Why Study Biology?

Individually, write **two** questions that would allow you to understand geckos and their feet.

In science, we gain knowledge through asking questions.
It is important to consider how we *use* the knowledge, and its effects.
Science, technology, society and the environment are inseparably linked.

Why Study Biology?

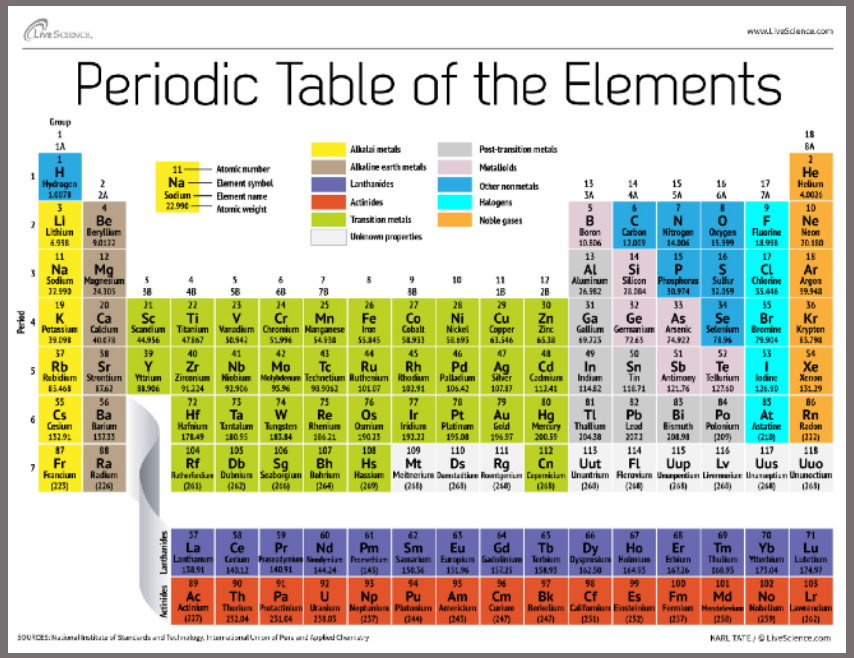
- Watch Gecko Feet Teach NASA How To Stick To Space Objects | Video

- *Things to consider….*
  - Who is responsible for how developed knowledge is used?

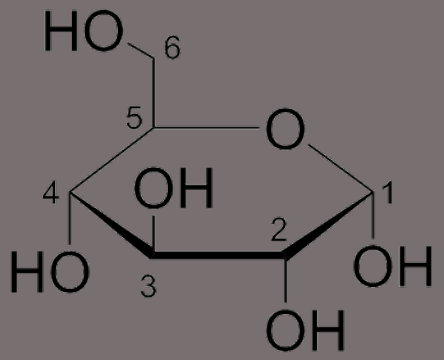
Chemistry in Living Systems

Elements & Compounds

- All matter is composed of **elements** – which cannot be broken down into simpler substances.
- Elements can be chemically combined to form **compounds**.

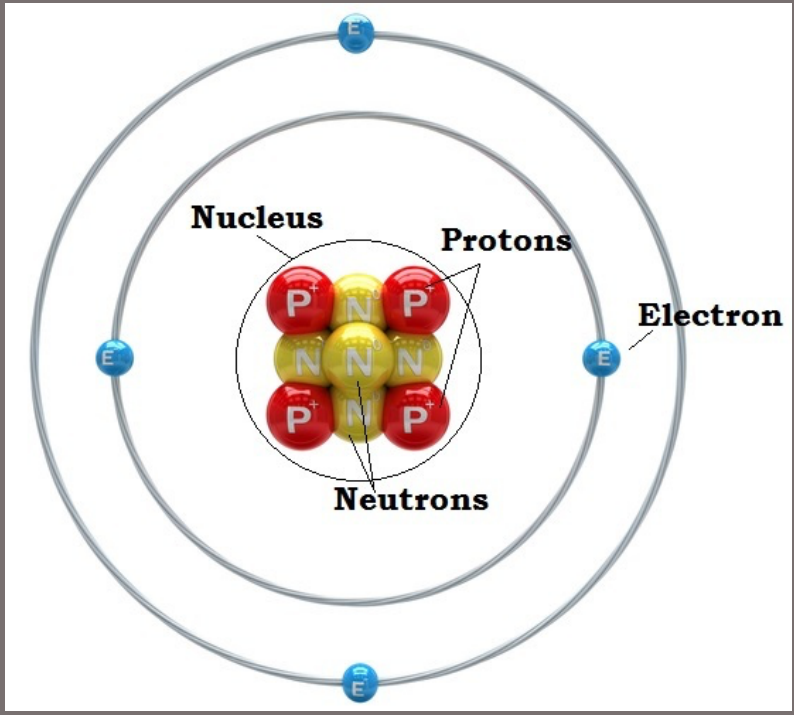


- There are approximately 92 naturally occurring elements.
- 6 of these – C, H, N, O, P and S are key in biological molecules.



The Atom

- The **atom** is the smallest particle of an element that keeps the properties of that element.
  - The *atomic mass* represents the sum of the **protons** and **neutrons** found in the nucleus
  - The *atomic number* represents the number of **protons**



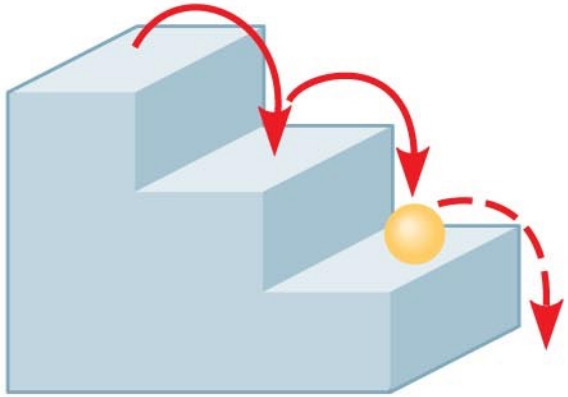
Energy & Electrons

- **Energy** is the capacity to cause change
- **Potential energy** is the energy that matter has because of its location or structure

- The electrons of an atom differ in their amounts of potential energy they possess
- An electron's state of potential energy is called its *energy level*, or electron shell

- An **orbital** is the three-dimensional space where an electron is found 90% of the time
- Each electron shell consists of a specific number of orbitals

(a) A ball bouncing down a flight of stairs provides an analogy for energy levels of electrons



Third shell (highest energy level)

Second shell (higher energy level)

First shell (lowest energy level)

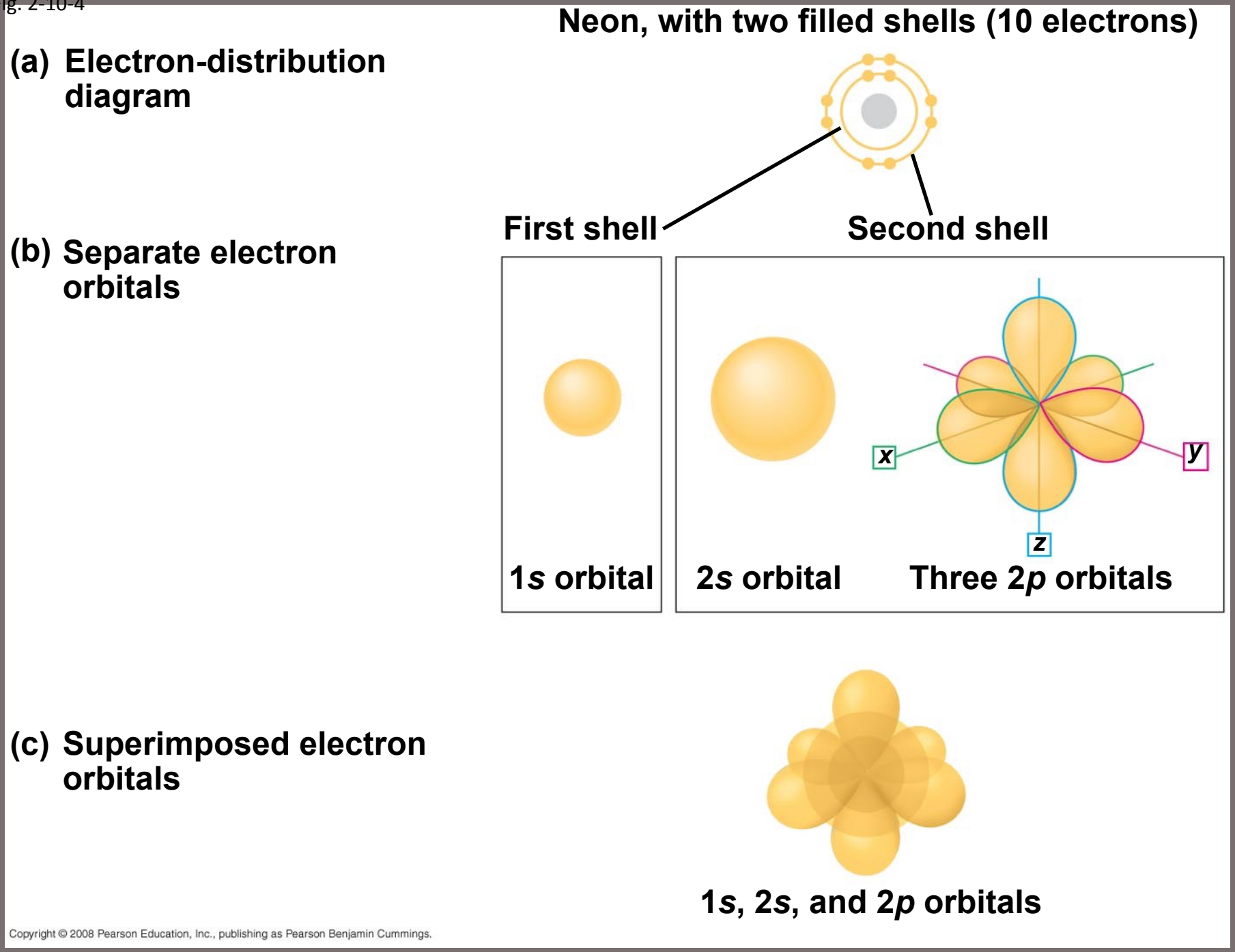
Energy absorbed

Energy lost

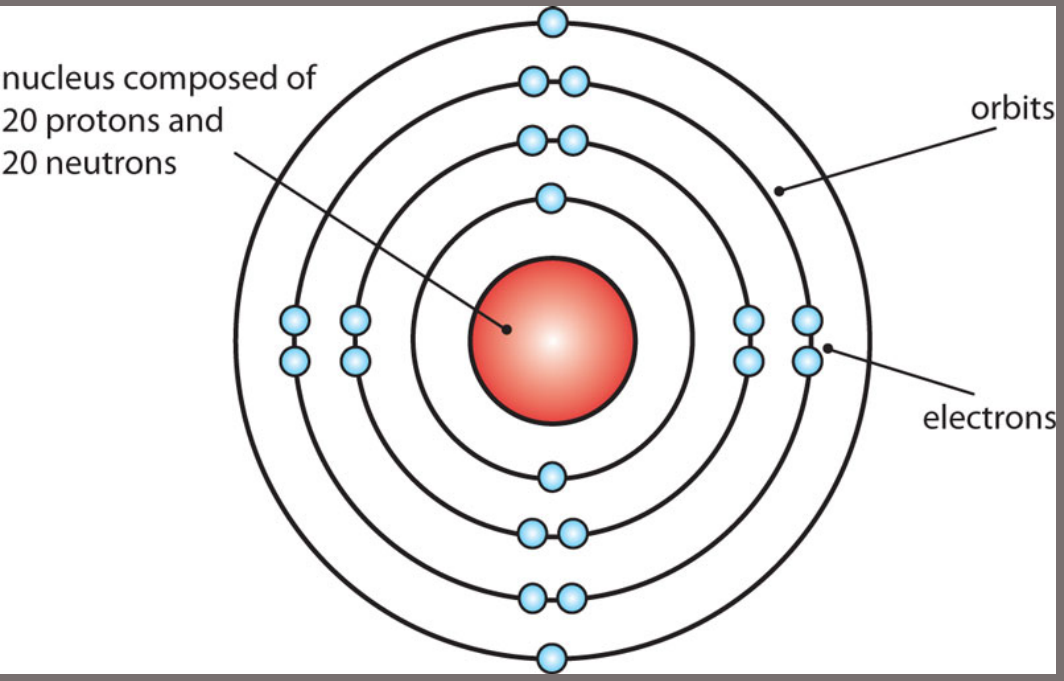
Atomic nucleus

(b)

Fig. 2-10-4



The Atom



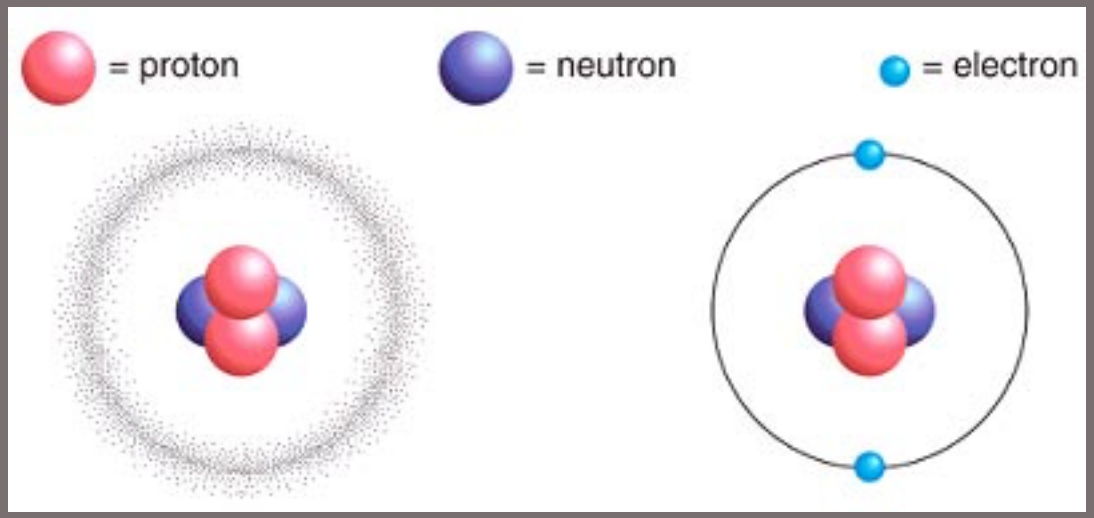
Electron Configuration: *2, 8, 8, 2*

- The first energy level (orbit) can hold a maximum of 2 electrons
- The following orbits can hold a maximum of 8 electrons

The Atom

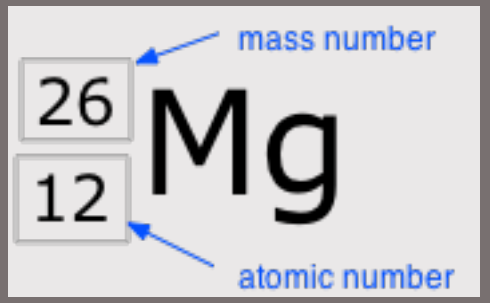
- Summary of Subatomic Particles:

Particle	Location	Charge	Mass
proton	in the nucleus	positive	1.67×10^{-24}g
neutron	in the nucleus	neutral	1.67×10^{-24}g
electron	orbiting the nucleus	negative	1/1836 of the proton



Representing Atoms

- Atoms can be represented using:
  - Standard (nuclide) notation



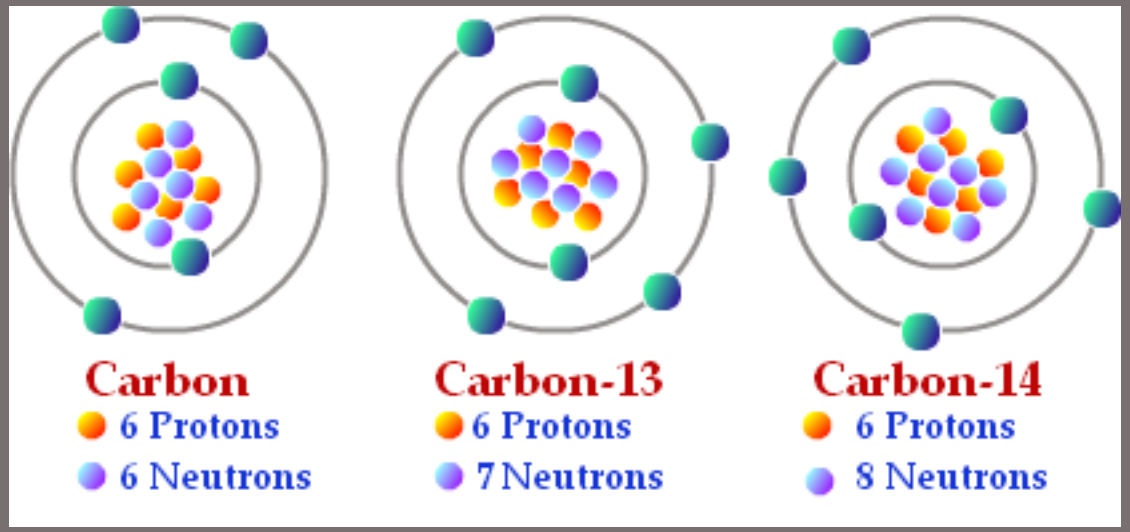
  - Bohr-Rutherford Diagram

  - Lewis Diagrams

Mg:

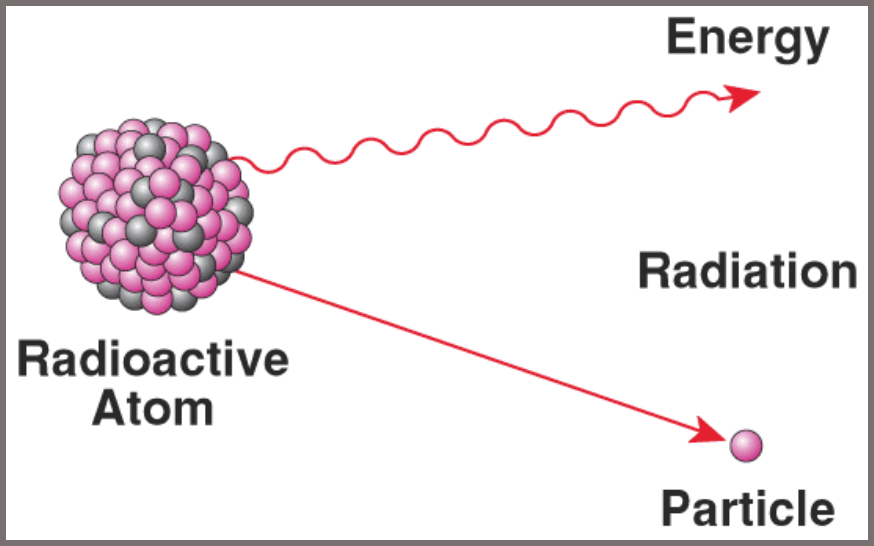
Isotopes

- **Isotopes** are atoms with the same number of protons, but a different number of neutrons, thereby affecting their mass



Radioisotopes

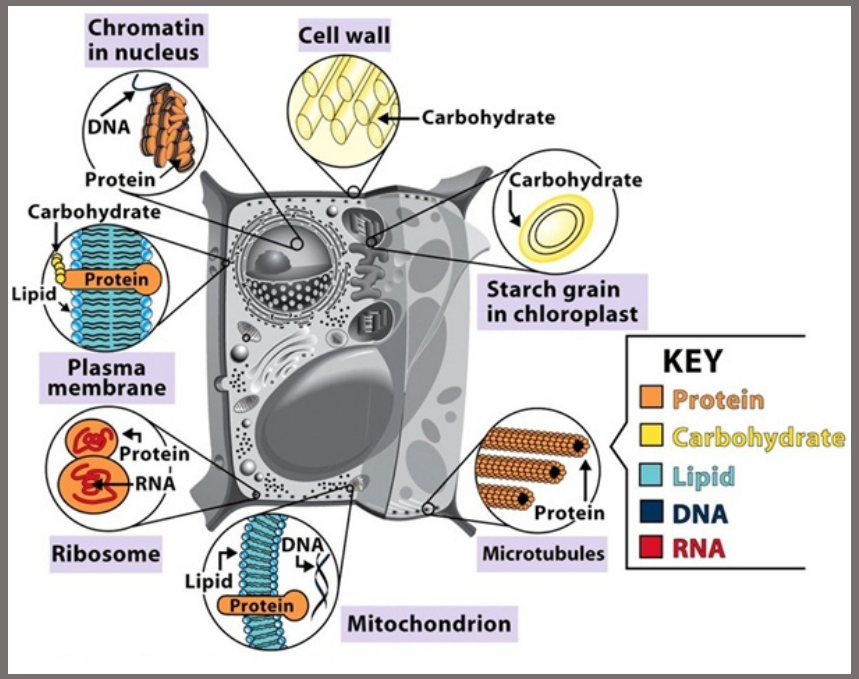
- Isotopes that are unstable experience *nuclear decay*.
- The nucleus breaks down by emitting radiation in the form of subatomic particles
- These **radioisotopes** are used in *radioisotope tracing* for diagnosing diseases such as cancer.



Biological Molecules

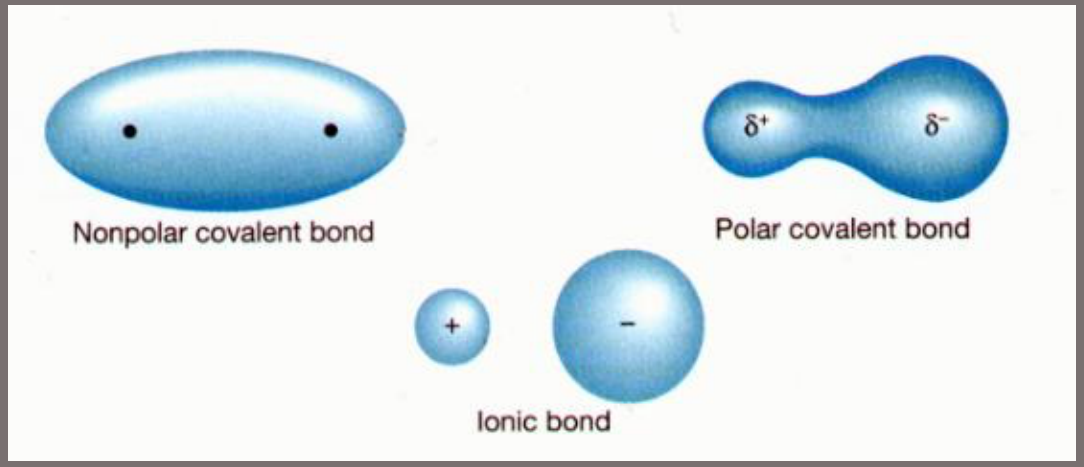
- **Molecules** are composed of two or more atoms.
- Many molecules involved in living systems are carbon-based **organic molecules**.

- In order to understand how biological molecules function in the cell, it is necessary to understand their properties.



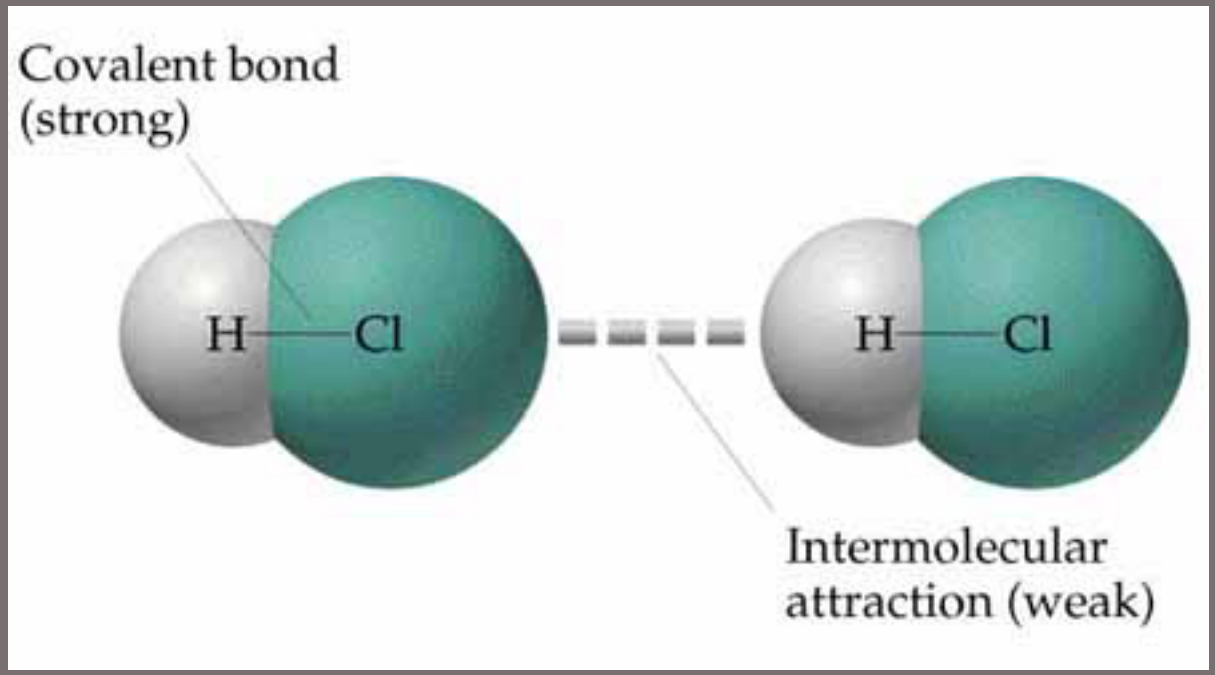
Interactions Within Molecules

- **Intramolecular forces** hold the atoms *within* a molecule together.
  1. *Pure Covalent Bond* – 2 atoms share electrons (nearly) equally
  2. *Polar Covalent Bond* – 2 atoms share electrons, however the atom with greater electronegativity attracts electrons more, forming a dipole
  3. *Ionic bonds* – force of attraction due to oppositely charged ions



Interactions Between Molecules

- **Intermolecular forces** are forces of attraction that exist between molecules.
- They are much weaker than intramolecular forces.



Water

- Due to the polar-covalent O-H bonds in water, an unequal distribution of charge in the molecule causes one end to be slightly negative and the other to be slightly positive

- This **polarity** of the *molecule* gives water many unique properties.

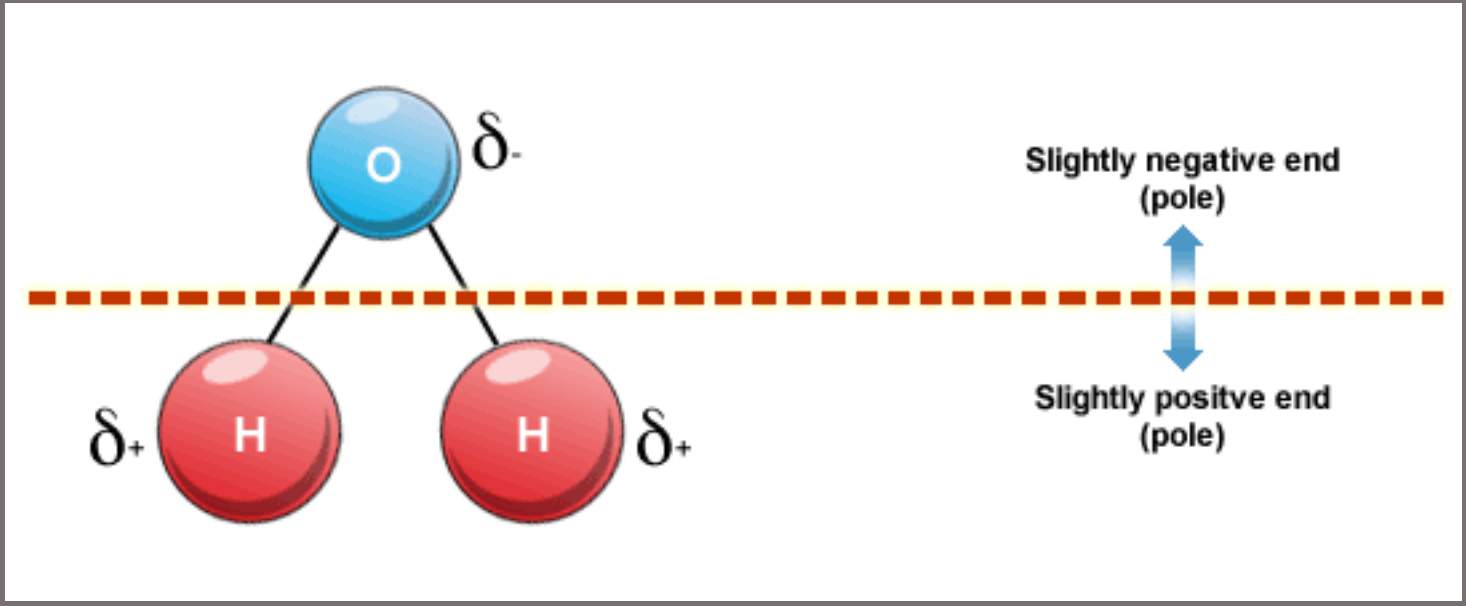
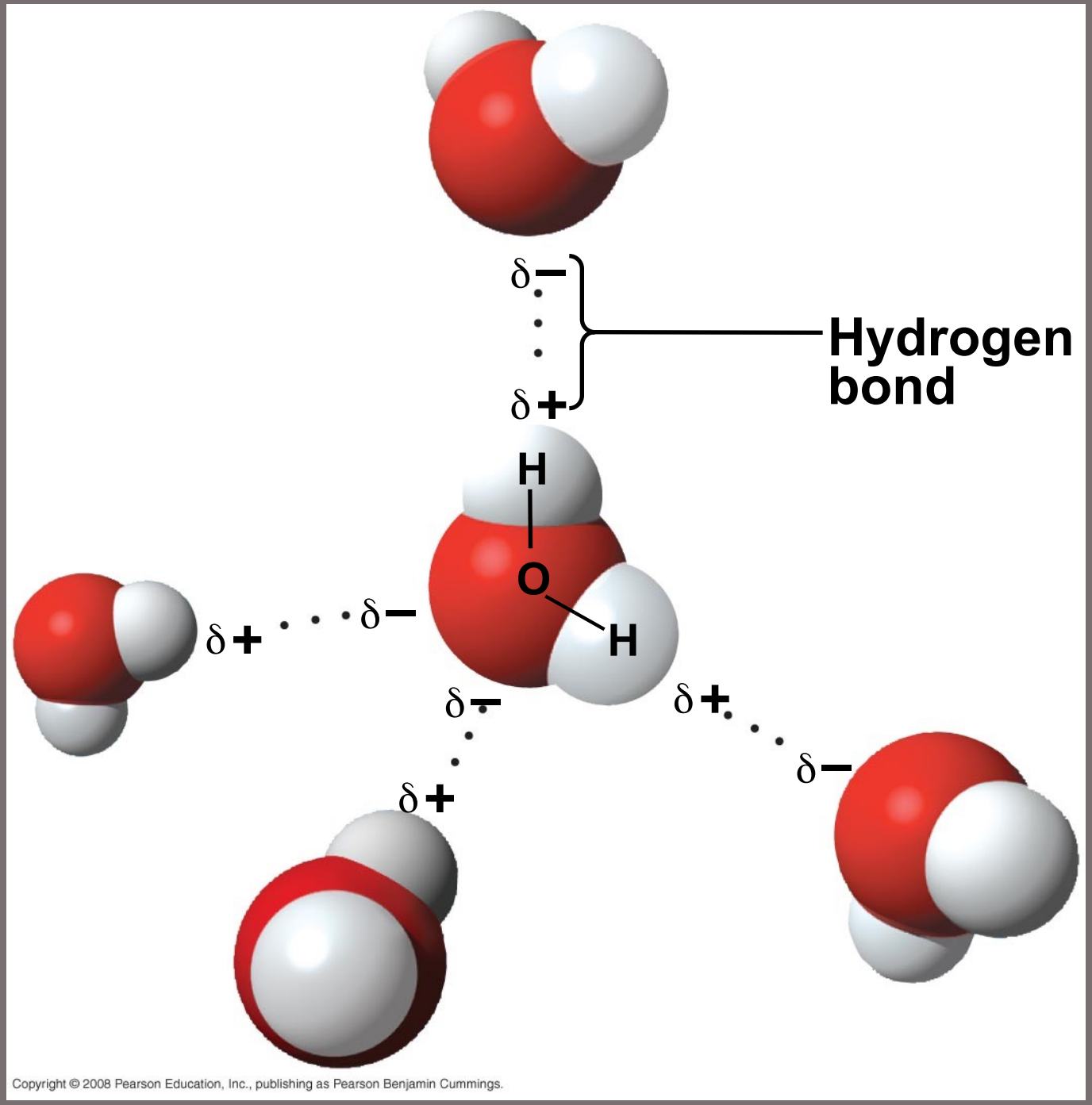


Fig. 3-2



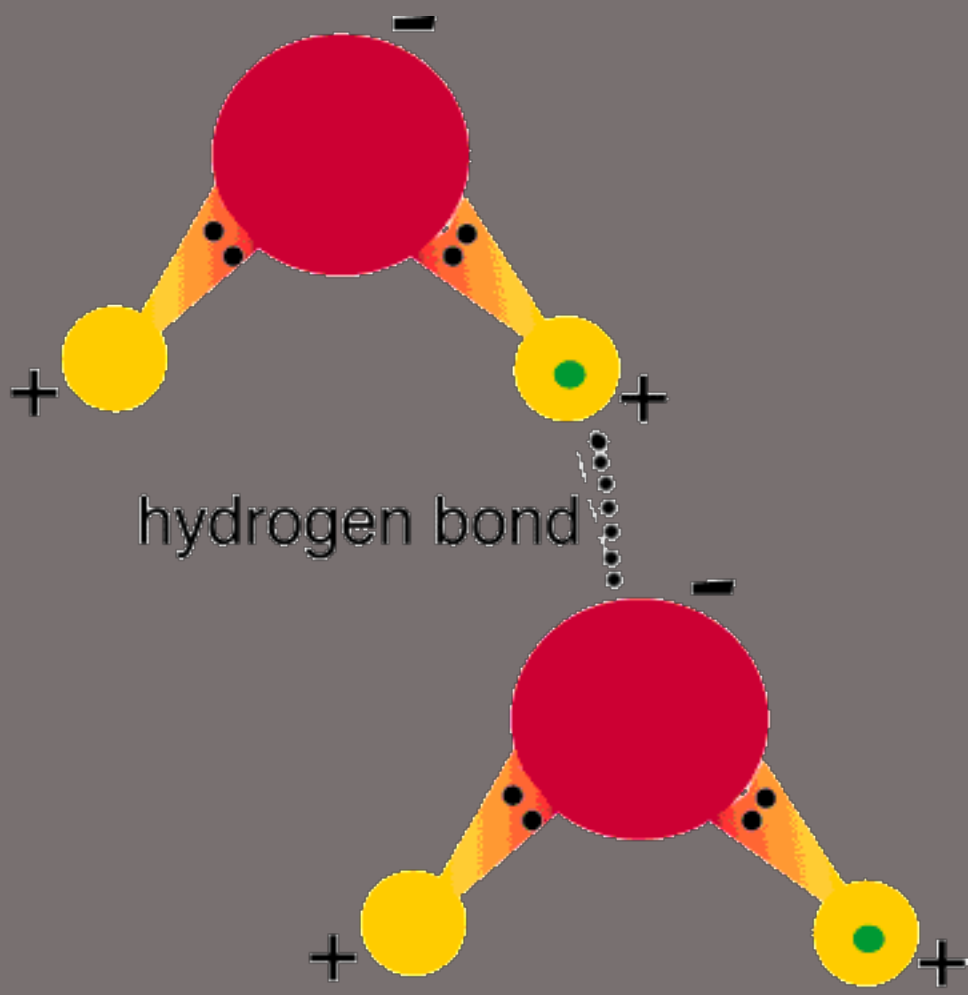
Intermolecular Forces

1. *Hydrogen Bonding*:

   - The slightly positive hydrogen end of a water molecule can attract to the negative end of another molecule

   - Can form between hydrogen atoms and N, O, F atoms

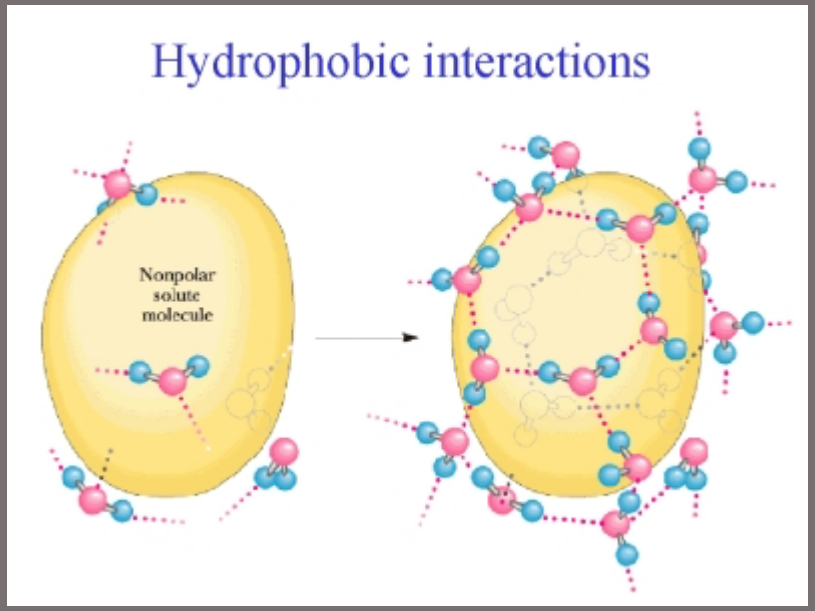
   - The strongest of intermolecular forces



Intermolecular Forces

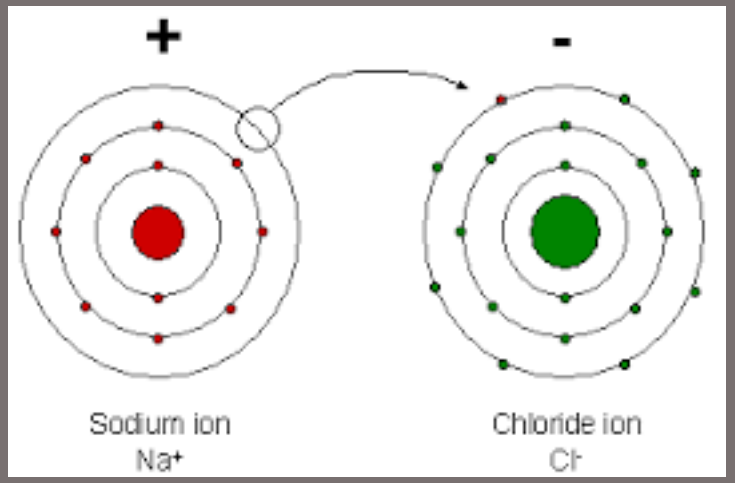
2. Hydrophobic Interactions:

   - Non-polar *(hydrophobic)* molecules have a tendency to clump together when mixed with polar *(hydrophilic)* molecules



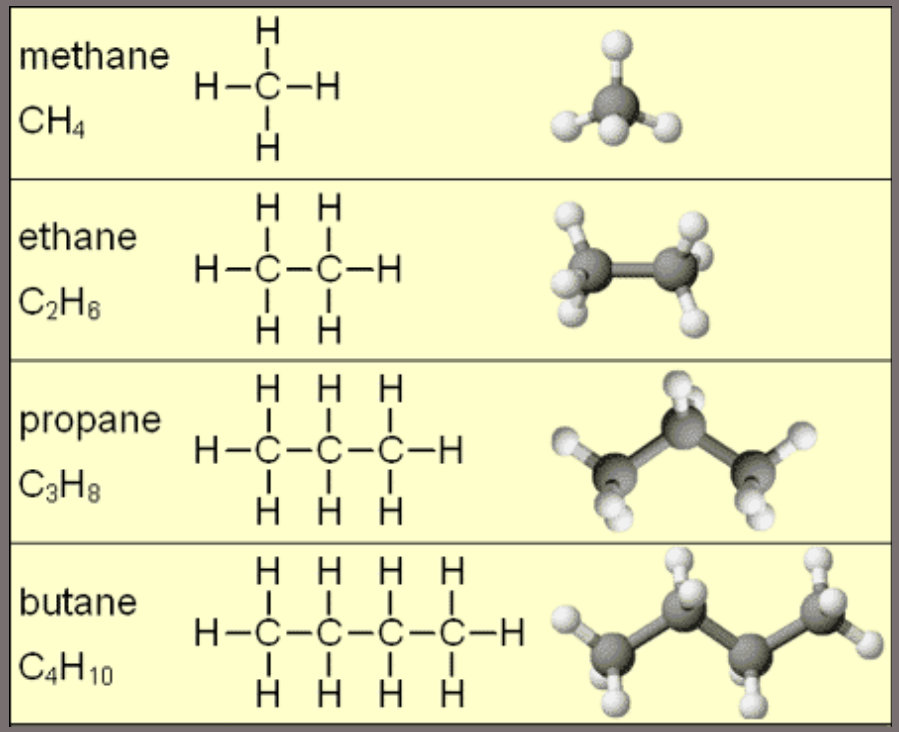
Ions in Biological Systems

- **Ions** are atoms that have obtained a stable valence shell by losing or gaining electrons.
- *Anions* are atoms that *gain* electrons to become *negative*.
- *Cations* are atoms that *lose* electrons to become *positive.*



Hydrocarbons

- **Hydrocarbons** are organic molecules composed only of carbon and hydrogen atoms
- Properties:
  - Non-polar (don't dissolve in water)
  - Low boiling points
  - Flammable
  - Often used as fuels



Functional Groups

- A **functional group** is an atom/group of atoms attached to a hydrocarbon that gives the molecule particular properties

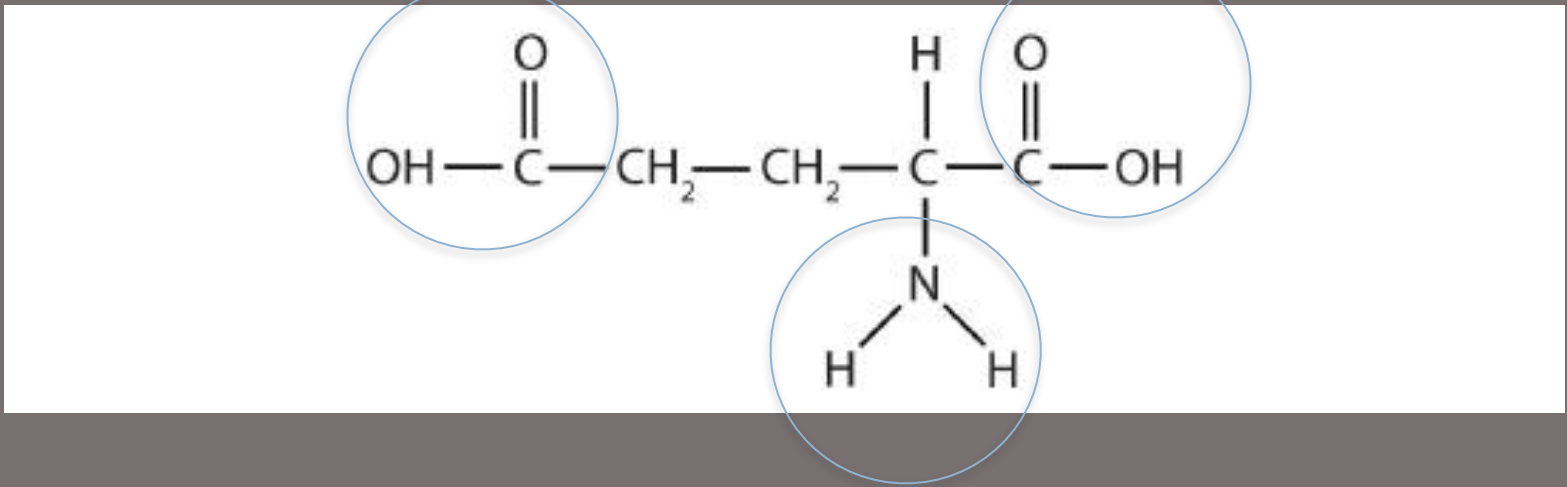
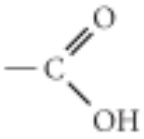
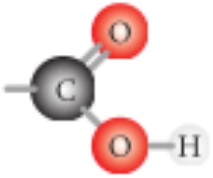
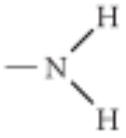
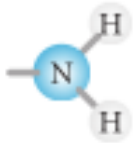
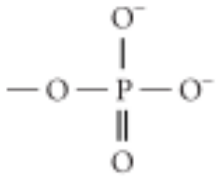
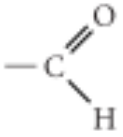
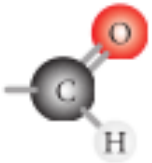
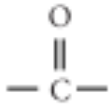
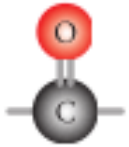


Table 1 Functional Groups in Biomolecules

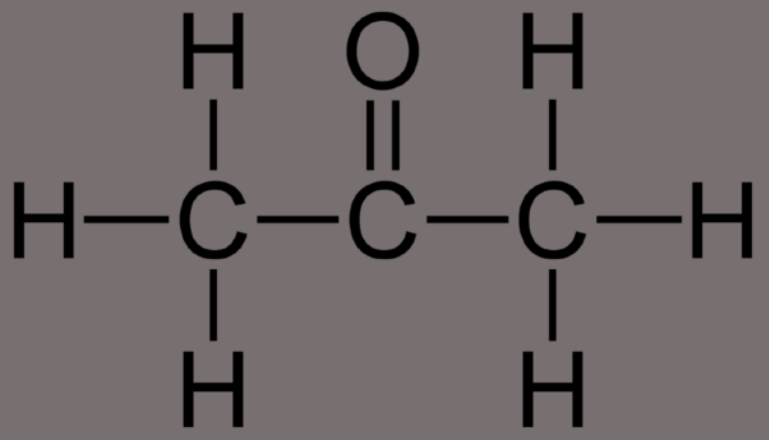
Group	Chemical formula	Structural formula	Ball-and-stick model	Found in
hydroxyl	—OH	—OH		alcohols (e.g., ethanol)
carboxyl	—COOH			acids (e.g., vinegar)
amino	—NH_2			bases (e.g., ammonia)
sulfhydryl	—SH	—S—H		rubber
phosphate	—PO_4			ATP
carbonyl	—COH			aldehydes (e.g., formaldehyde)
	—CO—			ketones (e.g., acetone)

Representing Molecules

- The *molecular formula* shows the number of each atom in an element or a compound.

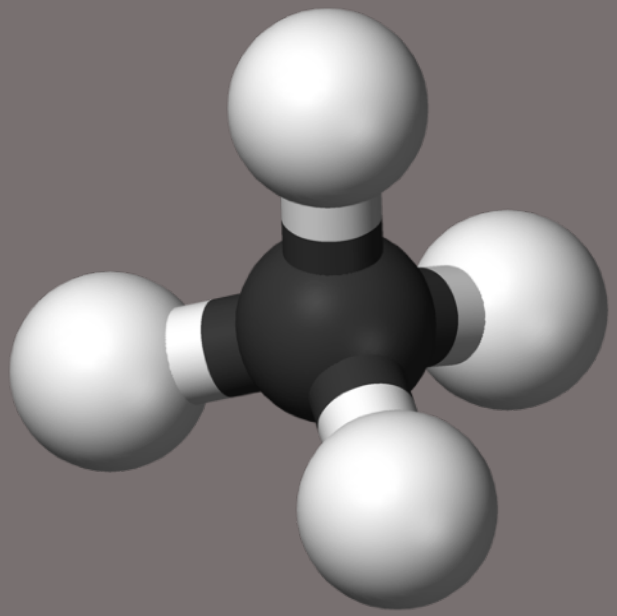
CH_3COCH_3

- The *structural formula* shows how the different atoms are bonded together

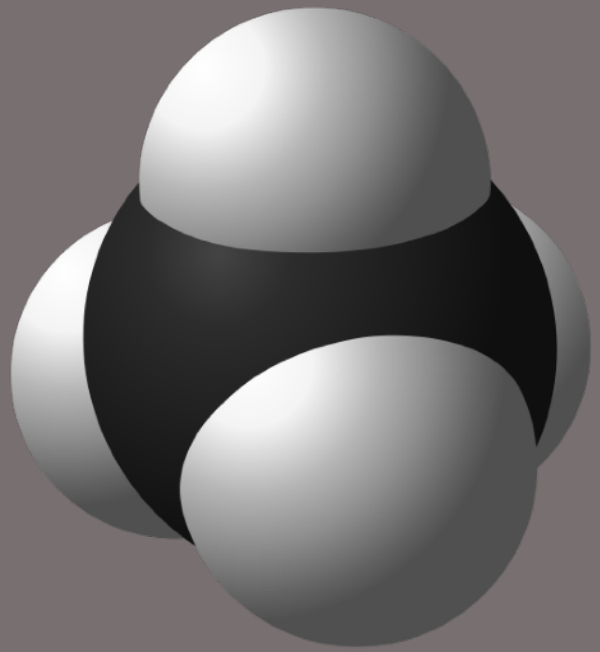


3D Models

- A molecule's 3D shape influences its behaviour and function

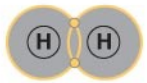
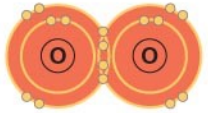
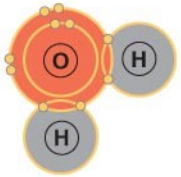
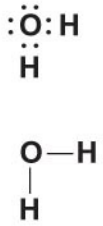


Ball & Stick Model



Space-Filling Model

Fig. 2-12

Name and Molecular Formula	Electron-distribution Diagram	Lewis Dot Structure and Structural Formula	Space-filling Model
(a) Hydrogen (H_2)			
(b) Oxygen (O_2)			
(c) Water (H_2O)			
(d) Methane (CH_4)