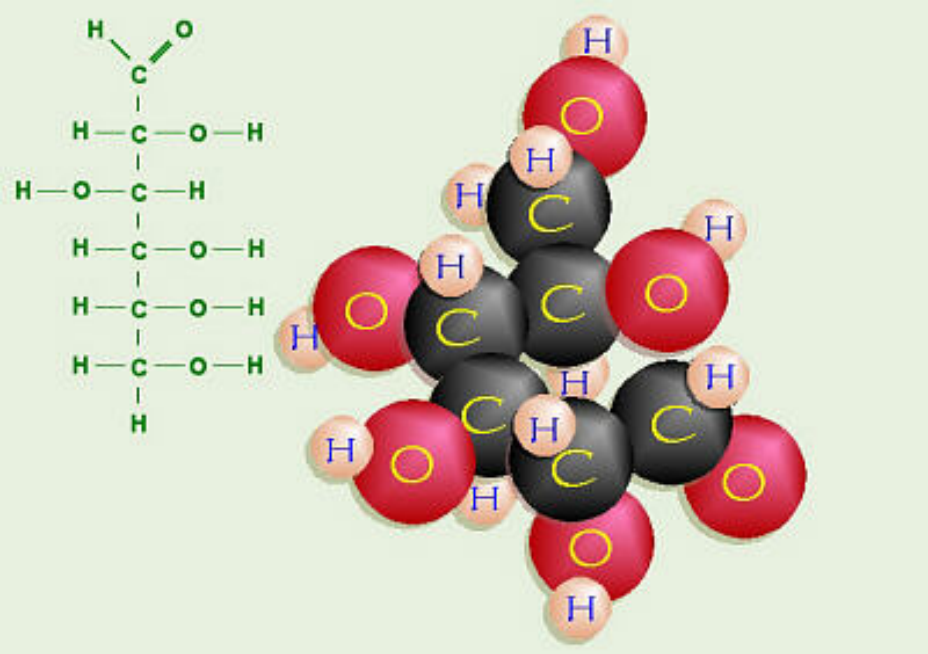
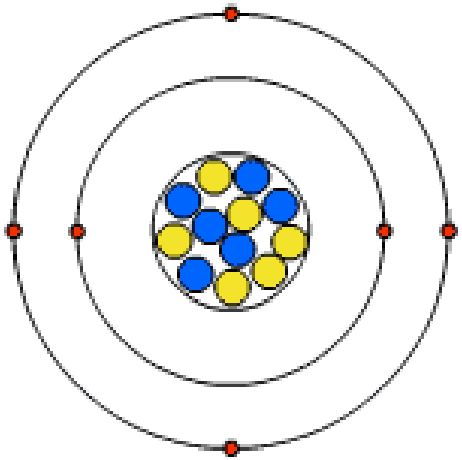
Organic Compounds



Carbon



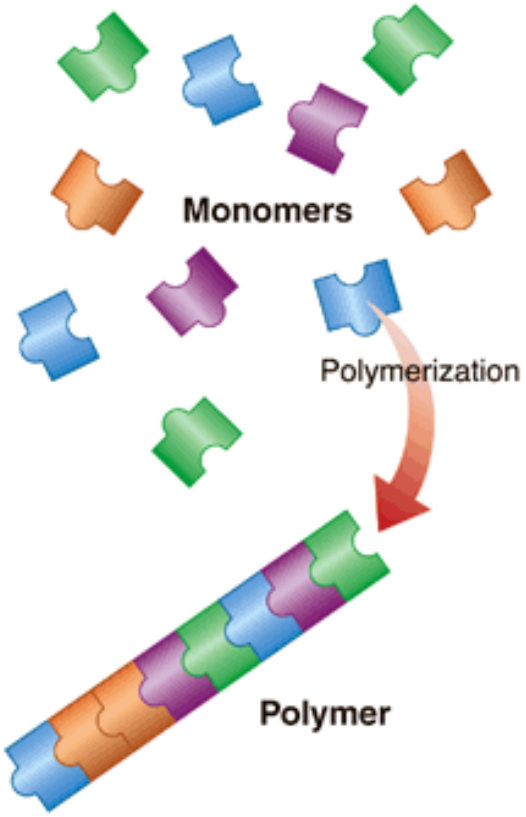
- Has four valence electrons
- Can bond with many elements
  - Hydrogen, Oxygen, Phosphorus, Sulfur, and Nitrogen
- Can bond to other carbon atoms
  - Gives carbon the ability to form chains that are almost unlimited in length.

Carbon

- Has the ability to form millions of different large and complex structures.
- No other element even comes close to matching carbon's versatility.
- Organic chemistry - study of all compounds that contain bonds between **carbon** atoms.

Macromolecules

- Macromolecules – "Giant molecules" made from smaller molecules
  - Formed by a process known as polymerization, in which large compounds are built by joining smaller ones together.
  - The smaller units, or **monomers**, join together to form **polymers**.

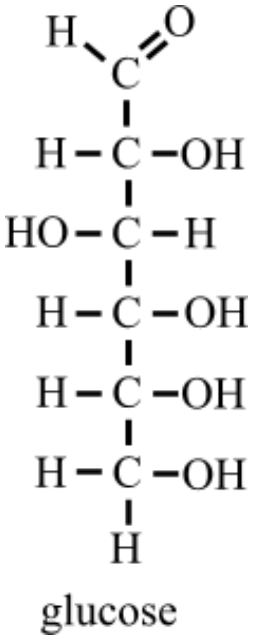


Organic Compounds

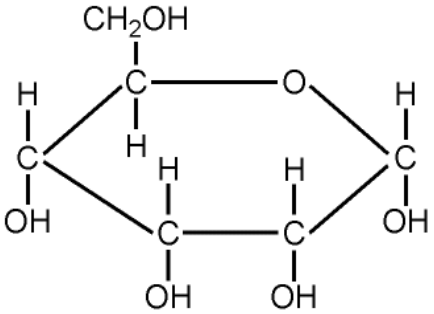
- Four groups of organic compounds found in living things are:
  1. Carbohydrates
  2. Lipids
  3. Nucleic Acids
  4. Proteins

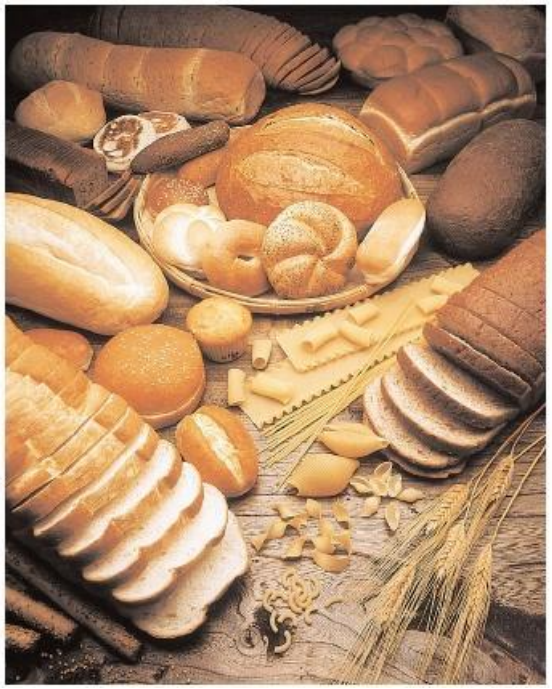
Carbohydrates

- Carbohydrates - Compounds made up of carbon, hydrogen, and oxygen atoms
  - Usually in a ratio of 1 : 2 : 1.



glucose





Uses of Carbohydrates

- Living things use carbohydrates as:
  1. Main source of energy (starches and sugars)
  2. Plants and some animals also use carbohydrates for structural purposes

Uses of Carbohydrates

- Animals
  - Store excess sugar in the form of glycogen
- Plants
  - Store excess sugar in the form of starch
  - Use tough, flexible **cellulose** fibers to give them their strength and rigidity

Classification of Sugars

- Monosaccharides - Single sugar molecules
  - Examples: Glucose, Galactose, Fructose
- Disaccharides – Double sugar molecules
  - Examples:
    - Glucose + Fructose = Sucrose
    - Glucose + Galactose = Lactose
    - Glucose + Glucose = Maltose
- Polysaccharides – More than two sugar molecules
  - Examples: Starch, Cellulose, Chitin, Glycogen
- Dehydration Synthesis- how you join these monosaccharides together.

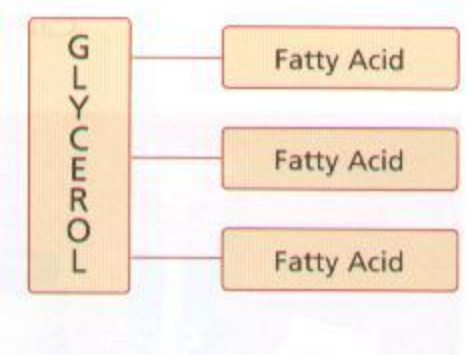
Lipids

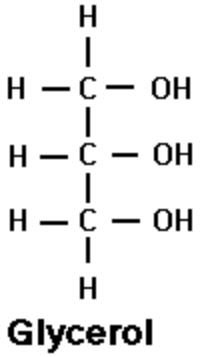
- Common categories of lipids are
  1. Fats
  2. Oils
  3. Waxes

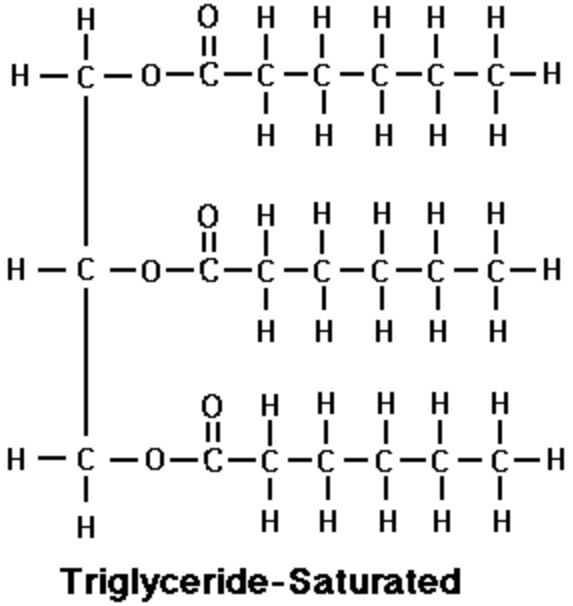
- Functions:
  1. Can be used to store energy
  2. Some lipids are important parts of biological membranes and waterproof coverings
  3. Can serve as chemical messengers (steroids only)
- Generally not soluble in water

Structure of Lipids

- Made mostly from carbon and hydrogen atoms
- Glycerol molecule + 3 fatty acids



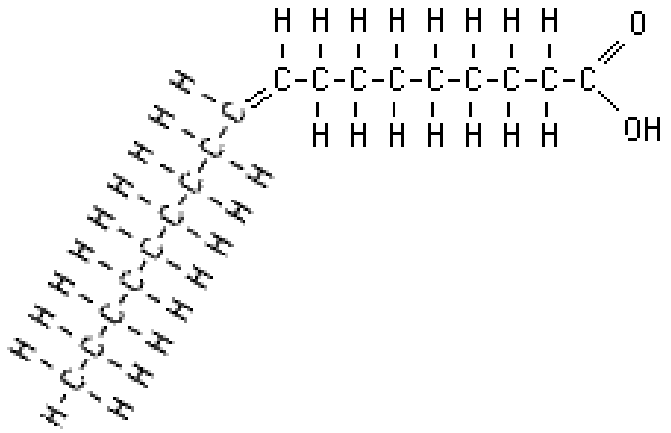




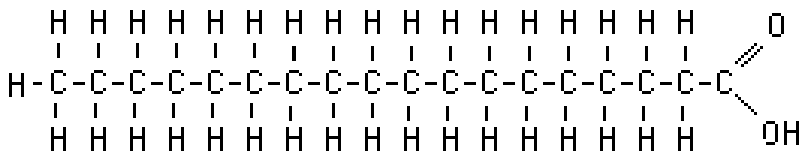
Saturated and Unsaturated Lipids

- Saturated - If each carbon atom in a lipid's fatty acid chains is joined to another carbon atom by a single bond.
  - *"saturated"* is used because the fatty acids contain the maximum possible number of hydrogen atoms
- Unsaturated - If there is at least one carbon-carbon double bond in a fatty acid.
  - Examples - Corn oil, sesame oil, canola oil, and peanut oil

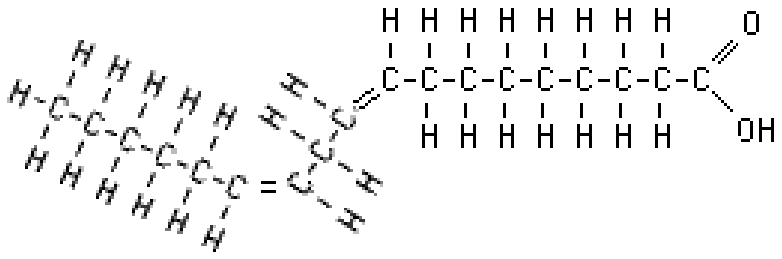
Saturated and Unsaturated Fatty Acids



Oleic acid, a monounsaturated fatty acid. Note that the double bond is *cis*; this is the common natural configuration.



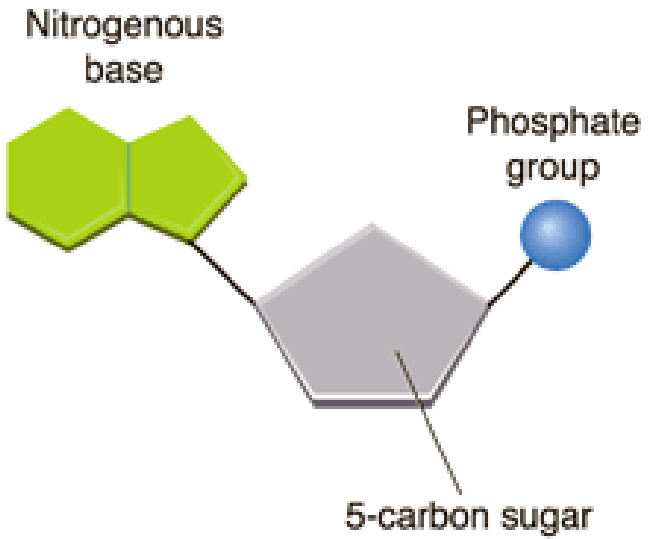
Stearic acid, a saturated fatty acid



Linoleic acid, a polyunsaturated fatty acid. Both double bonds are *cis*.

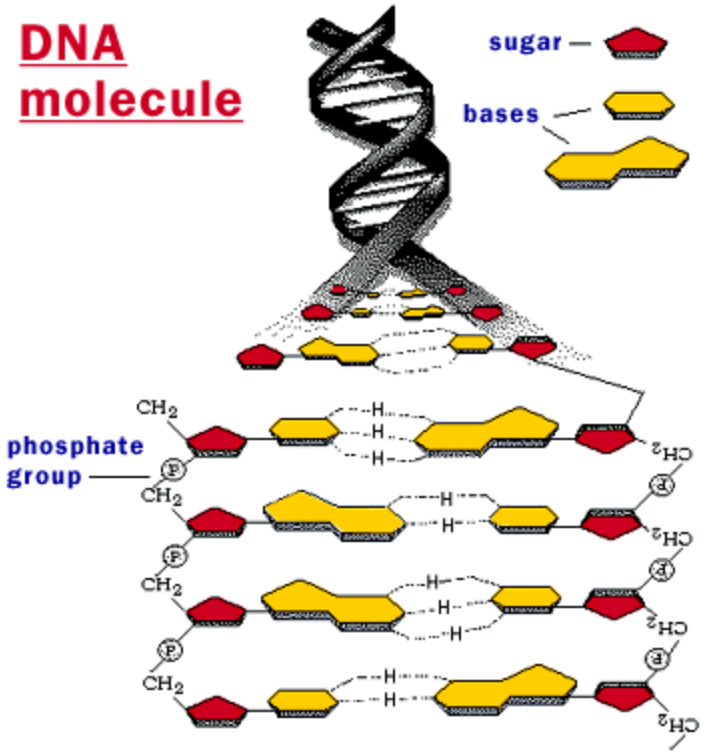
Nucleic Acids

- Nucleic acids - Macromolecules containing hydrogen, oxygen, nitrogen, carbon, and phosphorus.
- Made up of repeating units called nucleotides
  - Each nucleotide contains:
    1. 5-Carbon Sugar
    2. Phosphate Group
    3. Nitrogenous Base



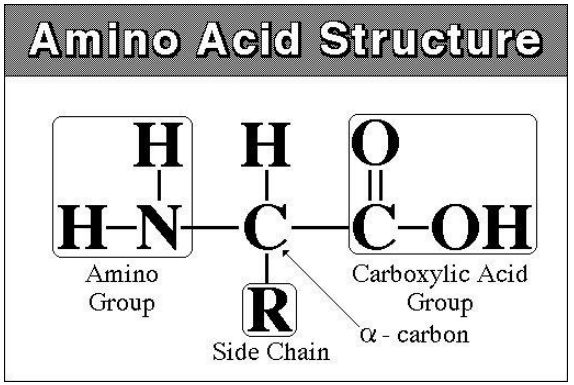
Nucleic Acids

- Function:
  - Store genetic information
  - Transmit genetic information
- Two Kinds of Nucleic Acids:
  1. Ribonucleic acid (RNA)
     - Contains the sugar ribose
  2. Deoxyribonucleic acid (DNA)
     - Contains the sugar deoxyribose



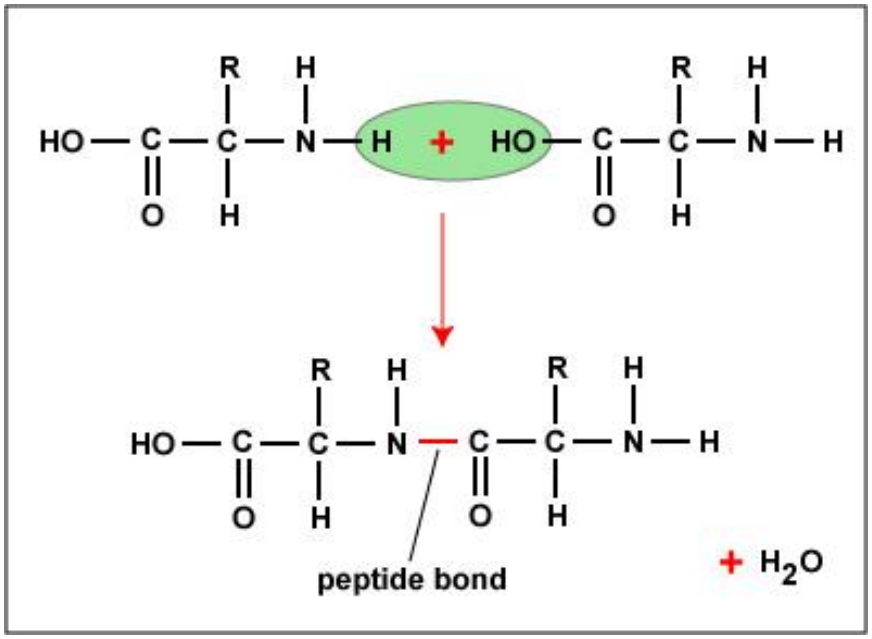
Protein

- Proteins - Macromolecules that contain nitrogen as well as carbon, hydrogen, and oxygen.
- Made up of chains of amino acids folded into complex structures.
  - Amino Acids - Compounds with an amino group (−NH2) on one end and a carboxyl group (−COOH) on the other end.



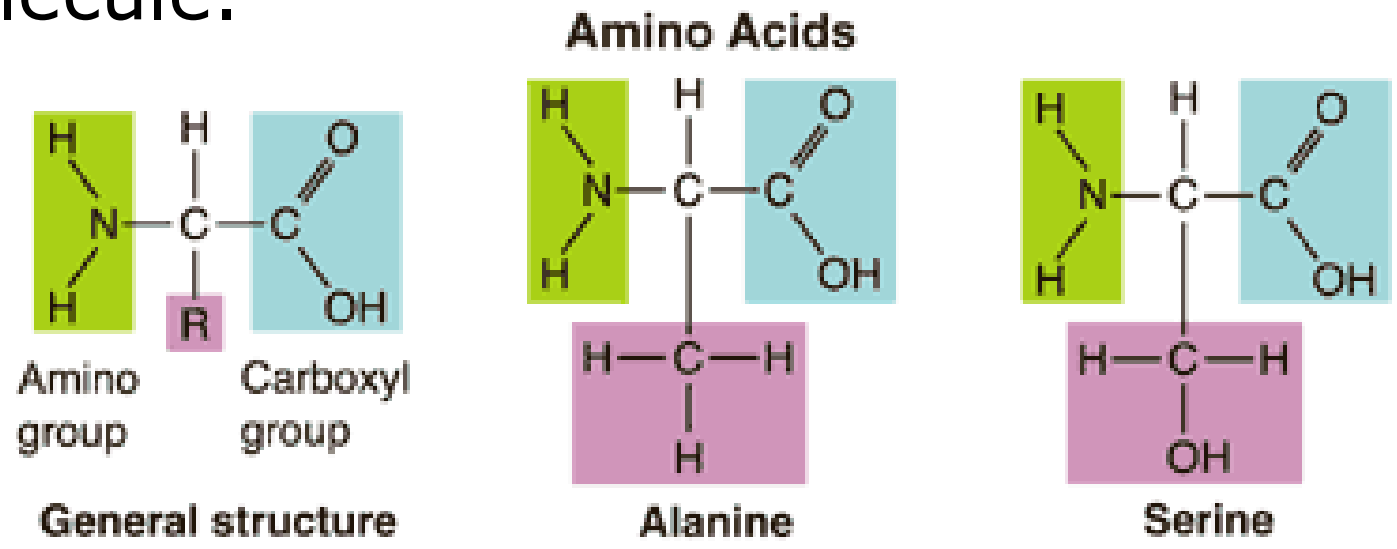
Amino Acids

- There are more than 20 different amino acids.
- Any amino acid may be joined to any other amino acid by bonding an amino group to a carboxyl group .



Amino Acids

- There are more than 20 different amino acids.
- What distinguishes one amino acid from another is the R-group section of the molecule.

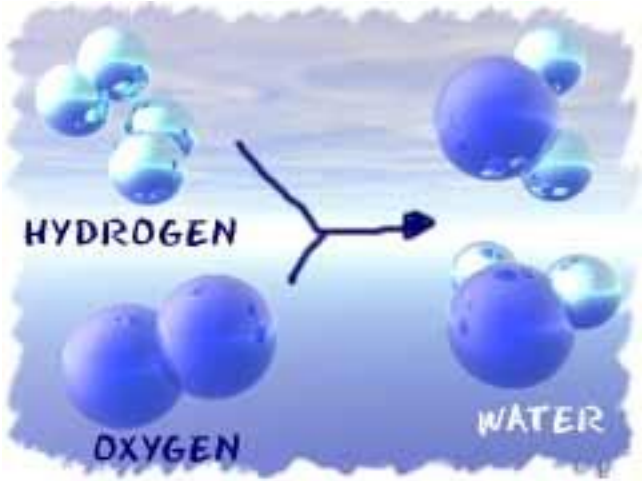


Functions of Proteins

- Each protein has a specific role.
  1. Some proteins control the rate of reactions and regulate cell processes.
  2. Some are used to form bones and muscles.
  3. Others transport substances into or out of cells or help to fight disease.

Chemical Reactions

- Chemical Reaction - A process that changes one set of chemicals into another set of chemicals.
  - Always involve the breaking of bonds in reactants and the formation of new bonds in products.



HYDROGEN AND OXYGEN MOLECULES COMBINE TO FORM WATER.

Chemical Reactions

- Reactants - The elements or compounds that enter into a chemical reaction.
- Products - The elements or compounds produced by a chemical reaction.

$$Na + Cl \rightarrow NaCl$$

Reactants **Products**

Energy in Reactions

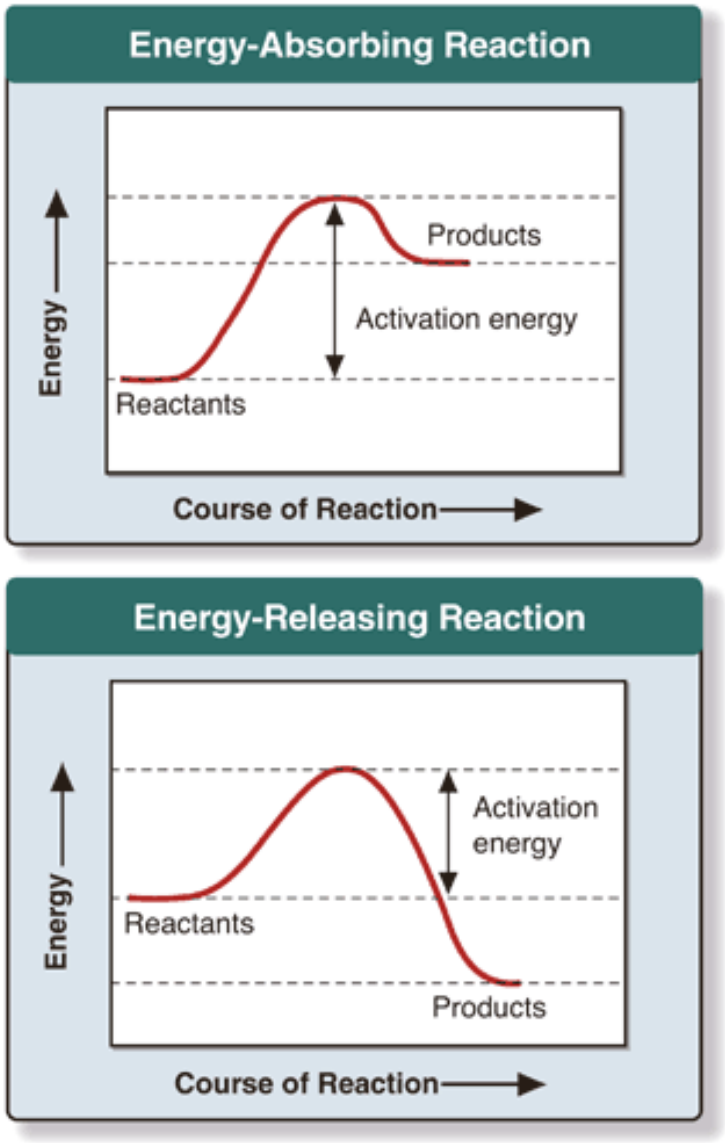
- Because chemical reactions involve breaking and forming bonds, they involve changes in energy.
- Will the chemical reaction occur?
  - Chemical reactions that release energy (in the form of heat, light, and sound) often occur spontaneously.
  - Chemical reactions that absorb energy will not occur without a source of energy.

Organisms and Energy

- Plants
  - Get their energy by trapping and storing the energy from sunlight in energy-rich compounds.
- Animals
  - Get their energy when they consume plants or other animals.
  - Release the energy needed to grow tall, to breathe, or to think through the chemical reactions that occur when humans metabolize, or break down, digested food.

Activation Energy

- Activation Energy - The energy that is needed to get a reaction started.
  - The peak of each graph represents the energy needed for the reaction to go forward.
  - The difference between this required energy and the energy of the reactants is the activation energy.



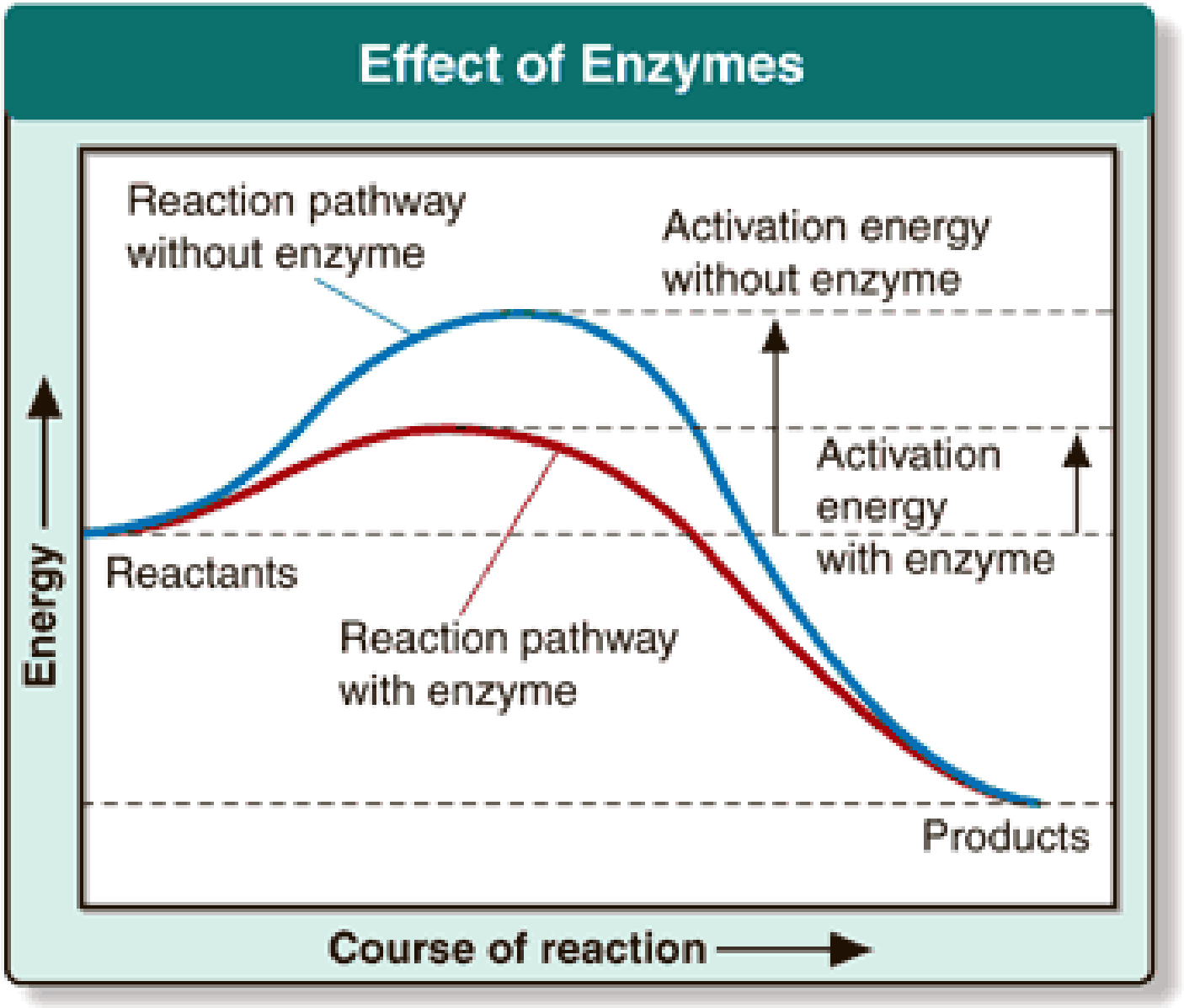
Catalysts

- Some chemical reactions that make life possible are too slow or have activation energies that are too high to make them practical for living tissue.

- Catalyst - A substance that speeds up the rate of a chemical reaction by lowering a reaction's activation energy.

Enzymes

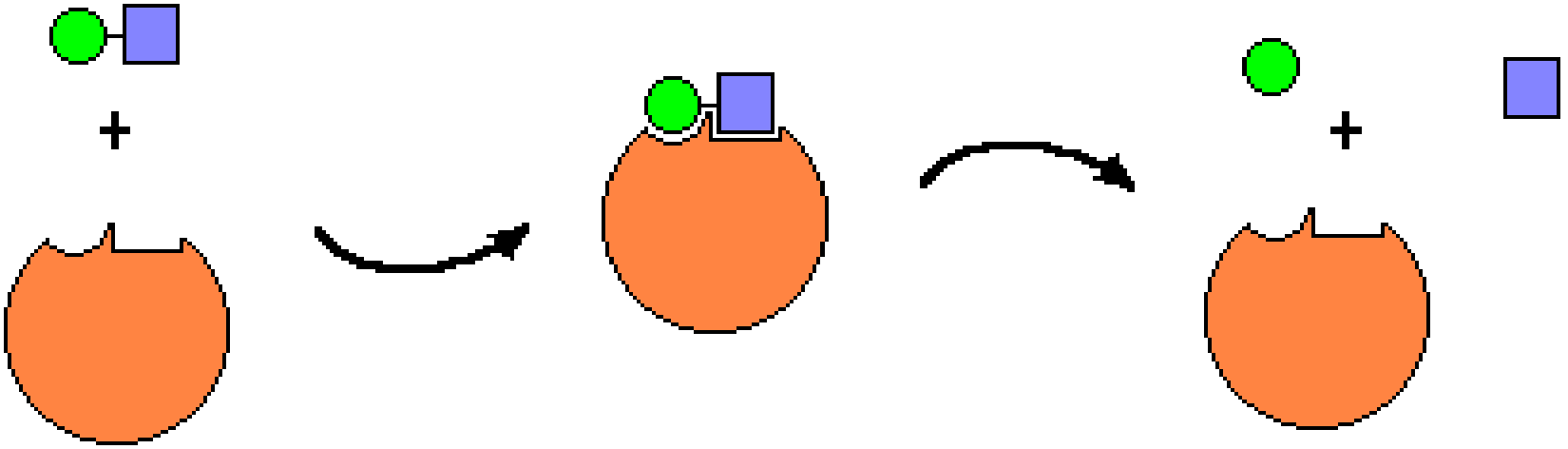
- Enzymes - Proteins that act as biological catalysts.
  - Speed up chemical reactions that take place in cells.
  - Very specific, generally catalyzing only one chemical reaction.
  - Part of an enzyme's name is usually derived from the reaction it catalyzes.

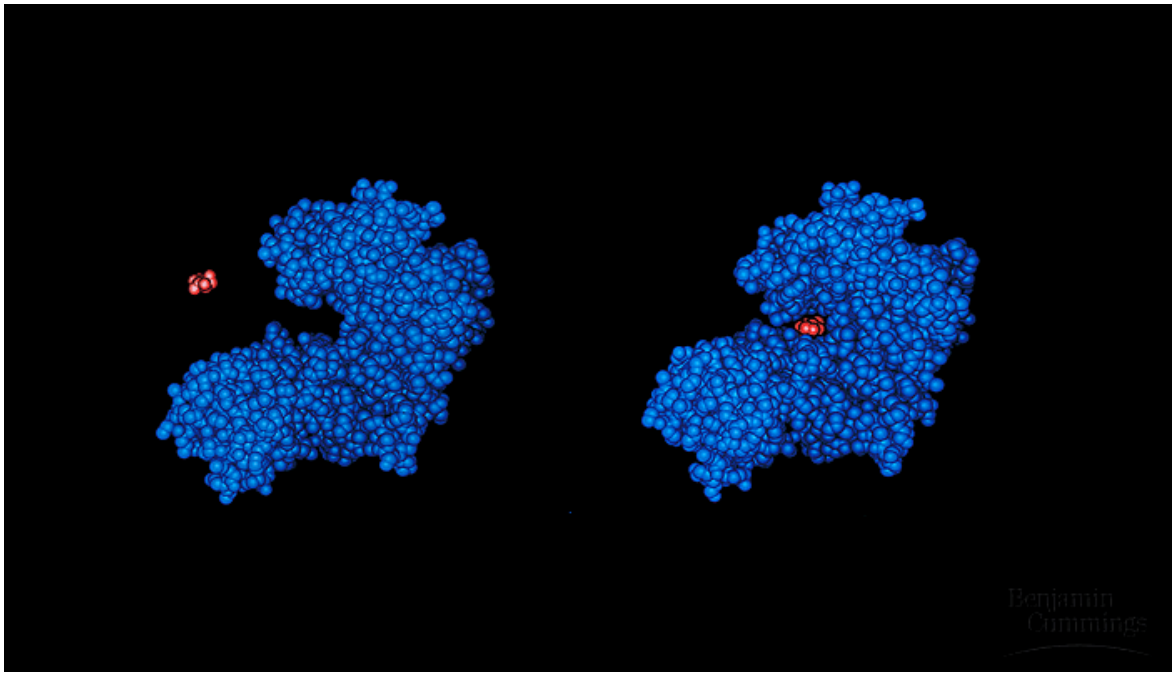

Effect of Enzymes
Reaction pathway without enzyme
Activation energy without enzyme
Activation energy with enzyme
Reactants
Reaction pathway with enzyme
Products
Energy
Course of reaction

How Do Enzymes Work?

- Substrates - The reactants of enzyme-catalyzed reactions.
- The Enzyme-Substrate Complex
  - Enzymes provide a site where reactants can be brought together to react.
  - This site reduces the energy needed for reaction.
  - Each protein has a specific, complex shape.
  - Active Site – The site on the enzyme where substrates bind.
    - The active site and the substrates have complementary shapes, which is often compared to a lock and key.

Enzyme Substrate Complex





Regulation of Enzyme Activity

- Enzymes can be affected by any variable that influences a chemical reaction such as:
  1. pH
  2. Temperature
  3. Cells contain proteins that help to turn key enzymes "on" or "off"