

## **Basic Chemistry**

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## **Matter and Energy**

- **Matter**
  - Has weight and occupies space
  - States of matter
    - Solid, liquid, gas
- **Energy**
  - Ability to do work or put matter into motion
    - Kinetic energy
    - Potential energy

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## **Forms of Energy**

- **Chemical energy**
  - Energy stored in chemical bonds
- **Electrical energy**
  - Movement of charged particles
- **Mechanical energy**
  - Directly involved in moving matter
- **Radiant energy**
  - Energy travels in waves

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## Composition of Matter

- **Element**
  - **Building block of matter**
- **Most common elements**
  - C - carbon**
  - H - hydrogen**
  - O - oxygen**
  - N - nitrogen**

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## Common Elements

Common Elements in Living Things				
Element	Atomic Symbol	Atomic Number	Atomic Weight	Comment
hydrogen	H	1	1	These elements make up most biological molecules.
carbon	C	6	12	
nitrogen	N	7	14	
oxygen	O	8	16	
phosphorus	P	15	31	
sulfur	S	16	32	
sodium	Na	11	23	These elements occur mainly as dissolved salts.
magnesium	Mg	12	24	
chlorine	Cl	17	35	
potassium	K	19	39	
calcium	Ca	20	40	

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## Composition of Matter

- **Atom**
  - **Smallest part of an element**
- **Atomic structure**
  - **Nucleus**
  - **Orbitals**

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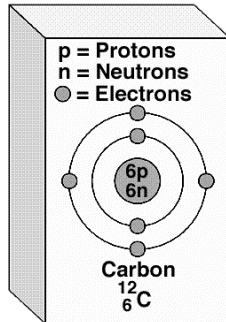
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## Structure of an Atom



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## Subatomic Particles

Particle	Location	Weight	Charge
Proton	Nucleus	1	+
Neutron	Nucleus	1	0
Electron	Orbital	1/1800	-

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## Atomic Weight and Isotopes

- **Atomic weight**
  - Combined weight of protons and neutrons in nucleus
- **Isotope**
  - Different atomic form of the same element
  - Numbers of neutrons varies
- **Radioisotope**
  - Isotope that exhibits radioactive behavior

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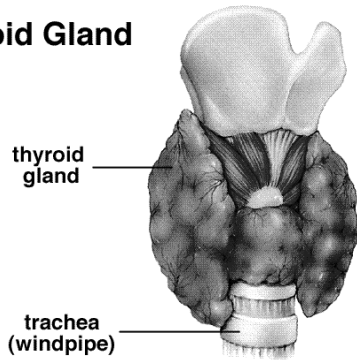
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## Thyroid Gland



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## Molecules and Compounds

- **Molecule**
  - A particle made up of one or more atoms and held together by chemical bonds
  - Example  
 $H \text{ (atom)} + H \text{ (atom)} \rightarrow H_2 \text{ (molecule)}$
- **Compound**
  - Substance composed of two or more different atoms held together by chemical bonds
  - Example  
 $4H + C = CH_4 \text{ (methane)}$

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## Chemical Bonds

- An energy relationship involving interactions between reacting atoms
- Energy levels
  - Electrons orbiting nucleus
  - Outermost energy level most important in forming chemical bonds
  - Outermost energy levels between interacting atoms must overlap

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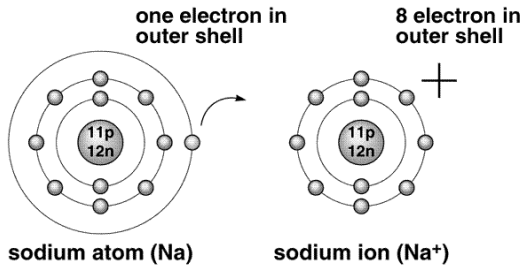
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### Formation of Positive Ion



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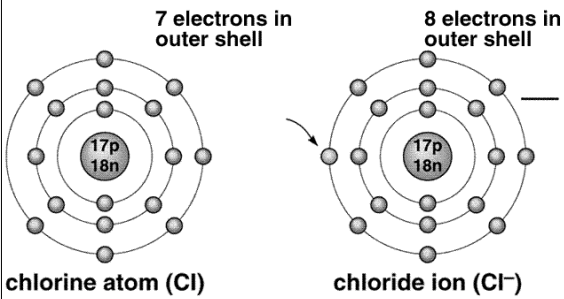
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### Formation of Negative Ion



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### Types of Chemical Bonds

#### Ionic bonds

Electrons are transferred from one atom to another.

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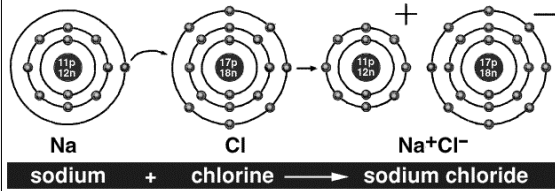
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## An Ionic Bond



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## Types of Chemical Bonds

### Covalent bonds

Electrons are shared between interacting atoms.

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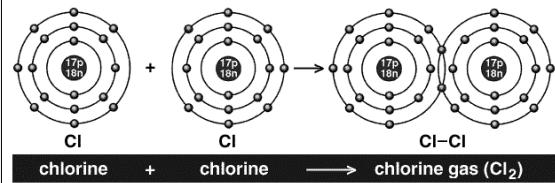
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## Covalent Reaction—Chlorine Gas



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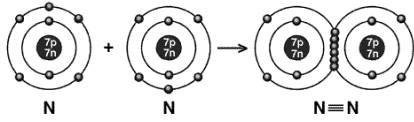
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## Covalent Reaction—Nitrogen Gas



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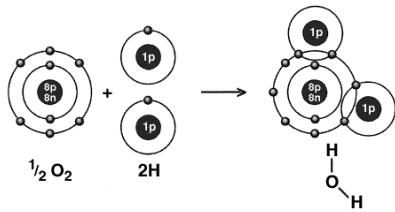
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## Covalent Reaction—Water



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## Types of Chemical Bonds

### Hydrogen bonds

Hydrogen atom forms bridge between electron hungry atoms. A weak, intramolecular bond.

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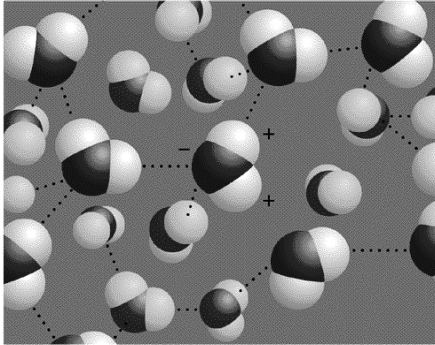
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## Hydrogen Bonding in Water Molecules



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## Chemical Reactions

- **The making and breaking of bonds between atoms.**
- **Total number of atoms remain the same, but new combinations of atoms appear.**

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## Patterns of Chemical Reactions

- **Synthesis reactions**
  - Builds larger, more complex molecule  
 $A + B > AB$  (amino acids > protein)
- **Decomposition reactions**
  - Breaks molecule into smaller atoms  
 $AB > A + B$  (glycogen > glucose)
- **Exchange reactions**
  - Involves both synthesis and decomposition reactions  
 $\text{glucose} + \text{ATP} > \text{glucose phosphate} + \text{ADP}$

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## The Chemical Composition of Living Matter

- **Organic compounds**
  - Compounds containing carbon
  - Examples
    - Carbohydrates, lipids, proteins and nucleic acids
- **Inorganic compounds**
  - Compounds lacking carbon. Smaller, simpler
  - Examples
    - Water, salts, acids, and bases

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## Inorganic Compounds

- **Salts**
  - Compounds that separate (dissociate) into charged particles (ions) when dissolved in water.
  - Examples
    - Calcium, phosphorus, sodium, potassium, iron
  - **Electrolyte**
    - A substance that breaks down into ions when dissolved in water and is capable of conducting an electric current.

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## Inorganic Compounds

### Acid

A substance that can release hydrogen ions (H<sup>+</sup>)

### Example



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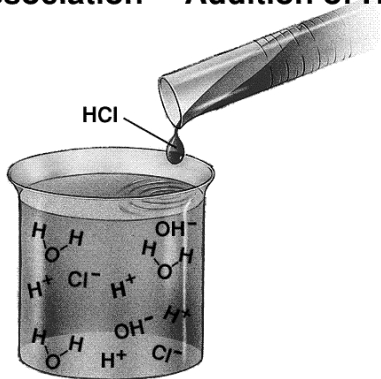
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## Dissociation — Addition of HCl



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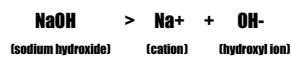
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## Inorganic Compounds

### Base

A substance that can accept hydrogen ions

### Example



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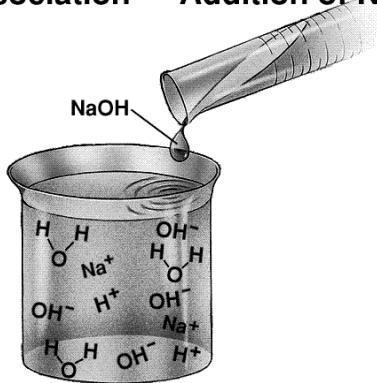
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## Dissociation — Addition of NaOH



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## Acid-Base Concentrations

### pH

A measure of the concentration of hydrogen ions.

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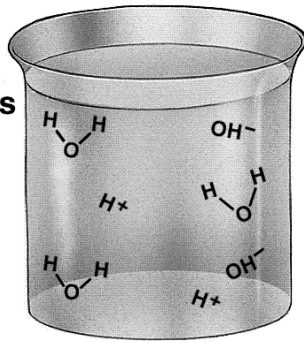
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### Dissociation of Water Molecules



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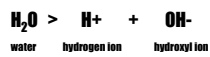
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## pH Scale

**Water dissociates:**



$$1 \text{ H}^+ / 10,000,000 \text{ water molecules} = 10^{-7}$$

$$-\log 10^{-7} = 7$$

$$7 = \text{neutral pH (H}^+ = \text{OH}^-)$$

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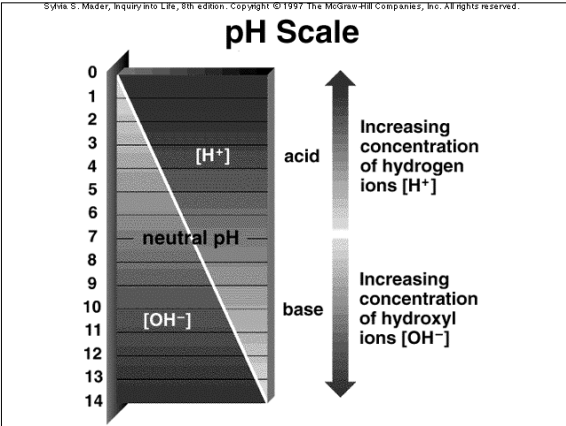
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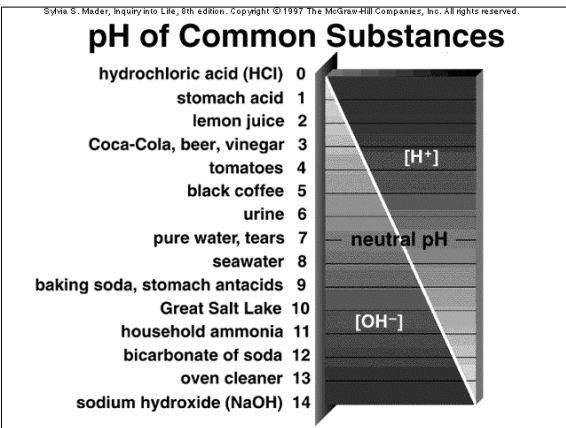
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## Regulating Acid-Base Concentrations

**Buffers**

**A substance(s) that help stabilize the pH of a solution.**

**Example**

Maintaining blood pH between 7.35 - 7.45

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## Organic Compounds

- **Carbohydrates**
  - Sugars and starches
- **Lipids**
  - Neutral fats, phospholipids and steroids
- **Proteins**
- **Nucleic Acids**
  - DNA and RNA

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## Carbohydrates

- **Monosaccharides**
  - Structural unit or basic building block
  - Simple sugars
  - Examples: glucose, fructose, deoxyribose
- **Disaccharides**
  - Double sugars
  - Examples: sucrose, maltose, lactose
- **Polysaccharides**
  - Long, branching chains of simple sugars
  - Examples: starch and glycogen

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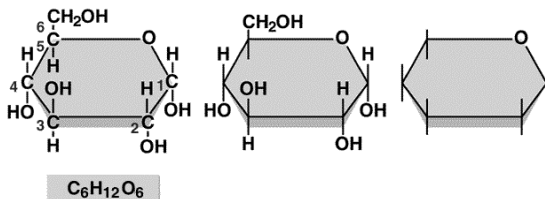
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## Glucose Structure



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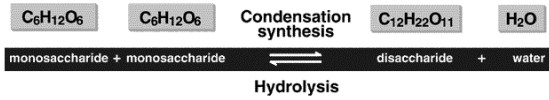
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## Condensation Synthesis and Hydrolysis of a Disaccharide



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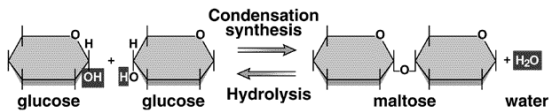
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## Condensation Synthesis and Hydrolysis of Maltose



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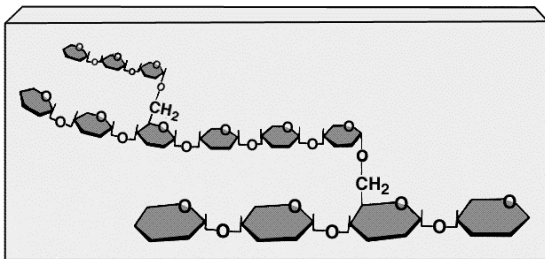
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## Starch Structure



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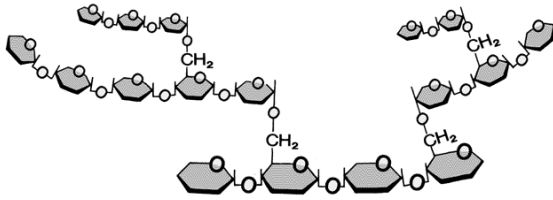
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## Glycogen Structure



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## Lipids

- **Neutral fats (triglycerides)**
  - **Building blocks: fatty acids and glycerol**
  - **Found in fat deposits (skin and around organs)**
  - **Protects and insulates body organs**
  - **Major source of stored energy in body**
- **Phospholipids**
  - **Found in cell membranes**
- **Steroids**
  - **Cholesterol, vitamin D, sex hormones**

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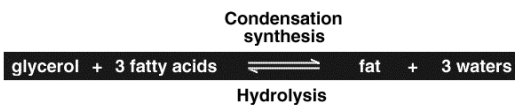
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## Synthesis and Hydrolysis of a Fat (Basic Equation)



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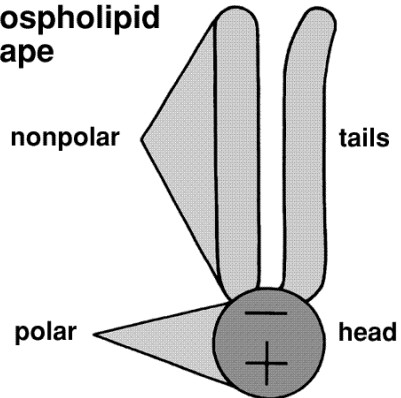
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## Phospholipid Shape



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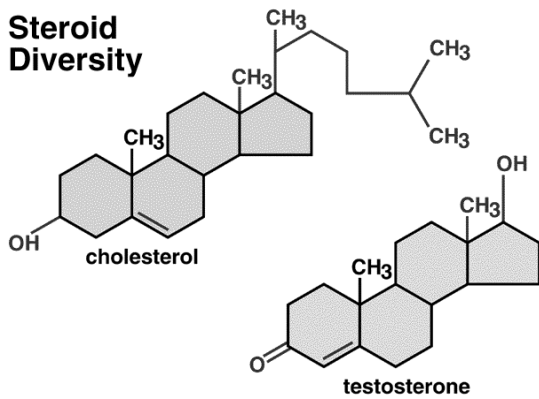
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## Steroid Diversity



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## Proteins

- **Building blocks: amino acids**
- **Amino acids join together in chains - form large, complex molecules**
- **Sequence of amino acids in chain determines the structure and function of the protein**
- **Examples: enzymes, antibodies, hormones**

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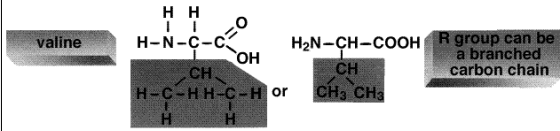
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### Amino Acid Structure (Valine)



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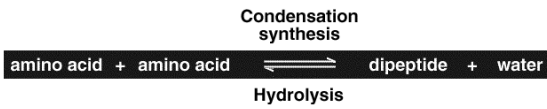
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### Synthesis and Hydrolysis of a Peptide (Basic Equation)



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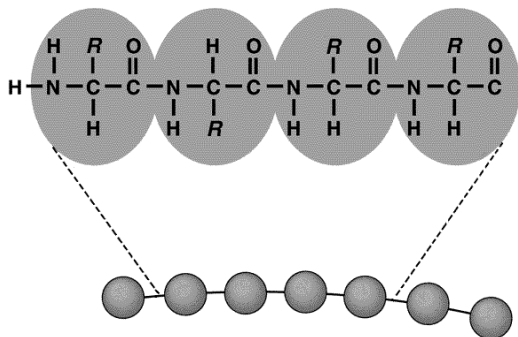
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### Primary Structure of Protein



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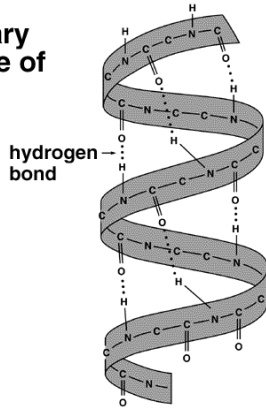
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### Secondary Structure of Protein



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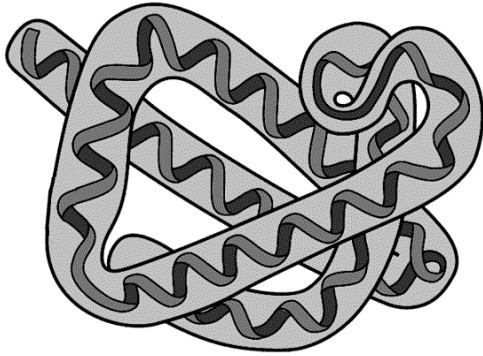
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### Tertiary Structure of Protein



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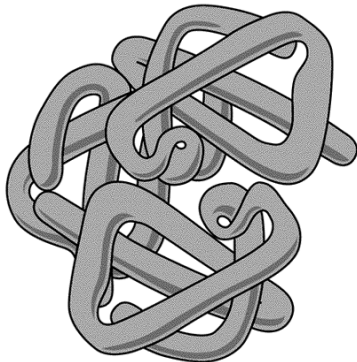
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### Quaternary Structure of Protein



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## Enzymes

- **Proteins that increase the rate of a chemical reaction (catalyze) without becoming part of the product or being changed itself.**
- **Each enzyme controls one specific chemical reaction.**
- **Recognized by suffix -ase**

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## Nucleic Acids

- **Function: making protein**
- **Building blocks: nucleotides**
- **Major Kinds**
  - **DNA (deoxyribonucleic acid)**
    - Double stranded - spiral staircase-like structure
    - Makes exact copies of itself
    - Provides instructions for making protein
  - **RNA (ribonucleic acid)**
    - Single strand
    - Carries out instructions from DNA to make protein

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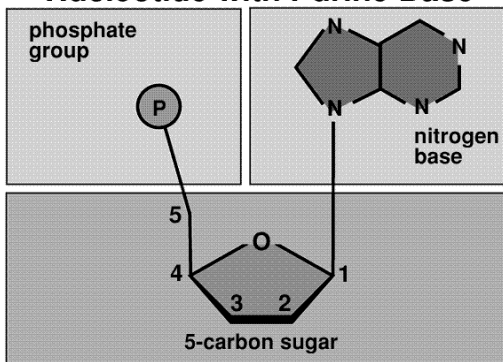
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### Nucleotide with Purine Base



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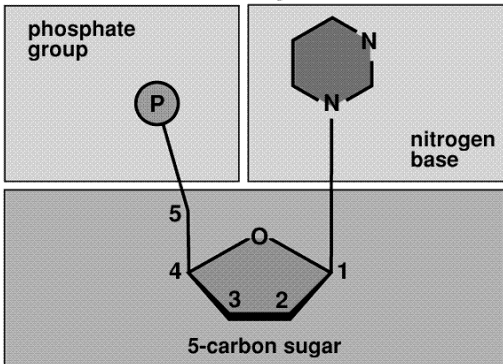
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### Nucleotide with Pyrimidine Base



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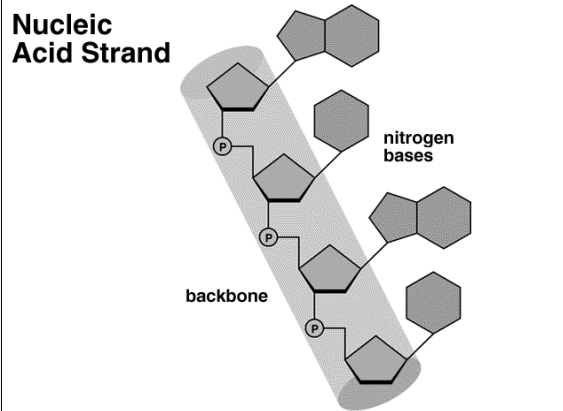
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### Nucleic Acid Strand



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### Adenosine Triphosphate (ATP)

- A modified nucleotide
- Provides chemical energy used by all body cells.
- Energy released from ATP
  - Used to transport certain molecules across cell membranes
  - Causes proteins in muscle cells to shorten
  - Used to drive energy-absorbing reactions

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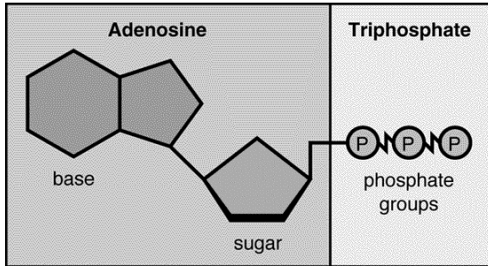
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### ATP Structure



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**The End**

**Finally!**

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