

# Chapter 2

## Chemistry of Life

# 2-1 Nature of Matter

- All matter is composed of atoms
- Atoms-the smallest unit of matter that cannot be broken down by chemical means
- Atoms are made of 3 particles
- Electrons (e-) – Charge
- Protons + Charge
- Neutrons Neutral Charge

- Element-a substance composed of one type of atom (gold, silver, oxygen)
- Compound-a substance composed of the joined atoms of two or more different elements (NaCl)
- Cool thing about compounds is that individual elements lose normal characteristics and acquire new ones as compounds

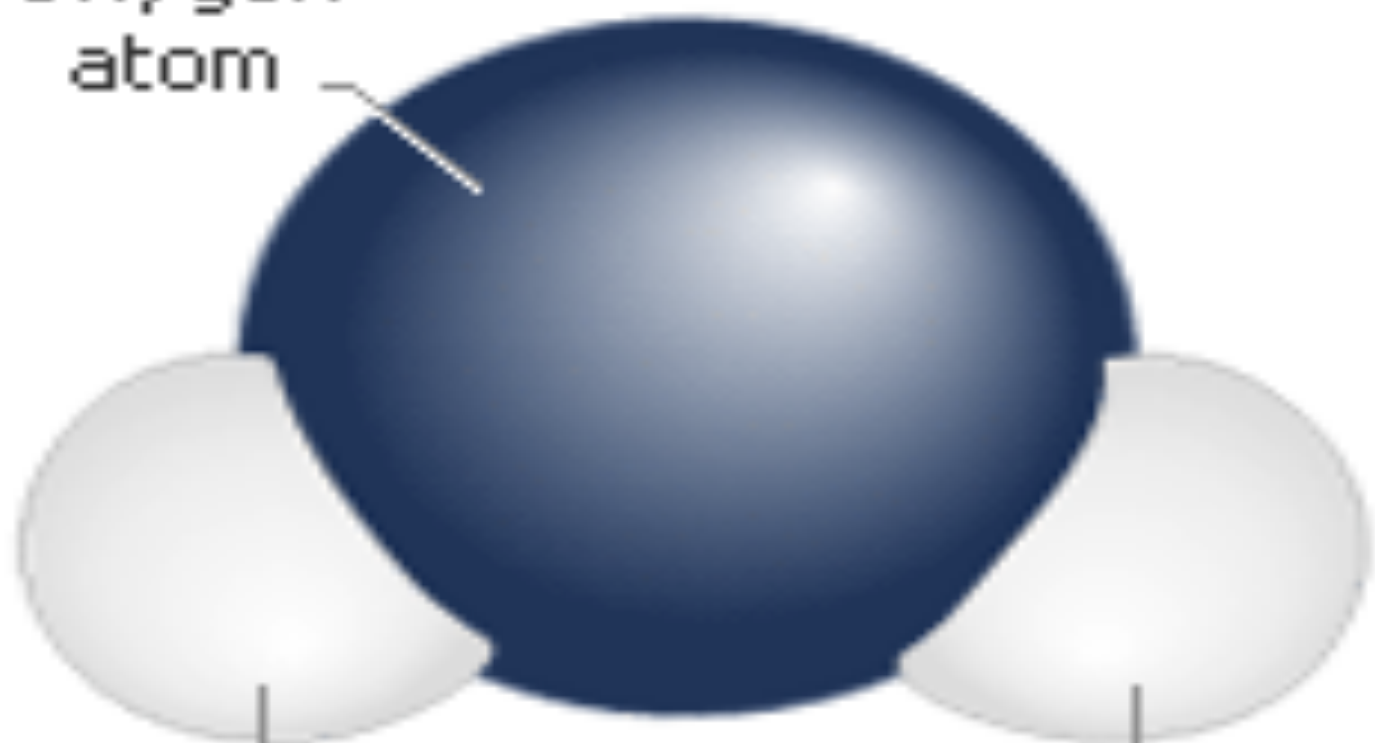
# Covalent Bonds

- Covalent Bonds-form when two or more atoms share electrons to make a molecule
- Molecule-a group of atoms held together by covalent bonds
- Electrons are held in different levels

- Inner levels have less NRG than the outer levels
- Atoms become stable when the outer level is full
- If outer level is not full, atom will react with other atoms to fill outer level

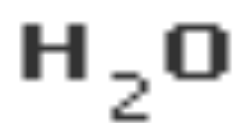
- Proton # determines element
- Electron # = Proton #
- Examples of molecules include  $\text{H}_2\text{O}$ ,  $\text{CO}_2$ , and  $\text{O}_2$

Oxygen  
atom



Hydrogen  
atom

Hydrogen  
atom



# Hydrogen Bonds

- Hydrogen Bond-A weak bond between two atoms (one of which is hydrogen) with partial but opposite electrical charges
- H<sub>2</sub>O molecules are attracted to other water molecules by hydrogen bonds



- The oxygen in water attracts the hydrogen atoms more strongly
- This creates positive and negative ends on water molecules (poles)
- We call these molecules polar molecules

- Nonpolar molecules have an equal distribution of charge
- <http://programs.northlandcollege.edu/biology/Biology1111/animations/hydrogenbonds.html>

# Ionic Bonds

- Ionic Bonds-A chemical bond formed by electrostatic attraction between oppositely charged ions.
- Ion-An atom that has gained or lost one or more electrons
- Lose an e-, you are positive
- Gain an e-, you are negative

- $\text{Na}^+$  Sodium added to  $\text{Cl}^-$  makes
- $\text{NaCl}$
- Sodium needs one electron while Chlorine wants to get rid of one electron

# 2-2 Water and Solutions

- 70% of your body is water
- Water has certain properties that make it essential for life
  - \* Stores Heat Efficiently
  - \* Water Bonds Itself to Other Substances
  - \* Dissolves Many Other Substances

# Water Stores Heat Efficiently

- Water stores heat more efficiently than most other substances
- This allows organisms to maintain a constant internal temperature in changing environments
- Sweating allows organisms to release heat in the form of evaporation

# Water Bonds To Other Things

- Cohesion-the attraction between substances of the same kind (droplets, and films caused by hydrogen bonds)
- Adhesion-the attraction between different substances (Capillary Action)
- Capillary action is when water moves upward against gravity through a narrow tube

# Water Dissolves Many Substances

- Water can dissolve more substances than any other chemical
- Solution-mixture in which one or more substances are evenly distributed in another substance
- Solvent-dissolves substance
- Solute-is dissolved by solvent



- <http://programs.northlandcollege.edu/biology/Biology1111/animations/dissolve.html>

- The polarity of water allows many substances to dissolve
- Ionic compounds and polar molecules dissolve the best
- Nonpolar molecules cannot dissolve in water
- Important because the shape and function of cell membranes depends on the interaction between polar and nonpolar molecules

# Acids and Bases

- Although bonds in water molecules are strong, a tiny fraction can break
- This produces a hydrogen ion  $H^+$  and a hydroxide ion  $OH^-$
- Compounds that form  $H^+$  when dissolved in water are called acids
- Compounds that form  $OH^-$  when dissolved in water are called bases

- The pH scale is a numerical representation of the amount of  $H^+$  or  $OH^-$  ions (Power of 10 scale)
- pH 7 is neutral
- Less than 7 is acidic (Orange Juice, Vinegar)
- Greater than 7 is basic (Soap, Antacid)

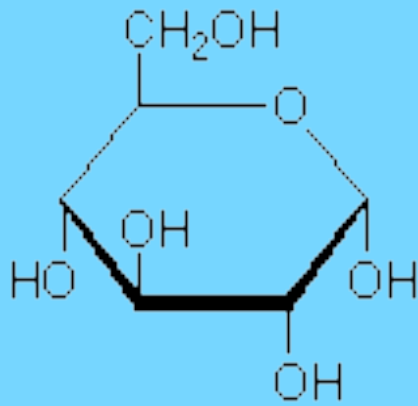
# 2-3 Organic Compounds

- Most matter other than water in your body is made of organic compounds
- Organic Compounds-compounds which contain carbon atoms (compounds of life)
- 4 Main Organic Compounds

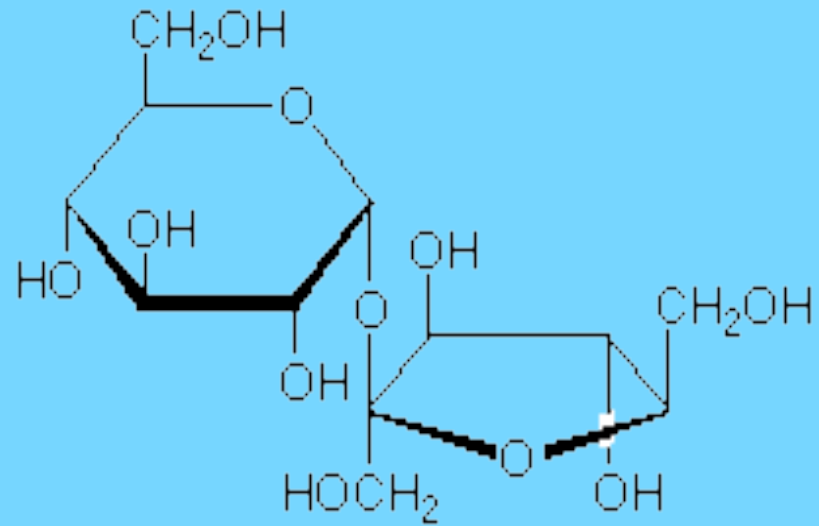
# Carbohydrates

- Made of carbon, hydrogen, and oxygen atoms in a 1:2:1 ratio
- Key source of NRG
- The building blocks of carbs are monosaccharides
- Examples are glucose and fructose

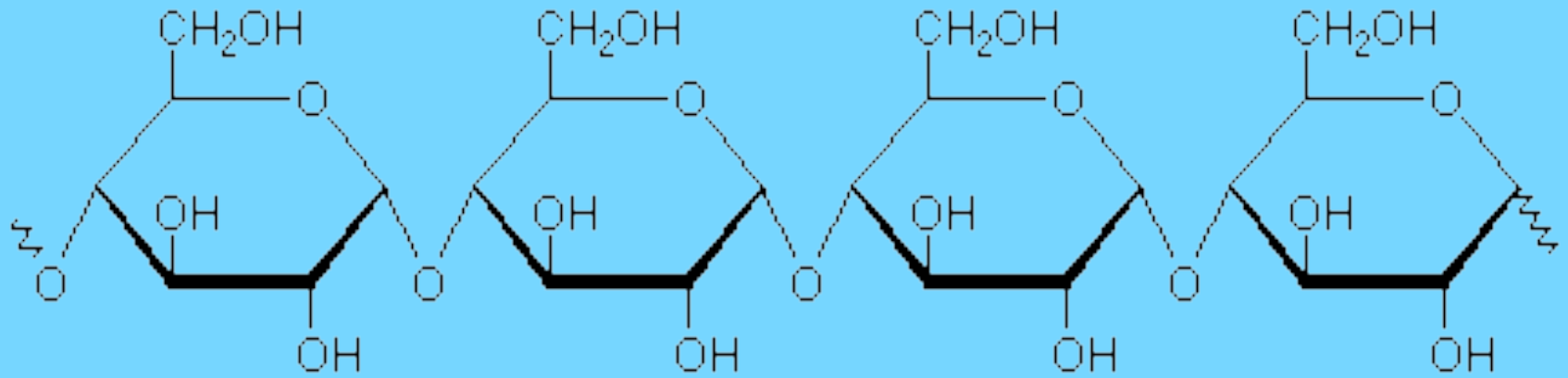
- Disaccharides form when two monosaccharides bond together
- Example is sucrose (glucose and fructose together)
- Polysaccharides are macromolecules (many small molecules)
- Examples in plants are starch and cellulose, in animals it is glycogen
- Some function to store NRG



monosaccharide (glucose)



disaccharide (sucrose)



polysaccharide (amylose starch)



# Lipids

- Nonpolar molecules
- Include fats, oils, waxes, phospholipids, steroids
- Fats store NRG
- A typical fat is three fatty acids (long chain of carbons with hydrogen atoms bonded to them) bonded to a glycerol molecule (alcohol with 3 carbons)

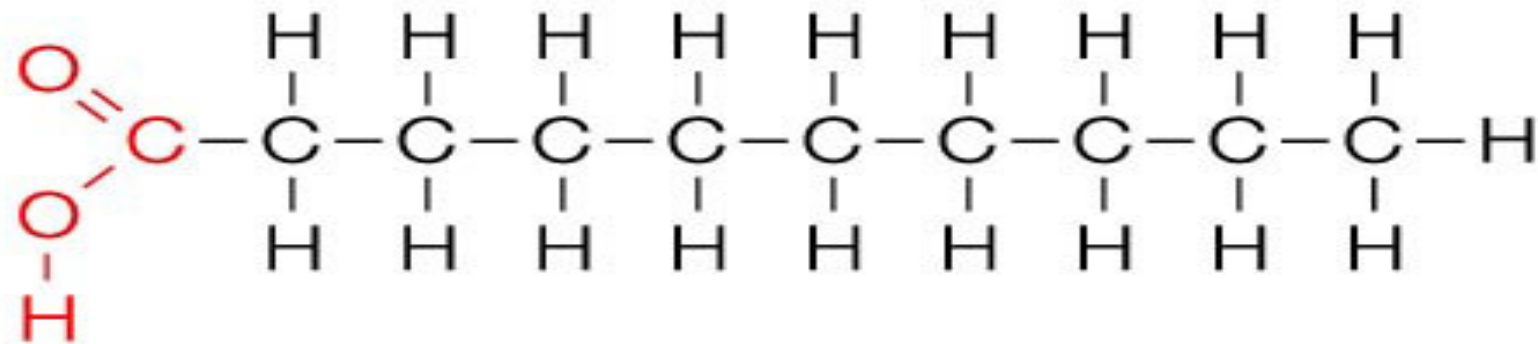
# Saturated Fats

- Saturated fats have two hydrogen atoms bonded to every carbon in the chain
- Solid at room temperature
- Animal fats, butter, lard, and grease from cooked meats

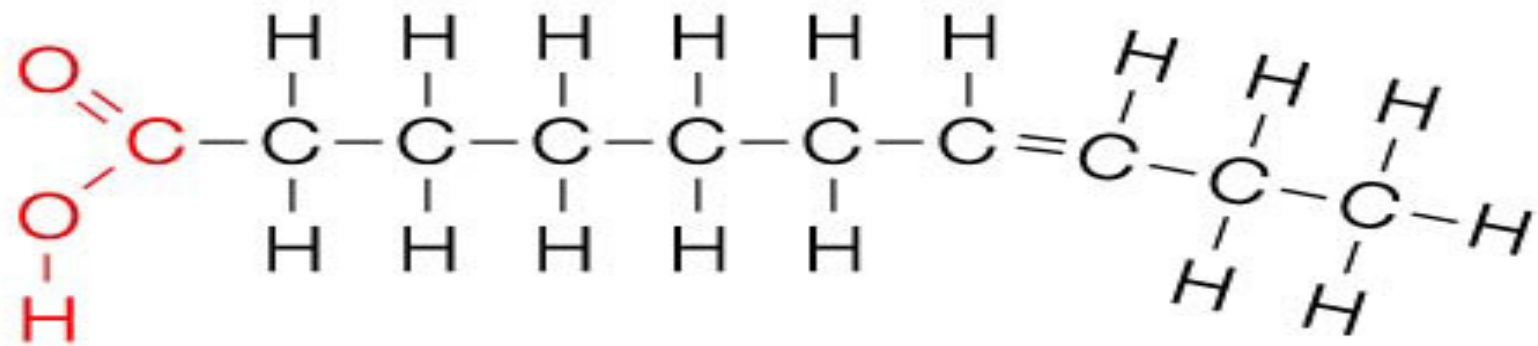
# Unsaturated Fats

- Unsaturated fats have some carbon atoms linked by double covalent bonds each with only one hydrogen
- Produces molecules with kinks in them
- Liquid at room temperature
- Plant oils, and fish oils

## Saturated



## Unsaturated

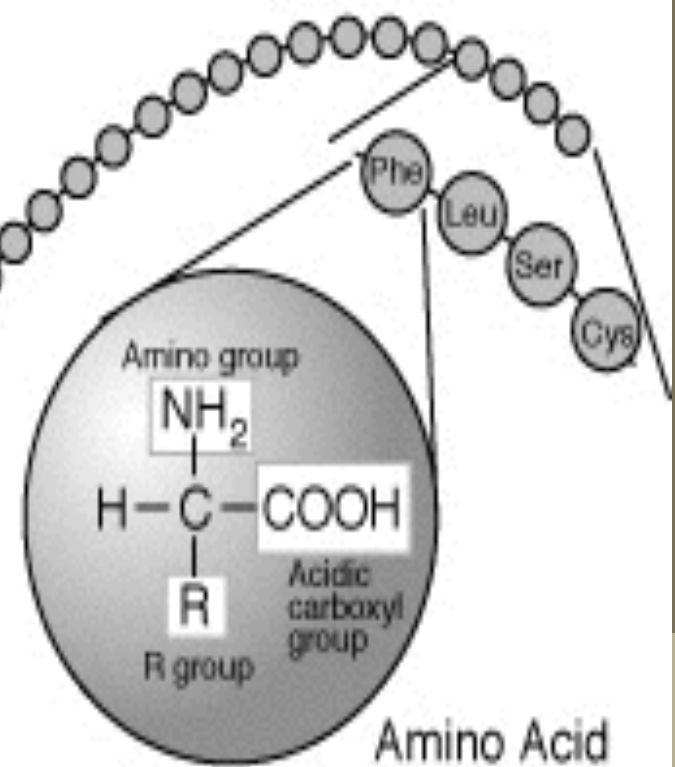


- Why NRG rich?
- NRG rich because hydrogen bonds store NRG
- Break the bonds to release NRG

# Proteins

- Proteins are molecules made of chains of amino acids (20 different kinds)
- Shape of protein is determined by how amino acids react with on another and with water
- Enzymes are proteins that promote chemical reactions
- Also important for structural functions and for the immune system

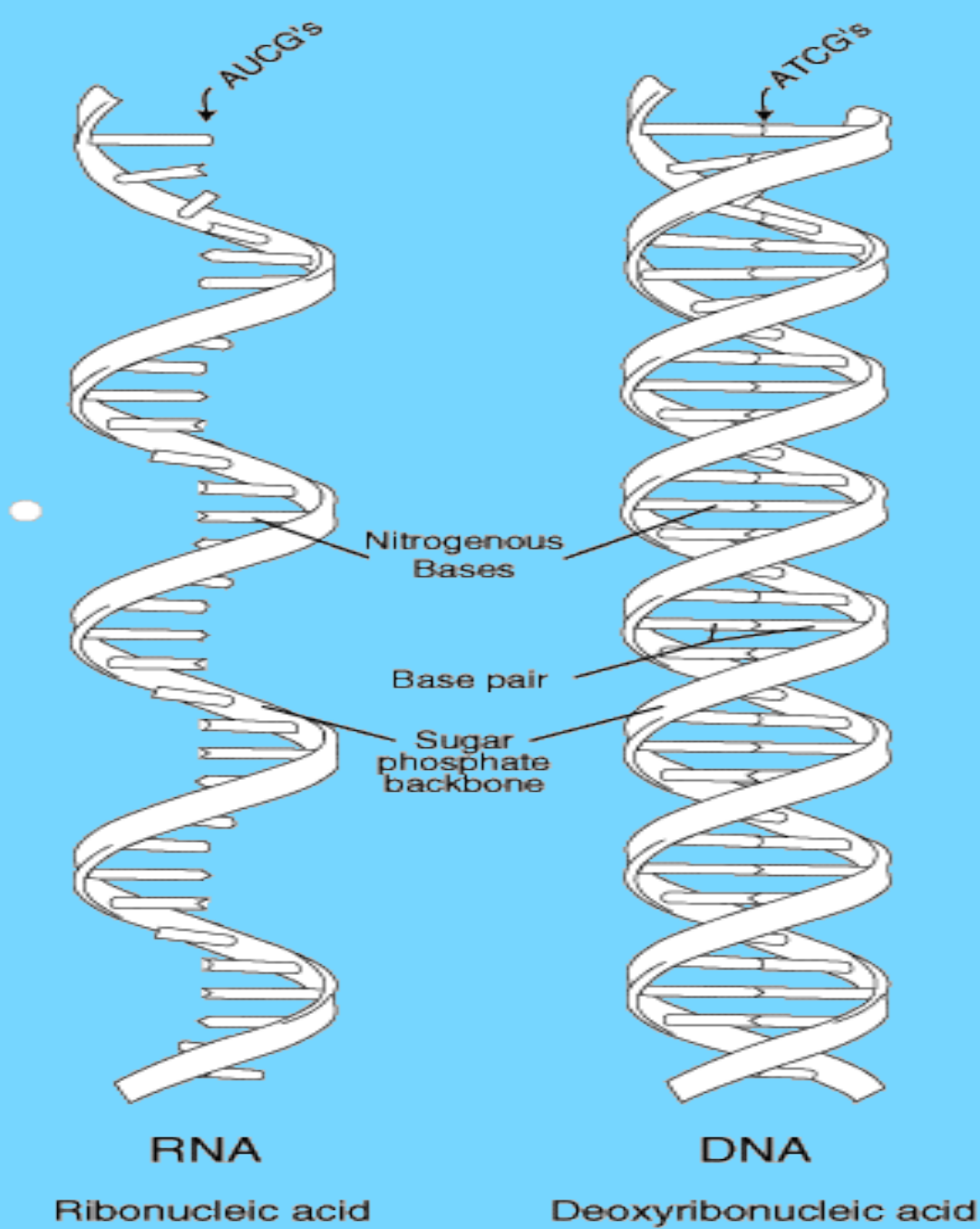
Primary protein structure  
is sequence of a chain of amino acids



# Nucleic Acids

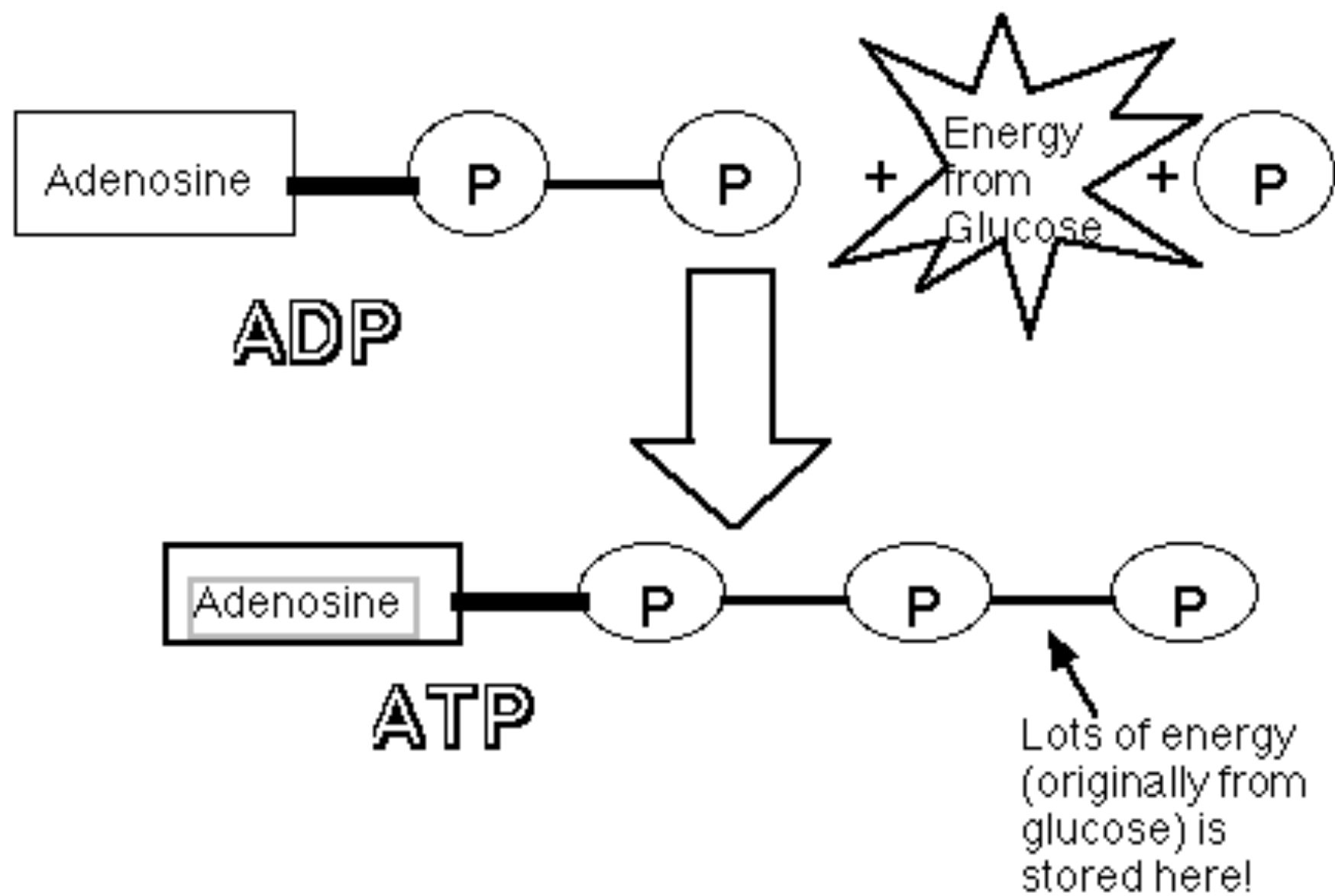
- Nucleic Acids are long chains of small molecules called nucleotides
- Nucleotide has three parts: a sugar, a base, and a phosphate group
- 2 types of nucleic acids: DNA, RNA
- DNA is a double helix, stores hereditary information
- RNA is a single strand, used for manufacturing proteins





# ATP

- Adenosine Triphosphate (ATP)
- Made of a single nucleotide with two NRG storing phosphate groups
- Release NRG when phosphate groups are broken off

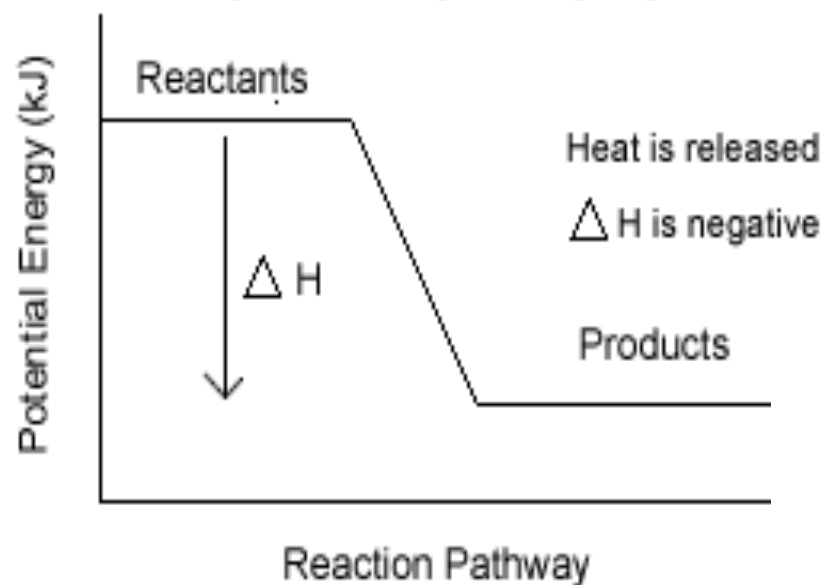


# 2-4 NRG and Chemical RXNS

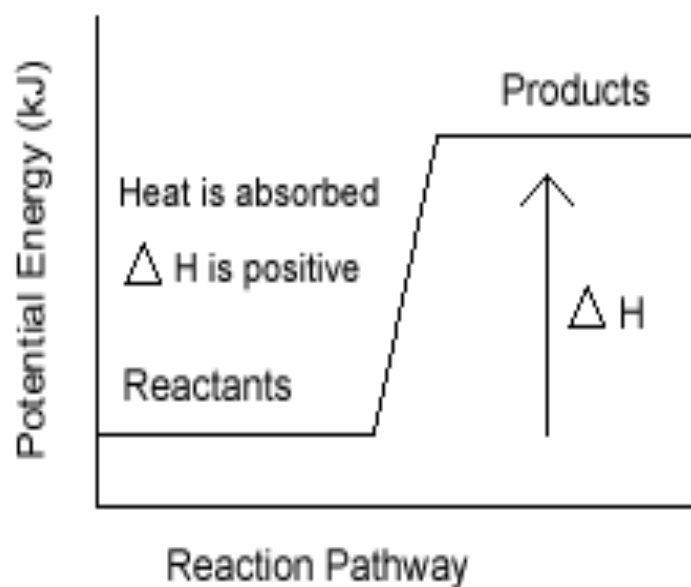
- NRG-the ability to move or change matter
- NRG stored or released during chemical rxns
- Summarize rxns with a chemical equation
- Reactants  $\rightarrow$  Products
- $\text{NaCl} \rightarrow \text{Na}^+ + \text{Cl}^-$

- Exothermic Reaction-releases NRG  
(heat)
- Endothermic Reaction-absorbs NRG  
(heat)

## EXOTHERMIC REACTION



## ENDOTHERMIC REACTION



# Enzymes and RXNs

- Enzymes-substances (proteins) that increase the rate of chemical rxns
- Catalysts-substances that lower activation NRG
- Activation NRG-NRG needed to start a rxn
- Enzymes help organisms maintain homeostasis

- Enzymes are substrate specific
- Substrate-substance on which an enzyme acts
- Enzyme shape forms folded areas called active sites
- The specific substrate fits into the active site



- <http://programs.northlandcollege.edu/biology/Biology1111/animations/enzyme.swf>

# What Affects Enzyme Activity?

- Temperature
- pH
- Enzyme Concentration