

# Scientific method

- Why is there a hypothesis and prediction?
  - If only prediction: then there is no way to finish the prediction and conclude whether the results support the hypothesis
    - If surfaces are sampled and streak across the agar plates then there will be growth of organisms on the agar surface.
  - Hypothesis : If there are organisms present on non-living surfaces that are not visible then when given they are placed on a nutrient media they will multiply to numbers large enough to be visible (simulating the appearance of spontaneous generation)
  - Hypothesis : If there are non-living components necessary for spontaneous generation on a non-living surface then when those components are placed into the petri dish spontaneous generation will occur.
  - Hypothesis : If there are non-living components necessary for spontaneous generation on the table surface then when those components are placed into a petri dish that allows for the correct amount of air circulation then spontaneous generation will occur.

## Research Science

### Biology

#### ■ The study of living organisms (Study of life)

##### ▪ What is life?

■

##### ■ Composed of cell(s)

isolated from external environment by a membrane

##### ■ **Metabolism**

living things need energy

##### **Homeostasis**

maintain a stable internal environment

##### ■ Reproduction

able to produce another organism similar to themselves

##### ■ Heredity

possess a genetic system which is preserved by replication and duplication (DNA)

## **Interactions of Life**

- Ecology - Study of interactions of living organisms with one another and their physical environment.
- Community - Collection of all species inhabiting an area.
- Habitat - Place where an organism lives.
- Ecosystem - Largely self-sustaining collection of organisms and their physical environment.

## ***Trophic Levels***

- Energy flows into biological world from sun.
  - Producers capture and transform sunlight into chemical energy through photosynthesis.
  - Consumers obtain energy by consuming plants or other animals.
- Trophic Level is a feeding level composed of all organisms within an ecosystem feeding at the same energy level.
  - Food Chain - Food energy passes through ecosystem from one level to another in a linear path.
  - Food Web - Path of energy flow is composed of multiple linear chains as a predator may eat more than one kind of prey.

## ***Trophic Levels***

## ***Environmental Water Cycle***

## ***Carbon Cycle***

## Interactions of Life

- Ecology - Study of interactions of living organisms with one another and their physical environment.
- Habitat - Place where an organism lives.
- Abiotic factors- environmental factors such as temperature, light, water, and nutrients
- Biotic factors – interactions with other living organisms

## Chemistry characteristic of Life

### Definitions

- **Matter**- Anything that has mass and occupies space.
  - States of matter
    - Solid
    - Liquid
    - Gas
- **Energy**
  - Types of energy
    - Potential
    - Kinetic

**Elements =** A substance that can not be broken down into substances with different properties; composed of only one type atom.

**Atom=** Smallest unit of matter that can not be divided by chemical means.  
Differ from each other in the number of protons

Periodic Table of the Elements

## Mixtures versus Compounds

- Mixtures

- No chemical bonds
- Can be strained, filtered, evaporated to separate compounds
- Homogeneous or heterogeneous

## Common elements of the Human body

### What is a chemical bond?

- An energy relationship between electrons of 2 different atoms
- Electron shells
  - 1 with 2 electrons
  - 6 with 8 electrons
  - Outermost shell termed the **Valence shell**

### Energy shells

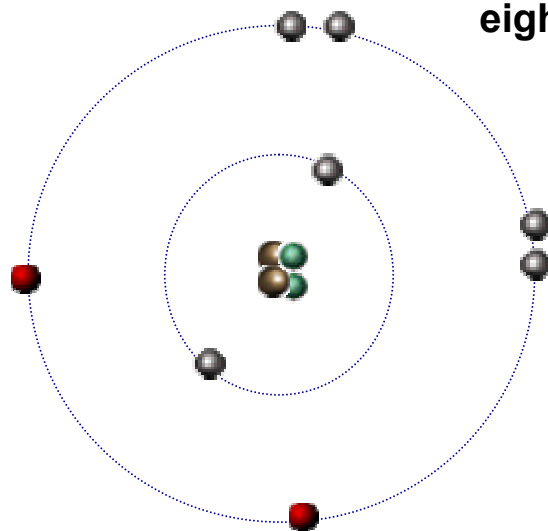
- Each shell is a different energy level
- If the energy shell is full, the element is chemically inert
  - Noble gases (ex. He, Ne)
  - Beyond the second shell, atoms can carry more than 8 electrons per shell, but only are reactive with 8 of these electrons (octet rule)

### Octet Rule

# Octet Rule

**First shell holds two electrons**

**The second and third shells hold eight electrons**



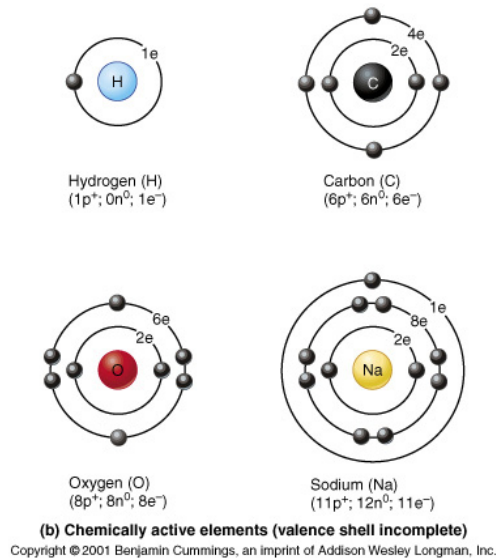
Each orbit within a shell holds two electrons

Each orbit is represented with one electron before filling the first orbit with a second electron

Example :  
How many bonds are available for an element with 8 electrons?

Answer = 2

# Chemically active elements



## Types of chemical bonds

- Ionic
- Covalent
- Hydrogen

### Ionic bonds

- Ionic
  - Atoms can give up or acquire electrons changing the balance of + and – charges.
    - Anion: electron acceptor (becomes more -)
    - Cation: electron donor (becomes more +)
  - Opposites attract: ions stay close together, forming the bond
  - Most are salts, that form crystals (like NaCl)

## Covalent bonds

- Atoms share electrons, having an orbit common to both atoms

## Multiple covalent bonds

- Atoms can share more than a single electron pair, forming double or triple bonds

## Why is the polarity of a molecule important?

- Molecules can be balanced – non-polar
- Molecules can be unbalanced, orienting themselves toward the charged particles  
polar molecules

## Polarity affects solubility

- Polar molecules are termed hydrophilic (water-loving).
  - All polar molecules that dissolve in water are termed soluble.
- Nonpolar molecules are termed hydrophobic (water-hating).

# Hydrogen bonding

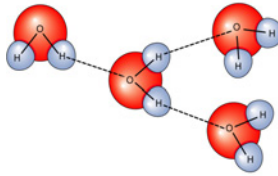
- Weak bonds formed between hydrogen and another atom
  - Surface tension of water
- Important as intramolecular bonds, giving shape to proteins and other biomolecules

## Properties of Water

- 60-80% of the volume of cells
- Numerous properties due to the hydrogen bonding

- Cohesion

Example:  
Water stride  
Water surface  
tension



- Adhesion

Example:  
water molecules  
the cell wall of  
Plant xylem  
tissue

- High heat capacity– ability to stabilize temperature
  - Specific heat = amount of heat lost or gained for 1 gram of substance to change 1 °C.
    - water = 1 cal/gram/ °C
    - iron = 0.1 cal/gram/ °C
    - ethyl alcohol = 0.6 cal/gram/ °C
- High heat of vaporization
  - Energy required to vaporize one mole of liquid at the pressure of 1 atmosphere



## Biochemistry

- Inorganic compounds: are compounds that do not contain both carbon and hydrogen
  - Water, salt, acids, bases, etc
- Organic compounds: Contain carbon and hydrogen
  - Proteins, lipids, hydrocarbons, etc. Often are large complex molecules

## Inorganic Salts

- An ionic compound other than hydrogen
  - $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Cl}^-$
- An ion is a charged particle (often in solution)
- All ions are electrolytes (they conduct an electrical current)

## Organic compounds

- What is so special about Carbon?
  - C
  - Valence shell has 4 electrons
    - Electron neutral: never gains or loses electrons
    - Can form single, double, triple, or quadruple covalent bonds
    - Can form long chains, rings, and complex forms necessary for biological structures

## Carbohydrates

## Lipids

- Fats
  - Neutral fats: triglycerides (saturated, unsaturated)

## Other lipids: phospholipids

- Phospholipids: modified triglycerides- two fatty acid chains and a phosphorus group
- These have polar and non-polar sections

## Other lipids: Steroids

- Flat molecules with interlocking rings
- Cholesterol
- Hydrocortisone
- Testosterone
- Estrogen

## Proteins

- 10-30% of cell mass
- Structural and biochemical properties
- Derived from amino acids

### Linkage of amino acids and peptide bonds

- 20 common types of amino acids
- Amine ( $-\text{NH}_2$ ) and an organic acid group ( $-\text{COOH}$ )
- Linked by dehydration synthesis
  - C-N linkage created termed a peptide bond (strong)

### How many proteins can be formed from 20 molecules?

- $20! = 243,290,008,176,640,000$  types
- Yes, that is quadrillion...

- What about their shape?
  - Alpha helix
  - Beta pleated sheet
  - Combined forms?

### How complicated is this?

- Primary
- Secondary
- Tertiary
- Quaternary