Cell Chemistry and Macromolecules

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How cells survive, communicate, and work together explains how our bodies function.

Chemistry Builds Cells

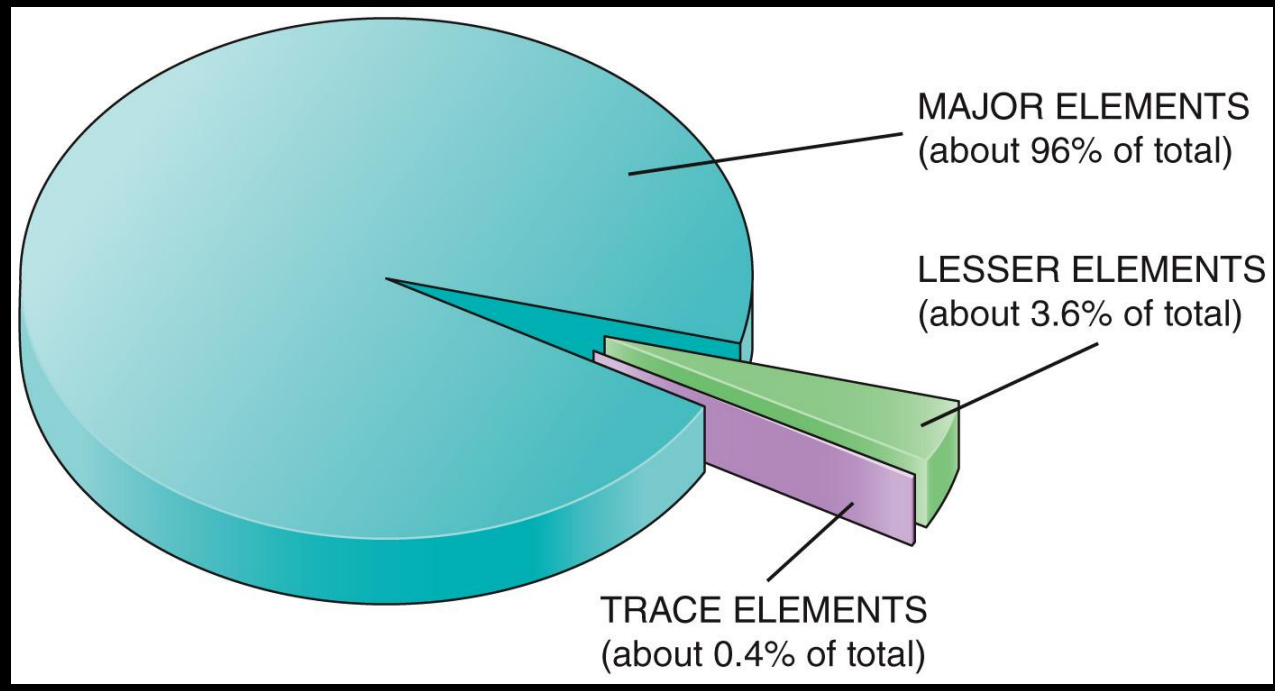
- Cells are made of molecules
- Molecules are made of atoms
- Atoms interact through attraction and bonding
- These interactions build macromolecules
- Macromolecules allow cells to function

Matter & Elements

- **Chemistry:** the science of structure and interactions of matter = anything that has mass and takes up space
- **Matter**: anything that takes up space and has mass
  - Organisms are composed of matter
- **Element**: a substance that cannot be broken down into other substances by chemical reactions
  - Matter is made up of elements
  - Made up of a single type of atom
  - An element's properties depend on the structure of its atoms

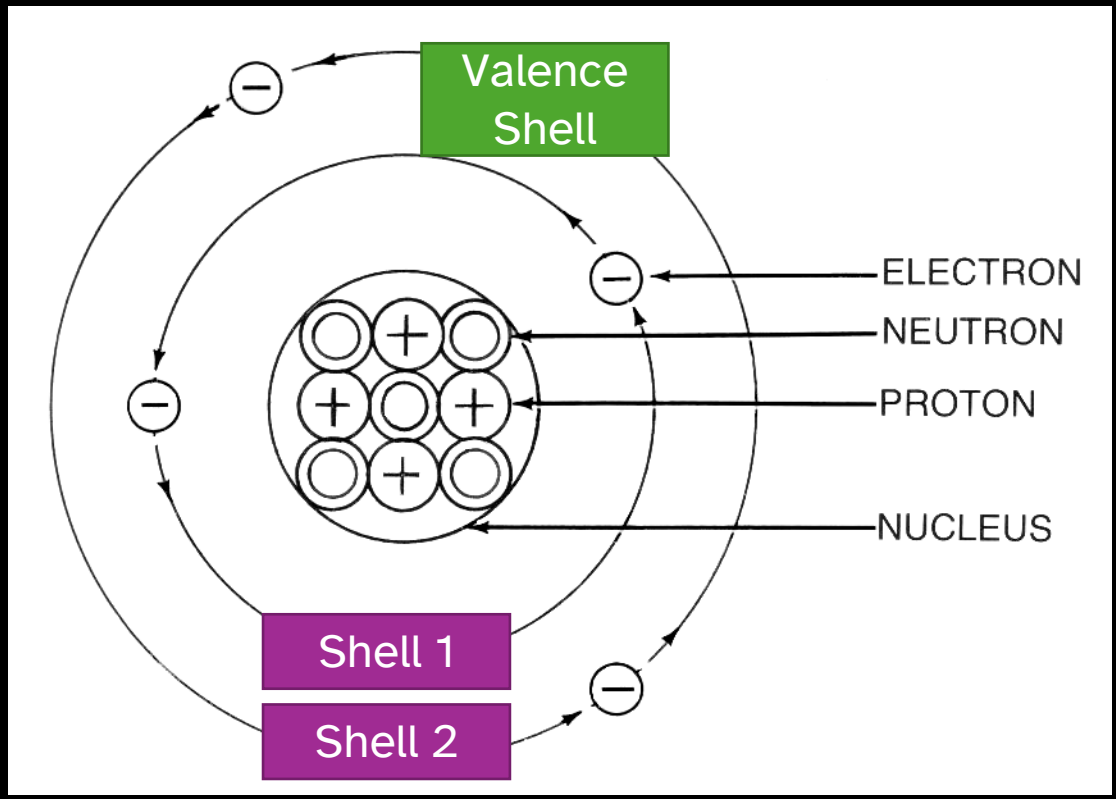
Elements of Humans

- **Major elements**: constitute 96% of the body's mass
  - oxygen (O), carbon (C), hydrogen (H), nitrogen (N)
- **Lesser elements**: constitute about 3.6% of body mass
  - calcium (Ca), phosphorous (P), potassium (K), sulfur (S), sodium (Na), chlorine (Cl), magnesium (Mg), iron (Fe)
- **Trace elements**: present in tiny amounts, but some are very important for bodily function
  - E.g. iodine, selenium, copper



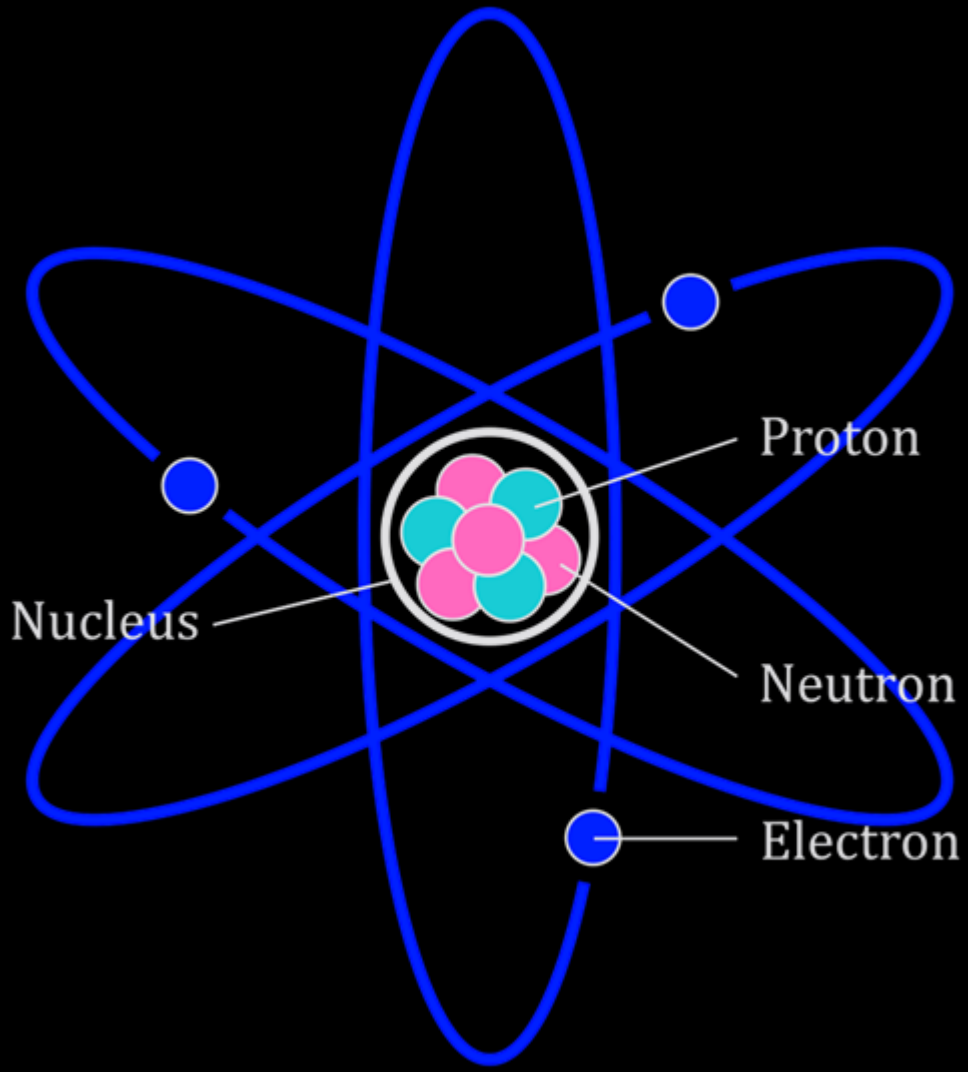
Parts of an Atom

- **Nucleus**: tiny, dense, center of an atom, contains protons (positive) and neutrons (neutral)
- **Electron shell**: a region surrounding atomic nucleus where electrons are found
- **Valence shell**: the outermost electron shell of an atom, containing electrons furthest from nucleus



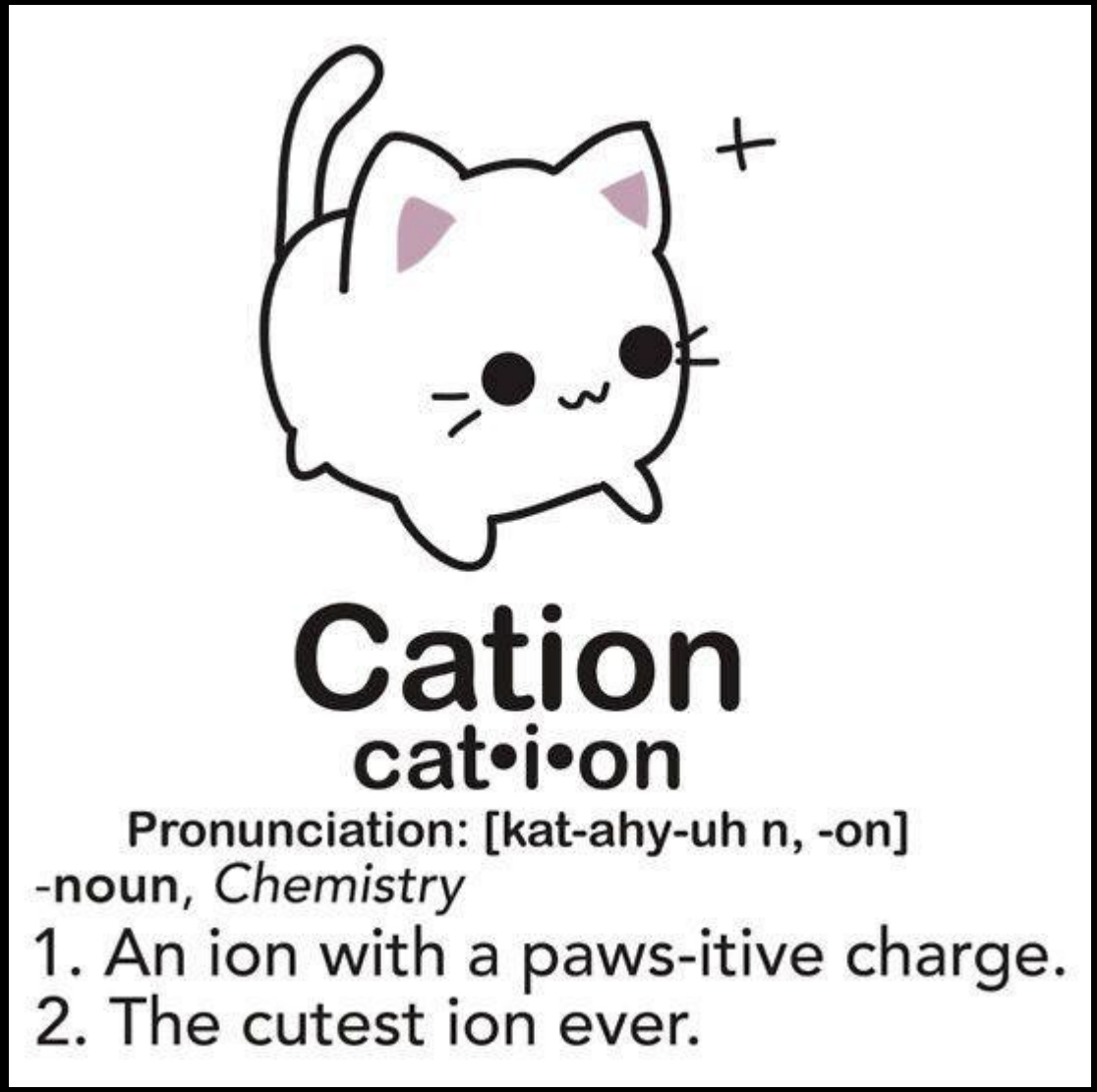
Subatomic Particles

- **Atoms**: the smallest unit of an element that still retains its properties
  - **Protons**: positively charged particles, located in center of atom; defines the element
    - If you change the number of protons, you change the element
  - **Neutrons**: neutrally charged particles, located in center of atom
  - **Electrons**: negatively charged particles, orbit the center of the atom
  - Standard atoms: always have equal numbers of protons, neutrons, and electrons
    - Exception: Hydrogen (H) has 1 P, 0 N, & 1 E



Ions

- Neutral atoms have the same number of protons and electrons
- **Ions:** are charged atoms, formed by changing the number of electrons
  - **Cations**: have fewer electrons than protons and are positively charged
  - **Anions**: more electrons than protons and are negatively charged
  - Ions are fundamental for life for electrical charge, nerve signals, heart function, and many more functions

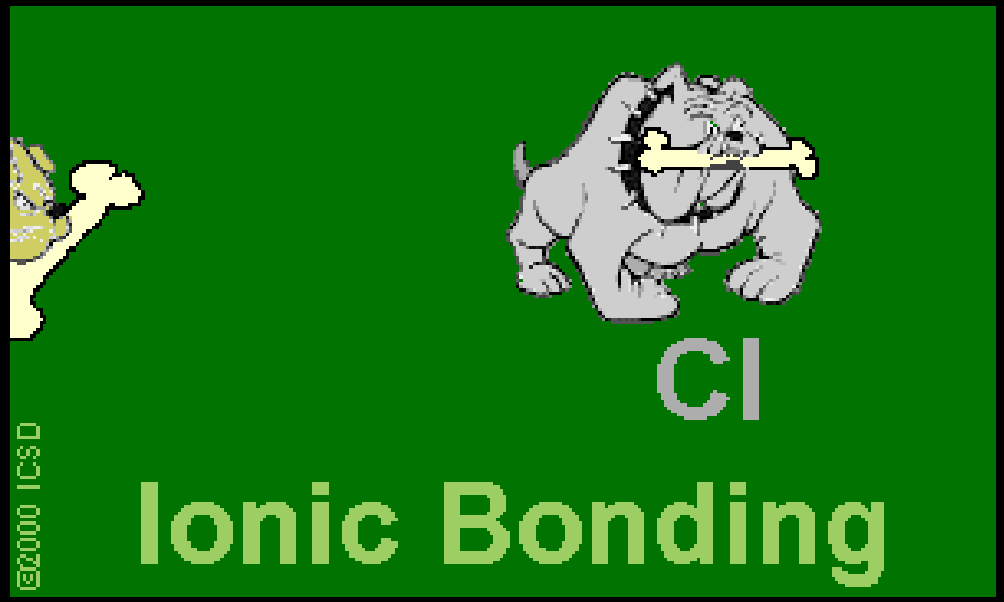


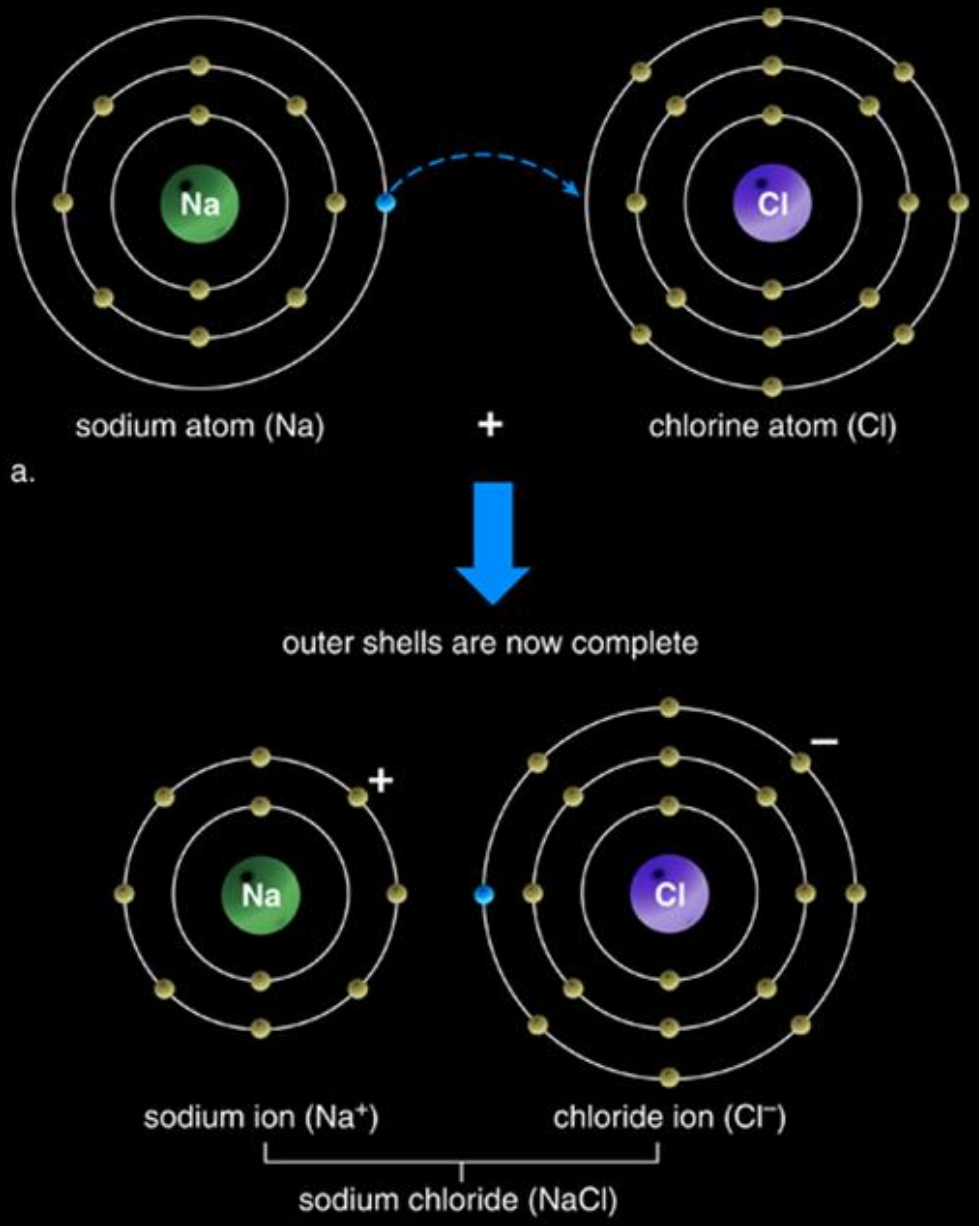
Chemical bonding

- Bonding: elements rearrange electrons between 2+ atoms to “fill” valence shells and provide chemical stability to each atom
- Three types of bonds:
  - Covalent
  - Ionic
  - Hydrogen

Ionic Bonds

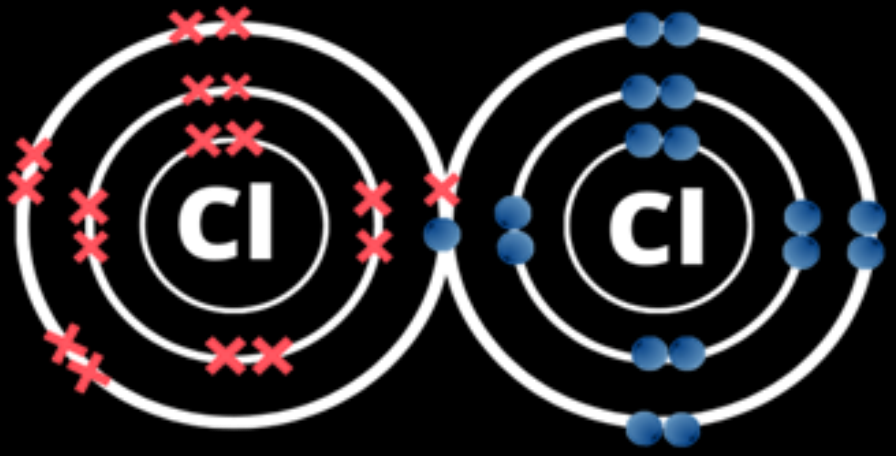
- Ionic bond: an electrical attraction between charged atoms
- Uses a paired redox reactions





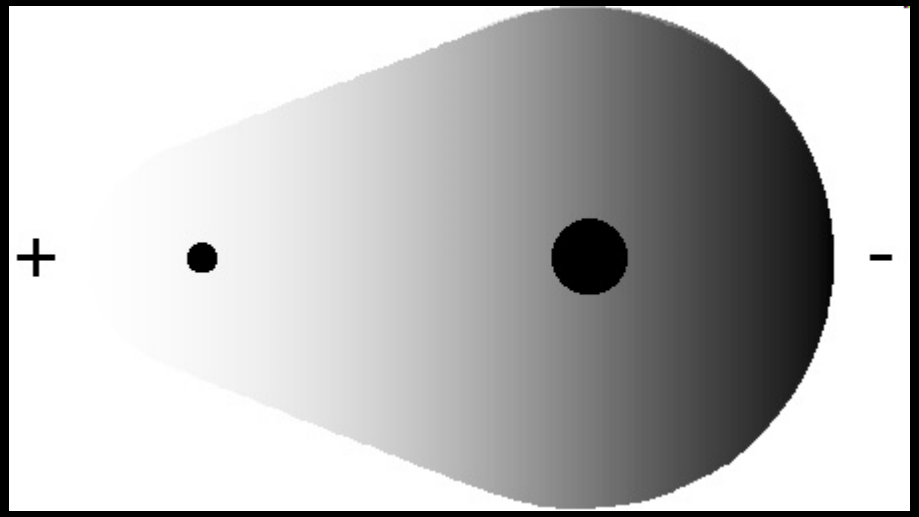
Covalent bond

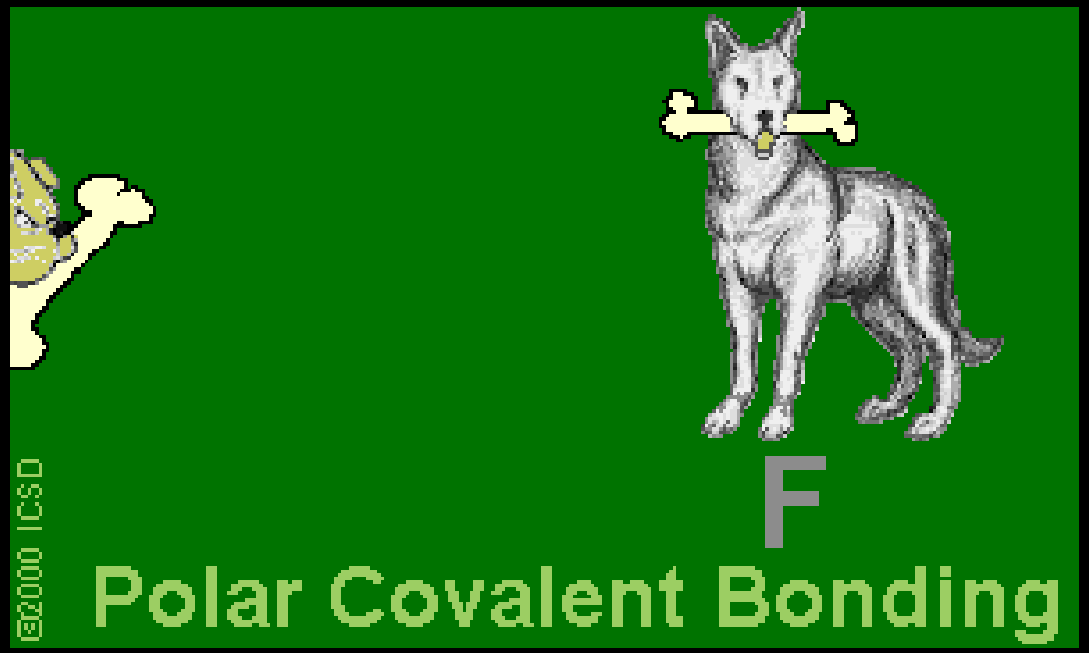
- Covalent bond: two atoms share one or more pairs of electrons
- This is the strongest chemical bond due to the physical overlap of electrons
- Symbolized with a solid line between atoms



Unfair Covalent Bonds

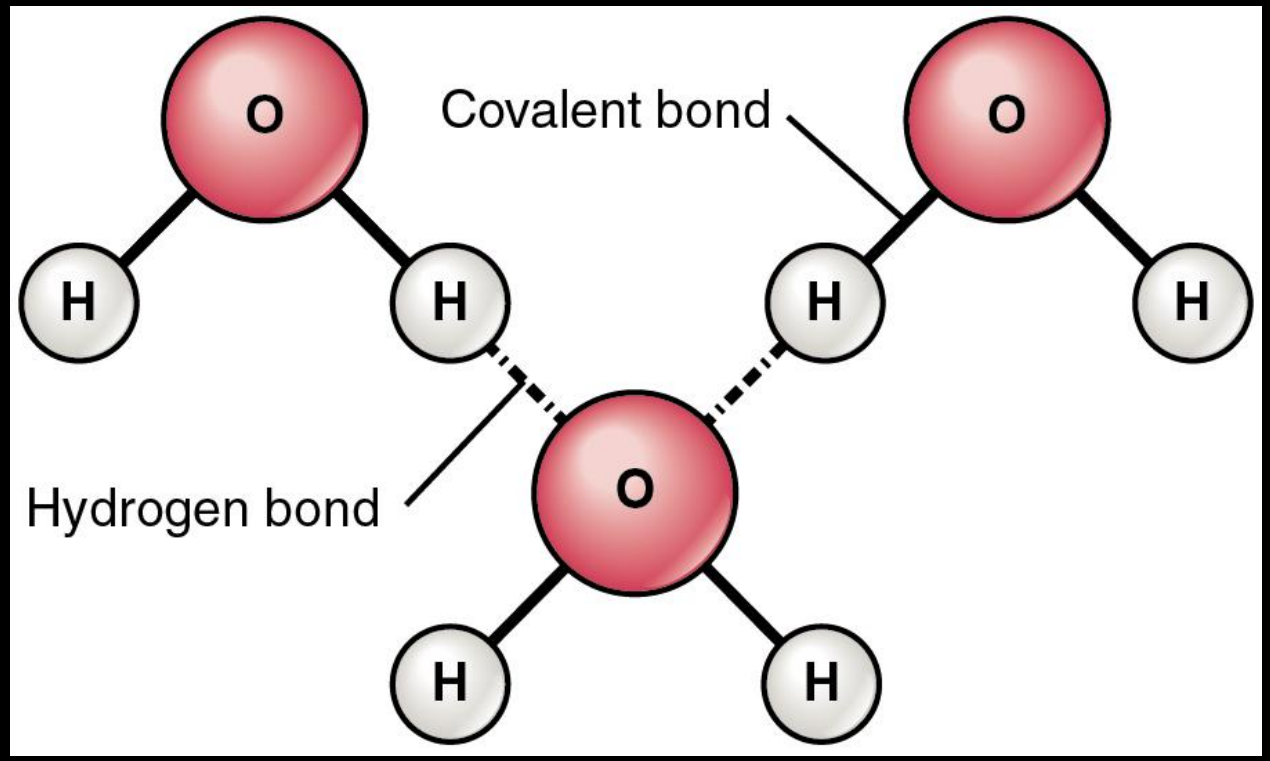
- **Polar**: some covalent bonds do not share electrons equally between atoms





Hydrogen bonds

- In water, oxygen holds the electrons longer than hydrogen, this makes the oxygen slightly negative and the hydrogen slightly positive
- Because of the slight +/-, nearby water molecules adhere to each other like tiny magnets
- **Hydrogen bonds**: the weak attraction between a slightly positive molecule and a slightly negative part of another molecule
  - Drawn as dotted lines between molecules



Building and Breaking Molecules

- Cells constantly build and break molecules
- Two main reactions:
- **Dehydration synthesis**: builds large molecules, releases water
- **Hydrolysis**: breaks molecules, uses water
- These reactions allow growth and repair

Carbohydrates (Energy Molecules)

- Main source of short-term energy
- Made of sugar units
- Stored as glycogen in humans
- Functions:
  - Provide fuel for ATP production
  - Support brain and muscle activity

Lipids (Energy Storage & Barriers)

- Lipids are fats and fat-like molecules that do not mix well with water
- Functions:
  - Long-term energy storage
  - Build cell membranes
  - Produce hormones
- Main Types:
  - Triglycerides
  - Phospholipids
  - Steroids

Proteins (The Cell’s Workforce)

- Proteins perform most cell functions and are built from amino acids
- Shape determines function
- Functions:
  - Enzymes, Transporters, Receptors, Muscle fibers, Antibodies

Protein Shape and Function

- Proteins fold into specific shapes
- Shape depends on chemical interactions
- Shape determines what the protein can do
- Damage to shape = loss of function
- Some things that can damage protein shapes:
  - Fever
  - Toxins
  - pH changes

Nucleic Acids (Cell Instructions)

- Nucleic acids store genetic information
- Two main types:
  - DNA – instructions
  - RNA – messengers
- Functions:
  - Control protein production
  - Guide cell activity

ATP (Link Between Chemistry and Work)

- ATP is a special nucleotide
- Stores usable energy
- Powers cellular processes
- Functions:
  - Muscle contraction
  - Transport
  - Synthesis
  - Signaling

Macromolecules Work Together

- Carbohydrates supply energy
- Lipids store energy and form membranes
- Proteins do the work
- DNA gives instructions
- ATP powers activity

Chemistry → Cells → Physiology

- Cells depend on chemistry
- Water enables reactions
- Macromolecules perform functions
- ATP provides energy
- Balance keeps cells alive

Resources

- Dingess, Paige (2025)
- Grammarly. (2026). Grammarly (Version 14.1268.0) [Software]. https://www.grammarly.com/
- OpenAI. (2026). ChatGPT (GPT-5) [Large language model]. https://chat.openai.com/

Creation and Copyright Information

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