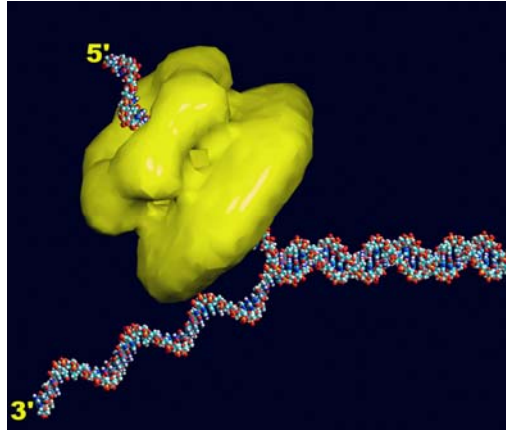


Atoms, Molecules and Life

Chapter 2a



Source: <http://www.msi.umn.edu/general/Bulletin/Vol.14-No.1/Protein.html>

Chapter 2

- Three Lectures

Wednesday – Atoms, Molecule Water

Friday – Carbon and Polymers

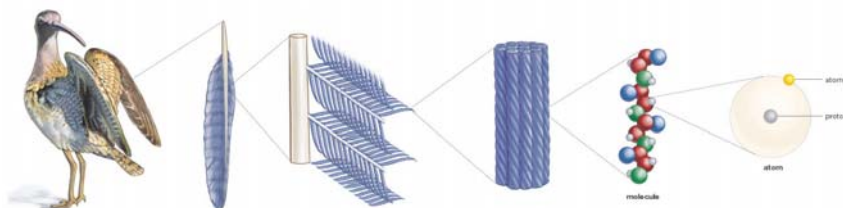
Monday – Four Biomolecules

Carbohydrates, Proteins, Lipids
and Nucleic Acids

Outline for 2a

1. Structure of Atoms
 - a. Subatomic Particles
 - b. Atoms of Life
 - c. Isotopes and ions
2. Chemical Bonds
 - a. Ionic bonds
 - b. Covalent Bonds
 - c. Hydrogen bonds
 - d. Hydrophobic interactions
3. Properties of Water
 1. Hydrogen bond lattice
 2. Cohesion/adhesion
 3. pH

Structural Hierarchy



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Elements and Molecules

- **Atoms** - building blocks of molecules
- **Elements** – types of atoms
 - 92 natural elements
- **Molecule** – composed of two or more atoms.
- **Compounds** – molecules composed of more than one element.
- **Emergent properties**



Campbell and Reece, Biology 2005

25 Elements Essential for Life

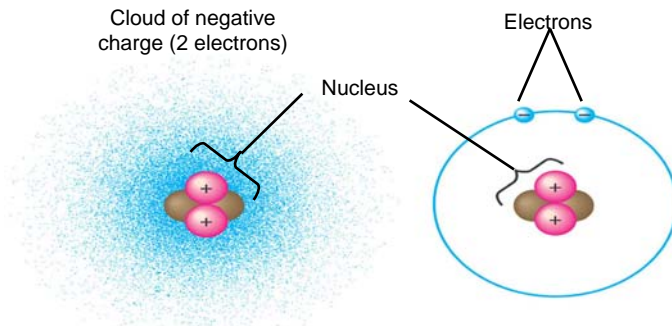
- 96% of living matter made of 4 elements.
 - Oxygen O
 - Carbon C
 - Hydrogen H
 - Nitrogen N
- Most of remaining 4% just 7 elements (Ca, P, K, S, Na, Cl Mg)
- Remaining >0.1% are “**Trace Elements**”

Symbol	Element	Atomic Number (See p. 34)	Percentage of Human Body Weight
O	Oxygen	8	65.0
C	Carbon	6	18.5
H	Hydrogen	1	9.5
N	Nitrogen	7	3.3
Ca	Calcium	20	1.5
P	Phosphorus	15	1.0
K	Potassium	19	0.4
S	Sulfur	16	0.3
Na	Sodium	11	0.2
Cl	Chlorine	17	0.2
Mg	Magnesium	12	0.1

Trace elements (less than 0.01%): boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), and zinc (Zn).

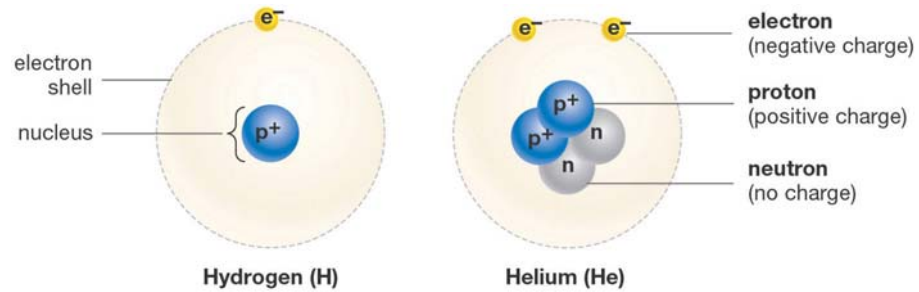
Campbell and Reece, Biology 2005

Atoms



- **3 Subatomic Particles**
 - Protons
 - Neutrons
 - Electrons

Structure of Atoms



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- **Characteristics of Particles**
 - Location
 - Atomic Number
 - Atomic mass
 - Atomic Charge
 - Atomic Volume (Size)

Structure of Typical Atoms

Rule 1

Neutral atoms have equal number of protons and electrons

Rule 2

Typically, atoms have equal number of protons and neutrons

Exceptions to these rules

Ions – unequal protons and electrons (electric charge)

Nitrogen atom – 7 proton and 7 electron

Nitrogen ion – 7 proton and 6 electrons
(positive charge)

Variable Isotopes – variable number of neutrons

Carbon – 12 (6 protons, 6 neutrons, 6 electrons)

Carbon – 14(6 protons, 8 neutrons, 6 electrons)

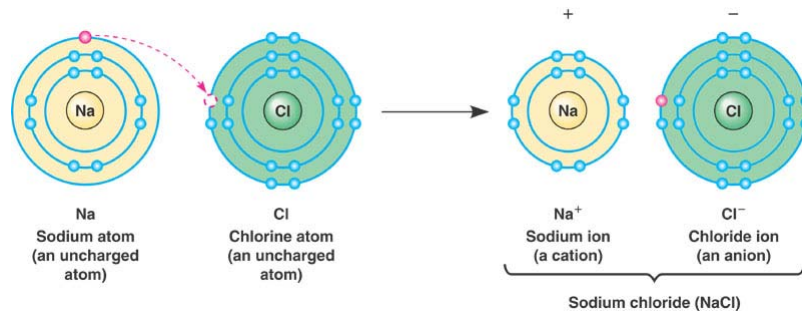
Properties of Common Atoms

Element	Abv	Atomic #	Mass #	Valence #
Hydrogen	H	1	1	1
Carbon	C	6	12	4
Nitrogen	N	7	14	3
Oxygen	O	8	16	2

Four Chemical Bonds

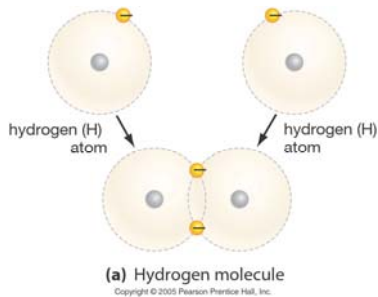
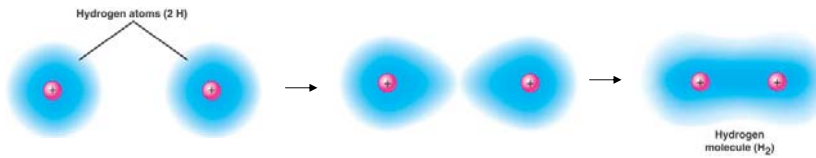
- Strong Chemical Bonds
 - Ionic Bonds
 - Covalent Bonds
- Weak Chemical Bonds
 - Hydrogen Bonds
- Other Interactions
 - Hydrophobic Interactions

Ionic Bonds



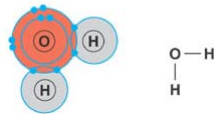
Attraction between positive ions and negative ions

Covalent Bonds

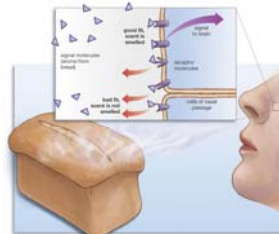


Properties of Covalent Bonds

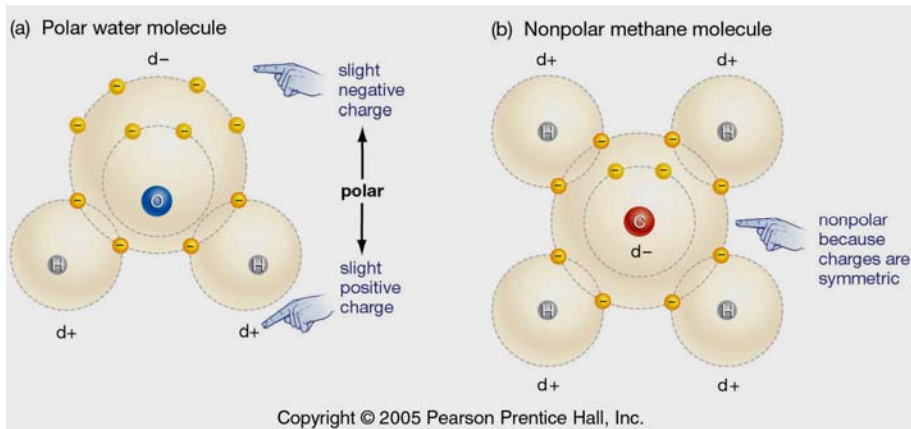
- Sharing of pair of electrons
- Strongest of chemical bonds
- Valence number
- Single, Double, and Triple bonds
- Important for Shape of Molecules
- Nonpolar/polar forms



Element	Valence #
H	1
C	4
N	3
O	2



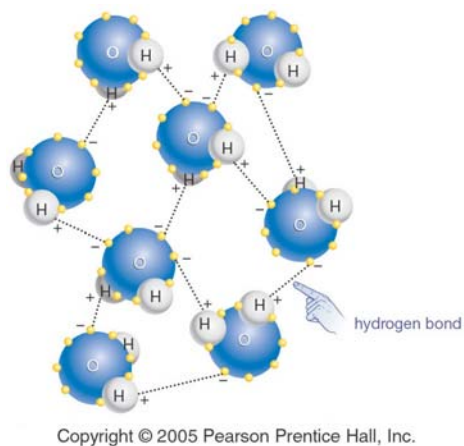
Polar Covalent Bonds



Oxygen and Nitrogen are electronegative atoms

Hydrogen Bonds

- Attraction between a hydrogen with a partial positive charge and an electronegative atom (oxygen or nitrogen.)
- Requires polar bonds.
- Weak Interaction

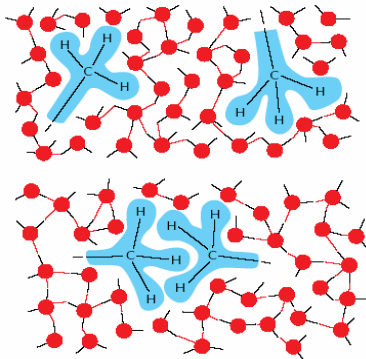


Hydrophobic Interactions

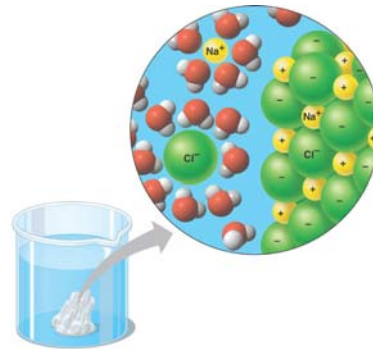
- Solvent and Solutes

Hydrophobic Molecules

HYDROPHOBIC FORCES

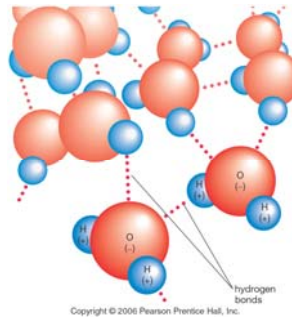


Hydrophilic Molecules



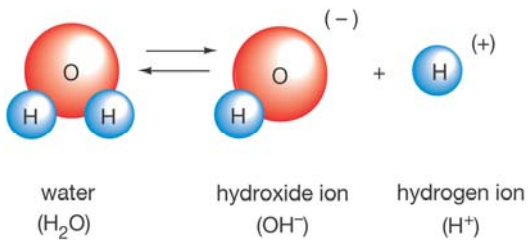
Properties of Water

- Hydrogen bond Lattice
- Solvent Qualities – hydrophilic molecules
- Cohesion and Adhesion
- Ionization/pH



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Ionization and pH



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