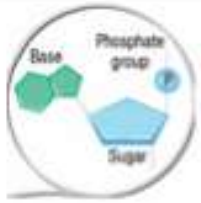


Proteins - Enzymes

- Each enzyme has a specific shape that allows it to target a specific substrate



Macromolecules Graphic Organizer

Characteristics	Macromolecules			
	Carbohydrates	Lipids	Proteins	Nucleic Acids
Elements				
Chemical Subunit (Include Drawing)				
Cellular Functions	-short term energy -structure -cell ID	-energy storage -cell membrane -signals	-enzymes -transport -structure -signaling -movement	-controls cell activities -transfers energy
Examples	-starch -glucose -lactose -cellulose -chitin	-phospholipids -cholesterol -steroids	-keratin -collagen -hemoglobin -transport	-DNA -RNA -ATP
Food Sources	-bread	-fats -oils	-meats -eggs -beans	-all

How do macromolecules help maintain cellular structure and function?

- Macromolecules make up cell structures and each group carries out specific cellular functions.
  - Lipids – cell membrane, energy storage
  - Carbohydrates – short-term energy, structure
  - Proteins – enzymes, structure, movement, transport
  - Nucleic acids – controls cellular activities

Questions?